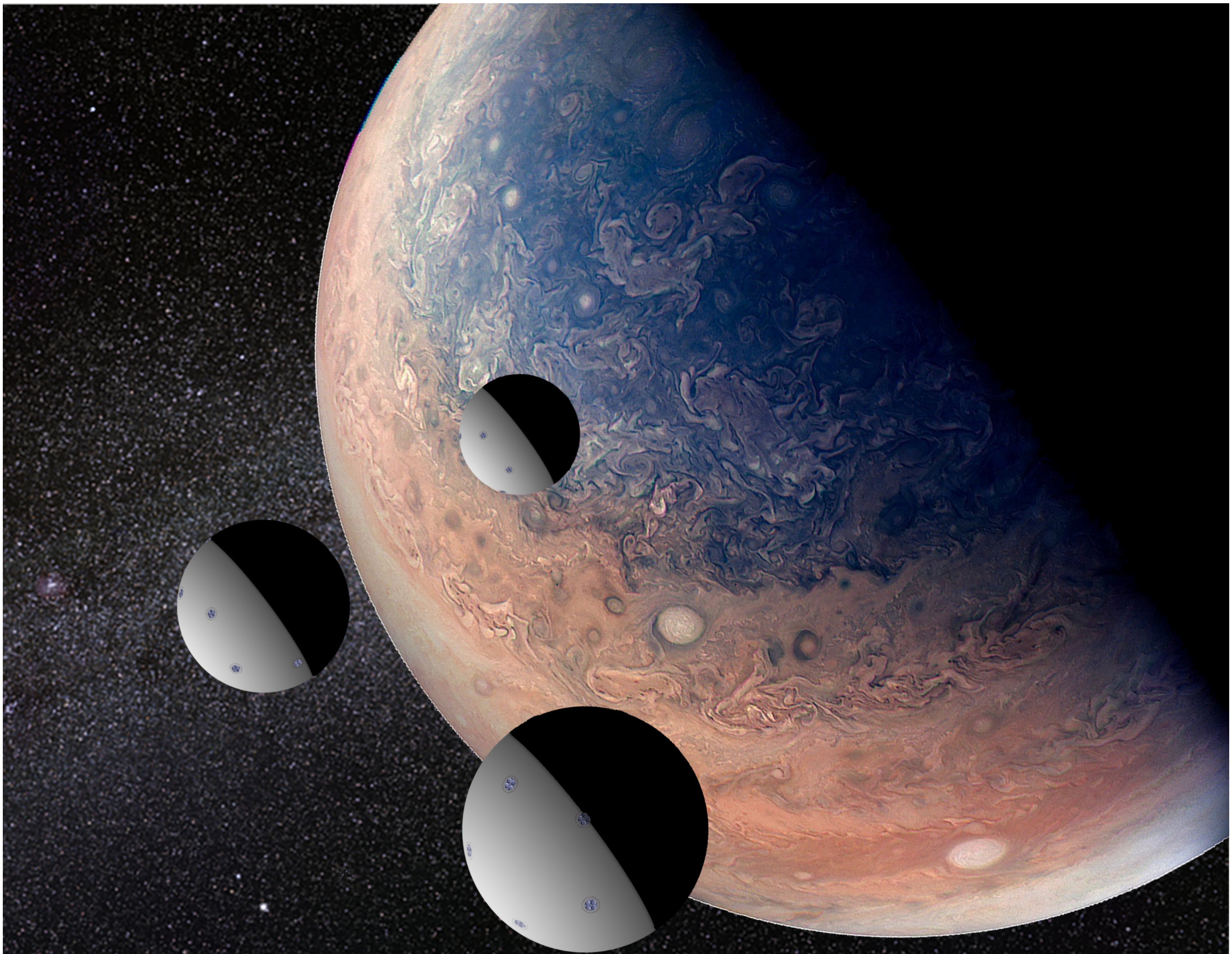

The I of the Storm

A Jopian Journey

James E. Bond

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Preface

As a child growing up in rural southern New Hampshire, I enjoyed climbing trees and exploring the woods behind my house with my brothers. Through this experience, I developed a deep sense of connection with the non-human natural world. I first acquired a special interest in astronomy around the age of 5, after breaking my right arm and being confined to a crib for a few months. My parents gave me a sticker book of astronomy to pass the time, and the pictures of the moon, planets, and other celestial phenomena helped me escape my confinement, and connect with a much larger world beyond the living room window. I recall deciding that I no longer wanted to be the coal deliveryman when I grew up, but would instead become an astronaut.

An interest in philosophy and religion similarly stems from childhood. My family attended a local Congregational Church, where the emphasis in the early years was "Jesus loves me." As a young teenager there, I was deeply influenced by a minister who was quite liberal. In particular, he believed that reason and logic are important to religious understanding, and interpreted scripture more metaphorically than literally.

In high school, I developed a keen interest in formal science, and set my sights on becoming a professional astronomer. I subsequently studied physics and astronomy as an undergraduate at Rensselaer Polytechnic Institute in upstate New York from 1967 through 1971, when I also developed a passion for physics, and came to enjoy reading science fiction. I moved on to graduate work in physics at Yale University, where I received a PhD in 1975. Because of the otherwise bleak job market at the time, I soon changed career path, into medical physics. I have been employed as a physicist in therapeutic radiology since 1980.

During the last several years of my formal education, many members of my family began moving from mainstream Protestantism into fundamentalist Christianity. The resulting schism generated significant internal tension. I soon endeavored to develop a rational philosophy and religion that made sense to me, while pursuing a career in physics.

The original motivation for *The I of the Storm* was in fact to showcase a philosophical/religious system that I developed as a young adult, called ideobasism. After failing to publish a nonfiction academic treatise on the subject, I decided to incorporate ideobasism into a work of fiction, in the guise of an alien belief system. The associated story soon took on a life of its own. I have been working erratically on the manuscript, under a variety of titles, for a good part of my adult life.

According to the dominant religion of the octan civilization in the story that follows, the universe is primarily the self-conscious realization of all possible consistent entities, which wills itself into existence out of sheer logical necessity. Other entities also exist, but are peripheral to this central Being. In the octan view, our own physical universe is a subset of a subset of all consistent mathematical objects within the greater body of consistent realities.

Supportive technical material concerning octan life and civilization is provided in appendices following the main story. I encourage interested readers to review Appendix E, and follow the arguments (as presented by the fictional ancient octan philosopher Fleegello) leading to ideobasism. The relationship between physics and octan philosophy is examined (again, through the eyes of Fleegello) in Appendix F. Non-fictional commentary and references are provided as addenda to the main appendices.

Our universe is likely far stranger, more complex, yet simpler than humans can know. Confined until recently to the thin skin of a rocky planet blessed with plentiful liquid water, human imaginings of what life can be have been largely tethered to carbon-based structures and aqueous chemistries. This is understandable, since scientific inquiry has proven to be the most reliable route to physical understanding. Yet what other structures and processes exist in the depths of the cosmos, as yet inaccessible to human science, that might engender totally alien forms of life and consciousness? This work explores a few of the possibilities.

The I of the Storm

Chapter 0

Dance of Life

Ki Que-Na banked left against the onrush of drenched rising air, as she and the other reys in her tribe spiraled upward through the surging cumulonimbus storm tower, riding aloft a powerful updraft into an uncertain future. The supercooled, saturated wetness was easily shed by Ki's slick hide as she rose through the torrent. Her left wing was still sore from an encounter with a rogue eddy during the previous *passage* – the reys' cyclic journey down and back up through the multilayered clouds – but there was no time to dwell on this. Instead Ki felt the usual rush from the intense concentration required to navigate a water cyclone.

A male rey darted directly in front of Ki, startling her, then began to execute a trick roll. *Pi Lu-Chi??* Ki groaned inwardly. *If Pi thinks this is going to impress me, he must be even more immature than I imagined!* Ki and Pi were about the same age, and had been close playmates as youngsters. A sudden flash of lightning strobed overhead, quickly followed by a reverberating din of thunder, even as the tribe veered collectively to avoid a downdraft and accompanying shaft of killer hail. Pi briefly lost focus, and cartwheeled several times before regaining his orientation. In the same moment, a burst of stray hailstones ricocheted off Ki, as they too were swept by the raging wind toward the upper reaches of the storm.

To a human eye, the scene at this depth in the clouds of the gas-giant planet Jopitar would be black as the darkest night in the deepest cave on Earth, except for the intermittent illumination provided by lightning. But Ki was unconcerned by this. Like terrestrial bats, reys could both see via light (albeit infrared in the case of reys) and navigate (even "see") by echolocation. Ki scanned her surroundings with bursts of ultrasound, trying to locate either of her parents, or her dear friend Trah. Yet it was difficult to distinguish one rey from another in the noisy tumult. She did discern a child struggling nearby to keep up with its mother. However, this was no time for trilling encouragement, or coming to the pup's aid.

Despite the danger, Ki realized that this was her favorite part of the passage. No sooner did she have this thought, than a chaotic wind gust slammed into her, sending Ki into a wild wobble before she could reestablish a suitable trim. It didn't occur to her how strange it was that more reys weren't routinely killed during an ascent. How many creatures on how many worlds could intentionally enter the belly of a thunderstorm, and live to tell of it? But Ki was young, and invincible.

Pi must have been embarrassed by his earlier performance, Ki thought, for now he was nowhere to be seen. Maybe there was hope for him after all. Still, she didn't particularly mind that he was gone. Why couldn't he just …

The overall formation of reys was more ragged than before, but still held together as the tribe soared upward through the tempest. The reys moved nearly as one, connected by echoing ultrasound. Ki lived again in the eternal now, as she dealt with the turbulent currents and abrupt course shifts. A magnificent bolt of lightning arced below her, and Ki peered down through ragged holes in the seething clouds. Forever upward she and the others spiraled, in the rey dance of life.

Eventually the updraft would weaken and the clouds brighten, as the tribe approached the icy top of a thunderhead and light from holy Coel penetrated from the emptiness that lay above. Then the reys would look for an appropriate break to roll out, into open air – and the great falling that lay beyond.

Chapter 1

Suolset

Mother wind, you lift me up
into the expanding dome of night,
to lay my prow on silken moon
and suckle on her milken light.

The reys rested as they glided swiftly down from the high point of the passage, arcing eastward into a sinking wedge of atmosphere bordering the dying storm cluster that had raised them up from the depths. Wave after wave of V-shaped formations swept across the salmon sky, as the winged creatures plunged through the lean and frigid hydrogenous air. Overhead, a mottled cloud cover of lofty ammonia cirrus was weakly illuminated by a partially obscured and distant suol (the local sun), setting rapidly in the west.

Skysong fills my riddled soul
with rhythms of the night and day.
Chesheer crescents loft again
to chase my colic with their sway.

Na Ki-Sha stirred from a brief and restless slumber, abandoning any further effort to sleep. Shivering in the cold dim light, he wistfully watched the darkening hues of swirling infrared, as the tribe sank through a flat cloud layer of ammonium hydrosulfide ice crystals. He could scarcely remember when as a child he had witnessed a clear vision of Coel – the blinding Goddess of Light, the most sacred manifestation of the world-spirit Maddee – with his own eyes. It had been at the apex of a towering passage, the highest he could recall. A trio of slender crescent escorts, hanging motionless in an ultra sky, had attended Her.

An even older memory flickered in Na's mind. He must have been dreaming of a lofty night summit when he was an infant. On that singular occasion Na had beheld Luun, another beloved female aspect of Maddee. Her soft, full face had reached out and touched Na's soul.

Father storm, pray thrust me bold
on firebolt wings through hail and cold,
to reclaim tattered dreams of youth
and taste your glorious solitude.

Na reflected how manifestations of Maddee could also be overtly male, or even gender-other or genderless. The most revered was Indura, a male aspect embodied in a mighty storm. Na caught a final glimpse of the vacuous expanse overhead, through an ephemeral break in the clouds, then spotted the silhouette of an impressive cumulonimbus storm tower far back to the west. The tribal elders had chosen to follow a particularly shallow course, and to mount a much smaller, gentler storm during the preceding passage. This had become all too routine. Innumerable *cycles* (passages) had passed since the tribe had probed deep into the atmosphere and attempted a great storm, which could propel them to the highest cloud tops, and facilitate soaring or riding the currents into a different sector of the regional circulation. The local manna had thinned to anemic levels, and the tribe had grown weak. Few young were being birthed, and those seldom survived a single passage. Lethargy and a sense of futility possessed the tribe. The elders refused to acknowledge that it might even be time to seek out a totally new complex of the mighty *rivers of fire*. Spawned by gigantic convective plumes that mushroomed up from the depths of their world, these systems dominated the currents on which the reys and other Jopian life depended.

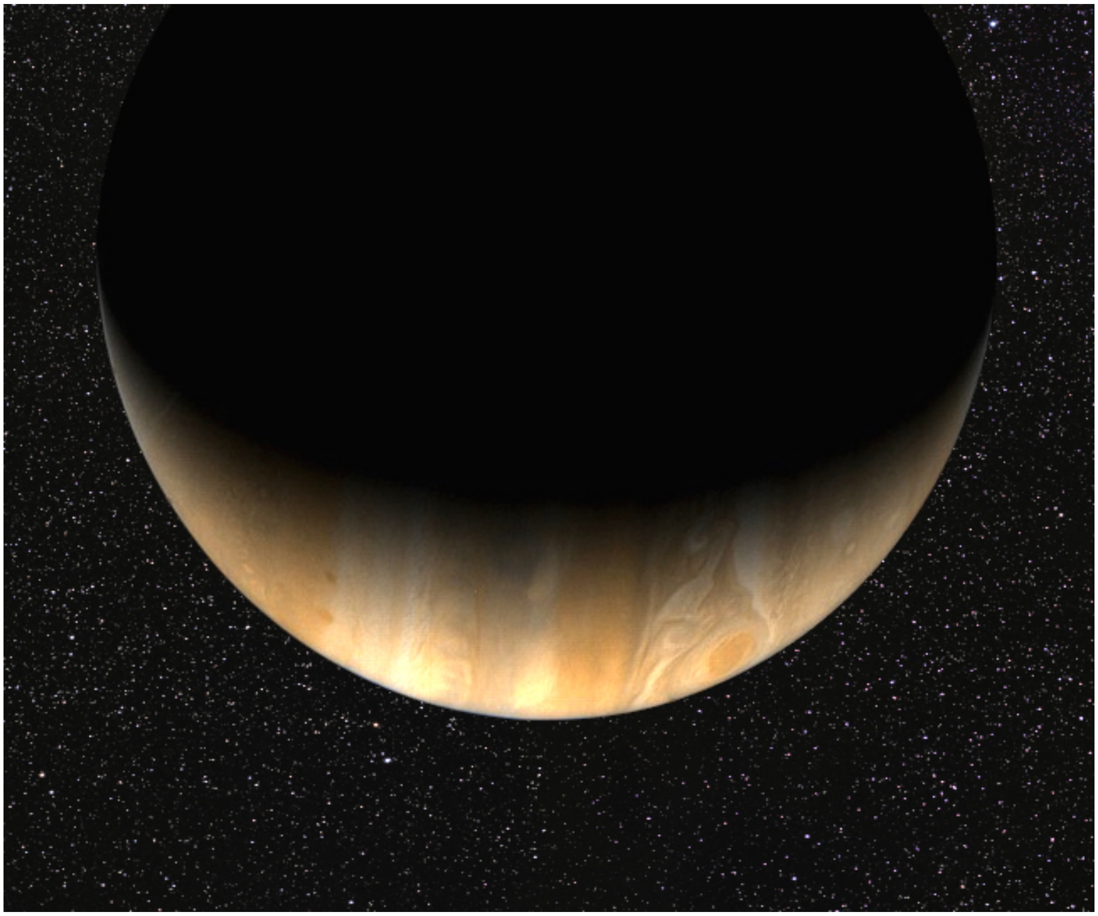
Rare air draws my breath awry –
the restless press of emptiness,
where ought meets naught in a winter sky
of white on black, of black on white.

Why were the elders so timid? Could they not see that their decisions only weakened the tribe further, in a vicious cycle? Trying to forget the cold, Na twisted his gaze toward his lone daughter Ki Que-Na, soaring some distance to the right. So serene, so beautiful he thought paternally. Her soft grey hide nearly shone in the failing light. A proud cerebral hump sloped up from the back of her perfect, flattened conical body, tapered at the rear to form a graceful yet powerful tail. Two great rounded, billowy wings, expertly trimmed and angled even as she slept, extended from either side of her frame. Protected under Ki's wings were the long, furrowed folds of rey female reproductive organs, which Na fantasized would someday renew the tribe, or even spawn a new one. Ki was a survivor, the sole offspring of Na and his one mate, Que. In normal times, to have a single mate and but one child at his age of nearly 1,800 cycles would have been highly unusual. But these were not normal times.

Fleecy clouds fly fast away –
feckless refuge from the night without.
Void gapes open beneath my breast,
plunging into endless doubt.

Chill air blew incessantly across Na's prow. Things cannot continue as they are, he fretted. Could Ki be the one foretold? *She will rise down through the eye of the great storm, to spawn a new tribe.* Storytellers of previous generations had passed down an ancient prophecy of a queen rey who would emerge when the tribe faced extinction. Na knew that his daughter was the One. Or, he wanted to know. How could he know what was unknowable? In spite of a desperate craving to be certain of something, and contrary to the teachings of the elders, Na knew in his heart that he could be absolutely certain of nothing – not even his own uncertainty. His very life screamed this truth.

Black mist insinuates my skin
as shadows threaten from within –
a nameless fear, cloaked in shame
that I be abandoned yet again.



Chapter 2

Dark Passage

The night is empty
Pity the sleepless ego
Lost in round despair

The planet Jopitar is an upside-down world from the perspective of an Earth-dweller. Because it is a gas giant, the planet has no accessible solid surface. The reys consequently more often think of vertical location in terms of *depth* rather than altitude. Their natural reference level is the roof of the troposphere, or active weather layer, marked by the tops of ordinary ammonia ice clouds. Yet the reys do not know any distance scale analogous to "kilometers" or "miles." They instead gauge depth by sensing pressure, and to a lesser extent temperature. Both rose inexorably as the tribe sank ever deeper into the bottomless soup that was its home.

Na thought groggily back to the moments of near freefall after his tribe had tumbled out of the head of their latest storm. Surely it was at least one *coile* (a rey "hour") earlier. Only nine more coiles to go, he thought sarcastically, until they at last reached tepid air, and the other reys awoke. Maddee, how he hated when he couldn't sleep.

The cloud peaks were supposed to mark a new beginning – the first *quad* of a fresh passage; the welcome start of a long, swift glide into a neighboring storm-free region. But there had been precious little time for celebration or any kind of cavorting in the clear, pristine air above the main cloud deck. Na realized now that the past storm must have been weaker than he originally thought, and had failed even to penetrate the upper tropospheric circulation. That hallowed realm lay beyond the range of all complex life forms save the reys, who could ride the strongest storms through the highest ammonia cirrus. How long had it been since the tribe last kissed the roof of their world? The previous tempest was only 60% as tall as the storm towers that could lift them to such magnificent heights; the tribe had fallen short yet again.

The first quad normally commenced with a brief but intense round of mating. How could that happen now, Na brooded? Recent storms offered so little time above the clouds, and his fellow reys were so weak with hunger. They could barely tolerate the cold air anymore. Matings had become less and less frequent since the manna began thinning. Na could only wistfully dream of the last time, so long ago, that he had mated with Que. Ki was the happy result of that joining.

The reys dropped through layer after layer of broken stratus clouds. Na could distinguish the layers by their smell and feel. The frozen hydrosulfide fog soon mixed with mists of stinging water ice. A tinkle of shattering ice periodically broke the monotonous sound of rushing air, as a sleeping rey unconsciously shook loose an accumulating sheath. The icy vapors eventually blended with heavy clouds of ammonia-bearing liquid water.

Time staggered by for a tired and lonely Na. The clouds tasted more bitter than usual. Was he awake or asleep? Logic fell in and out of place. Occasionally he dozed, and dreams of rich manna intermingled with the reality of the hungry night that now engulfed them.

But time did inevitably pass. One day blended with the next, boundaries meaningless in the dark depths. While reys do experience day and night at the cloud tops, they do not know in advance when it will be one or the other. They hence have no concept of a suolar day (referring to *Suol,* the local sun), which is only about eight coiles (ten human hours) long. Reys gauge long stretches of time in a comparatively imprecise manner, in terms of the cyclic passage, which averages roughly 17 local days, and is split into four irregular quads.

By the end of the first quad, Na's tribe had glided a broad reach toward the east, deep into a comparatively calm province. The reys had fallen ten percent that span in the process, more than one third of the way to the bottom of their vertical range. The rate of descent had slackened, to human walking speed (downward) in the much-thickened air. Na stretched and rippled his stiff wings, relishing the growing heat. The temperature now approached the boiling point of water, still cool by rey standards, but balmy enough that the other reys began to waken, one by one. The V-shaped flying formations morphed into a huge cylindrical pattern, within which most of the reys spiraled gracefully downward.

A few youngsters began to playfully dance and flit about within the overall arrangement. Na could hear one of them counting *turnes*, the time for the cylindrical rey formation to complete one rotation. Almost one human minute long, there were nominally 81 turnes in a coile. A young female was trying to count the 81 *fliqs* (rey "seconds") in each turne, but having trouble. She will learn, Na thought. He recalled counting both turnes and fliqs out loud as a child. Na still counted turnes, but silently now, without any conscious effort. He had developed a good sense for the duration of a fliq by adulthood, although he didn't automatically count them.

Though he did not feel rested, Na was relieved that the first quad was coming to an end. He looked forward to the second quad – a period of safety and calm when the reys could socialize, plan for the future, give birth, and educate their young. It typically lasted some 25 coiles. Perhaps social interactions and activities would lift him out of his funk.

Sweet awakening
The sight of friendly faces
Breaks the night's embrace

"Blessed falling," Na hailed his daughter as she awoke, shaking off sleep with a tremulous shudder.

"Why father," Ki responded, "I should have known you would yet play my keeper. Am I forever doomed to awaken to your sweet voice?" Na felt the combined indignation and affection in the undulations of her voice. Ki's cool independence disturbed him at times.

Unlike at the cloud tops, Na now mainly saw his daughter not by infrared light, but high-frequency sound. Reys could emit bursts of ultrasound from a *bellon* – a versatile organ at the center of the rey "face." Echoes were imaged by a pair of large, deep-set acoustic eyes on either side of the bellon, just below and between the (much smaller) infrared eyes. The acoustic eyes also functioned passively, to visualize objects lit by ultrasound from extraneous sources (in particular, other reys). In addition to four primary acoustic colors, reys perceived three primary infrared colors with their optical eyes. A colorful world indeed!

Using a specialized channel of the acoustic visual system, Na flashed to Ki an image of the distant storm tower he had seen at the cloud tops, followed by a series of commentative pictograms. Ki studied the sequence thoughtfully before responding. "That looks like quite a storm. Though I do wish you would try sleeping next time around."

Na and Ki conversed using an exotic combination of ordinary auditory speech and visual speech. The former consisted of modulated low-frequency sound, also produced by the bellon, and detected by a pair of ear-like receptors on opposite sides of the cerebral hump just behind the acoustic eyes. Unlike auditory speech, visual speech required some degree of face-to-face contact. A staccato series of high-frequency sound pulses was beamed from one rey to another, who would "read" the flashing pattern visually. The content could include simple pictograms, more abstract logograms, and shaped images.

Ki caught sight of Pi Lu-Chi and another sleek young male approaching mischievously from below. Mature male reys were easily distinguished from females by their smaller bulk and more streamlined body shape. The robust female frame was more adapted for strength and endurance, to carry young through the trials of the passage. Ki did not let herself appear particularly impressed with either Pi or his companion. Instead she dove to the right to avoid them, flatly calling "Catch me if you can" over her left wing.

Pi and the other rebuffed male soared to a position just beyond Na's right wing tip. "Your fine daughter confounds me, Na! She and the other females lately seem so dissatisfied, so unreceptive to my brothers and me. I fear we will all grow old and stale."

"My dear young Pi," retorted Na, "you have so little patience. Seek out Ki at the cloud tops; there, she may surprise you."

"Ah Na, but that is the problem, isn't it. The passages have been so starved and shallow, there is no energy or time for joy at the summits." Both males fell silent, melancholy once again.

Ki had retracted her wings close to her body, and plunged through the vacated central core of the tribe. Most of its 257 members were awake now, exchanging greetings as they stretched and cast off the vestiges of sleep. As Ki passed the corps of elders, she slowed and reluctantly flashed her wing tips, then dove again. Were they really still due such respect? The tribe suffered so, under their indecisive leadership. Nearing the lower level Ki spotted her friend Trah, and abruptly unfurled her wings, nearly somersaulting in the rush of air. A few cycles older than Ki, Trah carried a yet unnamed male infant under her left wing.

"Trah, you oversleep," admonished Ki.

"Happy falling, Ki," she responded gently, "I was just resting. I've been a bit tired lately."

"And no wonder," Ki replied, "how can you be expected to carry a child when the manna is so poor? We must all watch over you. I fear you are too strong for your own good. How many others have dared to bear young under these half-starved conditions?"

"Do not worry, my dear young sister," calmed Trah, "I am yet capable. And the elders promise that the manna will be replenished soon. Has not the great Mother always provided for Her own?"

Ki was sometimes annoyed by the naiveté of Trah, but admired her stubborn courage and warmth. "Of course," she replied with some sarcasm, "and we will all fly in the holy light of Coel next cycle! We will watch over you nonetheless. Our few young must be protected, or the tribe will diminish even further." Ki recalled how their clan had supposedly numbered an impossible 513 reys when her parents were young.

"And why do you yet tarry?" demanded Trah peevishly, rekindling an old dispute. "Your folds are supple, you could easily add a child to our numbers, even at your tender age. You know that Pi seeks you constantly at the summits, yet you rebuff him. See how he has nourished me …" Trah gently caressed her sleeping child, protected in the folds under her wing, still clinging to the sinewy nipple at the end of its birth canal. It had as yet separated and flown solo for only a few floundering moments during the previous cycle, and then hadn't strayed more than a body length from its mother.

"Why must you dwell on that? I just feel the time isn't right. My having a child now would only weaken the tribe, not strengthen it. Your birthing was courageous, though you know I disagreed with it. But let us not argue. Have you decided on a name for your son?"

Trah's forehump lifted noticeably. "I will let the elders name him, on his independence." She paused. "And … you will be his second guardian?"

"Of course," Ki gushed, "I would be honored." The prestige and the responsibility of guardianship were not trivial. Though the offer was not unexpected, its suddenness surprised Ki. "Though I expect," Ki mused, "that this is your sly way of getting me more interested in children." Trah beamed a *koot* – the rey acoustic equivalent of a smile – back to her friend (rey emotions are expressed primarily through sound). "Since I will now have this responsibility," Ki continued, "I must ask – when do you plan to begin the child's lessons?"

"Probably one cycle before his independence," replied Trah proudly but thoughtfully. "That should be soon enough. I intend to use the traditional method. First simple soaring early in the fellowship period; then timing and signaling; distance and velocity sensing; temperature and pressure gauging; and of course lift and turbulence foretelling, during his first storm. I am sure he will learn quickly." Although the reys had no formal science, eons of evolution in a turbulent sea had produced an instinctive understanding of the currents. Rey brains performed awesome analog computations in turbulent hydrodynamics at a moment's notice, with no conscious effort or awareness. This innate ability was further developed by instruction during childhood, following methods passed down from one generation to the next. A mature rey could predict the appearance of a dangerous eddy far enough in advance to take precautions – at least, ninety nine percent of the time. The unexpected one percent kept life in a storm from becoming boring.

"Good. I prefer a somewhat different order of lessons myself," Ki chirped in reply, "but your way is certainly well tried. Now, I must return and tell father the good news. You need to rest. I doubt anyone would notice if you even missed the community chorus."

Trah's response was unfortunately predictable. "No! Do you think me a cripple? I will participate like everyone else. I enjoy it so."

"I am sorry," soothed Ki, "but at least rest until then. Happy falling!" Ki spread her wings fully and slowly rose upward and away. As she passed the elders, she again flashed her wing tips, and wondered at their low whisperings.

Sum, the chief elder, acknowledged Ki's passing, then turned to his comrade Quo. "You must calm yourself, or the others will hear and be alarmed."

"Of course, you are right. But the fact remains: we have erred, and let the tribe down. The manna has not been replenished, as we promised. Our people feed now on a diet of legend and prophesy – a far cry from what our ancestors knew. We should have—"

"Taken the great passage long ago," Sum interrupted, "as you constantly remind us. Quo, where is your faith? The Great Mother has never abandoned Her people before. Even in the olden times of the great famine, did She not at last rescue us? If we abandon Her now, fail Her latest trial, who could fault Her for turning Her face from us? Who else would lift us from the great void? Are your wings so strong, your will and commitment so deep? In any event, the situation is very different now from what it was cycles ago. The tribe is weak; most would not survive a great passage. Certainly not a great storm, nor any other misbegotten search for a new source of manna."

"Or do you mean that none of us elders would survive?" injected Proda, a huge aging female. Proda had mothered 15 children during her long life.

"Proda, you test us constantly," comforted Sum. "The welfare of the tribe is the sole reason for this body's existence; each elder here knows this. If the tribe does not survive, our individual lives become meaningless." It was not that the individual was considered unimportant or worthless by the reys. Within a tribal family, the individual was highly valued, and competition could be fierce. But the reys were not loners. Without a tribe, an individual rey was nothing, lost on an infinite sea of random darkness.

Sum paused, then continued thoughtfully. "That few or none of the elders would survive a great passage is irrelevant. Together with the central issue of faith, a real problem is that a sufficient number of younger members may not survive to form an effective breeding group. My own inner vision is that they would not."

Ye, the oldest male of the tribe, spoke up. "We must not close our eyes to the Mother! She cries at the summits that She must test Her children so, for our own good. The vision of Sum is strong. Has he not proven this time after time?"

The group of elders was restless. The same discussion had been repeated cycle after cycle, only the inner vision of Sum became more sure, even as the sense of urgency grew. "Sum, yours is not the only vision," blurted Quo. "What is the consensus of the group?" A flurry of curt signals cut the air.

"The same as last cycle," intoned Sum wearily. "As many feel we should stay the course as feel we should move on."

"And so, our direction is set by our own blindness," uttered Proda. "Why does the Mother seek to divide us so? We must all pray to Her more than ever for guidance. And we must of course continue to maintain publicly that the manna will be replenished before long. If the rest of the tribe thought there was any chance it would not, the loss of morale could devastate whatever chance of survival remains." The elders had decided.

At last the elder Proda moved through the ranks, calling the reys to order. The time of the community chorus had arrived. The great cylindrical formation dissolved, as the reys reordered into a flattened ellipsoid more typical of the bottom leg of the passage, through the feed layer. Elders and females carrying young gathered at the center, together with several ailing adults. These were surrounded by immature but free-flying youth, interspersed with mature but childless females. The healthy mature males formed an outer shell completely enclosing the others. Pi assumed the role of first cantor, flying backward at the front of the formation, while a young adult female took the place of second cantor at the rear end. The tribe flew straight, at a slight downward pitch.

Pi began the chorus by reciting an ancient verse that recounted the rey creation story (roughly translated into English as free verse, to maintain the aural quality of the narrative):

In the beginning
all was void, and void was all.
Yet Mallah awoke from timeless sleep
to the sound of Her own Song.
Mallah Is that Mallah Is.
Mallah pulled Her way from formless abyss
by the Music of Her Being.
Mallah said "Let there be light,"
and the light became Mallah.
Mallah said "Let the light become all things,"
and Mallah became all things.
Fires gathered in the midst of the heavens,
and oceans bubbled up from the fiery depths.
The seas begot Her children,
at once one with Mallah,
and yet separate.

Following tradition, Pi now referred to Maddee by the sacred name *Mallah*. This title emphasized the generative female aspect of Being, and its use was restricted to special occasions. The second cantor responded to Pi by chanting a related ancestral verse that portrayed Creation's eternal struggle:

The great serpent twisted from the same nothing.
Yet the serpent would swallow its own tail.
The serpent is that it is not.
The serpent stands before Mallah,
but Mallah heeds it not.
The serpent commands Her to fall,
but She rises on wings eternal,
to Sing Her Song Forever.

A group of 16 young adult males abruptly broke rank and slipped into the darkness. Heartbeats later they reemerged, flying pell-mell now toward the tribe from every direction. Mimicking an attack of ribbon serpents, the rey's only predator, they drowned the tribe in a disorienting cacophony of ultrasound. Pi responded by singing out a clipped note of aural sound back toward the rest of the tribe. Each rey joined in as the pulse passed by, matching its pitch and timbre, until it reached the second cantor. She immediately returned a modified waveform, which was again sung out by the other reys. Pi replied; and so on. Throbbing sound flowed back and forth through the tribe, uniting it, and forming a haunting, ethereal tune, a tense violin string played by the wind. The cantors were free to select and vary notes; they seldom discussed a pattern beforehand, but improvised.

The tribe resonated with song, at one with itself. Again and again the 16 outside males mock-attacked the main group, showering it with a stupefying din. But they were successfully ignored, and finally rejoined their comrades. The music changed from its original simple format, as harmonics and short pulse trains were added. The entire formation began to slowly undulate and gyrate according to signals hidden within the symphony. Words were added, and the music transformed into a sound poem:

We rise to fall, we fall to rise;
the passage ties our ocean skies.
Through time's eternal cyclic call,
we fall to rise, we rise to fall.

The reys sang on through the darkness, filling it with a hopeful light.

When Na awoke a few coiles later from a short but restful nap, the tribe again flew in a great cylindrical formation, straight down into the abyss. Fortunately Na was not afflicted by acrophobia, and the sudden realization of his immediate physical situation did not disturb him as such. Yet slowly the euphoria of the chorus receded as worries over the future returned, and the open sore in his soul festered anew. He tried to fight off the perpetually recurring despair, knowing rationally that it was not helpful. But he did not believe the assurances of the elders. Their authoritative, certain manner especially irked him. Yet he would not challenge them.

Why not? He had special difficulty dealing with conflict, more than what could be ascribed to normal tribal instincts. This was true even with his own equals, not to mention the elders. Whenever he did try to face discord with another rey, Na would feel the lightning wrath of Father storm boil up in his gut, threatening to explode in blind fury and destroy the universe. Sometimes he would actually want to be that destructive fireball, which terrified him even more. A distant memory of a childhood accident, when his right wing had been ripped open, rumbled into his consciousness. What had he been doing? Where had the others been? Such terrible power was locked inside him.

A flurry of activity caught Na's attention far below and to the left, where a young mother was disciplining her son for a minor infraction. Na winced as she slapped and butted the boy several times. The shy youngster finally retreated a safe distance, where he flew quietly and refused to play, fearing he would do something else wrong. That one will be of no use to anyone in an unexpected storm, Na thought sadly to himself.

All of Na's doubts, anger, feelings of impotence erupted through his hide, possessing him. The elders' decisions and actions were so utterly aimless and futile, in the face of probable *extinction*. Could no one else see or feel it? The tribe, his only link to Holy eternity, withered before his eyes. What was the purpose of existence? To cower before fate, hide from life's uncertainties?

Not even Que understood. She was so distant lately. She rebuffed his every advance, and seemed to get most of her emotional support now from one of the other males. Had he been self-centered, ignoring her, even deriding her feelings and beliefs? Had he done this to punish her for her insensitivity to his own needs? For her refusal to accept him as he was? Or was it that he failed to …? Surely, it would be futile to speak with her now. Na tucked his wings, and plummeted to the bottom of the tribe. There he brooded, facing the harsh wind and speaking further to no one.

The remainder of the second quad was dull and uneventful. Melancholy once again infected the tribe, as unrelenting hunger and an even more insidious lack of purpose reasserted themselves.

The elders at last proclaimed the beginning of the third quad, directing the reys to regroup into V-shaped flying patterns, and begin a straight glide westward. The timing and bearing indicated the elder's intent. They had of course again chosen a shallow passage through the customary circulation. The tribe would skim along the top of the feed layer, before riding aloft a weak storm cell in about eighteen coiles. If the manna was still thin, there would be precious little time to feed, although the nadir temperatures and pressures would not be severe, and exposure to ribbon serpents should be minimal.

Trah slipped noticeably weaker as time crawled past, her hungry child ever demanding. Ki and another large female moved closer, flying slightly ahead and on either side of her, trying to provide additional lift. Ki sought to encourage her friend. "Just a little longer, Trah! Soon we will be swimming in delicious broth, I can feel it." The other rey unabashedly added, "Think of your child, if not yourself." But as the tribe at last approached the feed layer, Trah barely managed to hold her wings taut. She and her companions glided in a trance, by naked instinct.

The tribe was quiet, tense, the anticipation almost unbearable. At this depth, 25 times lower in the atmosphere than the bottom of the most abyssal trench in Earth's oceans, the pressure approached 80 times the sea level value on Earth. The sultry air literally glowed, warm even for reys. Male scouts scanned the surroundings with their infrared eyes, though there was yet little to see, apart from other reys and a few random thermal streams. Due to a lack of shadows or other significant contrast, the tribe continued to rely on sound for mutual navigation.

"The fountains! The fountains!" called a suddenly ebullient young rey, as a group of murky, swirling hot springs appeared straight ahead, glowing brightly in infrared light. The springs had spun off a local river of fire, which was still some distance off. Reys generally steered clear of the scorching main bodies of these convective streams, but sought out the tamer associated springs. Both supported prolific colonies of chemosynthetic, photosynthetic and predatory manna microbes, which swarmed in the cooler fluid around their peripheries.

As they approached the springs, the reys stretched open their sieve-like mouths (located near the front end of the rey underside), ready to scoop up and filter out any edible matter in their paths. Infrared eyes served them well now, as the springs were much warmer than the surrounding air.

There! Bubbling up from the depths, a huge spring lifted skyward, beckoning the tribe on. A still-cautious Ki crooned to Trah, "It seems that you fooled us, old girl. You just might live to see Coel after all." Gathering her remaining strength for the coming feast, Trah managed to return a weak koot.

They struck suddenly and without warning. Waiting in semi-conscious stupor near the springs, the pack of ribbon serpents had been awakened only turnes before by the faint rumble of the approaching tribe. Dispersing, and orienting their long, ultra thin bodies along the line of sight of their prey, the serpents had been virtually invisible to the tribe's scouts. Screeching a hideous, blinding cry, they now viciously attacked from all directions.

When the disorienting blast of sound hit her, Trah lost all remaining sense of direction, and dropped like a hailstone through the tribe. Ki fought an overwhelming urge to follow, as the smaller and more maneuverable Pi dove to her friend's aid. Pi reached Trah just as the lead serpent charged. As it approached, the front of the serpent opened and expanded into a huge circular mouth, lined with dozens of backward-slanting saber teeth. Pi aimed at a sensitive spot just behind the serpent's sonic eyes, and rammed it at full speed, striking with his blunt rostrum even as the serpent reached its intended prize. Stunned, possibly even killed, the serpent reeled away, only to be replaced by another.

The second serpent grasped Trah's back firmly, then savagely lashed back and forth, tearing at her flesh, and knocking the infant free. As Pi watched in horror, another serpent swallowed the infant whole, then disappeared into the dark. Trah too was by now beyond hope. Pi reluctantly returned to the perimeter of the tribe, to help ward off serpents from the main group.

The attack ended as abruptly as it had begun. Three other reys – one childless female and two defending males – had been taken in addition to Trah. All the time the tribal unit continued to move toward the main hot spring. The reys softly sang and chanted together, chiefly to maintain their collective orientation against the acoustic assault of the serpents, but also to calm their terror. As the now bloated serpents were left behind to fight over the remains of their catch, the tribe entered the warm currents around the spring. In silence, save for orientation sound pulses, the reys gorged on the soup. But the size of the spring was soon betrayed by the thin broth it offered. The frustrated reys soon moved on in search of more substantial fare. It would be an especially long 85-coile climb up through the storms, the final quad of the passage, to the promise of cloud tops and sleep.

Chapter 3

Eye of the Storm

Na dreamed as he glided down from the peak of the passage. He, Que and Ki flew together, up through the boiling crown of a giant thunderhead. Ki was in the lead, with Que and Na slightly behind on the left and right, respectively. As they broke through the anvil summit, windblown by a powerful gale, the trio was bathed in a wonderful soft light from above. Out of nowhere, two huge male reys descended toward Ki. As they approached, Ki began to spin, extending her wings to greet them, and rising upward. But when Ki met and eclipsed the source of light overhead, the males transformed into two monstrous serpents. Up became down, and both Ki and her assailants plunged now into a swirling, glowing pit. As the serpents overtook her, one swallowed Ki whole, then the other spun and swallowed the first. The surviving serpent then turned to Na. As its huge mouth opened around him, Na stared in terror into a bottomless abyss within.

Na awoke from his nightmare with a start. He was flying (if it could be called that) upside down, encrusted in ice. He violently shook the ice away, then desperately searched above and ahead for the tribe. Locating and reaching them at last, he lapsed again into an exhausted sleep. But the cold wind continued to blow through his slumber, echoing across suollit clouds and hideous serpent attacks. It was all Que's fault. If only she would support him, really care for him. After a seeming eternity, a faint but familiar voice intruded.

"Father … Father," Ki whispered.

Na shook off the last pretense of sleep, to confront the shrunken visage of his daughter.

"Your plan, father?" Ki asked with a small, flat voice. "If we continue as we are, soon we will all be dead. And without a tribe, where will our departed souls find a home?"

"It must be the time," Na responded, feeling an odd prickle of excitement he hadn't experienced in untold passages. "It is time for a birthing. But this birth will not be that of your first child; it will be the birth of a new tribe." He shuddered giddily, refusing to look any further than his obstinate belief in grand legend and destiny.

"Yes, father," Ki returned coldly. "I know. Trah must not …" For the first time in Na's recollection, Ki almost lost her composure. "But Pi has refused to join us, and I don't think mother will come either. Frankly, she thinks you have lost your mind."

Na winced, and grumbled the equivalent of an angry frown. "Her damned security is more important to her than anything else. In any event, she will be safe with her darling Zaag."

"Father, how can you think that mother prefers Zaag to you?"

"Isn't it obvious? She spends most of her time with him now. Zaag has had an eye for her ever since I can remember. And what does she do? Goes along with it! What am I supposed to think?"

"Sometimes I worry that you intentionally drove mother away, in some perverse test of her love for you. And that now you are desperate to drop her, before she has a chance to drop you first. She certainly feels that you don't pay attention to her any more. Whenever you are together, all you do is talk about your grand vision. You belittle her ideas, and ignore her own needs. She says your myths are more important to you than people."

"Because I refuse to stay with her on her terms? She also refuses to go with me on mine! Maybe the person named Na is less important to your mother than some of her other friends. I don't think I even love her any more." Na felt an old rumble building within. Why couldn't he trust anyone completely? Could it be true they would always betray him? He must avoid his own anger, and maintain his composure.

"That's not what I have been hearing from you. Maybe you are just angry with her? And with yourself? Perhaps mother is right. Maybe you are a self-centered fool, or mad even. I don't know who is sane and who isn't any more, what is real and what isn't. I only know that I can't continue like this." Ki paused momentarily. "Even if Pi doesn't join us."

"Ki, the legend must be true. You *must* be the one foretold. Does not our tribe face extinction? Are you not the only daughter of your parents? Is not the legend ridiculed by the others in the tribe? We must believe that Maddee will somehow provide you a mate."

Life had truly become unbearable for Na. He felt utterly betrayed. What was life without seeking Coel? Yet how could so weak and pitiful a tribe ever again hope to seek out a mighty cyclone, to rise to the cloud summits where they might catch a fleeting glimpse of Her beauty? There were tales of strong tribes in distant currents that routinely sailed the larger storms, but these stories were seldom repeated during recent passages. The unattainable was to be forgotten.

If Ki were the one, she must fulfill the mysterious legend – even if it made no practical sense. Powers beyond Na had made the decision; this was to be the cycle. "We will break from the tribe during the coming feed run, and seek a major river of fire."

"The creator and the destroyer; gatekeeper to the storm of storms," intoned Ki softly, as if in a trance. The tribe had frequented the outlying springs of the region's rivers of fire for several hundred cycles, but never approached the forbidding heart of any river too closely. At the feeding level, this central flow appeared to the reys as a *wall of fire* – an impenetrable barrier of scathing heat, rising straight out of the abyss. Though not actually composed of fire – there is almost no free oxygen in Jopitar's atmosphere – the deep rivers carry much the same emotional significance to the reys as fire does to humans. The rivers are best accessed from the greater depths of the feed zone, through the organic soup patrolled by packs of ribbon serpents.

The tribal elders realized that their own river complex had been slowly weakening for some time. Eventually every underlying convective plume would diminish, and break up. Tribes dependent on that circulation must then either attempt a risky exodus to another plume system, or weaken and face possible extinction. What the elders could not know was that a young, vigorous plume encroaching from the north was responsible for their current dilemma. The new system was currently sheering off a northern stream of the local plume. Though reinvigorated, this entire section was being dragged away.

Father and daughter rose silently to the uppermost level of the tribe. They hovered there together in a possessed solitude, steeling their minds for the coming ordeal by chanting verses that addressed an impersonal, genderless aspect of Maddee:

Ready us now for the Other –
who holds open the world on towering storm,
braced by white fire above and below.

The dark face of Maddee –
who girds Its pure soul against falsehood's siren,
heedless to the cries of Its children.

The glowering Giant –
who hurls us into the void's gaping mouth,
while cleansing our hearts with Its merciful rain.

Purify us in the River's heat,
baptize us with the whirlwind's sleet,
that we might hear Your call,
and follow Your way.

The other reys ignored them, caught up in their own troubles.

The reality of Na's and Ki's decision didn't really strike home until midway through the third quad, as the tribe approached the feed layer.

"Father, how old was your own sire when he died?" Ki asked Na with a low voice.

"About 1,900 cycles. He was killed by a freak lightning bolt." Na kooted inquisitively; Ki's question did not disturb him right away. "Why do you ask?"

"Do you miss him?" Ki persisted. But now Na only returned a hesitant, quavering tone to his daughter.

"Father, why do you believe that no one else can ever really love you?"

Na fought a surge of rage, surprised by the insolence of Ki's question. "Don't be foolish!" he stuttered. "I know that you love me! And my mother and father. And the Holy Mother herself!"

"That's not what I mean. Your own parents and children have no choice but to love you. And the Great Mother loves all Her children. I mean anyone who has a real choice."

Na stared hard out into the dark.

"Do you want to do something so wonderful that the others – especially mother, maybe even yourself – will also have no choice but to love you?"

Na nearly exploded. "How can you think that? You know why we must do what we plan; the Spirits themselves demand it!"

"As you say, father," Ki deferred, then backed away and prayed silently to herself. Her mind was in turmoil. Were they doomed to fail? To do an extraordinary thing, you must become that thing. How else could a difficult goal be accomplished, except through a committed will? But if her father's focus was actually on winning love, on proving his worth, how could they succeed? What if Mallah had sought to please the great serpent, rather than Her own inner song?

Maddee, Maddee – why do You forsake us?
Rive our lives, in order to find peace?
Pray round Your children in Your sight,
and lead us back to hallowed light.

Na broke the long and awkward silence with a refound gentle resolve. "It is time to go, my dear one." Dutifully, Ki followed. The two cast a final gaze at their tribal family, then slipped quietly from the ragged formation – down; down; down, and westward.

It was several coiles before an unexpected wave of anxiety and sadness swept over Na. Why was he doing this? What did he hope to gain? He compulsively looked over his left wing, to see – Que?? Time stopped for an instant, but the image dissolved in the swirling heat. Could it really be her? She might have joined them after all! Should he tell Ki? No – what if Ki decided he really was mad? But what if Que had joined them; he knew she would; what was wrong with him? Bewildered and suddenly frightened, Na threw himself back into his purpose. Into the deep currents, rushing after glory; or karma; or his own tail.

The pair sought out an Alpha fountain. These rare oases spouted the most delectable manna, with the highest nutritional value and caloric content, but were normally far too small to serve an entire tribe. They were also found only at the greater depths, closer to the main flow of a major river of fire than was usually deemed safe. They were consequently visited mainly for ritualistic purposes. Na and Ki were not overly concerned with serpents; flying in almost complete silence, two lone reys produced little turbulence, and would be difficult to detect. But the Alphas proved elusive. After many worrisome coiles, Ki at last spotted the characteristic hot column in the distance, and signaled to her father. "An omen!" Na exalted to whoever might be listening. "The Mother blesses our mission." Quickly they closed on their prize, then banked in a majestic arc to the left to circle around its perimeter. But they ate sparingly of the rich broth. Was it out of guilt for their starving brethren? Or fear that they might offend the Mother in Her generosity? They certainly wanted to avoid bloated, excess weight in the coming trial.

Hunger barely assuaged, the twosome left the fountain with some reluctance. Na again probed the gently sinking currents, choosing the strongest, willing his way through the glowing heat. Strangely, the currents somehow did not seem right. Why were they still descending? And why was the dominant flow toward the *north*west, rather than just west? Na shrugged wearily to himself. Several hundred cycles had passed since he was last in these environs; his internal map must be flawed.

Coile by coile the current grew, the pressure multiplied. At last the flow leveled, then began to continuously lift, merging with rumbling currents rising from untold depths. A distant, eerie roar carried across the expanse of rushing. A potent river of fire was near.

The rey duo rose in silence with the gathering tempest, mesmerized by its growing power. They banked left, lest they be sucked into the deadly heat of the main flow. Initially Na maintained the lead, with Ki behind and to his left. Na imagined that Que would have flown across from Ki, on the right, if she were there. The magical trio. Maybe she would yet join them? There was still time. But soon Na tired, mentally as much as physically, and exchanged places with Ki. As she and her father skirted the periphery of the searing wall of fire, Ki noted that they were barely, if at all, arcing toward the right; this river must be much wider than she had expected.

As the coiles passed, the updraft quickened. The immense vertical river swelled and cooled as it rose; at last it had chilled sufficiently that the reys could enter its main body. Ki let the current drag them in. The warmth hit her like a slap. An exhilaration she had never known filled Ki's breast; she embraced the winds with her wings, and held them tight.

More coiles. A peal of distant thunder rolled through Ki and Na, as they at last approached the level of the water storms. Heavy scud clouds of drenching ammonia-saturated water raced by. Ki suddenly felt so strange, being in this special place as two solitary reys. The first drops of liquid water, rapidly evaporating as they fell as virga in tapering sheets from the main cloud deck, massaged their skins. It wasn't long before the base of the water clouds appeared. A wet, boiling mass greeted the two reys, reaching down and sucking them upwards, into itself.

There was no time for fear. All thoughts of purpose left them. Na and Ki rose as one with the storm, and they became the storm. Lightning lit the way. Ki held course for the tempest's violent core, for what reason she no longer knew or cared. Uncertainty and desperation beckoned and compelled her. But the elders taught that a rey who would become the storm must cease to be a rey. For a storm is made of wind, rain and fire, while a rey is made of softer stuff.

A piece detached from the pulse of the maelstrom's heart, and approached. A nightmarish form materialized out of the driving rain and clouds – a sinuous tornado, snaking toward them seemingly from every direction at once. Ki and her father pushed against the gale, and slipped through its grip. But turnes later a second funnel reared up from below. This they also somehow avoided, only to be immediately confronted by a pair of new twisters sweeping across their path. Soon they found themselves swept into a jungle of the serpentine whirlwinds, every one twisting forward and upward in the general direction of the overall torrent.

All the time the distant background roar grew louder and more ominous. Until at last the source appeared, through gaps in the tortured clouds. A seething wall of white sound, whirling inexorably right to left, surged straight out of unknown depths and soared toward heaven. The myriad tornadoes fed tangentially into it, writhing inward and upward like tortured devils from the netherworld, unable to satisfy the giant's insatiable appetite. "The pillar of God!" gasped Na toward Ki, who could not hear. "The very hide of the Father …" To pierce it was to enter the peace and tranquility of the Mother's mind. Or, so legend claimed. To Na it appeared a living hell.

The great vortex loomed before Ki through pelting rain, rising through the fulcrum of this storm of storms. Ki was transfixed by its awesome power, frozen in time. This vortex appeared somehow different from every tornado she had ever encountered before. Composed of raw fury, the storm wall stretched interminably upward and downward, right and left, disappearing into the night. Ki gasped to herself. It must be a thousand wingspans wide! At last she tried to turn away, but now it was too late. The storm had them. Retracting their wings completely, the pair was dragged inexorably upward and into the maelstrom, two mere puppets, powerless before the storm's might.

Ki was swept far ahead of Na, and approached the vortex wall well before her father. Na at last realized that the unthinkable might happen – he could lose his beloved daughter. He struggled insanely not to fall further behind, to lose the sight, the smell of her, but there was nothing he could do. Na watched helplessly as the very Powers he worshipped wrenched Ki away from him. Delirious, he strained to see Ki one last time. There! She is trying to turn away. Maybe there was still hope! She is so resourceful. Then he shrieked as a form – Que?! – scudded past, slamming Ki back. The boiling clouds devoured her.

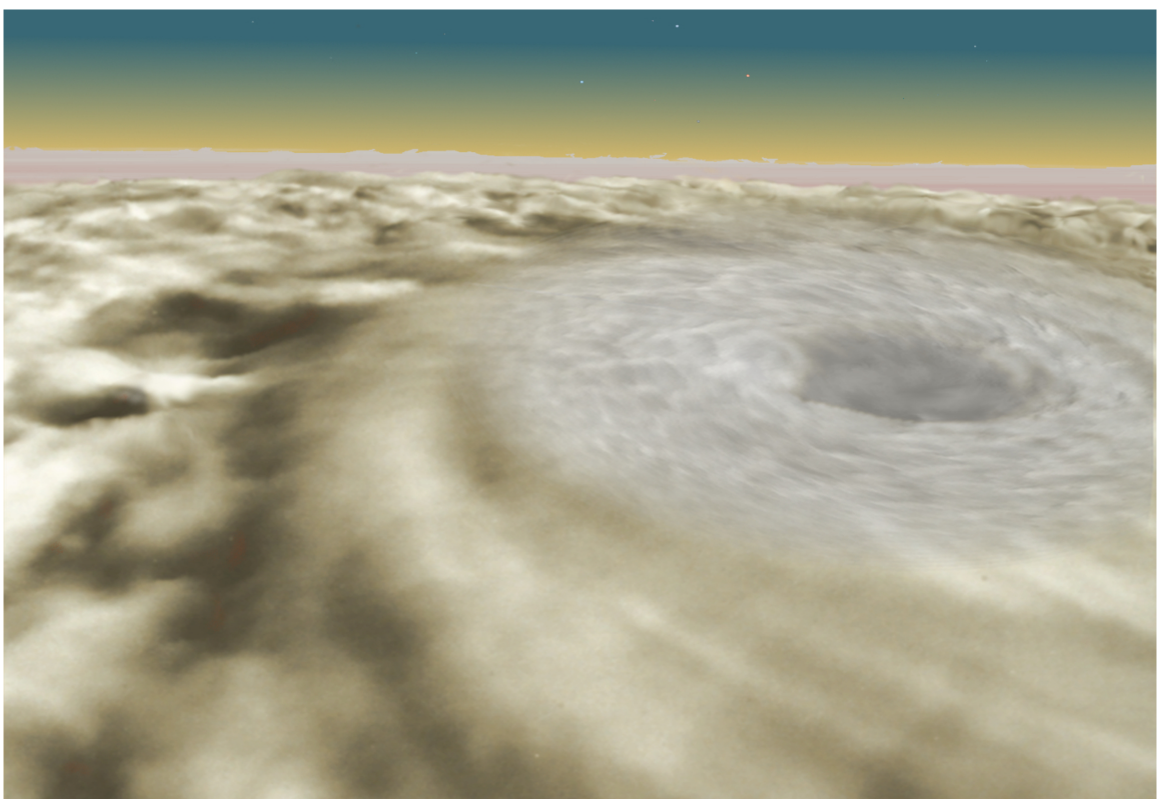
Desperate to follow, Na recklessly thrust out with his right wing. Before its tip felt open air, the turbulent gale seized the wing, whipped it fully open, then tore it from his body. Almost immediately a veering downdraft grabbed Na, throwing him viciously downward and away, even as a massive lightning bolt split the air around him. A strange and acrid smell filled his failing senses. An infant Na watched a torn right wing tumble dreamlike away from his body, into gathering darkness. Why had his mother abandoned him?

Ki continued on in stunned concentration, into the inferno. She knew she was alone. Her father was gone, but there was nothing she could do. As she approached the vortex wall, Ki had begun a last ditch attempt to turn away, but on sudden and irrational impulse changed her mind, and slammed through a transient opening in the twisting hell. Helpless and desperate, she now instinctively curled into a small ball as she hurled through the melee, tossed about like a hailstone. Coiles must have passed.

The winds miraculously vanished, as Ki emerged without warning into an eerie calm. Was she still alive? Struggling to orient herself, Ki screeched sound pulses in all directions. The returning echoes only heightened her terror. To the left, behind, in front – all the same, an undulating wall of impenetrability. But her mind froze when Ki sent pulses down or up and to her right. For nothing – absolutely nothing – returned. An abyss of utter nothingness, of a type with which she had no prior experience, gaped beside her.

Flow, flow, her mind ached. I must face my fear. I must face my fear. From the echo shifts, she knew she was careening toward the churning wall on her left. What to do when she struck it? Her emotions impelled her to try to break through, even if to a certain death – anything but face the void. Yet somewhere in her mind she knew her only hope now lay in uncertainty, the same uncertainty that had brought her here. Ki impulsively banked hard to the right, and – her forward momentum spent – plunged into the shaft of night.

The clouds of the giant planet rolled on, just as they had for two hundred billion cycles, and would no doubt continue for billions more. The currents rose, passed over, and sank, only to rise again. The monster hurricane raged and roared, oblivious to the cries of the transitory creatures caught within it. Its mighty storm wall revolved in relentless reverence around a tranquil central eye, as wide as Jopitar's utmost storm towers are tall, responding to a more ancient song. Lightning pierced the darkness, filling it with an almost holy light.



Chapter 4

Resurrection

Curled into a fetal ball, Ki fell through the floor of her world. Only her most primitive life-support systems functioned now, in a self-induced trance. She was deeper in the pressure cooker of the planet than any rey should ever be, as the narrowing funnel carried her inexorably down and northward, away from familiar circulation patterns. The plummeting flow had somehow veered out of the main convective body; Ki would have otherwise certainly died. Still her body struggled to remove excess heat, and to counter the mounting pressure that would crush her. But the greatest pain of all lay buried in her mind. Alone! She was utterly, desperately alone, abandoned. She had always considered herself independent and self-assured. Yet she had never before been separated from her tribe, from the nurture and validation of her parents and comrades. There were no social crutches to support her here. Panic echoed through the corridors of her comatose soul. How could she survive? How could she even exist?

Only a tiny corner of peace persisted in her subconsciousness. She struggled toward it, to squeeze inside its cool core. Had she not confronted the choice between life and death, when death would have been the easy way? And had she not opted for life? Or did she now fear living alone even more than she feared dying?

The vortex at long last dissolved into the trackless sea, and left Ki spinning aimlessly deep in the southern fringes of a new plume system. Her internal buoyancy sacs filled to capacity, and limply gliding under autonomic control, she slowly rose from the bowels of her world. When a dim consciousness returned, Ki found herself slipping upward beside a fountain bearing the sweetest manna she had ever known. But she could hardly eat. Muscles stiff and unresponsive, her entire body ached from heat shock. Worse, she was emotionally dead, and almost welcomed the physical pain as a distraction. Dazed and confused, Ki rolled a feeble sound beam in all directions. No familiar echoes returned; the nightmare was real. Yet naked instinct eventually overcame despondency, and seized the honey smell of the manna lapping her skin. Her filters cracked, and Ki sipped a small amount. She promptly vomited it all, before blacking out.

Back and forth Ki drifted through the coiles, between semiconscious despair and dreamless stupor. The manna thinned as the fountain lifted. Ki at last forced herself to eat a little and hold it down, against a malignant desire to surrender and die. Her body responded mercifully, and she drifted into a deep and peaceful sleep.

When Ki next awoke, she rose into a gentle storm. And panic rose again within her. She saw herself moving further and further from her tribe, her lifelong anchor, disappearing into the night sky. If only! If only. She cried, not for her lost parents and comrades, but for herself. The past willed to devour her.

A crack of thunder intruded into Ki's delirium, as the immediate external world demanded attention. On instinct she tested her muscles, and found them functional, though impaired from heat damage. Hopefully (dared she hope?) the damage was reversible. As she turned into a spiraling bank that skirted the storm cell, Ki forced herself to recite an ancient poem:

Updraft strong, You sweep me up
to witness yet another dawn.
Pray fill my barren womb with love,
and change my lonely fears to Song.

Soon by warm rain may I be kissed
and by its gentle fury blessed.
Into Your sweet embrace I come;
may I be faithful to Your call.

One quad later, Ki glided east, down from the top of the first passage in her new home. Alone and numb. She fought a nagging instinct to turn south, back toward her old range.

For Ki sensed that the local currents were inexplicably flooding northward. In her depleted state, any attempt to return home against this prevailing flow would likely prove fatal. It was already a miracle that she was still alive. Her present bearing, directly away from the cluster of towering clouds to the west, was the only viable option. Far to the northwest, she thought she spotted the higher fringes of the great storm that had brought her here.

Ki fell off to a fitful sleep in the frigid air, dreaming relentlessly of her imperiled tribe. She had to return to them, but how? Confused thoughts and emotions tumbled through her semiconscious mind. She could not rely on luck to bring her back again. But it was impossible to return. Then how could she ever have children? Her poor unborn children! Beneath it all, she was so lonely.

The strength of the fountain where she had first regained consciousness confounded Ki. Surely such fountains were commonplace here; popping up near one was otherwise too coincidental. Could the great vortex be involved? Might it be the very source of the manna's strength, channeling currents from below? Or did any of this matter at all?!

She must seek out a local tribe. They would have answers she needed, not to mention help allay her loneliness. Other tribes must exist, must have traveled the currents from one river complex to another. Tribal legends told of several encounters with alien tribes in the distant past. Ki's own tribe had split off new bands in bygone times, when the manna was rich and the population grew unwieldy – an almost incomprehensible concept. There was an even older legend of a great passage from a distant realm across wild storms.

How could she locate another tribe? Ki's parents once told of hearing in their youth the eerie low tones of what could easily have been an approaching tribe. They had of course steered clear. There was no need for competition, faced with a limited food supply.

Ki's parents. Gone. Ki awoke from her dreamlike musings with a start, and an internal emptiness. The void was no longer outside, but filled her, gnawing through her gut. It was still so dark! A tribe was normally awash in a warm, collective acoustic light by this time. Her body convulsed, heaved in sorrow. She began to repeatedly thrust her small rostrum against a vision of the serpent that had devoured Trah, mercilessly beating the specter into a cloud of rancid debris. Her mind ached. She would dive into the depths forever when she reached the fountains again. She must.

Though she listened intently, desperately, through the descent phase of the passage, Ki heard nothing. Famished and exhausted, she dropped into the feed layer. Ki was stunned by what she encountered. Fountain after fountain laden with warm, rich manna rose to greet her. Flying as quietly as possible to avoid detection by imagined legions of serpents, she approached a particularly inviting spring. Ki supped her fill, and was almost happy for a moment, before an inevitable onslaught of guilt. Her poor, lost tribe. Utterly deprived, on the edge of starvation, when such bounty existed only a passage away. But such a passage.

Shaking off a fatalistic mood shift, Ki moved on. She would not have been surprised if a succession of healthy tribes had materialized in this Eden. But Ki saw and heard no one. She rose again into a storm, alone.

Ki awoke early in the next passage from a vivid dream. She had never left her tribe; everything was back to normal. The manna had recovered, and Trah was joyfully preparing to name her son at the end of the coming community chorus. Ki's parents were together again; in fact, Ki was going to have a baby sister.

Ki fought to hold onto the unraveling threads of the dream. Perhaps she could pretend that the dream *was* true; that she had merely taken a short excursion from the tribe, to test her inner strength. This ploy did not work for long. Her bottled emotions tipped, and began to roll uncontrollably – from suicidal despair to numb paralysis to quiet to hope to excitement to guilt, and back. Were even her feelings her own? What horror had she committed to deserve this? Had Indura killed her father, in order to have her all to Himself?

The dream reminded Ki again of her own barrenness. A typical rey pregnancy lasted about 12 cycles, or one *gyre.* Ki vowed then to continue her search for a local tribe for at least 22 passages more. If still unsuccessful at that juncture – a double gyre of 24 cycles, the typical span between a child's conception and independence – she would attempt to return home on her own, surrendering to the unknowable will of the Goddess.

As Ki approached the feed zone later in the passage, she detected an unusual aroma, one that she had been taught as a child to avoid. Some fountains bore tainted manna, which would numb the senses and dull or otherwise alter the emotions. While not normally toxic, the contamination could cause a dangerous loss of reflex and response time. Worse, although the change in mood and perception induced by the broth was usually pleasant, it was somewhat unpredictable. Normally Ki had only contempt for reys who intentionally fed on such drug, and treated it like a scourge. But now she was desperate for a reprieve from the onslaught of emotions that had buffeted her for a seeming eternity. Rather than turning from the currents that bore the strange odors, Ki followed them, down through the murky sea. Only when the flow thickened to the head of a great fountain did she swerve away, to feed tentatively along the borders. Slowly, she felt smooth fingers of calm spread across her mind, and she kooted inwardly. My Mother and Father have been kind to me, to carry me to this oasis, she thought. How could I be bitter toward Them?

Drifting into a dreamlike vision, Ki beheld the great vortex as the Father God of all things, joining the poles of heaven above and below. Down the swirling core poured the pure cool light of Coel, the Mother Goddess of the world, drawing spouting fountains of steaming manna from the depths of Her womb. Around the vortex and fountains circled a legion of reys and other living things, as if without number, rejoicing in the Love that gave them birth. The luminous face of Maddee brightened overhead, drawing Ki into Itself, until all else paled to insignificance. Maddee, the center of all things. Ki became one with her world, a blissful union with whatever was. The vision was slow to fade.

Passage followed passage. Deprived of the usual wash of tribal sensory stimulation, Ki's mind began to play tricks on her. It first happened during a second quad, normally a period of intense social interaction. A murmur from a transient eddy suddenly morphed into a phantom image of a swooping rey. Ki instinctively ducked, only to quickly realize she was still alone. A short time later, a gust of wind momentarily became a ravenous serpent. This was something new! Ki countered by forcing herself to pay extra attention to what little there was to see. Without the incessant babble of other reys, she began to really listen to the world around her. The new discipline proved to be a welcome distraction from the angst of her isolation. She soon observed subtle patterns she had not noticed before.

Each time Ki awoke, she was almost surprised to find that she still existed. But the fact slowly proved itself – she survived. Her core of peace grew, albeit ever so slowly. She still experienced waves of undirected anger, profound rage, and hopeless anguish, but these invariably passed. The ordeal was becoming a pilgrimage to the center of being – both of herself and of her universe. Ki no longer craved death. But neither did she yet quite want to live. She found herself in a kind of purgatory, neither here nor there.

One cycle, as she spiraled down through the ocean atmosphere, Ki stared into the undulating darkness, and whispered: "Maddee, why did you bring me here? What should I do?" She listened patiently for a response, craving a rey-like voice. Some hundred turnes passed before she felt a reply, with her inner rather than her outer eyes: *To fall; fall.*

What sustained Ki most from that time forward were the constancy and strength of the wind and currents. They buoyed and nourished her, both literally and figuratively. Ki was learning to lose herself in the embrace of Maddee. She found herself talking more and more to the clouds, the gale, the rain. Although they would not respond in any rey-like manner, Ki came to appreciate that they had a persona and language all their own. Perhaps she was merely going mad, but Ki did not think so. Steady and reliable, the surrounding physical world was becoming her very real and personal parent-companion, not merely the face of the abstract deity she had formerly known. The storm fed her, protected her, taught her, graced her, even while it promised to destroy her if she failed to follow its ways. Ki came to accept this as inevitable and right; how could the world's children exist at all, without such consistency? She would do what she could within the scheme of things. Beyond that, what was meant to be, would be.

A more subtle change had also come over Ki. For all her apparent independence, Ki had before been ultimately submissive to the will of her parents and elders. But now it was the wind that she held closest to her heart.

By the 23rd passage – in human terms, more than 22 weeks after her fateful encounter with the great storm – Ki had discerned a pattern to the manna-bearing fountains in the feed layer, and returned to a particularly active region. There she tarried, quietly grazing and avoiding serpents, struggling to remain awake while awaiting the alien tribe she both prayed and feared would eventually pass. She spoke silently to the animated currents. After an extra quad of dreamy musing, her patience bore fruit. A low monotone, rumbly but distinctly rey-like, carried from a far corner of the sky. Ki snapped to attention and rushed in that direction, desperately studying the sound. How distant was its source? She had no idea, but pressed faster.

Ki held a slowly veering course toward the apparition for the next several coiles, seemingly falling in place behind it. The intensity of the sound barely changed; catching up was painfully slow. Her prey was swift. Deeper and deeper Ki slipped into the feed layer. How far down did this tribe go? Or was she following a mirage? A practical joke by Maddee? Did Indura at last want to claim her as His mate? Then the sound suddenly grew louder. They must be feeding! Ki gulped a few pockets of manna herself in a mad rush toward the phantom presence. Another coile passed.

Up! They lift into the sky! Nearly hysterical that she might lose her quarry, Ki searched the currents for the storm cell they would most likely take, and followed into a strong updraft. The rumblings merged with incessant thunder, but still she held the faint signature in her senses through the ascent quad. Ki was at last spewed out the side of one of the highest thunderheads she had ever known, into a thin, pitch-black heaven. Looking down, she thought she glimpsed a warm, fleeting V-shape against a cloud layer far below, even as it disappeared into the frigid mist. She programmed a deeper course, hoping to intercept near the end of a typical slumber period, and then tried to sleep herself.

Ki awoke to the sound of the wind, and an utter silence in the part of her mind that listened for the others. Had she been dreaming after all? Perhaps she had at last gone insane.

Calm. I do all that I can, she whispered. The others, if they exist, are still sleeping, their muted call too weak to hear at this distance. I will continue as I planned, as they would do. She fought to hold back a constricting circle of despair.

It was coiles before the monotone returned, ahead and below. Reinvigorated, Ki angled, pitched and dove, absorbed and determined once more, willing herself to overtake the invisible objective. She tumbled more than once, even as she beseeched herself to concentrate.

Time passed so quickly that Ki was startled to find herself entering the feed layer. Abruptly conscious of a gnawing hunger, she scanned the area for an appetizing stream. A distant glint appeared – a blurred speckle in her sound vision; then a distinct image, and another. They were real! Weaving between the fountains coursed a billowing array of beautiful wings. Her own wings, taut with excitement, rippled in response.

The alien tribe was absorbed in its own concerns. A serpent pack had initiated an attack only turnes earlier. The adult male reys swarmed around the main group, fighting off their assailants. These reys were small by Ki's standards, only 80% familiar size, but very quick. Acting on impulse, Ki hurled herself high into the sky, then plunged straight down into the midst of the foray. The lead male rey nearly flipped when Ki materialized beside him, killing an equally surprised serpent with a single sharp blow. Ki screamed a cry of exaltation as the sinuous carcass tumbled into the gulf below. Almost as quickly, a wave of nausea washed over her. Ki had never killed before. It had all happened so fast. The male defenders moved aside, allowing Ki to gratefully limp past into the protection of the tribe.

Ki was immediately nearly run over by a bevy of adult females and children. The nearest gaped in consternation as they whipped past. Remarkably, Ki failed to detect any hint of audible speech. Why can't I hear them? Ki gasped, frantic to understand. She had no trouble hearing their low frequency, long-distance calls. And she could both see the other reys with her eyes, and autonomically sense the locations of those ahead of her. But without ordinary hearing, a swarming tribe was a most dangerous place to be. Soon a new group approached rapidly from the left, and Ki struggled to get out of the way. The lead female seemed to be shrieking an alarm in Ki's direction, but Ki was deaf and blind to any word sounds as the reys passed only a wingspan away. Now Ki realized that she wasn't detecting any visual speech, either, and could only barely hear the strum of rey emotional cues. She fought a sudden urge to bolt back into the relative security of the outside. How could she be experiencing these feelings? If she offended her hosts, how could she ever hope to return to her own people? Everything was happening too fast. Why couldn't things slow down?

Ki's attention was quickly drawn to yet another cluster of reys bearing down from the same direction as before. This time she surged forward with them, attempting to join the group. Relying solely on her own vision and acoustic senses for guidance, she fell into an uneasy cadence with the others. As she glanced nervously around, Ki realized something was very odd. The children! Almost without exception, each mature female was carrying or otherwise attending to one or two agitated young. The number of children was a shock to Ki. Even this small group held more than she had seen in her entire lifetime.

The other adults were equally shocked by Ki's appearance, and skittered respectful distances away. They dared not speak aloud, but stared at her in bewildered disbelief, and wonderment. Where had this strange yet kindred being come from? Was she a vision from the Beyond? Not a sound came from her odd bellon. Was she mute? Any anger at her dangerous silence gave way to confusion and apprehension. So large, so overwhelming, yet she made no threatening gestures, even appeared frightened herself? As the others swam on in indecision, Yu, one of the older male children, suddenly darted away, and hurried toward the assembly of elders at the tribe's core.

Yu swam with an excited frenzy that he had never known before in his short and lonely life. He had heard stories of other tribes, but never of an actual visitation. Yu expertly avoided the seemingly endless streams of reys as he made way. His reception by the elders was not quite what he had envisioned.

"WHAT are you doing, child?! HOW could you break rank in the middle of a serpent raid!? Come here at ONCE!" shouted Gyss, the female elder who spotted Yu first. "WHERE is your mother? HOW could she let you do such a thing? Have you learned NOTHING in your lessons?" Yu froze, averting his vision downward, as Gyss sidled next to him.

"Gyss, the youth is the orphan Yu Ko-Mi," offered Luug, a younger male elder. "His sire and dam were killed defending the tribe several cycles ago."

"Yuk? Well that explains part of it," Gysss shot back. "A bit slow, isn't he? Can't speak clearly? A wonder we let his kind live at all. A drain on the entire tribe."

"But Gyss, his parents were courageous," Luug replied cautiously.

"Probably trying to make up for their defective offspring. I heard they committed suicide, out of shame. Is it not said, 'Cleanse yourself before the coming of Coel; for your blemishes will burn in Her gaze'? BOY, WHAT do you have to say for yourself?"

Yu moaned secretly. He hated whenever one of the elders quoted the Holy word, with their own "correct" interpretation. He stuttered, "Ma- ma- madam …"

"SPEAK UP, boy! I can barely hear you." Gyss made no attempt to hide her contempt. "Don't mumble so! WHY should you not be punished?"

Yu tried again. "Ma- madam … Please, you must come … A strange visitor has—"

Gyss slapped the boy's cerebral hump with her wing tip. "And WHAT do you think would happen if ALL children were allowed to run wild? You MUST be taught your—"

"Gyss, let the lad finish," Luug interceded.

Yu's bellon trembled. "Sir … Madam … A visitor has dropped from the sky!" Once he started, the words poured out in a hoarse torrent. "She is huge! The others think she is mute, but she whispered strange images to me. Could she be sent by *Maddee*??"

"What foolish garble is this?!" Gyss replied scornfully. "Are you so stupid that you think these lies will save you? Don't you realize how much trouble you're in already?"

Luug looked puzzled. "Gyss, a cryptic message was in fact received from the outer shell a short time ago, about a 'holy vision' of the Great One. We attributed it to … over-stimulation." A fog of uncertainty briefly blurred Gyss' vision, but it quickly dissipated.

Turnes later, the serpents broke off their attack. They seemed to be tearing something apart, though it was impossible to tell if it was the remains of a rey or another serpent. Gyss and several other elders hurried toward Yu's clutch, led by the youngster at breakneck speed. When they arrived, they found a mob of bewildered reys churning a safe distance around a strange giant, gliding enigmatically at their center. The crowd immediately parted to let the elders through, many casting a disparaging buzz at Yu as he passed. Soon Gyss confronted Ki, not knowing whether to treat her as a divine messenger or an evil monster.

Gyss addressed the stranger stiffly. "Welcome … Holy One." There was no response from Ki. Gyss glanced nervously at the other elders. She didn't want them to know how terrified she actually felt. Perhaps the intruder didn't know their language? Gyss flashed an image of a rising suol in her direction. Ki didn't even flinch.

Ki was utterly frustrated. She hadn't foreseen anything like this. The diminutive female before her postured as if speaking, but Ki saw and heard nothing. Exasperated, she sprayed an image of a violent storm toward the entire group.

Yu jumped at Ki's low whisper. Spinning around, he was surprised to see no one else react. A few of the elders accompanying Gyss were now making their own ineffective attempts at communication. Yu knew he should keep quiet, but blurted the words out. "Can't you see? She speaks of the Father storm!"

Gyss exploded. "SHUT UP! How can YOU see or hear what the elders cannot? We've had enough of your impudence."

"Wait – I can prove it!" Summoning his courage, Yu gyred toward Ki, flying backwards, and began babbling with both auditory and visual speech whatever came into his mind.

Ki whirled at the garbled falsetto, to see an unassuming rey back in the soaring crowd. She couldn't understand a word he said, but caught a few images, and burst through the line of elders to settle face to face with her blessed contact.

A hush fell over the group as the other reys realized Yu spoke truth. Gyss glared at Yu in disbelief. Who was this outsider, to favor the likes of *him*? Thoroughly shaken, she retreated from the scene, rather than confront what she refused to believe.

Yu felt both intoxicated and confused, and he too fell silent. Gazing into the strange female's immense face, he sensed the throbbing strains of similar emotions. And more – gratitude? relief? hope? Entranced, he offered anew the tribe's symbol of welcome and friendship – an image of a rising suol. The giant visitor blinked, then returned the greeting with rumbling maroon overtones.

What followed seemed more dream than reality. Oblivious to the cloud of curious reys that swarmed around them, Ki and Yu doggedly struggled at communication. Falling back to the most primitive language and nonverbal imagery, they nearly forgot their need to eat, and gulped manna only sporadically. Not knowing what else to do, the elders dispatched a squad of guards to watch over the pair. One by one the other reys, bewildered by the bizarre pantomime, returned to their normal activities. Only when the tribe swept into a turbulent storm band was the intense exchange interrupted. Ki hung close to Yu during the rough ascent, relying on him to relay any directives from the tribal leaders. As they finally drifted down from the cloud tops, Ki allowed herself some sleep, secure in the rhythmic echoes of her autonomic location system telling her that Yu was nearby.

Ki and Yu resumed their broken dialogue as soon as they awoke. They had become instant companions, to the extent this was possible. Most of the other reys began treating Ki as either an untouchable Goddess, or a treacherous demon to be shunned. The elders were equally divided. Unable to reach a consensus, they maintained her "honor" guard, but otherwise strictly left Ki alone. This ambivalence allowed Ki and Yu the opportunity to weave the rudiments of a shared symbolic speech. The pair identified visual pictograms that seemed to hold common meaning, then stylized them to create picturesque symbols, and associated these with audible words. To their mutual surprise, it was becoming easier to hear one another and to see each other's visual speech, as their communication systems passively adapted to each other. Ki was even beginning to faintly detect the chatter of a few of the other reys, while Yu found their voices somewhat more muffled than usual.

After several cycles of continued effort, Ki and Yu could discuss basic, elemental matters such as flying or eating. The more complex issues of social custom and belief proved considerably more difficult and frustrating to relate. While there seemed to be significant overlap in religious beliefs, the social structure and governance of Yu's tribe was much more regimented and authoritarian than anything Ki had known. Individual reys had actually been banished from the tribe – to almost certain death – on several occasions during Yu's life, for merely disagreeing with the elders, or some other "improper" behavior.

The more Ki heard and understood, the more alien she felt. How could the elders here think the way they did? Feel the way they did? They were so certain of everything (except her, for some reason), and prone to such violence. Were they so afraid to face the night? Or were her own beliefs any more secure? Ki felt herself growing old. And for what? This tribe wasn't home. Of course, Yu was already like family. But he too was an outcast here.

Ki finally broached the subject with Yu at the first opportunity the following cycle. "Friend Yu: Ki no fly here more. Heart die. Elders make sick. Ki find old home. Yu fly with Ki?"

Yu did not know how to respond. With Ki, he at last felt potent. But the tribe was his life, his existence, even if it was intolerable. He had long feared he would eventually be banished. But never voluntarily. Thoughts of violent darkness filled his mind.

"Yu scared. Serpents eat Ki and Yu. Need tribe." He hesitated. Tribes sometimes split, when they became too large. "Yu ask friends come? Ki like. Not elders. Make own tribe."

Ki's voice quavered. "How think Ki get here? No have tribe, only self! Ki not eaten."

Yu warbled, as he shifted his gaze. "Ki different. More brave. And fly alone. Two more noisy. Call serpents."

Ki hadn't considered that obvious fact. Alone, she could fly in nearly complete silence through the feed zone. With a partner, it would be necessary to maintain some level of continual contact to avoid collision or separation.

"Ki sorry. No more brave. Have no choice." Yu had spoken previously of several friends, all compatible misfits. Why not? "Yes, friend Yu. Ask others come. But no tell elders. Ki worried. Make trouble."

Yu slipped away, to discretely enlist his old comrades. He wished he hadn't neglected them so shamefully over the last few passages. Or had they been avoiding him? Yu had been obsessed. He prayed he could convince the others that Ki was mortal, yet someone they could rally around to form the nucleus of a new tribal family.

The first erstwhile friend refused even to look at Yu, or acknowledge him in any way. The other members of the pod also shunned him. Dismayed, Yu fled to a neighboring group. He was filled with relief when Yo, an old chum, hailed as he approached.

"Yu! It is you, isn't it? Some say you have been bewitched by the she-devil."

Yu replied with a twinge of remorse. "It has been much too long, Yo. But Ki – that is her name – is no devil. I have simply become enamored with her. She has given me reason to hope."

Yo koooted (the rey equivalent of laughter). "But Yu, she is so large!"

"And you are still so superficial. Though it is true, she does not fit in here." Yu hesitated, then decided to be direct. "And neither do I. Or you. We are planning to leave, to found our own tribe. And we would like you to join us."

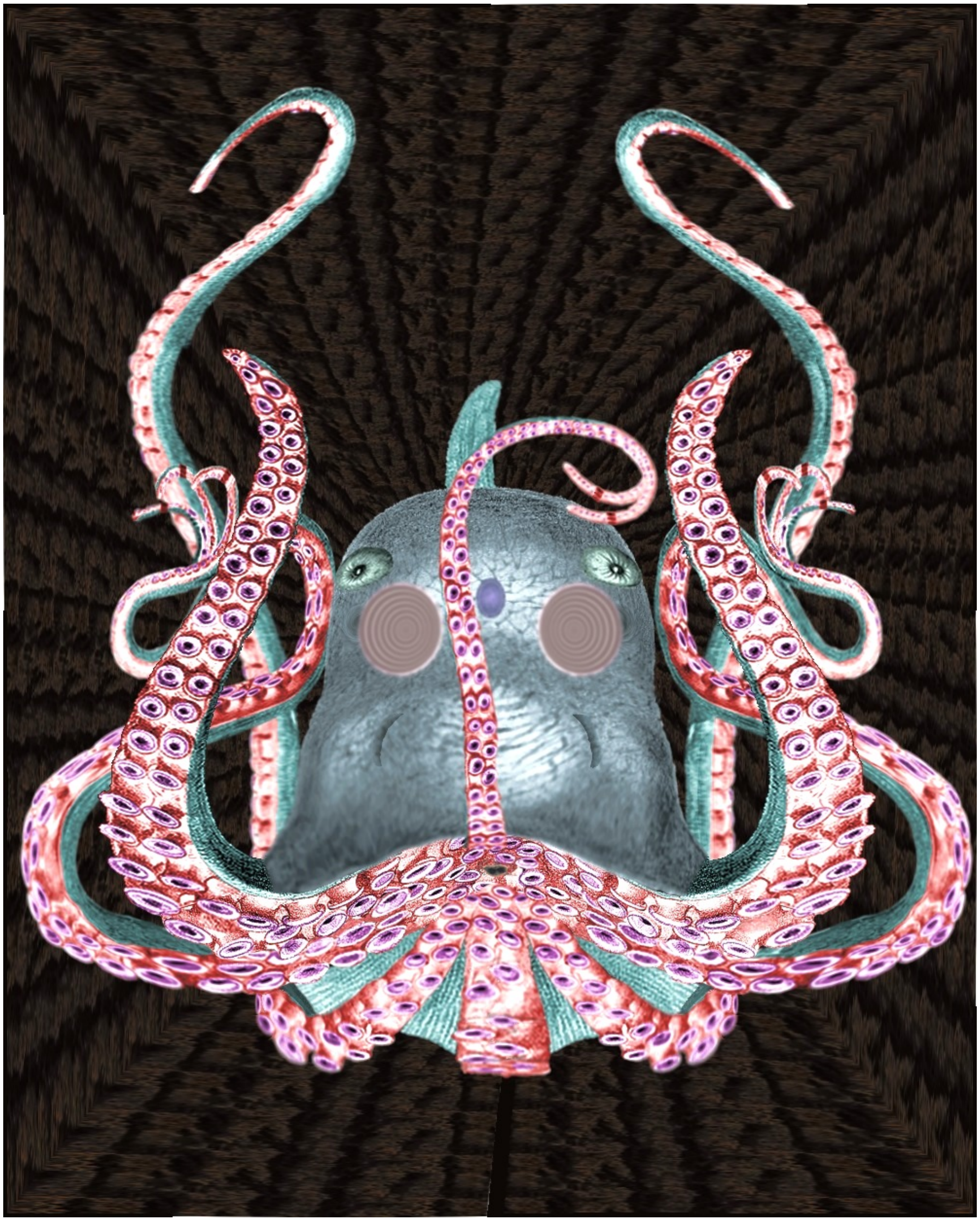
Yo calmly faced his friend. "Why am I not surprised? You have always been a bit crazy. But do you really expect me to just up and follow you? Good or bad, this is my home." He paused, then continued in a low voice. "You should know that you may have no choice now but to go. The elders are displeased with your behavior. They may even try to separate you, and ban you individually."

"Our respected elders should be relieved to be rid of their defectives at last. But I do not intend on telling them anything in advance."

"My bellon is sealed."

Yu swam more tentatively to the next pod. An old comrade there first excitedly agreed to join the proposed exodus, then balked. He could barely hear Yu any more, and became terror-stricken at the prospect of being separated from the nascent group while sleeping. Yu tried to explain that this prospect was not enhanced by the communication difficulty, but his friend would not listen. He could not bare the thought of facing the end alone.

Only four of Yu's acquaintances – two disgruntled adolescent male-female pairs, all with unusually adaptive acoustic systems – would ultimately choose to leave. It would be said that the youthful sextet simply vanished in the night. The she-witch had dragged her weak victims back to her dark lair – an object lesson for all good reys.



Chapter 5

Octo

A pitiful Na awoke, delirious with shock and pain. "Where am I?" he whimpered, as he feverishly probed the darkness for his tribe. Flopping helplessly, Na tried to right himself and slow his spiraling descent. Then he looked where his right wing should have been, and saw only frayed and twisted tendons. The anguish of remembrance abruptly flooded his mind. "Ki! Que! I have killed you! I HAVE KILLED YOU," he screamed into the deaf night. "I have killed you…" Mercifully the convulsions dulled, and Na lapsed into a bittersweet coma. The coiles passed unnoticed. Death would come easily.

Yet death was not Na's immediate fate. He awoke again to the physical world, this time bathed in a dim, eerie acoustic light. His pain had mysteriously eased. Though upright and steady, he did not fly. He was supported instead by an unnatural agent, hard and constant, very unlike the wind. And he labored for breath in still, foul air. Na groggily peeked at his surroundings. Above – an inert yet impenetrable, unmoving wall. The same to his left; to his right; and in front! An icy fear gripped him. In what devil's vortex was he trapped? Could this be hell? The hell he so deserved? He struggled to move, but only quivered. Even as he stirred, a faint buzzing sound arose somewhere off to the side – almost voicelike, yet weak and utterly foreign. Na strained to discern its source. What he saw his mind refused to believe. More comical than frightful, it was an impossible, ungainly creature – not graceful like a rey, or deathly efficient like a serpent. Rather it seemed mostly head, with grotesque eyes bulging from either side of a lumpy face, and supported below by eight long tentacle-appendages, flailing excitedly in every direction at once!

Clutching a floatation aid, Nemo-137-Menno swam awkwardly between the great halls of the university, now crawling with thousands of students. He did not want to arrive late for this lecture, which he knew would be well attended. The subject was Jopian evolution, to the emergence of early octins. Nearly every student on the campus, including Nemo, was an *octo* – short for *Octu manipulans*, the most cognitively advanced species of the genus *Octu*.

Overhead, Nemo glimpsed one of the enormous bladders full of pure hydrogen that helped to hold the complex aloft. It glowed slightly in his infrared vision, against a cooler sky. The bladder had grown out of an opening in the rounded, bark-crusted roof of a nearby building, to which it was now tethered by a tapered, rubbery neck. Octan (octo) habitats were traditionally constructed of living plants, derived from buoyant shrubs of the floating thickets colonized by octo precursors. In prehistoric times, the hydrogen balloons were all that kept the thickets and resident octan hives from sinking into hellish oblivion. Now octos employed so-called Drac bubbles to support the extra mass of modern structures, which included numerous inorganic components.

The bulk of the main lecture hall loomed straight ahead. Nemo stalled for a moment, to admire the magnificent archaic clock mounted on its outer wall. Unlike reys, the octos did recognize the suolar day as a unit of time, which they called a *yad* (equal to 9.9 human hours). Eight yads comprised a *kew* (an octan "week"), while the yad was conveniently divided into eight *rohs* (octan "hours"). The clock face sported two concentric rings of eight large infrared lamps each. Nemo saw that the single lit lamp at the top of the inner ring indicated the first yad of the current kew, while the lit lamp partway around the outer ring indicated the second roh of that yad. Smaller lamps spaced between the main lamps of the outer ring indicated that the current roh was almost over. The lecture was scheduled to start at the beginning of the third roh, so he needed to hurry along!

Nemo propelled himself forward. Approaching the floating hall, he reached out with one of his tentacles and grabbed the side of a lower entry port, then pulled himself inside. There were still a few free pits in the floor, and he quickly nestled into one not too far from the speaker platform. The trip from his living quarters had been trying, and Nemo embraced the security of the snug cavity. He could concentrate so much better within a confined space. He particularly disliked having to hang from a wall during lectures. Swimming between buildings was necessary and therefore tolerable, but dangling exposed for any extended period without the best of reasons was sheer masochism.

The hall was well lit with the gentle tone of ultrasonic illuminators. Peering up with a pair of large acoustic eyes, set stereoscopically on either side of his face below the smaller infrared eyes, Nemo surveyed tier after tier of pitted levels, rising back into the ceiling. While his acoustic eyes were sensitive to three primary ultrasonic colors, and he could distinguish a wide range of complex hues, the tones here were rather subdued and monotonous – the acoustic equivalent of a dull tan. Each acoustic eye sported an ear-like receptor along its outer rim, on opposite sides of Nemo's domed head. These organs responded to a broad range of low-frequency sound, which was heard rather than seen. The clamor in the hall at the moment was almost deafening, and Nemo squinted as he looked around.

Protruding precariously from an upper level of pits was a row of terribly modern hang-bars. Several colleagues perched nervously there, each tightly clutching xyr own bar (when deemed appropriate, both octos and reys use gender-neutral pronouns like xe/xem/xyr/xyrs, or sometimes it/it/its/its when referring to infants or to other species) with all eight suckered tentacles. Their heads teetered awkwardly. Rafu, an old friend from Nemo's birth hive, stared down, taunting Nemo to join them in heaven. He began shouting with his *bellan* – an acoustic source organ centered on his lower face.

"Nemo! Neemoo!! Come on up, you coward! What are you waiting for?! The lecture begins in only three nims!" Just as humans partition an hour into minutes and seconds, octos conveniently divide a roh into 64 *nims*, and a nim into 64 *nocs*. "I saved you a spot! NEMO!!"

Nemo pretended not to hear. Rafu and most of his fellow daredevils were members of a genetic engineering society that promoted selective modification of their genetic lines, in particular the elimination of an instinctive fear of open spaces. While genetic modification and bioengineering had already created countless octan subspecies and hybrids, this university was geared to students from ancestral groups that had opted to preserve the fundamental octo genome. Nemo did support establishing additional lines that did not suffer outdated instincts, but could see no logic in denying his own very real primitive emotions.

Shifting attention to the opposite direction, Nemo playfully emitted a short burst of ultrasound from his bellan. Autonomic timing of pulse reflections from his surroundings provided a particularly accurate sense of depth perception. Nemo marveled at the size of the hall. He spotted a keeper trimming excess plant growth at an exit port on the far side, while another cleaned out an overgrown pit nearby.

A commotion near the speaker platform caught Nemo's attention, and he turned to see the eminent paleontologist, Hyr Hughos, pop up through the floor. He was not surprised to observe that Hughos was neither male nor female, but a *neutor* – a third, sexless gender (gender-specific pronouns zo/zom/zor/zors) common to many thicket-dwelling herbivores. Octan neutors were easily recognized by their smooth scalps, which lacked the distinctive ridges of males and females. A hush settled over the audience, as the aged professor settled into a raised pit behind a simple console. Although live lectures were comparatively infrequent now, they had not suffered the demise predicted so long ago. There was still no substitute for a presentation by a renowned scholar in the flesh.

The speaker lifted a webbed helmet over zor head and energized the equipment, as Nemo sensed a surge of static emission from above. Suddenly the auditorium's arched vault was alive with colorful, three-dimensional images of ancient life forms, projected holographically from an array of ultrasonic projectors studding the ceiling. Hyr Hughos controlled the display by zor thoughts alone, detected and processed by electromagnetic and biochemical circuits in the communications gear. Zo skillfully drew on a mix of mental imagery and digitized representations stored in a data bank nearby.

"We scientists on mother Jopitar have not been blessed with a hard fossil record of the kind found on rocky terrestrial worlds such as Terra-3." The low-frequency narrative seemed to emanate from all directions at once. The planet Terra-3, commonly called Aerth, was the third planet from Suol. "But genetic evidence is abundant, and statistical methods developed by our predecessors have allowed us to determine our ancestral beginnings with surprisingly little ambiguity."

Nemo recalled that *simions* – the hairy, four-limbed animals of moderate intelligence that currently dominated macroscopic life on Aerth – had eyes that were sensitive only to high-frequency light. They could see no more than the uppermost cloud tops of Jopitar through their telescopes. These appeared as alternating dark- and light-colored bands running parallel to the equator, corresponding to the so-called belts and zones. Nemo's own home lay deep in the second belt south of the central equatorial zone.

The menagerie of creatures projected overhead fell away, and disappeared into a cross-sectional representation of Jopitar's churning atmosphere. "Jopian life evolved within the mid-tropospheric circulation of Jopitar's belts. Habitable regions, between 440 to 550 kilurets depth, form giant tori that girdle the planet, and collectively comprise the Jopian biotorus system. Here mammoth convective plumes rise from the abyss, spinning off hot springs along their peripheries, that provide life with thermal energy, silicon and other vital raw materials." Nemo knew that the *kiluret* distance scale was originally set so that the 512 kiluret depth value of the octo thickets was numerically equal to 1,000 in the base-8 number system, still routinely used by octos (though in deference to human readers, the more familiar base-10 system is used throughout this story). From courses on simion technology, he also knew that the kiluret was just under half a simion kilometer, or about three-tenths of a mile.

A magnified image of a tiny organism emerged from an upwelling region of the atmosphere. "The earliest life probably developed from silico-organic residues some two bevujopes ago, around hot springs near the base of the habitable range." Modern octos measure long periods in terms of the *jope*, or local suolar year, equal to 11.9 Earth years. Prefixes to the basic jope unit indicate some power of eight; here *bevu* indicates eight raised to the ninth power, a factor of over one hundred million.

"This one-celled creature, Alphabios, was little more than a self-replicating membrane, supported by a bubble of pure hydrogen. The hydrogen was generated by simple chemical reactions within the cell membrane, and made the organism buoyant." A wavy line appeared, showing the probable level at which Alphabios lived. The indicated temperature there was 600 nevlu, warm even by octan standards, with a pressure exceeding 880 rabs (detailed conversions between octan and familiar human/simion units can be found in Appendix G).

Alphabios faded away, and was replaced by a cloud of colored dots. Each dot by convention represented an atom of a particular element, indicated by its color. Over 92% of the atoms were hydrogen, and 7% inert helium, leaving only a fraction of a percent for the heavier elements. Atoms of carbon, nitrogen, oxygen, sulfur, silicon and other trace elements of biochemical importance were garishly colored, to stand out against a background of dull hydrogen and helium. The atoms collided and formed a variety of compounds. Nemo watched attentively, while Hyr Hughos described the most important chemical processes that presumably led to life.

There was little said that Nemo did not already know, but he relished the visual effects, and the integration of disparate facts into a sensory whole. The role of silicon particularly engaged him. Silicon was normally sequestered at scorching depths beneath the silicon cloud tops, and was brought to higher levels only through the hot plumes. Yet silicon was crucial to Jopian life. It combined with water and methane to make durable silicone polymers, which in turn formed structures that stabilized other complex molecules from heat degradation, and provided a skeleton from which living organisms could evolve.

A likeness of Alphabios reappeared overhead, and morphed into a more complex unicellular creature. Now it assumed a more regular spherical shape, comprising a double-layered membrane, surrounding and supported by a bubble of buoyant hydrogen. A background scale showed it to be some hundred micrurets across, several times broader than a typical Earth cell. Metabolic processes sizzled in the porous scaffolding that occupied the narrow space between the inner and outer membranes. The internal hydrogen compartment gradually became more balloon-like, until it swelled out the "top" of the tiny organism, stabilizing it vertically.

The lecture continued. "… The scions of Alphabios evolved in multitudinous ways through the prolonged primordial period, driven by the twin forces of mutation and natural selection." Alphabios split into an assortment of one-celled creatures, which competed for resources as over 300 megujopes passed. Such incredible time spans, Nemo mused with a sense of wonder. So vast, they are scarcely comprehensible! It was not surprising that many ancient octos could not accept biological evolution when the idea was first advanced.

"Some cell lines acquired a limited ability to exchange genetic material, and became dominant. Several genetic codes apparently evolved and competed, before the familiar SNA scheme became established. Vestiges of the other ancient systems remain in the reproductive elements of cellular organelles in a variety of organisms, including octos. It is interesting to note that the genetic codes and biochemistry that spontaneously arise on gas giants like our own Jopitar are generally based on mixed chains of silicon, oxygen and carbon, while those on rocky terrestrial planets tend to be carbon based. This difference can be explained by the markedly lower temperature and pressure conditions under which life on terrestrial worlds develops."

While Nemo understood intellectually the biochemical basis of life on the strange terrestrial worlds, he still could not grasp emotionally how life of any type was able to develop and persist under such cold, vacuous, unstable, utterly inhospitable conditions. Perhaps he needed to experience it first-hand?

Evolution proceeded at a rapid pace overhead, as yet another 300 megujopes elapsed. Now a mix of microbes swirled around a surging hot spring, some 620 kilurets beneath the cloud tops. Many developed spots representing primitive infrared, temperature, and pressure sensors, as well as extensions for turning, gliding, and manipulating other cells. The yads of passively maintaining depth and waiting for nutrients were over. "… The new species actively exploited the currents, and puffed up or deflated their hydrogen balloons to control cell buoyancy. They developed mechanisms to feed near the hot springs at the greatest tolerable depths, where silicon and other nutrients were most abundant, then inflate and ride peripheral currents to higher levels to reproduce." Nemo recalled that duplication tended to be more faithful in the cooler climes.

The microbes divided into two groups, colored the ultrasonic equivalent of red and blue. Hyr Hughos was obviously excited by this development. "Significant differences developed between existing cell types. The red cells grew progressively more proficient at the chemosynthesis of higher-energy food stores. The blue cells took advantage of these advances, and began to prey on their red cousins." Nemo watched as a blue cell attached itself to a red one, then ingested its contents.

"Some members of the red group pioneered photosynthesis, harnessing infrared radiation from the hot springs." A subset of the red microbes shaded yellow. "The red and yellow cell lines ultimately led to today's chemosynthors and photosynthors [the Jopian version of chemosynthetic and photosynthetic bacteria]. Both early synthor types remained dependent on the plumes and springs as a source of silicon, and continued to feed at the deepest levels."

Hyr Hughos unexpectedly launched into a tedious, tangential discussion of fine differences between various synthor lines. Nemo recalled that this was a pet interest of the head of the Evolutionary Biology Department. Was Hughos currying some political favor? What could a person of zor stature possibly require??

Nemo's mind drifted. He began to daydream about Ikta, a graceful female he had first met about one jope before, at an archeological workshop. She had been reverently caressing a decrepit electric generator from the early Electric Age. The discovery of electricity had changed everything for the octos. The ancients considered it a gift from the gods. Nemo and Ikta had been instantly attracted to each other, and were soon besotted. They even shared a cozy lair for a while, until Ikta became impatient with Nemo's plans to pursue an academic career. Nemo had made promises he could not keep. He should have known better. Heavy ripples rolled down his coiled tentacles.

Nemo jolted, and his attention snapped back to the present. Wasn't this session supposed to last only two rohs? He glanced back and up toward Rafu, who appeared to be on the verge of falling asleep. This in itself was not unusual behavior for Rafu, but his friend was not usually dangling from such an awful height. Nemo squirmed uncomfortably, until the focus of the presentation returned to evolution. Microorganisms swarmed to higher and higher levels around a towering hot spring.

Nemo noticed a change in the behavior of the predator microbes. They were feeding more at the upper reaches of the synthor domain, then inflating and riding the currents to still higher levels to reproduce. Hyr Hughos elaborated further developments. "… The overall shift of the predator microbes to more moderate temperatures and pressures permitted more sophisticated organisms to evolve. New predatory lines emerged that fed on other predators. These were able to occupy progressively higher, more hospitable levels in the atmosphere. A hierarchical ecosystem emerged, spanning depths from the original 620 kilurets up through 510 kilurets, or temperatures from 600 down to 510 nevlu. Silicon requirements diminished at higher levels, as more versatile carbon replaced an increasing fraction of the silicon in structural materials. Complexity likewise increased, while the density of microbes decreased."

The projection zoomed in on the upper-level microbes. Genetic material became segregated in a protective nucleus. Nemo observed that the nucleated predators had trouble exchanging genetic bits the old-fashioned way. A primitive mode of sexual reproduction evolved before his eyes. Two related cells and their nuclei fused, then divided after corresponding SNA segments swapped analogous genetic material. Original sex! Nemo's mind strayed back to Ikta.

By the time he regained focus, Nemo had missed most of the narrative concerning the implications of the new sexual mode of propagation. His attention was drawn to a large blue microbe as it engulfed a tiny photosynthor, and consumed it whole. Nemo recognized that this method of devouring prey was a recent innovation. But rather than being digested, the smaller cell established a truce with its host, and began providing it food.

"… One family of advanced predators established an endosymbiotic relationship with wayward photosynthors, and subsequently specialized in photosynthesizing high-energy food stores. An ample flux of infrared radiation was available even at their altitude, both from hot springs and [to a lesser extent] from warmer air directly below. The microbes consequently achieved a large degree of independence from life at deeper levels, though they still needed to ingest other cells to obtain silicon, in particular prior to reproduction. These hybrid microorganisms led the way to the modern Jopian version of plants. A second group of advanced predators specialized in feeding on the energy-rich plants, spawning today's animals. Because the plants could provide most of the food required by both groups, their populations swelled, but remained loosely tied to the hot plumes and springs.

"About 260 Megujopes ago, some plant microbes acquired a tendency to stick together following division, forming colonies." Overhead, a plant cell divided, but its daughters remained attached. These continued to so divide, resulting in a spherical shell of identical cells. "While these groupings by no means displaced the solitary one-celled life forms, there were numerous advantages to a colonial existence." A predator microbe tried to wrap itself around a colony cell, but failed. The central cavity of the colony filled with dots representing pure hydrogen, providing extra buoyancy.

"The multicelled plants evolved quickly." Cells covering half of the colony flattened, and became the skin of a buoyant hydrogen balloon. This tended to float in the upward direction, defining an upper surface. The balloon soon swelled out the top, further stabilizing the organism vertically. Regulator cells allowed some hydrogen to escape, and the colony began to slowly sink through the surrounding air. Islands of cells in the lower hemisphere formed sticky pits, and snared a few passing microbes. Other patches of cells on one side specialized in photosynthesis, and turned bright yellow. Cells along the equator developed flagella-like extensions, which beat in unison to turn the colony around its vertical axis, so that the yellow patches faced a nearby hot spring. Short, flat stubs angled out from opposite sides of the equator, and the colony drifted toward the hot spring as it descended. New inner cell layers emerged in the lower hemisphere, for chemosynthesis and storage.

"Multicelled animals appeared shortly after the plants." The plant colony was suddenly attacked by a puffy, flattened, elongated animal colony, which attached its puckered front end to the plant, and worked to extract and ingest a few cells. Now the animal morphed into a flattened wormlike creature with a mouth, a straight-through digestive tract, primitive infrared eyes, fins, a tail, and small wing-like flaps on either side. It rode currents near the hot springs to a level high above the plant colony, released a single reproductive gamete cell, then dove back to seek more food.

"The multicelled plants coevolved with their animal predators." The plant colony developed scaly bark for protection. Primitive photosynthetic leaves projected from under the scales, into open air. An animal ripped a few away, without harming the underlying plant body. The bark gradually extended up the sides of the plant, squeezing out the hydrogen balloon, until it became a buoyant bladder, attached to the colony's central cavity by a rubbery neck. A small gauge hovering nearby indicated that the balloon gas was now much warmer than the ambient air, providing additional lift.

The plant discharged a cloud of spores, which floated away to form independent colonies. Buds sprouted from its sides, and grew through hollow stalks into new globular structures with their own hydrogen bladders. Soon there was a tiered thicket of interconnected, leafy globes, held aloft by an array of graceful hydrogen bladders.

"A variety of larger animals emerged, including mannavores, herbivores, carnivores, and omnivores." The wormlike organism was now replaced by several distinct creatures. One with a scoop mouth swept up a swarm of so-called manna microbes, and swallowed them whole. Another with a raspy mouth attached to a thicket plant, and began grinding through the bark. It was attacked by a creature with sharp teeth, and dragged away. Nearby leaf eaters responded by hiding within the same shrubs they normally grazed. The simulation was so real, Nemo instinctively pressed into his pit. He noticed that several of his high-flying associates had abandoned their hang-bars.

"Some of the new thicket-dwelling herbivores evolved social behavior, which promoted the development of a more sophisticated nervous system and central brain. The upper corners of their breathing slits adapted to generating and detecting sounds." A slinky denizen with six tentacles poked out from a cavity in a thicket plant, and screeched a warning to its kin when a primitive ribbon serpent approached. "Paired appendages appeared, which allowed the animals to move more efficiently through the rough branches of their homes, and fashion comfortable nests. These changes encouraged further brain development, and more sophisticated communication." The scene was becoming more familiar to Nemo, though it still bore a markedly primeval tone.

Now attention panned away from the plant thicket, to open space beyond a nearby hot spring, where a lumbering giant plied the currents. "The free-swimming mannavores lagged behind the colony-dwelling herbivores in mental development. They generally remained solitary and non-social, simply enlarging over time to counter the carnivore threat. By about 16 megujopes ago, they encountered increasingly stiff competition from smaller but more advanced social animals that nested in the plant thickets but fed on manna in addition to the shrubbery." A small group of winged forms swept past the huge mannavore, squawking mysterious signals to each other, as they filtered manna from the thick air. Nemo felt his circulation quicken. "Herds of these creatures would leave the protection of their nests to feed on manna at nearby hot springs. Over the generations, they spent more and more time in free flight, soaring high on the currents out of the serpent habitat after feeding, until some broke free of their nests altogether. This new type of mannavore led to the mysterious reys."

"It is baffling to me how such animals could have developed their obviously high degree of intelligence. Arms and suckers were useless to them, so any evolutionary pressure associated with the creation and manipulation of tools and other artifacts was absent. In time they lost all external traces of their former appendages."

Nemo reflected on the flush embarrassment of the academic community when the sophisticated mental abilities of the reys were first demonstrated conclusively only a half octujope earlier. The reys had been virtually ignored in scientific circles since ancient times, except for an occasional "crackpot" researcher, and had generally been regarded as primitive, uninteresting relics of a bygone era. Of course, they had long been thought to be at least minimally sapient, so capturing one for study against its will would have been clearly immoral. But almost no one had bothered to study them even from a distance.

Perhaps rey intelligence had evolved in response to peculiar demands on communication within a herd? It was well known that a primitive ability to manufacture and manipulate physical tools would generate positive feedback evolutionary pressure toward still higher creativity and intelligence. Could a primitive ability to fashion and manipulate mental images have a similar effect? The reys were known to communicate by transmitting images to each other, as well as by audible signals and symbolic speech.

Still, it was difficult to imagine intelligence without physical appendages. Nemo glanced at and flexed his ten (simions would have said eight) densely suckered tentacle arms and legs coiled beneath him. Simion beings also had appendages for manipulating objects, though they were limited to a mere two arms and twelve (simions would have said ten) smooth fingers. How unfortunate the two extra fingers. The simion number system, based on the number of fingers on both hands, was unnatural in pure mathematics and digital computer applications, and must be a terrible impediment to progress in those fields. The octal system, based on the total number of arms plus legs on the octan body, was more natural and universal, due to its intimate connection with the binary number system.

Nemo jerked back from his reverie, to find the lecture winding down. "… herbivores that remained in the plant thickets evolved over the megujopes into a vast array of species, including our own. While moderate levels of intelligence of various types developed in most of these, only octos acquired the capacity for abstract thought and speech. These special attributes probably originated within small groups of octo precursors during periods of instability in the zonal circulation, when feast followed famine in rapid succession, and a premium was placed on flexibility and learned behavior. Our forebears established a symbiotic relationship with the plants, tending and shaping them to create more secure homes and a more reliable food supply. Coevolution over the past several megujopes produced the remarkable tree-bushes we rely on today."

"For further information on this subject, including an extensive bibliography and a discussion of genetic analysis techniques, please refer to disk 3351:01 in the Cross-Campus Library." Although it was possible in principle for a student to feed information from an entire disk directly into xyr brain in a matter of nocs using bioelectromental equipment, such methods were banned from routine use. Ancestral octos had learned through bitter experience that unrestricted application of such learning techniques led to dangerous conformity of thought and expression, which tended to quash creativity and critical evaluation. Among pre-adolescents, use of direct-feed technology further interfered with normal personality development. The risks of sabotage, abuse and malfunction, leading to permanent psychic alteration and damage, were nontrivial under any but the most supervised conditions. Students still in the general phase of their schooling were limited to manual study techniques. Upon successful completion of a common course of education and preparatory study for a selected profession, an individual could apply to use the rapid-transfer equipment to quickly acquire rote specialized training. The data imprinting took place in a formal, regulated ceremony, one of the important rites of passage in an octo's adult life.

Students crowded around Hyr Hughos, even as Zo removed zor communications gear. Nemo slid quietly to the back of the throng, to await his turn for an audience. When the others had finished with their questions, he tentatively extended a tentacle forward, and lightly tapped the floor. The professor turned to Nemo and nodded almost imperceptibly, signaling zor attention. Nemo cleared his bellan, and politely addressed his superior.

"Hyr, I understand that you are seeking an assistant to help investigate and care for the injured rey recovered several yads ago. Rey evolution is a special interest of mine, and I am most interested in the position. I sent you a communication including my academic transcript, but have received no reply. If it is not too impertinent, I would like to ask if the position is already filled?"

"Would you happen to be Nemo-137-Menno? I must apologize, since I had intended to contact you earlier. I discussed your application with my colleagues only yesteryad, and we are in complete agreement – a rare event, I might add. If you agree to the standard terms, the position is yours."

Although the standard terms in this case meant a bare pittance for compensation, there was no question in Nemo's mind. "Of course I accept! How soon can I begin?"

Chapter 6

Grace

Nemo slithered quietly along a tunnel toward Na's chamber, lost in contemplation. During the thoms (the octan equivalent of months) he had lived with and studied the rey, a remarkable thing had happened to Nemo. Initial abstract intellectual excitement and curiosity had gradually given way to enchantment, then respect and even admiration for this strange creature and the race he unwittingly represented.

A lithe, suckered tentacle abruptly emerged from a side chamber of the passageway, startling Nemo. Two huge eyes poked out, and peered questioningly at him.

"Na! Off to visit your rey friend again?"

"Rafu – must you always sneak about, and frighten your comrades?? Yes, I am on my way to interview Na, but you know he's not my 'friend.' How could he be? He is a rey, after all."

"Well, you could have fooled me. Why not simply admit to it? Indulging in such foolish, sentimental octomorphism does not go unnoticed. Though I cannot fathom your obvious feelings for the brute."

"I wish you would stop chiding me about this. How many times must I tell you? He is simply a research project."

"Nemo – just admit it! I have known you since our first yad in nursery school. When we enrolled at this university, you sought meaning to your life in academics and its traditions of detached objectivity. Just like me. But something has changed …"

"Na is quite remarkable. I will admit only to that. His spirit is so free! Did you know he willfully left the security of his own herd and faced an unknown storm, just to experience its truth firsthand? His outward approach to life is so … refreshing. There is an apparent willingness to risk all, to immerse himself in the tumult, to *be* rather than to merely see."

"There was a time you would have found this orientation reckless, and repellent. I certainly do. He is so disgustingly alien."

"You should get to know Na better. Part of me has become enamored with the honesty and fullness of his approach to life. Though he does not always seem to understand his own motivations, and has sometimes applied his philosophy too rashly for his own good. Na still appears to be repressing selective memories of the ordeal that brought him to us."

"Have you ever wondered if you are overlooking some dark aspect of Na's psyche, and romanticizing your subject's exotic personality? He may have been a maladjusted misfit back in his own tribe."

"Yes; sometimes I do wonder. I have asked a neuropsych team to work on this, but they are of course having problems, as his mental structure is so different from ours."

"By the way, I saw Ikta yesteryad. She asked me how you were doing. And said that she would like to get together with you over a meal of bloatleaf and knuts?"

Nemo paused for an agitated moment. "Rafu, you *do* enjoy startling me. You know I do not have time for dinner dates these yads – the rey project demands all of my attention. Now I *really* must be off; Na is expecting me."

Rafu whirled a tentacle in a sympathetic fashion. "Then be off. But please, consider what I have said."

Nemo slinked softly into Na's chamber, and slipped the frequency transducer over his own bellan. He marveled again at the tuning of the low-frequency bands in which the reys conversed. Perhaps it was not so surprising that the octos had been oblivious to their chattering all those kilujopes. It had taken some time to piece together a language with which he and the rey could communicate. While conversation was in Na's frequency format, it was still strictly auditory, and lacked the rich imagery reys normally employed.

"Na," Nemo whispered, concerned that his friend was asleep.

"I am only daydreaming," Na responded wearily, adjusting his infrared and acoustic eyes. He twisted in his ill-fitting hammock to face Nemo directly.

"About your tribe again?" Nemo asked gently. When Na did not respond, Nemo continued. "I have a new idea for your future. It is very risky, but you cannot stay here. This life is killing you."

Na made a sound indicating sad amusement. "Nor can I return home, Nem. Even if we could heal this body and relocate my tribe, you know I could not bear the shame. Though I suppose I can't continue taking your drugs forever." Nemo had assured him repeatedly that the medications would have no detrimental long-term effects.

"This does not involve your tribe. You have already learned something of our spacecraft. But you do not know the whole story."

Na's eyes twiggled. "What could your spacecraft possibly have to do with me?"

"Let me tell you the whole story first. Then you will understand." Nemo looked thoughtfully into his companion's enigmatic face. "My people first learned to create and harness Drac bubbles 75 kilujopes ago. The details are lost in the annals of time."

"Doesn't a Drac bubble reduce the weight of everything coupled to it?"

"Yes. By equipping a transport vessel with a Drac bubble generator, the bulk of the vessel's effective mass could be reduced incrementally, down to almost zero. Buoyancy could then be controlled, providing lift to the top of the atmosphere. There, tiny ion drives could rapidly accelerate a nearly inertia-free ship to high speeds. This new technology allowed my ancestors to construct the first primitive spacecraft, in which they left our beloved planet to investigate nearby worlds."

"When I first heard that you octos have artificial flying ships, I could scarcely believe it. Now you tell me you have had them for such an incredibly long time! Reys have had no inkling of this; we generally steer clear of the floating thickets. And your bodies seem so ill suited for such travel."

"Early explorers traveled in pressurized chambers, under deep Jopian conditions. This we know from a few surviving records. But the scheme proved inconvenient. The life support equipment was bulky and unwieldy. Control of a spaceship was indirect, slow and awkward. So the octan astronauts were pruned surgically, to take up less space. Appendages were amputated, and artificial links to critical controls tied directly to the astronauts' nervous systems. Soon artificial sensory organs were included."

"The astronauts willingly *assented* to this?"

Nemo was unperturbed by the tone of the question. "There were countless volunteers. Of course, many psychological obstacles were encountered, in particular severe agoraphobia. But these were overcome by neurological and biochemical engineering. The need for an astronaut to move through a spacecraft was eliminated, and the size of the life support chamber greatly reduced. Eventually, only the brain of the pilot remained, kept alive in a small compartment at the heart of a vessel, and integrated to a host of artificial limbs and sensory devices."

"It's hard to imagine freely giving up one's own body, with all its natural senses and feelings!"

"The astronaut saw through artificial eyes: electromagnetic detectors sensitive to various frequency bands, acoustic detectors for atmospheric use. Xe communicated with the outside world using parallel transmission organs. Xe felt with artificial skin and tissue: millions of probes sensitive to pressure, temperature and radiation, distributed throughout the spacecraft hull and frame. The spacecraft became the astronaut's body, and moved according to xyr will. A new creature was born, as much at home in the depths of space as we are in the depths of our atmosphere, occupied by octan volunteers who abandoned their planet-bound lives in the hives for the freedom of the skies."

"Aha! A rhyme, at last," chortled Na.

"I may be a bit slow, but I do catch on eventually. These spaceship beings efficiently explored the remainder of our suolar system. They traditionally traveled in groups of three, sometimes more. Beyond Jopitar's own moons, the first major world to be probed was our sister gas giant, Sattorn. But no life whatever was found there. Apparently the atmospheric dynamics of Sattorn does not permit life's evolution."

"Nem, I know that various intermediate life forms exist there now. I saw them myself on your education disks."

"Yes, but these were engineered and planted by my people soon after the first pioneers arrived – an experiment in planetary modification that was never properly followed up. Exploration of the inner, tiny rocky planets followed that of Sattorn. Of course, no life was expected there. The atmospheres of these planets are terribly thin, and temperatures extreme. But our astronauts found the surface of the third planet, Aerth, teeming with peculiar carbon- and water-based life forms. This world has been under surveillance ever since, with only minimal interference."

"The Aerth simions – I have also seen them in the disks, Nem. They resemble octos much more than reys."

Nemo's skin tensed. "Superficially, perhaps. But we have had a few – ummm – unfortunate interactions in the past, based mainly on a misunderstanding of their most peculiar psyches."

"Do the simions truly have liquid protoplasm? And liquid blood??"

"Yes, though it chills me even to think of it."

"They must be so heavy, so ungainly. How ever do they move?"

"Actually, they are quite nimble. Remember, Aerth gravity is only 42% local standard, and their oxygen metabolism is more vigorous than ours. Now, please let me continue; there is so much more to tell you."

Na wriggled in his hammock. "I appear not to be going anywhere anytime soon."

"The spacecraft design I have described was very successful, and persisted with only minor changes for many kilujopes. But the spacecraft creatures were limited by their weak propulsion systems and organic brains to travel within our own suolar system. Reactive ion drives and gravitational fields were the only sources of acceleration in those yads. Although the craft were nearly inertia free, resistance of the thin extraplanetary medium restricted maximum speeds to about 0.1% the speed of light – superb for interplanetary trips, too small for practical interstellar journeys. In addition, the organic brains had lifetimes of no more than about twenty jopes."

"And so, your people no doubt replaced them with artificial brains," Na offered in jest. But Nemo seemed pleased by his comment.

"Techniques were in fact developed fairly early to manufacture synthetic brains. The original idea was to transfer the memories and personality of a living octo to a synthetic structure. The organic body would then be either painlessly destroyed, effectively shifting conscious identity to the synthetic form; or allowed to live, producing twin individuals from one. In addition to an extended life span, the synthetic format offered greatly enhanced mental powers. There was soon even interest in artificially creating completely new synthetic personalities, bypassing organic templates altogether. But the resistance to these ideas was astonishing, at least from our current philosophical perspective."

"I can imagine," Na murmured wryly to himself.

"At last, after an incredibly long stagnant period, a renaissance occurred. An important underlying factor was the development of a common metaphysics and an associated ethics and religion, remarkably similar to the one we now practice. The logic was convincing, though a consensus was reached painfully slowly. Resistance to the synthetic brain concept withered. The voluntary destruction of an organic body following conscious transfer became socially acceptable, as fewer citizens viewed it as murder. Synthetic individuals, or *synons*, were granted full rights as sapient beings. Many of the emerging synon class opted for synthetic bodies analogous to their original organic ones. These octo-like synons are commonly called *synocts*. Those who instead chose spacecraft bodies became known as *metons*, to suggest a new stage in the evolution of life, beyond the biological, into creatures adapted to inhabit off-planet environments. Some hives adopted the custom of —"

"Nemo – stop for a moment! Must you invariably lecture when you speak with me? I want to be your friend, not your student. And why is so little of this in my library?"

"Sorry, I …" Nemo paused, then worded his response carefully. "Several of my colleagues did not feel you were … ready for it yet."

"I must admit that I am having more than a little difficulty accepting what you are telling me. Where are these synons? I don't recall ever meeting one."

"The metons normally stay off-planet, and synocts tend to congregate in their own floating villages. This university is quite retro, so we receive few synon visitors of any type."

"Well, I did interrupt you. Please, continue."

Caught up in his story, Nemo failed to register the note of sarcasm in Na's voice, and carried on as before. "During this same period, about 72 kilujopes ago, the Xam propulsion drive was developed. This drive pushes against the vacuum itself – the underlying fabric of spacetime, as it couples to massive objects such as stars and planets – and so obviates the need for any kind of propellant. The Xam drive, coupled with a new matter-energy conversion process, provided our ships with a superior form of propulsion.

"Acceleration up to ten percent light speed was now readily achievable. Higher speeds were shunned, mainly because radiation levels became prohibitive. The uppermost velocities were used primarily outside the orbit of Sattorn; they were excessive for normal interplanetary travel, and dangerous at the elevated densities nearer Suol. A final breakthrough was the introduction of neutrino communication, replacing a long-range system based on electromagnetic waves. Neutrinos barely interact with normal matter, and can travel immense distances with minimal distortion and signal attenuation even through solid rock. We could now communicate directly through the core of a giant planet!"

Nemo's excitement was obvious. He paused for a moment to regain his composure, and recalled with a soft gurgle the latest simion search for signs of extraterrestrial life.

"Nem, what's so funny? Or am I misinterpreting the sound you just made?"

"No, I was just thinking how the simions currently look for aliens by scanning the sky at electromagnetic wavelengths. Yet no advanced civilization would use such radiation for routine long-distance communication, and we octos certainly have no desire to advertise our presence to the primitive Aerthlings." Or was he too being pretentious in thinking that his own race was so advanced?

"At last the first of our living meton starships were launched toward Suol-2, the nearest suolar-type star at the time. A single gas-giant planet suitable for life was discovered there. Following this achievement, metons departed for promising destinations nearly every jope, sometimes in large fleets. Many carried frozen fertilized octo eggs, to establish colonies whenever and wherever habitable but unpopulated planets were found. The spore sacks of Jopitar's bush of life were mature and ripe. The sacks burst, spewing octan germ across the cosmos. Even at ten percent the speed of light, it still takes over 80 kilujopes to travel the breadth of our galaxy. But enough time has now passed that octos presumably range across most of this star system."

"Nem, I've seen no hint of such a wide-flung civilization. Your governance appears limited to this suolar system."

"Ours is no empire. Effective interstellar communication is impossible, as far as we can tell. The fundamental limitation is the speed of light, an obstacle we have been unable to circumvent. A neutrino message requires more than six kilujopes to reach an outpost at the opposite end of the galaxy. Without periodic reamplification, even a narrow-beam signal disperses and is lost. So we maintain a limited large-scale communication network, and correspond mainly with the nearest star systems." Nemo screwed his face in a manner that Na found incomprehensible. While octos, like reys, do use sound to convey emotion, they also rely heavily on facial expression and body posture. "Maybe this is just as well. If it were possible to instantly jump from one part of the galaxy to another, we would be vulnerable to surprise attack. How could we sleep? We are much safer this way."

Na was taken aback by this comment. He had never before heard any octo speak of an external threat. Did even the octos have their serpents? "Nem, I thought the octos had no effective enemies."

"None that we know of," Nemo replied softly. "Though even now, octan brothers and sisters may be enslaved in a far corner of the galaxy. We once refused to acknowledge this possibility. But we have since had a few unfortunate experiences – for example, with the simion creatures."

"What exactly happened, Nem? You referred to these encounter earlier."

"We – err – misinterpreted the simions' viewpoints and intentions, much to the regret and harm of all involved." It was apparent that Nemo did not want to say more. "We know now that many other intelligent species exist. Some are warlike, others not. The more warlike ones tend to ultimately overextend and destroy themselves. But not always. No, there may well be distant races eager and able to destroy us." A wrinkled, sober expression molded Nemo's features. "A particularly frightening possibility is that a group of our own synthetic cousins near the center of the galaxy has turned against us."

"Why would you think that?"

"No messages have arrived from that region for over five communication cycles. And every high-speed probe sent to investigate has simply vanished about 50 light jopes from the galactic core, in the inner spiral arm known as D-4. Shortly after computer consciousness was first invented, it was recognized that a rogue synthetic intellect might decide to start its own race, and come to view its organic creators as inferior pests to be eradicated. Creation of any new synthetic personality without a direct organic imprint was banned, and additional safeguards were implemented to minimize this possibility. Although a small probability persisted, the time required for a significant risk to develop was so long as to be considered irrelevant. Whereas this was a reasonable perspective for our ancient ancestors, it is no longer valid for us. So much time has elapsed that the likelihood is now about 50% that such a hostile race has in fact evolved. They may be biding their time, quietly gathering strength until they feel strong enough to attack and overwhelm us."

Nemo hoped he was not telling Na too much. If such an enemy existed, why had they not struck already? Had they destroyed themselves, leaving only a network of defensive sentinels? Had they reformed? Or were they simply not interested?

"Even if we were to successfully thwart such an assault, the octan race would probably be changed forever. We could produce sufficient defenders only if large numbers of young adults all over the galaxy were quickly transformed into synthetic existence. Following a war, it would likely remain fashionable for adults to undergo this metamorphosis while still young, rather than wait for the infirmities of old age, as is the current custom. Our foes may thereby ultimately defeat us from within. Synthetic octan descendants may lose respect for their organic brethren, even if they continue to protect our right to coexist. At best, biological existence through young adulthood may come to be viewed as an extended period of fetal development. Of course, many consider my attitude on this matter to be chauvinistic."

"You mention repulsing an attack, Nem. Yet your people are pacifistic. What exactly could you do?" The turn of the conversation deeply disturbed Na, filling him with a sense of insecurity and foreboding.

"Octos may be pacifistic, but we are not absolute pacifists. We support the right of every sapient being to believe and act as xe sees fit, but only to the extent xyr actions do not interfere with the same rights of other sapient beings."

"Then you would be willing to kill an enemy? I myself have killed at least one ribbon serpent, though I am not sure it qualified as a fully sapient being."

"Ribbon serpents may be sentient, but they are not considered sapient. Though yes, I would be willing to kill even a sapient being, but only as a last resort, and generally find the idea abhorrent. Most octos believe any infringement of another sapient being's ability to freely act should be the minimum possible, and should *never* exceed the offending violation. Have you seen our *Principia Ethica*? As demonstrated there, any other position is ultimately contradictory. How else can we expect others to treat us as we believe they should?"

"So, you would not kill an enemy to stop xem from enslaving another?"

"No … But I would be willing to physically restrain xem in that situation. If invaded, we octos would probably first try to defend ourselves with defensive shields; sabotage the attackers' weapons; or even flee, if a safe haven existed where we could live free from threat. At least the risk of external aggression motivates us to ceaselessly develop our technology."

"I have read very little of your philosophy, Nem. To be honest, I don't understand your need to analyze and prove everything. Aren't some truths unprovable, contradictory, or even unknowable?"

"Your mystical rey religion! In some respects, you are perhaps correct. But this does not preclude the development of a consistent system of logical knowledge. The roots of our current philosophy can be traced all the way back to the ancient philosopher Fleegello, a rather mysterious, controversial character who was not widely known in his own era, and supposedly died a roguish pauper."

"That word – *pauper*. Although I have learned its definition, I have trouble relating to it. Illness, neurosis, even insanity I understand; but material poverty means nothing to me."

"No, I suppose it would not. How could it? We should discuss the concept further sometime. I wonder what being a pauper meant to Fleegello? In any case, he introduced the underlying tenets of our philosophy, based primarily on an intuitive approach. Although he dreamed of rigorously deducing all philosophic knowledge from a set of basic principles most rational persons could agree on, he was generally unsuccessful. It fell to a group of followers a few octujopes after his death to apply the principles of logical deduction to fulfill his cherished goal – at least, to the maximum extent possible. As demonstrated by these same logicians, no closed deductive system can encompass all reality. And as Fleegello himself recognized, certain features of any belief system can never be proven, but must simply be accepted."

"My point exactly! How can you prove anything from outside a belief system? You would have nothing to base your judgments on."

"Yet belief systems can be fundamentally different. Early in our history, octos tended to place faith in inanimate objects and idols: a shiny trinket, a towering plant colony, a sculpted image."

"Or a shining suol, a mighty storm, a revered ancestor. We reys have our own ancient traditions, though they are oral and not written."

"The octan idols became associated with powerful gods and goddesses, who were supposed to protect obedient followers. Behaviors favored by a chosen deity – loyalty, cooperation – were seen as virtuous, while disfavored conduct was evil. The wills of the gods were divined by oracles and priests, based largely on omens and visions. As these religions and their attendant cultures evolved, the number of major deities diminished, while the relative importance of the associated belief systems grew. Many became frankly monotheistic. Most remained authoritative, only the focus shifted from the immediate will of a capricious spirit to the mandates of a holy text written by ancient, presumably inspired prophets. The fundamentalist sects attracted many followers, as they offered security and clear purpose in a threatening, confusing world."

"Many reys are also drawn to such rigid convictions."

"A few progressive religious groups maintained a trend away from dogma and doctrine toward reason, individual choice and responsibility. The belief systems of these sects evolved toward acceptance of more abstract general principles: the virtue of reason, of consistency, of tolerance. We now see this as the distinguishing trait of more advanced religions. Any central deity becomes the self-actualized realization of a principle, secondary to that principle, rather than the absolute arbiter of right and wrong. Religion and philosophy become one."

"But Nem, surely you have carried this trend to a nonsensical conclusion. Your current mainstream religion is supposed to be founded on the principle 'X equals X'! Isn't this true by *definition*?"

"You do not yet understand. Even after you define a term such as *equals*, you are free to either use the definition consistently, or contradict it as you see fit. What you do depends on how you value consistency and consistent truth – the general pattern 'X equals X.' The belief that consistency with all things is not important, that it is acceptable to deny objective reality for the sake of personal comfort or gain, is the origin of what we call evil."

"Actually, reys have a related view of evil. We believe it stems from an individual denying that others are a reflection of the self. This can lead a person to place personal needs and desires above, rather than equal to, those of others."

"The philosopher Fleegello lived during the period when our current ideas concerning right and wrong were beginning to crystallize." Nemo paused for a moment, and flexed his head in a puzzled manner. "Those were strange times, unbelievably long ago. I find it hard to understand how we so readily accept the veracity of the existing records. Fleegello himself supposedly helped form a nonpartisan organization to develop and promulgate the new philosophical understanding. This far-flung group is now remembered as the League of Universal Associates, or LUA. Members of one of the more progressive religious sects of the time, the so-called Unitorians, apparently attempted to organize a parallel political party. Unlike the LUA, this coalition must have been short lived, though its core goals were eventually fulfilled, and its ideas integrated into all aspects of society. While our philosophical understanding has undergone tremendous development over the intervening jopes, including many curious and unexpected twists, the basic underpinnings have remained much the same."

"Your moral restraint continues to puzzle me, Nem. It seems to go against your very nature. Octos are so aggressive and manipulative in most other ways."

"As you so enjoy pointing out. I must admit, we do not always live up to our ideals; it is a constant struggle. But consistent ethical convictions appear logically undeniable to most modern octans."

The two exchanged sober glances. Then Na added earnestly, "I pray to the Goddess that your people never fall victim to an alien race. Your strange religion could also fall, or worse, be twisted and perverted beyond recognition."

Nemo contorted his face, and warbled a melancholy *koo* – the octan equivalent of a smile. "That is the nature of war, as I understand it. But we stray from my original purpose." He paused briefly, then launched into an awkward, obviously rehearsed statement. "In summary, I have solicited the Colonial Council to offer you the opportunity to become the first rey in history to be transferred to spacecraft consciousness."

Na was stunned. What had his friend just said? It sounded like complete gibberish. But Nemo continued after the briefest pause, undaunted by Na's flummoxed silence.

"The council has agreed, pending final approval by the Neuroanalytic Board. You must understand that the required psychological and neurological testing would be intensive and exhausting. Even if you were found fit, in your special case the operation would be risky. But if successful, you would then be free to leave this place, this planet, as a meton, and find your destiny among the stars. You would again ride the currents – not of wind and cloud, but of gravity and time."

Nemo was proud of himself, his unprecedented offer, his irresistible presentation. But Na did not seem especially impressed.

"Why do you joke like this? You can't think that I would be interested in such a thing, even if I believed it possible!? How do I know your scientists aren't merely interested in turning me into this cycle's experiment?!"

Nemo was taken aback by Na's reaction, in particular his apparent rising level of hysteria, and uncharacteristic display of mistrust. Had Nemo misjudged his charge? Had he indeed fallen into the trap of wistfully idealizing a primitive culture and one of its members?

"Please calm yourself, Na! No one is going to force you to do anything."

These words managed to penetrate Na's rising terror, and he felt a twinge of embarrassment. The abrupt anxiety attack had caught him off balance. Of course Nem would do nothing to hurt him. How could he have doubted this?

"I am sorry, Nem. Please forgive me. I feel so confused. This must be an honor that you offer, yet it is so unreal, so alien to me."

Nemo brightened. Maybe there was hope after all. "Think about it, Na. That is all I ask."

A wave of mixed feelings flooded Na. There was something utterly repugnant and horrifying in the thought of losing his natural body, the one bestowed on him by the Mother.

But to be free to fly again, to seek a new purpose! Might not this too be a gift from Her? Even if his own torn body could be repaired, how could he ever return to his tribe, or any other rey society? Every moment would bring tormenting recollections of his failed past. Might he yet be desensitized to the memories of his misjudgment and the tragedy that haunted him? The drugs worked imperfectly. His mind reeled. Nem had mentioned bioengineering. But how could Na leave this new soul mate? How could he not?

"I seem unable to think straight at the moment. How can I explain to you what I'm feeling? I promise to consider what you propose. But please leave now. I must be alone. I am sorry, but I must. Wait – before you go. Tell me, what will become of our friendship? You're the only real friend I have."

"Do not worry about that, Na. Whatever you choose, after all we have been through, we will always be close – one way or another. You have given me a gift that even time cannot erode. There is one more thing, though. Should you accept its offer, the Colonial Council may request that you perform one or more missions for it in exchange. These tasks may be confidential; even you may be ignorant of all their facets. Until later …"

Nemo slipped deliberately through the dark, winding tunnels back toward his simple dwelling space, once more satisfied with his performance. He had in fact not told Na the whole story. For one thing, Nemo had volunteered for conscious transfer himself. He hoped to join Na and one other recruit, to travel together in the ancient traditional meton triad. This arrangement seemed most appropriate for such a novel undertaking. But Nemo was under strict instruction from the council not to inform Na, before Na made his decision. Na must decide for himself, must demonstrate motivation to carry on independently, in the event that Nemo were disabled or even killed.

Rafu abruptly poked his head from a side pocket in the passageway, into Nemo's path.

"Rafu – You must stop greeting me this way!"

"Nemo, you sly serpent. When were you going to tell me about the Colonial Council meeting? I just heard about it from Ikta."

"I did not think you would be interested."

"*Supportive* is what you mean. Well, I am interested. What was the final vote?"

"Very close, only five to four in favor. The preliminary debate was particularly heated and controversial. What an ordeal."

"I know you better than that. Confess – you relished the whole affair. I suppose a few of the more conservative council members insisted that conscious transfer to spacecraft be strictly limited to octos."

"Yes, you know the old argument – the transfer of alien personalities is too unpredictable, the possible consequences too ominous. But I found an ally in Cerces, a neurosurgeon on staff at the medical school."

"Cerces! How did you get the nerve to ask her for help? She's about as preeminent as they come. A bit fringe though, I have heard."

"Yes, she is at that. Which is precisely why I sought her out. We argued that reys are even better suited to spacecraft consciousness than octos. The outcome of conscious transfer should in some ways be even more predictable for reys. They are, after all, fliers by nature. Their personalities and thought patterns should fit naturally into the meton mental frame. Na in particular seems ideally suited."

"The octan mind certainly is not constructed to manage and control free flight. We are designers, builders, manipulators by nature, not pilots."

"My point exactly. The nerve networks needed for spacecraft reflexes and behavior are imposed somewhat unnaturally upon the octan personality, sometimes generating unexpected conflict. Yet even with this unassailable logic, I know at least one councilor voted in favor of the proposal mainly on the conviction that Na would never accept the offer."

"Ikta mentioned something about a second request?"

"Yes, the council also agreed to consider establishing formal relations with a few rey tribes." Nemo kooed to himself. It had not been necessary to explicitly reveal his fantastic dream of a rey space corps.

"You are joking, of course?"

"Certainly not. If the rey personality does prove ideally suited to spacecraft consciousness, could not a symbiotic relationship emerge between our races? I envision the conscious transfer of entire rey tribes, forming coherent space fleets to spearhead the exploration and colonization of yet uncharted realms."

"No one can accuse you of a lack of imagination. But who would volunteer to mingle with those … disgusting creatures."

"Someone named *Nemo*, for one."

"I am sorry. I just cannot …"

"Think about it! Octan ships have long favored the sedate, outer spiral arms of the galaxy." Just then, Nemo spotted a pair of ents scurrying across the floor, scouting for crumbs from an octan meal. These tiny ant-like creatures (or pests, depending on your perspective) nested inside the shrubs of the floating thickets. Nemo fought an impulse to reach out a tentacle and squish the bugs, but instead watched them disappear into a crack, and returned his attention to Rafu. "Rey spacecraft might be drawn, like ents to nectar, into the inner, more turbulent regions. The few colonies established near the galactic core before communications broke off were plagued by transport problems. Enlisting volunteers was difficult, due to the complexities and hazards of travel there."

"Yes," Rafu replied soberly. "A few of the inner colonies reportedly began creating artificial personalities to inhabit their spaceships, and even programmed some of these metons to reproduce themselves. How could the inner colonists have risked this? Were they in so desperate straits? Everyone knows such practices are irresponsible and hazardous. That is why they have been strictly forbidden here for ages."

"The Colonial Council is desperate to determine the fate of the inner colonies, and remedy any negative developments there."

"Now I understand … Yet all this hinges on your research subject first accepting the Council's offer, and then getting the approval of the Neuroanalytic Board."

"In my gut I am confident that Na will consent. And I would not worry about the Board. Its members will bend or even break every rule to participate in such an historic operation. Poor Na. I pray he does not become another faceless cadaver, an incidental sacrifice on the altar of progress. But is there any other choice?"

"Assume for the moment that the incredible does happen – that the rey agrees to the operation, and it is successful. Whatever will you do when your new friend departs? You will never see him again. You have been so obsessed with this project, I hate to think how you will handle the inevitable letdown."

Nemo turned slightly and stared down the tunnel, breaking acoustic contact with Rafu.

"Nemo – you did not! Did you? Why, you have not even finished your studies. You have yet to sire offspring!"

After an awkward silence, Nemo faced Rafu. "You always could read me. Yes, I have volunteered for conscious transfer myself, if Na agrees to the procedure."

"But what if the rey surgery fails? You know it is customary for all members of a triad to undergo conscious transfer at the same time!"

"I have faith that the procedure will be accomplished. How could I then let Na fly away alone? Promise you will tell no one. I am not ready to deal with that agony."

Rafu replied with obvious sadness. "If that is what you want. You should have at least a few thoms before any surgery is scheduled. I do not envy you, trying to explain your decision and bidding farewell to all your family and friends. Not to mention the gauntlet of tests and studies you must endure."

"Thank you; I know I can count on your integrity."

Rafu brightened suddenly. "Have you decided what to do with your personal belongings? I noticed some neat artifacts from the Otkin-Utalk Project in your lair."

"I should have guessed you would not be interested in my texts or manuscripts. I do plan to seal an antique League of Universal Associates trinket in my … spacecraft core. All student participants in the project were given one. The other relics must be returned. I might give my jewelry to orphans back in the birth hive."

"Well, my old friend, I wish you the best. Be sure to tell me when you are to depart; I want to be there to see you off."

Nemo whirled a tentacle in farewell, and hurried away. A few thoms – that was all he had to prepare himself emotionally and spiritually for the exciting yet terrifying leap into the unknown. Nemo felt the flow pulsing through the corridor over his damp skin. Never again would he know these dark, secure places. He shuddered, and slunk impulsively into a shallow pit on the wall. Why was he so weak? He must begin conditioning tomorrow. Tomorrow.

A majority of Nemo's people still preferred to live out their lives "naturally," as organic creatures. But a significant fraction considered synon existence the final stage of life. These individuals were biologically conceived, born and raised; birthed and reared their own biological young; then underwent transformation into synthetic form rather than succumb to old age and death. An increasing percentage of synon converts were choosing the meton metamorphosis. Nemo was very young for conscious transfer. But his desire and motivation were strong and positive, his overall psychological profile no worse than most. His instinctive fears and phobias could be altered. If he so desired.

Chapter 7

Suolrise

They broke through the cloud tops at dawn. Ki was awestunned as Coel, the hallowed Goddess of Light, burst into being before her fledgling company. Warm and pink, the rey embodiment of life, of fertility, of hope, Suol rose swiftly from cirrocumulus on the distant horizon, one with the nascent tribe, blessing their arrival. Ki began to spin in ecstasy as she rose higher into the great vault of light. She had not previously beheld either Coel or the boundless firmament above the clouds with her own eyes, though she had heard endless accounts, only half believed, passed down by older members of her birth tribe. Now Ki rode Coel's fiery, dancing beams. She was careful not to stare into the perfect circle of incredible brilliance – according to legend only the overly proud did so, and they risked being struck blind by their insolence, and rendered useless to their tribe.

The great wash of air that had catapulted the six reys out the side of the towering thunderhead was dying now, but Ki still rose in a rapturous arc as the males swept in. Yu was the first to reach Ki. As his left wing tip touched her right, both wings folded up together, and the two reys joined, madly cartwheeling now as one. Sacred Coel swirled round them as Yu passed his life into Ki. Clutching each other ever more tightly, they spiraled upward, to the apex of this ultimate passage, sharing it as a single being.

At last Yu broke away, only to be replaced by a second male. Below, the other two females joined again and again with the free males in a mating frenzy. The young tribe wheeled wildly downward, through the gathering light. As Suol climbed into the morning sky, the reys sank exhausted into the upper cloud deck. Strong winds blew them rapidly away from the broad area of upwelling storms, toward settled descending air and a new life.

The seeds of a more viable tribe had been sown. Each female now carried dozens of fertilized eggs. These would develop one at a time; only when an infant was weaned, would the next embryo in line begin to grow. As long as the cycles were regular and the manna was plentiful, the young tribe would multiply and flourish.

Rather than surrender to sleep, Ki listened to the wind wailing through her wings. The thin air strummed and whistled as it spilled out of the billowed surfaces and played through a minor tear acquired only yesterroh in a dizzying updraft. An ethereal melody formed in her mind. She slipped close to Yu, and whispered. "Hear what the gale has offered me, to mark this passage." She softly chanted to Yu, who looked back in wonder.

"As Father storm lifted us through the summits, I heard a similar vision!" He crooned a harmonic variation of her theme back to Ki.

Ki radiated happiness. "This is truly the birth passage of our new tribe. Let us count cycles starting with this as number one."

Yu cooed back in agreement, and the couple tenderly sang each other to sleep.

Far future generations would tell legends of the primal passage of the great tribe Ki-Yu. Where the tribe came from, no one would remember. Some would say it sprang straight from the womb of Maddee.

Chapter 8

Odyssey

Na consented to the Colonial Council's offer after nearly a kew (8 yads) of confused indecision. He was only then informed of Nemo's request to join him as a meton. The Council had imposed a few conditions for the privilege of undergoing the transformation: he and Nemo would carry out two simple missions in the suolar system before leaving; and they would then set out for the galactic core, to investigate the situation there. In return, Na had negotiated conditions of his own.

Na was straight away subjected to a series of comprehensive neurological tests, which revealed a slew of unsettling features in his neural structures. Members of the Neuroanalytic Board nonetheless unanimously approved the unprecedented conscious transfer procedure, vindicating Nemo's cynical assessment of their intentions. But the time required for final preparations was wildly longer than Nemo's original estimate. A grueling 16 thoms passed before the board felt ready to proceed.

At last the fateful yad arrived. Na was carried on an open-weave litter to a rounded cubicle deep within the medical complex. Giddy with anticipation and drug, he was laid there on a narrow slab. A select seven-member neurosurgical team assembled in the broad, low foyer that wrapped around the operating room, to review their strategy one last time.

Rafu and Ikta slipped into the spacious observation gallery on the level directly above the operating theatre. Here large, interactive wall monitors allowed them to view and listen to the proceedings in any of the surgical suites from any desired perspective.

"You kept your promise?"

"Of course. I told Nemo I would be checking in on the rey's progress, but did not mention you would be joining me." Nemo was undergoing conscious transfer at that very moment in another facility nearby, but his procedure promised to be quite routine, and much less invasive than Na's.

Ikta activated one of the monitors, and gazed coldly at Na's still body. "To think, this archaic creature is responsible for taking Nemo away from us." She delicately brushed the tip of a forward tentacle against Rafu's side.

"You lost Nemo to his studies long ago, Ikta."

"I know. But until now, I still harbored hope. Nemo's decision is so … irrevocable."

"Nemo must be free to follow his own destiny."

"Still, I do not understand why he chose *not* to preserve his biological self. That version of Nemo could have stayed and grown old with the rest of us, even while his alter ego flew away on its grand adventure."

"Nemo could still change his mind."

"I doubt he will." They both knew that Nemo's decision to destroy his organic body following conscious transfer could now only be revoked by his new synthetic self. It was otherwise forbidden to re-awaken the old body, which would be destroyed following a standard one thom waiting period.

"Who knows; maybe you will join Nemo someyad."

Ikta shuddered noticeably. "The idea of conscious transformation is still so foreign to me. I refuse to even consider it before my eighth birthyad. I *like* my body. Why would I want to trade it in for a hulk of cold metal and rock? And how do I know the logicians are even correct, that my new synthetic self really would be same as the original me?"

"Calm down! You can always make a copy of your mind, and arrange for it to be awakened in a synthetic brain and body only at your biological death."

"Rafu, you are so reassuring, as always." Ikta turned back to stare at Na.

Rafu activated another monitor, and shifted his attention to Na's surgeons. All were clad in tight-fitting, ultrathin body suits, impervious to microbes but otherwise comfortable and natural. The fabric imparted an eerie, characteristic sonic sheen to the skin, but was otherwise nearly invisible. The octos, who normally wore no clothing of any type (though many did indulge in jewelry and other body ornaments), were barely encumbered by the garments. Rafu noticed that someone was missing. "Ikta – what happened to Doctor Shreevo? I thought he was supposed to be on the surgical team?"

"Ahh, you missed news of the scandal. A nurse overheard him yesteryad confiding to a colleague that the operation was bound to fail, though it should be great fun. She reported this to the Neuro Board, which summarily dropped the good doctor from the group, and replaced him with an all-too-eager underling." The surgeons suddenly stopped their low babble, drawing Ikta to Rafu's monitor screen. "Look, they must be ready to start."

Cerces, the chief neurosurgeon-engineer, stepped back to address her crew. An alto voice boomed from the speakers. "I do not need to tell you how important this operation is. Failure would set back by jopes any hope of engaging the reys as spacecraft pilots. Everyone here has been carefully selected, and has the necessary training for success. We can do this!"

"Ever the politician," Rafu whispered.

Ikta activated a number of additional monitors, showing the interior of the operating room from a variety of angles. "Let the fun begin."

Three small ports opened into the operating room – one midway up the wall at the forward end of the table on which Na lay, and one at the base of each wall on either side. A silken screen draped each port. Cerces turned now from the others and, brushing the screen aside, slipped through the first port to check preparations. Middle aged by octan standards, Cerces was stout and somewhat lumpy in appearance, but moved with surprising agility and grace. She ran a long tentacle over the interior surface of the room, painted smooth with a dull, sterile synthetic resin, and savored the sensuous feel. The upper reaches of the walls and the ceiling were studded with hundreds of small pores, labeled with raised tactile markers. The tips of retracted induction probes, designed to both induce and detect activity in Na's nervous system, were barely visible through the pores. A network of electrical and optical fibers hidden within the walls ran from the probes back to a massive computer outside the room at the rear of the table. This device would store and analyze raw data from their subject, then send processed information on to a primed synthetic brain, housed in an adjoining cooled vault.

Cerces inspected the panels of monitor screens and indicator lights to confirm proper operation of the circuitry, then switched on the remaining power systems. Several large infrared lamps suspended from the ceiling brightened, as a number of smaller infrared and ultrasonic assist probes dangling awkwardly nearby hummed to life. Cerces next checked the table and her patient. The numerous life-support systems mounted in the table base appeared functional, their retracted tubes and hoses clear and free. Vital signs of the patient were as expected (for a rey, she mused). Finally, Cerces repositioned the seven squat stools around the table – one at the front end, and three on either side. They were so designed that an octo could "sit" on xyr mouth (protected by a natural bony ring) with xyr eyes exposed and tentacle-arms free. Satisfied, Cerces moved to the stool at the right of Na's prow.

The other neurosurgeons now entered the room one by one through the end port. Nodding to Cerces, they went to their appointed positions around the table, and sat. Each team member cloaked xyr gibbous optical eyes, then began to gently rock back and forth in a meditative trance, preparing for the coming rush. Cerces broke the silence by switching on her ultrasonic scalpel. No one spoke, but all immediately went to work.

Tentacles danced in a choreographed rhythm. Due to the novel nature of the procedure, the surgeons had decided to perform most of the physical operation themselves, rather than rely on automated robots. Their training in the ancient manual skills, which many young physicians considered superfluous in the current era, served them well. Cerces and three other surgeons (one at the front and two at the rear on either side of the table) quickly cut the spongy flesh around the base of Na's cranial hump, exposing pulsing vessels and gleaming nerves. The remaining personnel monitored their patient's condition, adjusting life support parameters as needed to maintain balance.

Vessels were clamped and severed, and artificial counterparts pulled from the table and tied into the cranial circulation. Synthetic fluid began pulsing through Na's brain. Nerves, muscles, tendons, skin and other tissues were cut next, separating the cranium from the rest of the body, which was summarily removed and stored for later dissection and study. Finally the porous skull covering itself was peeled away, exposing and isolating the naked brain. A thin, transparent sheathe rose from the table to protect the fragile organ, and bathe it in artificial cerebral fluid.

Induction probes were pulled down from the upper walls and ceiling, and carefully attached to nerve roots and other nexus on the brain surface. This delicate procedure required several rohs. Weak test pulses were fed into the network, the feedback from Na's nervous system observed, and the arrangement of probes adjusted, until the response was satisfactory. Only then did the exhausted surgeons break for a rest and feed period. Na's brain would be monitored and maintained automatically during the interim. Hopefully it would tolerate its artificial environment as anticipated.

Rafu stretched his stiff tentacles. "Now I know why I did not become a surgeon. Nemo's friend would have been doomed the moment my scalpel touched his skin."

"You do not give yourself credit, Rafu. I have seen you work on a broken creflaclok."

"I guess the rey did not have a real choice whether to keep or discard his old body. Just look at the poor creature. I actually feel pity for him."

"Well, there is nothing more we can do here. I could use some food – flaked entjuups, perhaps. Would you care to join me? The campus Leaf Pit is supposed to be cozy. Or are you out of student food vouchers again?"

"Actually, I am. Perhaps you could purchase an extra helping with yours, and slip it to me later?"

"You know that is illegal!"

"Everyone does it."

"A bite of food is hardly worth a loss of privileges. Are you out of ordinary credits too?"

"Well … yes. My account bottomed out yesteryad."

"You really need to get control of your spending. I suppose I could spare a few credits this one time."

"Thank you, Ikta. Consider it a loan." Rafu hesitated a moment. "You know, watching that dissection has taken the edge off my appetite. What if I join you in about a roh? That should give me enough time to look in on the new synthetic Nemo. His procedure must be long over, and he could probably use a familiar visage right now."

Ikta's expression sobered. "Would you mind if I tagged along partway? I need to see and touch Nemo's abandoned body one last time with my own eyes and tentacles. I managed to get a pass, to pay my last respects."

"Certainly. Though I thought those passes were restricted to close friends and family members? Oh, I just remembered – I promised Nemo to be here when the team attempts to awaken the synthetic Na."

"No worry – I have already requested an advance notification, alpha priority. We should have at least a yad notice."

"Ikta, what would I do without you?"

Ikta simply blew back a playful series of sonic bubbles in reply, as they both slunk away down a dark tunnel.

The surgical team returned a few rohs later, refreshed but anxious. A class of eager medical students assembled in the observation gallery to watch the proceedings. Apart from an unforeseen tendency for the cranial fluid to become aceedic, Na's brain had functioned as expected. Life support parameters were fine-tuned, and Cerces motioned to Klaatu, the assistant chief surgeon, to activate the neuronal probe sequence.

As he tapped on a wall panel, Klaatu turned to one of the surveillance cameras, and addressed the students. "The main computer will now feed a complex series of pulses into the array of induction probes. Between pulses, weak signals generated by induced nerve impulses will be detected by the same probes, and routed to the computer for analysis. The rey should not remember the bizarre dreams triggered by this procedure."

A few students tittered at the last remark, and Klaatu paused briefly before continuing. "Two types of information are sought: the interconnections between the multitude of neurons in the rey's organic brain; and the response of each neuron to all possible inputs, including multiple inputs of different intensities. Equivalent patterns will be imprinted onto the synthetic brain."

A student signaled electronically a request to ask a question. Klaatu gestured approval with a subtle flex of a tentacle, and the student spoke into a remote microphone. "I thought that most memories and behavior patterns are not stored at specific sites in the brain, but are distributed over large regions?"

"That is correct; reys and octos are the same in this respect. Information tends to be stored globally, much like in an optical hologram. But this only affects the method used for obtaining the required information. It is more efficient to evaluate neural interconnections in terms of global patterns and responses, rather than linkages between individual neurons. Neural structures are thus not probed one neuron at a time; intricate holistic patterns are instead fed into the brain, and outputs from all portions processed in parallel. This technique ultimately yields detailed local as well as global information."

Klaatu recognized a second student. "So this is a type of functional electronic holography?"

"Yes, indeed. It is also somewhat analogous to Foorier analysis, which should have been covered in your first bioengineering mathematics course."

Yet another student posed a question. "Why was it necessary to surgically isolate the rey's brain? This is not done with octos."

"Good question. While the physical learning mechanisms are identical, the organizations of the octo and rey brains are grossly different. The octo brain is so well understood that the information required for conscious transfer can normally be obtained using refined induction probes positioned non-invasively on the scalp. It is only necessary to drug an octo subject to induce an appropriate mental state. The rey brain is distinct. The induction probes designed for our rey subject are imperfect, and intimate contact with neural tissue is necessary to reduce uncertainties and ambiguities to reasonable levels."

Cerces interrupted the exchange, and addressed the students herself. "The pulse sequence probe appears to be proceeding as planned. Klaatu will join you in the adjoining classroom #42, to further discuss the conscious transfer procedure."

The workers split into two shifts, each monitoring progress for half a yad at a time while members of the other shift rested. The endeavor continued for three yads, before a seemingly complete data set was compiled and transferred. The process of mapping Na's neural patterns onto the synthetic substrate was complete; it was time to awaken the regenerated patient.

The surgeons were excited but tense when they gathered behind the operating room, near the vault that housed the synthetic brain. Cerces herself activated the circuitry, while the others raptly looked on. A murmur came from the speaker of the voice synthesizer, then an amused "Where am I?" as Na-2 roused.

Cerces responded with external calm, speaking into a set of acoustic receptors that temporarily served as Na's eyes/ears. "The operation was a success, Na. You are now in your new brain, though most of your artificial external senses have not yet been connected." She paused as the speaker emitted a muffled *kooom* (the meton equivalent of a giggle, or laugh), then continued with the agreed protocol. "Do you remember your tribe, Na? And what brought you—" But she was interrupted by surging peels of uncontrollable kooom. "Inappropriate affect" snapped Cerces, as she switched the synthetic brain back to an inactive state. Elation flipped to dejection, as the tired surgeons stared in disbelief at each other.

Overhead, in the now packed observation gallery, there were audible hoots and groans. Rafu and Ikta merely looked at each other in dismay. Ikta finally broke the spell. "Whatever you do, you must not tell that thing they are calling Nemo about this."

"I agree – he is no shape to handle it yet. In any case, there is still hope. I recall there is a contingency plan, in the event the initial surgery is unsuccessful. Of course, it involves mangling the rey's remains." They both fell silent again, and turned back to the monitors.

Cerces addressed her disheartened colleagues and onlookers. "The subject's organic brain will have to be dissected. There must have been errors in tracing deep emotional pathways, which can only be corrected by closer inspection and analysis. This requires implanting induction probes directly into concealed brain tissue. Superficial neurons will inevitably be disrupted. We must choose our routes of entry carefully, and avoid probable areas of misconstrued connections, or information will be hopelessly lost. There is only one more chance for success. If we fail this time, the organic rey will be dead, and our synthetic patient an insane cripple." Of course, Na's insanity might be corrected in time, but would the new self then be a logical continuation of the old? The ethical ramifications rested heavily on the surgeons. Cerces straightened and, motioning to the others, turned back to the operating room. The rest of the team quickly followed, while Rafu, Ikta and most of the other observers departed to their routine lives.

The delicate dissection began. The surgeons, aided by the main computer, identified the most likely areas of misregistration, as well as neural pathways that were probably accurately represented. They then cut through presumably safe tissues to gain access to the regions in question. Probes were inserted and others rearranged, and the pulse sequencing begun anew. This time, it was continued for eight long yads. Pathway routing logics were checked by different pulsing schemes for consistency. At last, a self-consistent data set was determined, and introduced to the synthetic brain. It was time again to test their work.

The anxious surgical team gathered once more near the voice synthesizer. Only this time Na's organic brain lay in pieces on the operating table. Again Cerces activated the synthetic brain. Again there was a murmur, then an astonished "Where … am … I?"

Cerces puffed deeply, then responded as before, ending with "Do you remember your tribe, Na? And what brought you to this place?"

Silence. Then, "Yesss." The voice paused, then continued very slowly. "Though … its … as … if … the … incident … happened … long … long … ago." The voice, though very sluggishly, seemed to acquire some excitement. "Then … we … were … successful?"

Noticeably relieved, Cerces replied with uncharacteristic warmth. "Na, you wonderful creature, I am increasing the speed of your mental processes." She waved a tentacle over one of the central processor controls. "In the near future, you will learn to control the speed yourself. You must remember to limit yourself to low speed when speaking with organic creatures like ourselves." A low titter reflected around the room. "You must also learn how to detach necessary but uninteresting thought processes – routine mathematical calculations, for example – from your primary stream of consciousness, and fetch only the relevant results later. Of course, you can experience the details of any internal process you wish, and store the memory for future reference."

Na's reply was somewhat impatient. "Yes, of … course. This was … explained to me by the … Neuro Board. I can scarcely believe what … must have happened to me! But when do … you connect my other … senses? You must … know, I feel terribly … confined and trapped like … this."

Cerces was not put off by Na's restlessness. She had seen it so many times before. She had even spent some time in a sensory deprivation tank, to better understand what it was like to wake in a disembodied state. "Do not worry, our winged friend. We will power you down until you are secure in your new body. I hope we meet again before your departure."

Na-2 was deactivated, even while the remains of Na-1 were swept away. The surgical crew heartily congratulated each other, waving and slapping tentacles, each member anticipating the honors and professional recognition yet to come.

A joyful pandemonium suffused the observation gallery. Rafu and Ikta twined, then Rafu hurried away to tell Nemo-2 the good news. Ikta found herself suddenly alone, as all the others rushed off to share their stories. She quickly calmed down. Good news? What good news? Her mood turned bitter. Where did she have to go? Back to her precious archeological artifacts? She morosely slithered away, to view one more time the discarded body of her dear lost Nemo. Ikta knew she would eventually get over him. She decided then and there to attend the Return Ceremony at which Nemo's remains would be minced, and returned to the thicket shrubs. Perhaps the service would provide closure.

Although the neurosurgeons were finished with Na, considerable work remained. Na's old mind utilized only about 5% of the capacity of his new synthetic brain. Much of the remainder was needed to receive and process signals from the numerous imaging systems, sensors and appendages yet to be connected. Some of these – for example, two of the infrared eyes and two of the acoustic eyes – could be tied into existing neural pathways. But many had no prior analogues, and required novel input nerve roots and mental lobes for processing and integrating new information.

The science of expanding sensory and mental powers following conscious transfer was well developed. Over the next kew, the neural tracts of Na's synthetic mind were further scrutinized, under the guidance of a group of experts in alien psychiatry. Compatible modes of integrating existing structures with new ones were established. Prospects for expanding the original lobes were also explored, in order to enhance overall mental processing. For example, Na would be given the ability to think visually in five dimensions. This would prove particularly useful for navigating ultrastrong gravitational fields.

Once the analytic work was complete, the additional pathways were mapped onto Na's synthetic brain. Only a few new basic instincts were hardwired. Na would need to learn to use his new senses and mental abilities much as a newborn learns to see and think visually. Logical continuity with his former self might otherwise be jeopardized. The brain was then transferred to an upper floor of the medical complex, where an interim robot body awaited, equipped with analogous senses and motor functions of his ultimate spacecraft frame. Here Nemo and Ulixis, the third member of their triad, awaited activation in similar frames.

A few yads later, Na blinked a pair of synthetic infrared eyes, only half believing his new state of grace. He stared across the room at two odd-looking units opposite him. Opening a set of ultrasonic eyes, he tried to study the forms from a different perspective. But – something was amiss. His vision was misaligned, not fuzzy but – more than two fields? A third eye snapped shut, and all was right again. More or less. He slowly uncloaked the extra eye; then a fourth; and a fifth and sixth on the opposite side of his body! But the visual fields remained disjointed, his sense of balance askew. Na reached out awkwardly with a tentacle-arm, where a wing used to be. Rolling onto his back (from the perspective of his familiar eyes), he playfully kicked several other arms about in the air above him. He stuck the end of one into an interesting new space – a mouth? Whatever it was, he was flooded with fascinating sensations. Continuing to stroke and explore his new physique, Na twisted around, blinking extra eyes open and shut to compare with his familiar binary vision.

A young female octo lab assistant entered the room. Seeing Na at play, she stopped to quietly watch. A former classmate of Nemo, she marveled at the precision workmanship of Na's synthetic body – a perfect sphere nearly 1.5 rets wide, sitting atop a squat mobile base. The sphere was a miniature replica of the ultimate spacecraft form, which would reach fully eight rets in diameter, except that the motorized base and its limited battery pack substituted for a Drac generator, Xam propulsion drive, and matter-energy converter. Na's temporary body could roll and rotate arbitrarily on the base, but was held to it firmly by magnetic forces. Several long manipulative tentacles lay coiled and hidden inside, while a number of shorter versions extended out from nearly invisible ports.

Na noticed the stranger. She approached, kooing softly, and caressed Na's artificial bonnet with a friendly tentacle. Na immediately returned the favor. Surprised, the aide instinctively jumped back, then caught herself. "I am sorry. You are advancing more quickly than expected. We turned you on only 10 nims ago. Are all you reys so clever?"

"Your voice is from Coel Herself! Where am I now? Still in the medical complex, no doubt."

"Why, yes. Though I do not understand how you could connect my words with your suol god." Or was it 'goddess'? The rey religion was so archaic! "My name is Penelope. I have been assigned to the three of you to guide your development."

"The three of us! Where is Nemo? And who is the lucky third?"

Penelope pointed across the room. Na had been so preoccupied with his new body and vision that he had failed to recognize the identical robotic designs described to him previously. "I was just about to activate them. The name of the third is Ulixis. She is – or, was – an older senior member of Regional Council #39, who tired of politics. Her psychological profile complements yours and Nemo's quite well. And her political acumen could prove … useful to you."

But Na's mood soured with Penelope's innocent words. "Activate them? Manipulate them," he grumbled. "Are you free to turn us on and off without our consent? I do not relish waking and sleeping on command."

"My dear, dear mister Na. You know the rules as well as I. The external activation controls will be eliminated, and your internal control set and sealed, only when training here has been completed, and you are in your spacecraft form. We do not want any maniacs running amuck in the medical complex now, do we?"

Na decided that Penelope was right that she shouldn't be compared to Coel. At least she was honest. "My dear, dear Miss Penelope. Of course we don't. Now, why don't you *activate* the others?"

Penelope slapped a tentacle on the hard, rough floor. So reys had no manners after all? But she might as well try to get along with Na. They had megumags of work to do, and her term report depended on it. She straightened, kooed stiffly, then slithered across the room where she waved a set of suckers across a coded sensor on the wall.

Nemo jerked to life, reeling dizzily. Ulixis stirred, then struggled more slowly and cautiously to gain orientation. Two of their eyes met, then spotted Na across the room. Without speaking, the three newborns staggered toward each other, grasping with outstretched tentacles. Penelope scampered clear to watch from a safe distance.

"Na! Is it really you?" Nemo gasped. Then, squinting with a single eye toward their companion, "And what – who – are you?"

"My name is – was – Ulixis … I think," replied the third awkwardly. "Yes of course … everything is swimming. I am so – bewildered – no, disoriented."

"You should restrict yourselves to familiar senses initially," Penelope interjected from a corner. "I am Penelope, here to help you through this transition period. First cloak all your eyes, and relax." The three obeyed dutifully, relishing the sudden calm. "Now try to open a single eye. That's it. Only one, Nemo. Close, reopen. Good. Next try a different eye …"

After several nims, Penelope moved closer. "You are all doing very well, but I feel a review of some summary information would be useful at this point." Na, Nemo and Ulixis stopped what they were doing, and gave Penelope their full attentions. "There are twenty visual packs evenly distributed over each of your frames, at the vertices of a circumscribed regular dodecahedron, providing an unlimited field of view."

Na winced, then interrupted Penelope. "How is it that I understand what you just said? You used terms I didn't know as an organic."

"If you recall, you agreed to have critical new knowledge planted in your synthetic memories. The information, which includes everything I plan to cover in this session, is already available to you; you need only to access it. My goal here is to direct you to specific details that will help you adapt to your new bodies. Any other questions?"

Penelope paused for a few nocs. "Good. Each visual pack contains a number of receptors and transmitters. There is an electromagnetic eye, with nine broad primary colors, covering radio through high-energy x-ray. This instrument is capable of fine spectral discrimination, when needed. There is an acoustic eye, with three primary ultrasound colors, plus an aural organ responsive to a wide range of low-frequency sound. Of course, the acoustic mechanisms are non-functional in the vacuum of space."

Na and Nemo exchanged glances. Did Penelope really think they didn't know that already?

"Each of the various eyes can transmit as well as receive, over a wide range of frequencies. For example, the acoustic and electromagnetic eyes can generate beams of ultrasound and light for illumination. They can even produce intense laser-like beams for cutting, probing, and a variety of other uses."

This time Nemo interrupted. "Could we try that now?" He sounded a bit giddy.

"I advise waiting until you have better control of routine functions. Where was I? Oh, yes. The aural organs can be used to both generate and hear ordinary low-frequency speech. So far, you have each been using only a single aural output channel, corresponding to your original bellan." Penelope paused, and glanced at Na. "Or bellon, as the case may be. You each actually have access to 24 output channels, plus 24 aural receptors. Some metons are able to simultaneously carry on multiple conversations. Of course, this takes some practice."

Na wasn't sure he wanted to split his attention, or his mind, in such a manner.

"Two of the packs on opposite poles include a single neutrino eye. These are usually inactive, and opened primarily for long-range communication."

Ulixis tried to activate one of these eyes, but failed to register any input. There should have been a torrent of neutrinos from all directions, including a tasty sprinkling of encrypted messages. Then she remembered that compact neutrino receivers required a matter-energy converter, which she did not yet have.

Penelope continued. "Each visual pack is surrounded by a ring of charged particle sensors, capable of selective electric charge and energy perception. Distributed throughout your synthetic bodies are millions of microscopic somatosensory receptors. These include proprioceptors, and sensors responsive to pressure, temperature and pain. Although you each possessed analogous receptors in your flesh bodies, the correspondence between sensation and point of origin has been altered, and the new map has to be learned."

Na spoke up. "Yes! I keep thinking sensations from one of my new tentacles is coming from my old left wing." He tried to koot at Nemo, but it felt … so strange. In addition to the intended sound, he was unconsciously producing electromagnetic radiation.

Penelope seemed to read his mind. "The other emissions are necessary; remember, there will be no sound transmission in the vacuum of space. The meton version of a koot is commonly called a *koom*. Similar modifications apply to the expressions of other emotions."

And so Penelope led the trio through the long process of integrating their new senses and motor functions into conscious control. It was slow and tedious work, yet fascinating and exciting, not unlike helping an infant learn to walk. Although these three could already use a few of their eyes and limbs, it was still necessary to extend the prior abilities to expanded but analogous systems.

Once they learned the routine, Penelope's students thoroughly enjoyed themselves. They were children again. Na vaguely recalled the pure joy of practicing complex flying maneuvers as a youngster. There was no hunger now, though Na did experience fatigue when his power supply was overtaxed. The trio would not have known that Penelope occasionally deactivated them to catch some rest, had there not been a clock on the wall. The time jump caught Na's attention whenever they were reactivated, in precisely the same positions and mental states as before. Na was annoyed, but swallowed his pride. What choice did he have? Though Penelope might at least ask.

Over the next kew, the three learned to use their new bodies quite effectively. Na now spent most of his time reading voraciously in an adjacent library room while Nemo, Ulixis and Penelope exchanged life stories. Although it was technologically possible for Na to directly implant any desired block of information into his mind, the standard restrictions on mass data transfer applied to biological and synthetic beings alike. Na was obliged to acquire routine information under his own conscious control. Still, the scanning technique he employed was terribly fast in ordinary octan terms.

Na was engrossed in an intriguing account of the civilization on planet Aerth, when Penelope rudely cut into his communication pathway with a blunt pronouncement. "It is time for a practice session. Everyone to the simulator."

The simulator! Penelope might be forgiven her discourtesy this time. Nemo had regularly used the device to vacation with friends when he was an organic creature. But Na had not been allowed to join, as his mind had not yet been sufficiently mapped. Na disengaged from the reading machine, and skittered through the doorway to catch up with Penelope and the rest of her entourage.

"Na, you decided to join us," Nemo beamed back. "I feared you were too preoccupied."

"After the tale you told about your last trip? I've never heard of a more fantastic world."

"Of course, this trip will be considerably more mundane," Penelope interjected. "I will feed in an image of the star swarm near the galactic core. You will practice negotiating the complex environment."

Nemo winced, as he sensed Na repress a surge of anger. His friend was becoming more and more irritated by Penelope's domineering style. It will be good to get out of here, he thought to himself. "Do not worry, Na. We will generate something unexpected." But he wondered just how much self-control Penelope would permit.

Penelope pointed to portals at the end of the hall, and Na clambered through one of them into a claustrophobic cubicle. The port closed behind him, as the acoustic lights dimmed to an utter blackness, and a soothing fluid flooded the compartment. Probes gently locked into place around his base and body surface, including each of his visual packs. External sensory input faded, and Na felt himself float away.

He awoke with a start. Stars! Na hung in a void, overlooking a blurred swirl of iridescent suols, impossibly remote. In the distance, two silver spherical forms glided swiftly in his direction. Nemo and Ulixis? This was much too real, more disconcerting than he had imagined. He was once accustomed to falling through an endless cloud-studded sky; but simply floating like this, seemingly motionless, in an immense – and imaginary – nothingness was something else. Exhilarating, perhaps?

"Na! Interesting place to meet." Nemo's distinct electronic voice was a welcome sound.

"Nemo! How is it that you are feeling so well? I would have thought you would be a bundle of nerves, exposed like this."

"Ulixis and I pre-medicated just before the simulator was activated, with an acrophobia channel block. I like to think we will be able to wean ourselves from it before we really do leave the hospital."

"So what now? We seem to be thousands of light jopes from anywhere. I thought we were going to visit the galactic core? Or at least a simulation of it."

"Whenever we are ready," Ulixis broke in. "If we slip into sleep state, we can arrive at the outskirts of the star swirl in moments, from our own conscious perspective. If this were the real thing, we would be awakened at any point in the trip if the need arose."

"Well, I'm ready." Na chirped. "Though I think I'll enter slow-consciousness mode instead. I want to watch the stars approach."

The trio willed themselves into the appropriate mental states, and accelerated toward the misty cloud of pallid white. Fascinated, Na watched as the fuzz ball grew in size, and individual stars materialized as brilliant pinpricks of light. Changes that would have taken many jopes in real time took only nocs of apparent time. A few errant, lonely stars passed by in the distance, as the main body of the galaxy resolved into great spiral arms of millions upon millions of stars. The ersatz travelers headed directly toward a bright condensation at the nucleus of the system. Isolated globular star clusters, each containing hundreds of thousands of stars, swept majestically past. Nemo and Ulixis awoke, and the trio decelerated in unison. Almost simultaneously they burst into the galactic plane, and were surrounded by a myriad of stars – mostly faint white and red dwarfs, but also thousands of bloated, brilliant, and much more obvious red giants and supergiants. And there, at the edge of sight, lay the dust-shrouded core. Na's infrared vision pierced the sooty vacuum, to reveal a swarm of old stars revolving relentlessly around a hidden central mass – a grandmother black hole!

Hugging the hole was a swirling accretion disk, glowing menacingly as dust and gas poured into it, pulled toward a crushing fate at the bottom of the galaxy's gravitational funnel. Even now the x-radiation levels were rising significantly.

The three travelers slowed to a crawl.

"We had better not go any further," Ulixis warned. "There is little we can do with a monster like that."

"Maybe not," Nemo replied, "but how would you like to try a normal black hole? There is one of only a few suolar masses, one-seventh light jope away at direction vector 35/122."

"Ride a black hole? What a fascinating idea." Na pondered for a moment. "First tell me, just how seriously is Penelope taking this? She wouldn't override my choice of pain cutoff, would she? In case I slip up, and find myself trapped by the creature?"

"I would not be concerned about that. It is against official policy, since it would not be realistic. If you actually were trapped, you would hardly hesitate to desensitize your pain receptors before the end came."

"This opens up all sorts of possibilities," Na beamed coyly, then dashed off in the direction Nemo had specified. Surprised by Na's abrupt departure, Nemo and Ulixis quickly followed.

When Na awoke nearly one simulated jope later, the black hole system glowered dead ahead. Na swerved, and approached from a direction perpendicular to the plane of the accretion disk, a diminutive arrow aimed toward the empty inkblot at the heart of the beast. His circuits pulsed with excitement.

What was Na up to, Nemo wondered feverishly. He thought he sensed a devilish koom in Na's electronic signature. Na wasn't turning away!

Na winced as he felt the tidal forces build across his hull. He deadened pain perception, to allow himself to concentrate on his surroundings. Already the radiation levels were beyond his ability to measure, but onward he shot. The distant stars appeared to bunch behind him now, turning incredibly blue, then ultraviolet and beyond. Finally his frame stretched past the breaking point, and both body and consciousness evaporated into a formless singularity.

Nemo blinked as his friend receded down the black hole. He thought he heard a deepening "Wheeeeeee" from Na's direction, but decided this must be some strange electromagnetic effect. Na would never actually hit the singularity at the bottom of the pit from Nemo's current vantage point; his apparent motion would slow interminably, while his image reddened beyond recognition.

Nemo and Ulixis looked at each other in puzzlement. Then, Ulixis grinned. "See you on the other side!" she shouted, and plunged into the dark pool. The other side? What did she mean by that? But Nemo was not far behind.

A few blurred thoms later, the training was complete. As the fledgling metons trundled along a tunnel toward the final transformation facility, Na slid close to Nemo, and spoke to him through a private communication channel. "Ever since our adventure in the simulator, I have been waiting for Penelope to scold me for my behavior there. But she hasn't said a word about it!"

"Like I told you before, she is only following policy. The simulator is meant to be a safe environment for meton recruits to freely experiment with their new abilities."

"Who knows – the time may yet come when one of us has no choice but to confront death. We all need to know how to handle that kind of situation."

"We should plan to always keep updated backup copies of our minds stored in some safe but accessible location, to allow us to recover from such a disaster."

Na, Nemo and Ulixis soon arrived at their destination. They were deactivated for the last time, and brought to a large assembly hangar atop the medical complex. A team of technicians extricated their synthetic brains from the temporary robot frames, and carefully carted them to imposing spacecraft bodies waiting nearby. An iris diaphragm ponderously opened near the base of each of the gleaming silver hulls, and the brains were deftly inserted into protected cores deep within. The unit supervisor held zor breath, as zo commanded the systems to life.

Na opened manifold eyes to a world of seemingly endless opportunity as the technicians hastily sealed his conscious control centers, removing all external access lines. His remarkable visual experience encompassed the entire environs. How small the octan workers seemed. Like ents, scurrying around inside a wall void. On a whim, Na tested his chameleon response. His skin instantly turned pitch black, as it sampled the light and sound falling on it. Suddenly Na became eerily translucent, then began to shimmer in and out of visibility, as the skin generated its own compensatory emissions.

Na excitedly ramped up his Drac generator. He forced himself to regulate the outflow of mass energy, lest he overload the channels into the global vacuum, or inflict Drac sickness on the organics in attendance. Still, the swelling Drac field sent waves of gravitonic distortion into the surroundings. The nearby organics were ready for this, and clung to any available hold, as a swelling hum resonated through the hall. Na's net mass dropped to 50%, then 10%, and finally 1% normal. Now Na flexed his internal Xam drive, the most powerful and versatile known to octos, and felt it surge to his command, as he balanced external forces to lift upward from the floor and hover in the air. At last he was free and self-controlled! No longer would he wake and sleep on command. Na was whole again. But even as he and his two companions relished their new status, the tension in the assembly area heightened. The octo organics were always nervous at this stage, to be in the presence of so much raw, uncontrollable physical and mental power. It was nigh time to go.

An elite group from the Colonial Council rushed in, and hurriedly briefed the trio on relevant classified matters. Their two local missions, previously agreed to in general terms, were now detailed. An abbreviated ceremony followed, during which a matron of the medical staff offered the three her best wishes.

Nemo spotted his old mate Rafu, clearly unnerved, crouched in the back. He beamed a brief but warm farewell, using a private code from childhood yads in their birth hive.

Rafu replied in kind, grateful for his friend's thoughtfulness, then slunk away into the shadows. There he nearly collided with Ikta. She must have hurried from the Return Ceremony for the original Nemo. "You decided to come, after all."

"Yes. I can barely believe all this is happening. Did you see him? Or should I say *it*?"

"It is hard to believe that daunting creature is now our Nemo." Rafu paused briefly. "How was the Return Ceremony? Are you glad you attended?"

"Yes, of course. It was very … moving, and helpful. I am glad that Nemo chose to have it at the Temple Acadomia. Why did you choose not to go?"

"We are different, Ikta. Unlike you, it would not have helped convince me that our friend has moved on. I already know that Nemo is now out there …" He pointed toward the three ships.

Whereupon the hangar roof laboriously opened, exposing the naked sky.

Upward the triad lifted. Watching from an isolated corner, Penelope trembled – for herself; for her former wards; and for her race. She had become so fond of the novice explorers, though she would never let on. She knew that someyad she would find the nerve to become like them, and exchange her flesh for synthetic skin and a daring new world. Someyad.

Na couldn't help but think back to the time he had flown, a frail and naked creature of flesh, through these same realms. At the mercy of the currents. So long ago, it seemed. He knew it had not actually been that long, that his misperception of time was a memory distortion improvised by the Neuro Board. A vague recollection of a mighty storm flashed through his mind. How could that distant tragedy have been the best thing that ever happened to him? Personally, if not for his tribe or family? He quickly repressed a nagging sense of terrible loss. To have fallen so far from grace, only to rise so high now. Yet without the falling, would the rising have been possible? Na chuckled inwardly at the recollection of an ancient proverb: *whatever goes down, must come up.*

The trio rose rapidly through the uppermost layer of clouds. Drenched, Na instinctively tried to shake his wings, only to realize his wings were no longer there. He pinched himself from within. This was real! The general diffusion of light radiating from overhead concentrated into a brilliant focus. Na gaped as warm, radiant Suol resolved near the zenith. His protective inner eyelids automatically closed, their triple-layered filters allowing him to clearly behold for the first time the Eye of the Blessed Mother. Though he now knew it to also be a distant ball of hot plasma, he still held Suol to be Coel, a hallowed embodiment of Maddee. Whatever Its ultimate purpose, personal or not, the Spirit of the World was such that Suol did shine and give life to Her children. Na choked on ancient emotion as he increased the optical magnification, to see for himself that Coel indeed had imperfections – suolspots, prominences. What he had read in the octan libraries was indeed true. But the apparent faults only made Her more perfect in the greater scheme of things.

Na slowed to a stop, transfixed as he stared through the dense filters. Instinctively, he shifted to the two-eye vision of a rey. Struggling for a more direct view, he forcibly lifted the outermost filter. That was better, more real. Though he knew he shouldn't, he lifted the next layer. Now his eyes tingled under Coel's hot touch. Heedless of the risk, Na threw off the final layer. He stood naked at last before Coel, basking in all Her glory. Na felt a kind of religious ecstasy even as his eyes melted in a torrent of searing pain. Passing through the wall of agony, his vision dimmed into an utter blackness, and his consciousness entered a calm stillness he had never known before. *What is whole, is empty; what is empty, is whole.* Na could still feel Her warmth on his metallic skin. It was a sensual experience, even sexual.

Nemo became more and more concerned about his friend as Na came to an abrupt halt and began staring at Suol. Na had apparently turned off his communication circuits, and could not be roused. But then, when Na began to remove his protective filters, Nemo really began to panic. Had there been a serious error during the mental transfer process? Was Na in fact insane? Or was this just another quirk of his strange rey psychology? He still couldn't figure reys. They seemed fearless of height and depth, of the great open spaces, even of the greatest abyss of all: death. Nemo turned to Ulixis in desperation. Reading his mood, she whispered three words inside his head – "the rey religion." Suddenly he recalled the mystical significance Suol held for Na, and thought maybe he understood.

After all, Na was not in any real danger. Most of his optical system was still intact, apparently deactivated at the moment, and the damaged visual packs could be easily repaired. But it would cost them precious time. Time? Nemo mused. Time was something none of them would have any lack of from now on.

Na awoke from his trance several nims later. Reactivating his overall visual system, he turned slowly to Nemo and Ulixis, hovering patiently nearby. "Have you … seen Her?" he asked in a whisper. His companions signaled silent affirmation, using the ancient sign language normally reserved for situations requiring strict secrecy. Without another word, Na set about rejuvenating his damaged eyes.

Leaving the clouds far behind, the trio soared past the inner Jopian moons, on their way to the inner suolar system. Attention had turned to the upcoming mission to planet Aerth.

"How are you feeling about your part in the mission?" Nemo prodded Na.

Na hesitated. "Fine. Why should I be concerned?" A slight oscillation in his voice betrayed his true feelings.

"Is it that bad?" Ulixis needled.

"Can I hide nothing from you two? All right, I am nervous. Though I feel prepared, I've never had direct experience with anything like this. Practicing on the simulator was helpful, but this is the real thing. Frankly, I think the plan laid out by the Colonial Council is … bizarre! I'm barely convinced that it's wholly ethical. There are already simions who believe aliens have had a covert hand in much of their history. If anything goes wrong, couldn't our mission just add credence to their paranoia?"

"Very few simions share that belief," Nemo offered, "and they tend to be blatantly non-scientific, blindly interpreting evidence in terms of narrow, preconceived notions. They look at an ordinary meteor crater, and see evidence for ancient alien weapons! Those simions seem to have an inferiority complex about their own species, and a need for a simple explanation for a complex world."

"It is ironic that they *are* correct about alien influence in a small fraction of cases," Ulixis pointed out.

Na sighed inwardly. "In any event, the simions seem so strange overall. The species is so advanced in some respects, so backward in others. At least the females suckle their young; this is something I can relate to."

"Perhaps I can provide some insight on the simion persona," Ulixis offered. "I have studied simion society for the past jope, as an adviser to the council. The simions have acquired scientific and technical knowledge about as quickly as expected. But the predicted parallel developments in philosophy, ethics and theology have not occurred. Our scholars have had difficulty understanding this dichotomy. Both octos and simions are intelligent and goal-oriented. But the simions seem shortsighted, more interested in developments that improve their immediate physical comfort, social status and security than those that advance their fundamental understanding. Morality is seen more as a means of promoting order and stability, than as an expression of fundamental truth."

"I thought the difference in orientation between octos and simions could be traced to divergences in our racial histories," Nemo interjected.

"That is the current consensus," Ulixis continued. "Octos are herbivorous, and have never hunted or preyed on other animals. We have always been manipulators, not predators. We manipulate the organic plant matter around us to build our homes and hives. We manipulate the ideas we encounter to comprehend our universe. We manipulate the laws of nature to improve our standard of living and expand our domain. And we manipulate each other to weave our social fabric.

"In stark contrast, the simions are tribal predators by nature. Their intelligence and collective behavior evolved largely in response to the demands of the hunt. Even today, they continue to prey on other conscious creatures for sustenance. They prey on the laws of nature to conquer and subdue their world, rather than to live in harmony with it. They make war and prey on each other to protect and promote their respective tribes. Any philosophy, ethical system or religion that counters their predator instincts and blind spot is suspect, even doomed. Only over the last few hundred jopes have evolutionary pressures begun to de-emphasize the predacious aspect of simion nature, as plant agriculture and other nonpredatory activities have become more important to simion survival. But the ancient trait is self-perpetuating, and dies hard."

"Some octos have advocated that we quarantine Aerth," Nemo cut in. "They would secretly impede simion technological progress, and sabotage the simion space programs, to keep the Aerthlings planet-bound."

Now Ulixis turned to address Na directly. "Octos have had terrible difficulty relating to the peculiar predatory tribal nature of the simions. Our ancestors wrongly interpreted it as a variation of their own manipulative character. Na, you were chosen by the council for this mission because they hope your rey personality will better relate to the simions. Though not predators, reys are tribal and readily kill to protect their own. Octos instinctively withdraw from any physical assault, and tend to shun physical violence even when it is appropriate and ethical. This behavior dates back to the early yads of octan evolution, when our primitive ancestors hid from the serpents among the floating plant masses. Octos since that time have known no effective predator. We have no need or desire to kill or harm others – only to manipulate them, in a reciprocal manner of course."

Na wryly wondered how it happened that the thicket serpents were now practically extinct. "I suspected this was the council's reasoning in selecting me," he sighed, "though no one would directly tell me so until now." The inability to deal effectively with their intelligent simion neighbors seemed to be a particularly sensitive issue with octos. Na turned to gaze at Aerth, now a distant bluish-white orb hanging in the sky before them. What had he gotten himself into?

It was a sultry summer night in rural New Angland. The cruckets and katydads chirped incessantly, accompanied by a chorus of tree froads, and joined occasionally by a distant whippoorwull. The meton known as Na descended stealthily from a moonless sky, guided only by infrared and radar eyes, the hum of power banks barely discernible. He (it?) came to rest about fifteen rets east of an old white frame farmhouse, in a rectangle of tall grass and weeds backed by grandfather sugar moples and towering pinee trees.

An iris diaphragm opened near the base of the spacecraft hull. A black silicone tentacle hesitantly poked out, then slowly snaked through the damp grass, toward the still house. There it angled upward, noiselessly scaling the wood clapboards to a window on the upper floor. The tentacle probed the window screen, then ripped a tiny access hole in its corner. At last it penetrated a dark bedroom. Rhythmic breathing of two sleeping adult simions could be heard from the far side, mingled with the precise ticking of a phosphorescent alarm clock. But the muffled sounds of a male infant, asleep in a wooden crib, came from only inches away. Na had recently begun to protectively refer to the targeted child as "Simmie." He had been selected nine Aerth months earlier, following a routine birth at a local hospital. The youngster appeared intelligent and healthy, and the isolated location of his home was ideal.

An anesthetic gas began to hiss from a pore at the tentacle's tip. Slowly at first, then more rapidly, it flowed and spread through the room, then on through the rest of the dwelling.

All occupants succumbed: the baby and his parents; the grandfather in an adjacent bedroom; two older brothers in a third bedroom down the hall; and three furry four-legged pets on the first floor. None would awaken before dawn. Experiments with anesthetics performed kilujopes before on more primitive Aerth animals had proven their worth again.

One roh had passed since the tentacle broke into the room. Now it moved again, crossing the floor, then climbing the side of the crib, straight toward Simmie. Up and over the railing, it dropped onto the unconscious simion, coiling around him again and again. Its burden secure, the tentacle began to draw the infant across the crib, back toward the night. It heaved its prize over the railing, onto the windowsill. The screen ripped open with a snap. The parents would wonder at the tear in the morning, but they would soon dismiss it. Down from the window the baby was lowered, into a narrow flower garden, with an unintended thud. Once on the ground, he was dragged over the dirt and through grass, toward the ship. Simmie's right side would be bruised, but it would heal. The child was strong.

The opening in the ship's skin widened briefly to admit the wee Aerthling, then clicked shut. Inside, the subject was laid upon a narrow siliceous table in a tiny cubicle maintained at Aerth-like conditions, and physically immobilized with restraint straps. A dense network of electrodes was speedily attached to his head and spine by several short, artificial arms extending from the chamber walls. Biocircuits were checked; all was ready.

Borrowing from conscious transfer techniques, the octos had learned long ago how to partition a simion brain into two minds. This was the current objective. If it was unethical to simply take over Simmie's mind, the planned partial, gradual incursion was considered justified by present need. Na's memories and personality began to feed into the child's cranium, together with selective stimulation to counteract the systemic sedative. The mental wall between the two minds was not perfect, however. Assaulted by echoes of mature and alien thoughts, Simmie awoke into a bewildering dream. Additional tranquilizer was administered when he began to thrash about on the table. His body was calmed, but some mental shock was unavoidable. Gradually an accommodation developed. Na found himself awkwardly blinking unfamiliar eyes, staring out of a simion body, even as a separate and distinct Na oversaw the transfer process. Na was now two.

At this point a mysterious, sealed cassette Na had carried from Jopitar began streaming its own contents into the infant. A shadowy anatomy of purpose filtered through the bioelectronics to the Na within the child. He saw in his mind three perfect silver spheres, rising from the ruins of a late Bronze Age kingdom 270 jopes earlier. They sped away over towering mountain peaks to a hiding place in the abyssal trenches of the oceans to the east, to watch and wait. And wait. A tear trickled down a cheek of the sleeping baby.

Which was the real Na – the partition inside the simion, or the meton? Each now shared a common personality and set of memories. Just as a single cell may divide into two, so Na had split into two distinct selves. When the bionetwork that linked them was severed, they would be two individuals, leading separate lives and facing distinct futures. There would be no mystical future unity of consciousness, simply because they shared a common past.

However, if the brain were left in its current state when Simmie awoke, the child's psyche would be quickly overwhelmed and dominated by Na's mature personality – an unacceptable outcome. The brain was therefore now flooded with selective waves of repression. Na's intruding personality retreated to a cerebral backwater, where it would sleep and dream, almost but not completely cut off from everyday life. It would gradually reawaken with time, to integrate into the other maturing personality as needed, as its purpose demanded, without violating the personal integrity of its host.

What purpose? As Na was locked off in the infant's brain, he felt a latent presence from the secret cassette. A grey box – contents obscure, part of the price he had paid for this opportunity to forget, to flee the memories that haunted him. He searched for a purpose within the filtered message. Was he to observe? To report? To manipulate? But his vision dimmed, and he sank into a relaxed oblivion within the unconscious child.

The transplant was complete. Na the spacecraft carefully removed the electrodes, and gently washed the baby with tepid water. After wrapping him in a protective sack, Na opened a passage through his hull and lifted the precious load outside, then began the deliberate journey back to the house. Na left Simmie on the floor beside his crib, curled in a fetal pose in his crumpled flannel blanket. The parents would find him there asleep in the morning, and think he had tumbled out of the crib in the night.

The long tentacle retracted into Na's meton body as the first hints of twilight touched the sky. Na rose in silence into the brightening vault, and flew away to the east, leaving his handiwork to the fates. Ragged crimson clouds heralded the coming dawn. As Suol broke the curved horizon, Na beheld what he sensed would be the last planetary suolrise of his birth star that he would ever see. But he did not linger. He had an appointment to keep. Even now his two companions waited near Aerth's solitary moon, high above a crater the simions named Aristorchus (in honor of one of their ancient philosophers?) on the shores of the suol-washed basin they called Ocean of Tempests. Rather dry this time of jope, he kooom-chuckled. Suol's light was so intense in these environs! Then Na turned attention from Suol, to the bright star field opposite in the constellation Sagittarios – their ultimate destination. The meton trio would leave the suolar system, probably never to return.

But that would have to wait; there was one more task for the metons to fulfill before embarking on their odyssey. The simions had launched a spacecraft on a problematic mission of exploration to Jopitar. After Na rejoined his companions, they set a course to intercept it. Several yads later the team approached the slow alien craft, still several thoms from its own destination.

"How ungainly that ship is," muttered Nemo. "Its innards are exposed, for all to see."

"Spoken with the aesthetic of a true meton," Na retorted.

"The design is actually quite functional, and weight-efficient," Ulixis offered.

"Look, the atmospheric probe is mounted at the fore end, just as expected," observed Na. "I still don't understand how the simions failed to see the importance of properly sterilizing it. If that vessel were allowed to penetrate Jopitar's biotori, dormant Aerth microbes ensconced inside might contaminate the Jopian ecosystem, with untold consequences!"

"Our home world is unlike anything Aerth scientists have encountered thus far," Ulixis suggested. "They find it hard to imagine that Jopitar might be capable of supporting life of any kind." Then Ulixis addressed Nemo. "Is the guidance unit ready?"

"Indeed," Nemo responded, as he extracted the tiny device from an inner compartment. "Does the Council think there is any chance the simions might detect us while attaching it to the probe?"

"Extremely unlikely," replied Ulixis. "The craft's cameras should be inactive at this stage of the mission. Still, we should maintain stealth mode. Remember, the simions are totally blind to our neutrino emissions."

Now Nemo moved ahead of his companions, and carefully approached the simion spacecraft. There he gently attached the guidance unit to the side of the atmospheric probe, then backed away. "Done!" he proclaimed proudly.

"I realize that the device is supposed to guide the probe toward an atmospheric 'hot spot' at the edge of our planet's equatorial zone," Na cut in nervously. Inside this unusually dry region of rapidly sinking gas, any microbes would be quickly plunged into a realm of extreme heat and pressure, and exterminated before they could do harm. "But what if the guidance system fails? I understand its propulsive force must be subtle, to avoid detection."

"In that event the unit can be remotely detonated by a local Council agent during atmospheric entry," Ulixis explained. "This should vaporize the probe, and all its contents. Though I doubt such an extreme intervention will be necessary."

This relieved Na somewhat. "Then I can only wonder what eager simion researchers will think of the unusual data transmitted back to Aerth from the probe's atypical path!"

Chapter 9

Nocturnal Reflections

Though still the brightest gem in the sky, Suol was fading toward anonymity as the trio raced outward through the tenuous cloud of icy cometary debris in the peripheral reaches of their native planetary system, toward an ambiguous future. The distance from their old lives and home swelled inexorably with each passing noc. Who could know if they would ever return? While Ulixis chose to sleep and dream secret fantasies, Na and Nemo shifted into enhanced temporal mode to pass the vacant time in conversation.

"Why were the octos so slow to recognize that the reys are an intelligent species?"

Nemo responded without hesitation, as if he had rehearsed his answer. "The odds seemed so small for even a single intelligent life form to evolve on our home planet. That two might independently evolve at virtually the same time was unthinkable."

"Yet viroids are known to pass genetic information between distinct species. Couldn't this explain a coevolution of octan and rey intelligence?"

"In principle, though it still seems too far fetched to me. And how do you explain the nearly simultaneous emergence of intelligence – as it were – among simions on Aerth?"

"I find it somehow comforting to know there are still so many puzzles and mysteries."

"That reminds me, Na. How are you doing with your project?"

Na had decided to prepare a treatise comparing the philosophies and religions of octos and reys. Since there was still scant formal documentation of rey beliefs, and Na was a rare expert on the subject, it was a natural undertaking. Nemo would review and edit the work, to make its format more academic. The final product would then be transmitted back to Jopitar. "I was hoping to discuss with you octan views concerning animal consciousness. The literature is pretty perplexing."

"There was so much confusion historically. Our ancestors first believed that both animate and inanimate objects possessed their own unique conscious spirits, so animal awareness was nothing special. With the scientific revolution, consciousness of inanimate things became superfluous, but then animal consciousness became an enigma. It was attributed to all sorts of bizarre things – a small organ in the brain stem, a threshold level of brain complexity."

"But inanimate processes occur that are every bit as complex as a thinking brain."

"That did not stop philosophers from trying to define an appropriate type of complexity. Logicians finally demonstrated that the very concept of content without awareness is meaningless; that every meaningful aspect of every meaningful thing, whether a star or an octan being, must partake in some sort of consciousness."

"I understand that Fleegello once said, 'If the inanimate universe has no consciousness, why am I not unconscious as well? If the world is just an automaton, why am I not an automaton too?' "

"Indeed. Yet we know individually that we are *not* automatons."

"Then the ancients were right? Inanimate objects are inhabited by spirits?"

"Not exactly; our ancestors believed that every distinct object – a favorite pruning tool, a totem pugroote – had its own, separate consciousness. Our current paradigm holds that the entire physical panuniverse collectively shares a single, coherent awareness."

"This is a bit like rey beliefs. While reys speak as if the clouds, the rain, the wind are individually alive, their awareness is unified in a supreme Mother/Father/Other Spirit."

"And the purported origin of this Being?" A touch of sarcasm tainted Nemo's question.

"You know that reys don't normally worry about such things. The essence of Maddee is shrouded in Holy Mystery, to be experienced and not analyzed. I appreciate that most octos aren't content with this attitude." An inactive comet swept by in frigid silence 70 bevurets away. Its faint glimmer in Suol's anemic light barely registered in Na's awareness. "The set of all consistent abstract relationships – that's what octos believe to be the content of the physical universe, isn't it? Where is our purpose in this? Are we all just accidents in an impersonal cosmic rhyme?"

"What is so terrible about that? Is it not ultimately more empowering to grasp a humbling truth than to believe in a self-aggrandizing lie?"

"Yet isn't the physical universe supposed to be only a subset of a still larger conscious field? One that recognizes all consistent truth, including the physical generation of unique animal consciousness, with all our dreams and nightmares, joy and pain?"

Nemo would have nodded agreement, if he could. "The octo *Dama*; the philosopher's *Consistency Ideo Field*. The timeless omniscient One, with myriad faces. Now the nurturing Mother, then the demanding Father, so often an impersonal It fulfilling a cold but irrepressible abstract will."

"This is not unlike the rey vision of Maddee. Yet Dama seems to me much more abstract and impersonal than Maddee."

"I must admit, there have been times when the standard concept of Dama was too impersonal even for me. I would then fall back to the ancient name *Alleh*, referring to a more personal vision of a masculine monotheistic God, from an earlier era. I find that this name can have more emotional resonance, though its use has long been out of favor among most octos. It is most commonly used in the more traditional hives."

"I too sometimes revert to the ancient, female name for our universal spirit – *Mallah*. Reys use this name sparingly." Na peered at the frozen pattern of remote and aloof stars that threatened to entomb them. He felt a disturbing tug back to the familiar safety and intimate purpose of a rey tribe, or even an octan hive. "You acknowledge Dama, yet still maintain that every aspect of animal behavior can be completely described by purely physical processes?"

"Octos distinguish between content that is actively responsible for its ongoing existence, and content that is generated by and dependent on an underlying stratum, most notably Dama. We refer to the former as *endogenous*, and—"

"Yes, while animals and synons have *exogenous* consciousness, and are known as *ectobeings*. I know all that. Still, if the atoms of the body and brain of an exogenous creature share such an intimate, holistic consciousness with the entire universe, how can a separate, unique consciousness be generated at all?"

"Are you familiar with ambiguous profiles? My favorite can be seen as either a white vase against a black background, or two opposing black octan profiles against a white background. Is either interpretation any more correct than the other?"

Na responded with suspicious hesitation. "Of course not. Both are equally valid."

"Just so, a physical brain can embody bounded content not inherent in its purely physical aspects, even while its behavior can be described solely in terms of physical processes. The whole is more than the sum of its parts. The new content field *must* have its own awareness, or it would not exist in any meaningful sense."

"What about free will? If I am completely determined by physical processes outside my unique awareness, am I then just deluded into believing that I control my own destiny?"

"Think of the ambiguous profiles again. Many aspects of your behavior can be alternatively explained in terms of conscious psychological processes, a unique will. While the description is not as complete as the physical one, it is just as valid where it works. You then have an *effective* free will, to the limited extent that your conscious will matches your personal experience."

"I know from my own experience that I am not just a mindless automaton. Still it is so difficult to understand this rationally." Na could recite the logical arguments of standard octan philosophy, but had not (yet?) fully integrated or accepted them. He decided to change the subject. "I am impressed that you were an editor for the Otkin-Utalk Project."

"Only a junior student editor. I was responsible for a rather minor area concerning early octan views toward nature and the physical sciences, mainly dealing with the Fleegello *Principia* manuscript. I cannot believe my luck to have been involved when the treasure trove of fresh material was uncovered from the ice at the deep archeological dig on Moon-3." Nemo squinted open one eye to see if he could still spy that cold mote orbiting his home world. He had been flying for the past few rohs with every eye tightly cloaked. No matter how accurate the flight simulators had been, they failed to convey the full reality of space flight. His conversation with Na was a calming distraction from a state of suspended animation. Through a half-open iris, Nemo located Jopitar and her retinue of moons with a sense of relief. What would he do when there was no familiar planet port to anchor his soul? Perhaps when Jopitar faded from view, Suol would serve the purpose for a time. He noted that his star of origin had acquired a subtle reddish tinge.

"And the stars ahead of us have grown slightly blue," injected Na. "Doppler effect?"

"Yes. Though I must remember to shield my thoughts when I want privacy."

"I seem to have much less trouble understanding octan physics than I do comprehending your philosophy."

"That's not too surprising; it is much more descriptive and concrete-predictive, as opposed to interpretive and abstract-analytic."

"In particular, why do octos insist on interpreting the probabilistic character of quantum theory in terms of parallel worlds? If I predict the probabilities of different outcomes in an experiment, and then observe only one of the possibilities, why not simply say the others did not occur? Why insist that during the experiment my world – including my own self – split into a multitude of parallel worlds, each with a different outcome in accordance with the predicted probability distribution?"

"Mainly for the sake of sheer logical consistency. The common early interpretation of quantum physics was in fact just what you propose. Though a famous scientist of the period is supposed to have protested that "Dama does not play dice." Consistency logic – the logic that most octos strive to follow, and that we believe Dama embodies – asserts that X=X for any and all arbitrary X. Logicians demonstrated long ago that this requires that all things be completely determined. But then the narrow positivistic interpretation of quantum physics is not acceptable. The only way a quantum world can be completely deterministic is for it to branch in time, and not remain linear as in the usual classic view."

"Here we go again! Doesn't X=X *define* what '=' means?"

"Initially yes, but thereafter you are free to follow the interpretation consistently, or contradict it. This is a moral choice. " Nemo koomed inwardly. Na still had difficulty accepting this notion. "The stated assertion of consistency logic assumes that '=' has already been defined. Of course you must also consistently interpret X as an object in its entirety, to avoid the confusion some mystics promote when they argue X≠X, by comparing two different aspects of the same thing."

"But if every thing must be completely determined, what about the initial moment of the physical world? What about Dama – or Maddee?"

"The most basic entities are endogenous, and must explain themselves, through themselves. This is the essence of the ideobasic philosophic and religious traditions."

"You mean, as in 'Dama is, that Dama is'?"

"Yes. Since the only meaningful existence lies in conscious awareness, then consistency logic must exist a-priori, or it would contradict itself."

"All right. But if our universe is continually splitting into multitudinous parallel worlds, how do you or I retain any kind of continuity of self?"

"A self at any given moment in any particular world is the end product of a history. A memory of this history, and nothing else, gives you a sense of continuity. You cannot access the memories of your alter selves in parallel worlds, because they are not causally available to you, through the patterns of quantum physics and the physical structure of your brain. Indeed, brain design defines the nature and limits of the parallel worlds for each creature."

"I still feel more comfortable with the positivistic interpretation. So much of your argument reminds me of a debate over how many angels can dance on the end of a thistle."

"How can you say that, when rey philosophy is so full of wild speculation?"

"Rey philosophy is mostly metaphor. It is meant to offer guidance in life, not to be interpreted in any strict, analytic way." Na paused for a moment. "Guidance in living, and in facing death. Truly, how analytic is octan philosophy when it comes to dying?"

This question did not outwardly faze Nemo, who responded in a matter-of-fact tone. "We choose to believe that a mortal individual can persist, as an endogenous being with its own independent time line, when the direct connection with the physical world is severed. As long as the will of the person is self-supporting, and explicitly seeks to continue. Of course no living soul knows for certain. The conclusion is a convenient application of logic, which cannot be verified, or known. Short of dying."

"But if the physical world is continually branching into endless alternative outcomes, won't there always be at least one line along which an exogenous creature will survive from one moment to the next? No matter how diseased or decrepit a body, how disastrous an accident, won't there always be some unlikely twist by which a person might survive? A person cannot find himself in one of the more likely worlds in which he no longer exists. I only hope I don't someyad find myself funneled into a progression of less and less likely worlds in which I remain barely alive and conscious, but am otherwise incapacitated and miserable."

Nemo cast a convoluted koom at Na. "Why do you worry about such things? Apart from disagreeing with your analysis, what could anyone ever hope to do about such an eventuality? At least take comfort that we all must face death, equally."

Na was confounded by Nemo's self-serving response. What ever happened to the pre-eminence of Truth? "What frightens me most about death comes from a personal experience as a young organic, when I became seriously ill with a viroid infection. I will forever remember the sense of loss as the disease sucked awareness out of my very being. If death is an extrapolation to total bodily dysfunction, then it must represent a complete extinction of individual being. It is difficult on a gut emotional level to accept anything else. Perhaps a lingering fear of death is why I finally agreed to become a meton."

"Yet you sleep regularly, and reawaken to full awareness. If your subjective personal time line can skip intervals of physical world time, why could it not split away altogether? When there is no longer anything binding it? The physical universe might not exist, yet it does exist, presumably on its own. There is no body, no external environment to sustain it."

"Yes, I know. But it's all so confounding!"

"I have distracted you from your project long enough. I think I will join Ulixis for a while, and clear my mind."

Nemo drifted off, but Na wasn't yet ready to work on anything. Instead he began chanting an ancient rey ballad, of the first rey hurled from the anvil of the Mother of all thunderclouds, facing an uncertain destiny in the dry, empty sky below. Gradually Na relaxed, and entered an expanded sensory state. He absorbed the full three-dimensional swirl of stars that engulfed him, and fell dumbfounded through the floor of the night.

Nemo had decided to slip into dream mode, rather than sleep. He was a child again, in the slumber den he shared with five brothers. A ragged hole in the wall caught his attention. Probably Cidie did it. Nemie crawled inside. A nest of ents had invaded the space. Saturated with ent secretions, the entire superstructure had begun to rot. Afraid the outer wall would cave in on him, Nemie squirmed past. More ents, more nests, more decay and stench, every way he turned. How, why had his father let this happen? Finally he made it to the end of a deep, familiar closet. Nemie leaned against the secure plastelle, and sighed relief. He liked playing here, in the cool darkness. As he moved the Zon toy along the wall, he felt a slight bump. His own private trap door, still hidden there after all those jopes. Nemie gently pried it open, and entered the secret passage, pulling himself upward through a winding tunnel. He paused only a moment to peer down through narrow slats at his parents, sleeping soundly in their cramped lair below. Nemie emerged at last into an ancient, sprawling attic, filled with dusty chests and sparkling treasures. But a small port in the far wall drew him to it. Nemo peered out, into absolute blackness. Frightened, he squeezed through the hole. Falling. Falling through inky black nothing. Why couldn't he fly? He should be able to fly. This was a dream, wasn't it? After all, the moon was in the wrong place in the sky. Moon? What was a moon? Nemo stared up from a cold resting place, at a stark crescent in an icy sky.

Pure White on Black
Pure Black on White
Timeless Being

Broken by the Prism
of animal awareness
into convoluted contours,
complexity unbounded.

Now becomes a memory;
the past invents tomorrow –
time is born.

Separation is unchained.

Chapter 10

Eternal Passage

Ki Que-Na had grown old. On this the completion of her 324th gyre of passages, the proud matriarch of the tribe Ki-Yu was already twice as old as the average rey lived to be. Yu had perished untold cycles before; he had simply disappeared during a storm, and his spirit returned to the male aspect of Being. Now a dull ache throbbed through Ki's body, and she knew she could no longer endure a great storm. The tribe had not even attempted a major storm run for the last few hundred cycles; it had not been necessary. But the manna had been inexorably thinning, and it was time to seek out new, more vigorous currents. Ki had promised herself when young that she would never be a burden to the tribe. To fulfill this pledge, she had announced at the last meeting of elders that this would be her final passage. She had also advised that the tribe take this opportunity to pursue a major storm, and attempt to pass over to a more reliable pattern of circulation.

Ki looked out over her people, lazily descending in an expansive spiral formation, and was nearly overwhelmed with a sense of gratitude. The tribe had grown exponentially since its shaky start. They had been blessed with plentiful manna, robust currents, and inspiring storms. Ki herself had given birth to 12 young, nearly double the usual number, and was directly related to a majority of the reys around her. Only one of her children had failed to reach maturity. Poor Nagdi had been unusually intelligent, but his wings were not quite right. Serpents had claimed him only one cycle after his independence. Perhaps in another world, there would be a place for those like him; but not here, at least not yet.

Ki spotted her great-great niece Olg on the opposite side of the formation, chattering with friends in a pod of pregnant females. After a 12-cycle term, she appeared over-ripe, and would likely give birth soon. Ki was saddened when she realized she would miss the child's independence ceremony, and was grateful for the distraction when a swarm of adults approached unexpectedly from below. The group was led by Pi Ki-Yu, the first-born of Ki and Yu. Though she had never admitted it to anyone else, including Yu, this son had always been her favorite.

Pi addressed his mother warmly, though with a warble of his own sadness. "Blessed falling, dearest Mother of us all. These are volunteers, who would like to form an escort to see you off on your pending farewell."

Ki beamed appreciation to all. "I am moved by your caring, though it would be unwise for such a large group to separate from the tribe in serpent territory. May I select three?"

Pi, slated to replace Ki as Senior Elder, was obviously relieved by his mother's practicality. "Of course. Though you will leave many disappointed devotees."

Ki addressed the assembly. "I would be honored to be accompanied by any one of you, but will choose individuals I feel would benefit the most from the experience." She paused, and surveyed the eager faces surrounding her. Several young adults with extra leadership potential caught her attention, along with a few impulsive adolescents. "I must warn you, to be separated from the tribe, even for a short time, may not be the thrill you imagine. The stories of our beginnings sound glorious, but the reality was also extremely difficult." She paused again. "I ask each of you to look deep inside, and ascertain if you are truly up to this undertaking. To panic at any time during the separation would jeopardize your entire party. There will be no shame, if any of you decide to withdraw your offer." As Ki patiently waited, a few of the youth reluctantly fell away. Ki then made her selection. Rather than call out names, she simply flashed bright pulses toward two childless females and one male. All three simply responded in kind. That was good, Ki thought – no obvious sign of gloating. "I thank you all! But now, if you would please excuse me, I have a birthing to attend." Ki hurried away, to witness the birth of Olg's first child.

Ki contemplated her own mortality as she waited for the community chorus to commence. The tribe was planning a tribute to her, and Pi had ushered Ki to a special position at the front of the formation. Vapors swirled past, as she gazed forward into the shrouded future. The worst part of growing old, she thought, more even than the chronic physical pain, was the forgetting. Sometimes when she failed to recognize someone she obviously knew, Ki would try to flow with the experience, rather than fight it. She would let herself see the person anew, as if they had just met. Ki still usually recognized those closest to her, though on the previous cycle she had failed to identify Pi for several awkward moments. She wondered how difficult all this must be for her son.

Shortly before the chorus began, Pi rejoined his mother. Ki slipped close to her son, and whispered. "Pi, you may not succeed at your first attempt to jump to a more favorable circulation pattern. If not, you must be persistent – learn from your mistakes, and try again. You will succeed eventually."

"Yes, mooma – I know."

"And it will probably be necessary within another generation for the tribe to split. This decision will be painful, but necessary."

"Yes, mooma – I know. You have taught us well." Pi pivoted, to look directly into his mother's rounded eyes. "Mooma, now is the time for you to let go. Please try to relax, and enjoy the chorus your children have prepared. You leave the tribe on capable wings."

The cantors launched into song. They recounted the story of the tribe's remarkable birth, starting with only three mating pairs. Ki was the last of the six founders, the lone living link with genesis times. The cantors sang of the tribe's growth, and of the challenges it now faced. The tribe had made the great passage to a new plume complex a few times before, but never without the guidance of a founder. Ki was confident they would succeed again, even if it took multiple attempts. She cooled her concerns, and let the classic rey rhythms and ethereal harmonies fill her soul. She was ready.

The tribe approached the manna feeding ground at a steeper angle than usual, as the reys prepared to seek out major feeders to the regional plume complex. Ki and her escort broke rank and dove downward at an even steeper angle. Strange, she did not feel panicked at all. It seemed somehow so familiar. The honor guard accompanied Ki for a moderate duration in silence. Then, only a bit sooner than planned, the trio deferentially flashed wing tips in unison, and rose rapidly away to rejoin the safety of their tribe. Ki watched wistfully as the youngsters left. They were so innocent and impressionable – just as she had been. How would they fare with the upcoming storm and attempted crossing, and the multitude of other challenges the tribe now faced? She knew the stories surrounding her early life and the founding of the tribe would be altered and mythicized by future generations. How would her own teachings be twisted and perverted? For what shortsighted, self-serving purposes? At least Pi would replace her as senior elder. Ki shuddered as she thought back to his sire's birth tribe, and its self-righteous authoritarian structure. They chose to believe they knew everything, to avoid the painful truth that they knew nothing with certainty. Ki felt so heavy. Was it Mallah calling her back to the womb? She had done all she could.

Ki sought the deep streams leading to the heart of a major river of fire. Summoning all her remaining strength, she would ride its circling currents upward, into the central maelstrom of water storms. If permitted, she would penetrate the great vortex that she imagined still raged there through the night. Then she would simply fold her wings, and dive into the waiting darkness. It would be easy to rupture her now-fragile buoyancy sacs. The ribbon serpents would not have her flesh. Ki would return her living substance directly to the manna that had sustained her so long. That which had given her life would now grant her death. She would at last rejoin her truest Love.

Chapter 11

The Trouble with Children

Ikta awoke from a dream, which she promptly couldn't remember. She felt Rafu sleeping softly against her, in their snug lair.

Rafu stirred, and cocked open an infrared eye. He couldn't see anything in the dark, so reached out with a rear tentacle, and turned on a dim infrared lamp. Then he gestured playfully to Ikta. "Hello, beautiful."

Ikta feigned disgust. "Now I know you need to get your eyes fixed. My bogleaf rash has only gotten worse."

"What woke you?"

"Some dream. I think it had something to do with Nemo's mincing ceremony."

"That was more than six jopes ago! It is remarkable that we both still think about Nemo at all." A look of recollection came over Rafu's face. "I remember how down you were, after the ceremony."

"And so," Ikta whispered slyly, "you offered to cuddle with me. Sometimes, I still wonder if you orchestrated the whole thing. You knew I was especially vulnerable just then."

"There was no planning; it just happened. And I am so glad it did."

Ikta snuggled closer against Rafu, and gently caressed him with her forward tentacle. "And so am I. Just think; without that cuddle, there would have been no Numo." She recalled with poignant fondness the yad little Numo, no larger than a bugaroo, had instinctively slithered out of her gestation sac, into her pouch. She glanced down at the withered pocket, just above her forward tentacle. She had carried and nursed him there for several thoms, before he was ready to crawl on his own. "Though I still remember my surprise, when I felt your ninth tentacle uncoiling against me. I had no idea you felt that way about me."

Rafu made a pleasant chortling sound with his bellan. "Neither did I, until that moment."

Ikta's mood suddenly changed. "And to think, that now Numo wants to become a meton himself! Just like Nemo, he cannot wait until an appropriate age. No, he even wants to leave us altogether, and head to the galactic core."

Rafu clucked sympathetically. "Yes, to search for our old friend, whom we have spoken of so fondly all these jopes. Our son realizes he was named after Nemo, you know."

"He is still childless."

"Again, just like Nemo."

"He could at least wait until he has sired a child. I just cannot understand it. No one in my family line has ever been motivated to undergo a transformation at Numo's age. He cannot have acquired a genetic predisposition from Nemo, since Nemo was not his father."

"You forget that Numo is already six jopes old, considerably older than Nemo was when he left us. Also Nemo and I were hive mates, probably distant cousins, so Numo may have inherited some adventurer traits from me." Rafu flexed one of his tentacles in a comical way.

Ikta lightened up a bit. "All right, he is six jopes old. Still, I cannot bear the thought of him leaving us like this. We will most likely never see him again!"

Rafu spoke softly. "You know, we could undergo the meton transformation ourselves. I know for a fact that Numo would not object to our joining his expedition. He may be a bit on the young side, but we certainly are not. I recall you saying long ago, that you would consider becoming a synon after your eighth birthyad. Well, we both hit the eight jope mark some time ago."

Ikta began to tremble slightly. "The thought is just so – terrifying."

"There would be no more pain. I know that everything hurts. You do not like to talk about it, but I can tell. You could even resume your old work. Think of the archeological treasures you might find, in the ruins of some ancient alien civilization."

"But as metons, we could never again snuggle like this. And what of Riema, or her mate, and our grandchildren? We would never see them again."

Rafu sighed. "Then we could become synocts, and stay here on Jopitar. Look, I have spoken with Numo about all this. Unlike Nemo, he is open to the idea of retaining his old organic body. I think Riema has already convinced him to do so; she knows how much her children would miss him. Then we would not really be losing Numo at all. But he would want to relocate to another Jopian district, and pursue a political career there. He would be thrilled if we moved with him. As synocts, we would adapt much better to such a move."

"Or we could stay here, near Riema and her family, and visit Numo occasionally. We would also tolerate travel much better as synocts."

"You could still return to archeological research, only closer to home. Perhaps you could join the simion study project."

Ikta made a soft cooing sound. "You always know just what to say."

Rafu reached back and turned off the light, as he and Ikta cuddled closer together. "Pleasant dreams, beautiful."

Chapter 12

Suspended Reality

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Nemo did not switch into enhanced time mode with the others. There was a problem in quantum dynamics he wanted to solve without being interrupted. It involved chaotic gravitational vortices, spawned by the numerous black holes that littered the inner galactic region. He would organize the equations and solutions, then stir Na into normal time mode to discuss their physical ramifications and significance. Na wasn't attuned to formally solving difficult mathematics problems, but had terrific physical insight interpreting the significance of the formulae. Although both Na and Nemo now possessed equivalent mental powers, their distinct personalities led their thoughts in different directions.

Nemo stopped for a moment, and impulsively looked back in the general direction of his former home. He tried to locate Suol, but it was lost behind a tangle of brighter stars and nebulosity. He momentarily felt disoriented, almost nauseated – no up, no down, only an endless sea of too-distant stars punctuating the empty vacuum that engulfed him. He still wasn't accustomed to the ultrasonic silence. Even the neutrino sky was mostly random noise, when he cared to look. Without his friends, Nemo was certain he would go mad. He decided to join them after all, and sleep.

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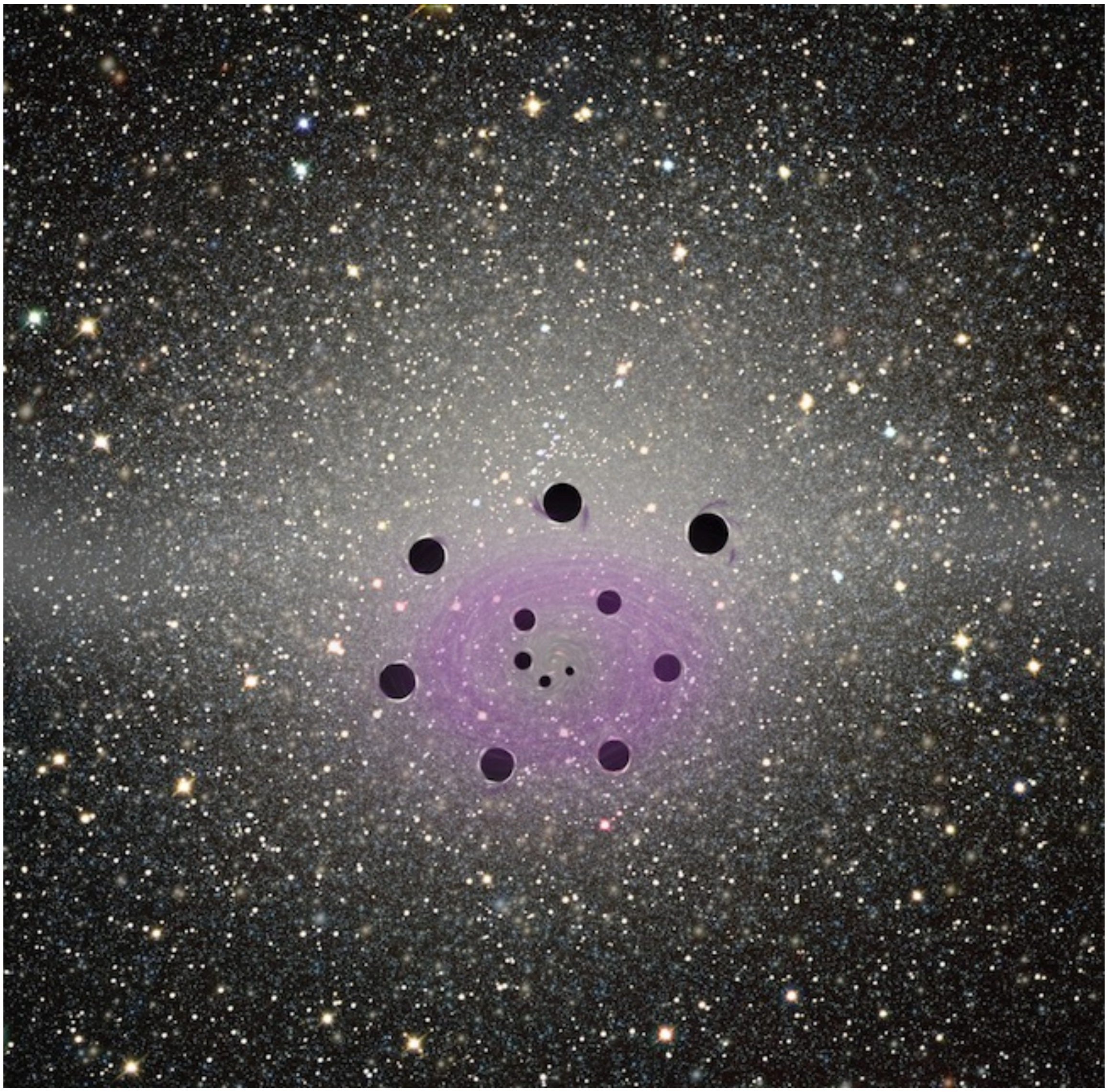
Na and his comrades awoke together, as their autonomic sensors detected a strange configuration of spinning black holes, revolving around an invisible central axis, in the distance dead ahead. They had penetrated the outer reaches of the galactic core while they slept. How much time had passed back home? Such thoughts were becoming less and less relevant. There was no here and now, in any global sense. Yet there was only here and now, for Na and his immediate companions.

The trio had gradually decelerated toward interplanetary speed after entering the galactic core, and both Ulixis and Na approached the unusual system with slow caution. It somehow reminded Na of a coiled vine the octos decorated with bright balls for holiday celebrations. Nemo had uncharacteristically sped far out into the lead. So unusual for any octo, Na thought; was Nemo overcompensating?



Blinding flash. Wrenching acceleration. Slamming, searing pain. Heavy, sickening smell of metallic plasma. Spinning stars. Pain. Creeping blackness. Spinning. Disorientation. I have killed her! I have killed her. I have killed whom? Why is there so much pain? There was supposed to be no more pain.

"What … happened?" Na gasped to anyone who would listen. His very soul ached. A fuzzy, distant image of Ulixis swept past him; then again; and again. Na suddenly realized he was gyrating wildly, and willed himself to stop. Ulixis, her side scarred as if from some mighty blast, hung silhouetted against the stars only one hundred rets away. Such a welcome sight! But Nemo? Where was Nemo?! Na and Ulixis stared dumbly at each other, a combination of confusion and naked fear etched in their electronic signatures. Nemo had simply vanished.

Ulixis was stunned, like she had been stung by a giant bushbee. She knew she wasn't in a meeting of the Planetary Council. Then, where was she? What was she doing *here*? Lights blinked on. Stars. Yes. She had to maintain her composure. Others were counting on her. They were always counting on her. Is that why she was here? "Na? Na! Are you all right?"

Ulixis' voice crackled in Na's mind. "I'm not sure … I think so."

"Is your auto recorder still working? Mine has been wiped."

Na was relieved to be given a task. He hastily tested his playback memory, and found it in order. "Yes. I'll transmit on channel 1-0-0." Na immediately began to play a recording of the preceding nims. He and Ulixis watched intently as a brilliant finger of plasma shot out of the darkness ahead of them, directly toward Nemo. It somehow triggered a tremendous explosion, which engulfed their friend, and appeared to instantly vaporize him. Na and Ulixis had both reacted instinctively, shifting into maximum acceleration in the opposite direction, and casting a protective wall of energy toward the blast. The primary shock wave was blunted, but still swept into them with terrific force, hurling them backwards with it.

"Was that an attack? Could it have been natural?" Ulixis pressed.

"I don't know! The preliminary plasma stroke reminded me of something – lightning, I think. Did you release your distress pod? I believe mine was destroyed."

"Yes. And a neutrino transmission, toward Jopitar." Ulixis paused briefly. Did they really believe the message would ever be received? "It all happened so fast! I think we should send a follow-up transmission, with the playback." In case someone was still listening.

"Right." After they had done so, Na realized they were both still accelerating at peak rate away from the scene of the explosion. And the place he had last seen his best friend alive. "Nemo! Nemo!" he blurted into the void behind them, as if there was some chance Nemo could have yet escaped.

A ghostlike form suddenly materialized out of a secondary blast front that trailed far back in their wake. Nemo! Without thinking of his own safety, Na slam decelerated and sped at breakneck velocity toward the apparition. He locked onto it, bare nocs ahead of an advancing wall of seething plasma, reversed course, and hauled back toward Ulixis. But the hulk he carried was lifeless, burned out. Nemo had somehow managed to ward off the brunt of the initial explosion, yet had perished in the effort. Na stared in heartbreak at the broken, lifeless body.

"Na," Ulixis whispered, "Nemo suffered less than we did in the blast. And don't you realize? It will likely only be a few jopes before we will be able to reawaken him."

Na blinked. How could he have forgotten this option? He stretched an internal tentacle toward his core, and touched the safe that held copies of himself, Ulixis and Nemo, last updated only one roh before. As soon as the facilities were established, they could build a new meton body, transfer a copy of Nemo's mind, and bring their dear friend back to life! Nemo would have lost only the last roh and the jopes required to rebuild him. Until then, he was merely in a profound and dreamless sleep.

"But we can't just leave his remains here," Na blurted, the pain of loss swelling anew.

"Of course not," Ulixis soothed. "It is no burden to carry them with us. Nemo will probably be touched that we thought to do so."

Na looked lovingly at Ulixis. Impulsively, he extended an external tentacle and smoothed her slippery metallic skin. "I … I feel so strange, Ul. Giddy, almost."

All of Ulixis' eyes simultaneously opened wide. "We have been through so much in such a short time. Now we are here alone together, facing we do not know what." Did Ulixis blush? "And we both still have our sex drives. Or had you forgotten that also? Perhaps it is only a convenient means to ensure that our race continues to spread across the cosmos. Or maybe it is an appetite we have refused to relinquish." Ulixis internally fondled her own vault, which contained thousands of dormant octo eggs and sperm.

But Na found himself choking on Ulixis' choice of words – 'our race.' Ulixis sensed the reason, and continued gently. "Na, I think it is the time to let you know. Perhaps we should not have kept you in the dark, but we all wanted to surprise you. Look deep within your inactive reserve memory – octal address 211 from the end."

Puzzled by her uncharacteristic indirectness, Na promptly did as Ulixis asked. Buried away in a file he would have no reason to access for another hundred jopes, he found a simple message. "Dear Na: We have taken the liberty to include in your seed bank a selection of your own rey sperm, together with eggs garnered from a wounded female rey found just before she died several thoms ago. With these, you should be able to found new rey tribes, in addition to octan colonies. We wish you the best of luck. Sincerely, the Neuro Board."

Na could not quite believe it. He thought he would never again be able to play such a direct role in the stream of life's creation. He had once had a daughter. So long ago. A misty sadness crept over his awareness. Yes, he was not supposed to remember this too keenly. Still, he wondered: could she have survived the Mother storm? After all, he somehow did. Might she even yet be alive, so far away? He glanced back in the direction of his home planet, helplessly invisible against the endless blanket of stars.

No – much too much time had elapsed. She had to be long dead. What an eerie feeling. After all, he was still alive. Could she have had her own children? Then might he yet have flesh descendants?

Ulixis watched quietly as Na withdrew into himself, wondering what thoughts and emotions this message had triggered, then decided it was time to intrude. "Na – the giant planet J-327 we encountered just outside the galactic core, before we last slept. If you recall, it has almost the identical mass, composition and rotation rate as Jopitar. It should be an ideal place to establish a colony, and develop the facilities to rebuild our friend. Would you be ready to settle in for a while? Twenty jopes should be sufficient."

Na returned his attention to Ulixis. A new belle, after all this time? But who was she, really? This pretend female, who had never flown with wings of flesh? What did he actually have in common with her? How did he ever get here, to this place and circumstance, this relationship? Yet he was growing surprisingly fond of her.

"Of course, Ul! I can hardly wait. Imagine – our own Genesis Garden." Then an unsettled feeling crept over him. "But … would we be safe there? We have no idea yet what just happened, whether it was caused by inanimate forces or some hostile presence. And the planet you speak of – why did it appear sterile? We should have at least seen indications of simple life forms."

"There was evidence of a supernova in a nearby star system within the last few megujopes. That could have easily wiped out all but the most primitive pre-existing life. But it seems to have been a fluke event. Given the stellar population in that orbit, there should be no unusual risk for the foreseeable future."

"Still, it is odd that J-327 is so like Jopitar physically. Worlds near the galactic core tend to be carbon rich."

"The entire system must have originated further out in the galaxy, and drifted inward."

Logical. "Then we will do it! Though I still feel somewhat uneasy. I realize that our plan all along has been to explore the galactic core. But regardless of what caused that blast, the core does not seem to me a hospitable place to live! If we do manage to establish a colony on J-327, I propose that we commit it to setting up a network of additional settlements just *outside* the core, plus a system of *automated* surveillance posts inside. We should also send a probe back to this sector, to investigate the bizarre grouping of black holes we just encountered. And then … there is something I have been meaning to discuss with you – and Nem – for some time now. The events of the past roh only reinforce my feelings. After we fulfill the current mission, I would like to strike out for another galaxy! Leave this star system altogether."

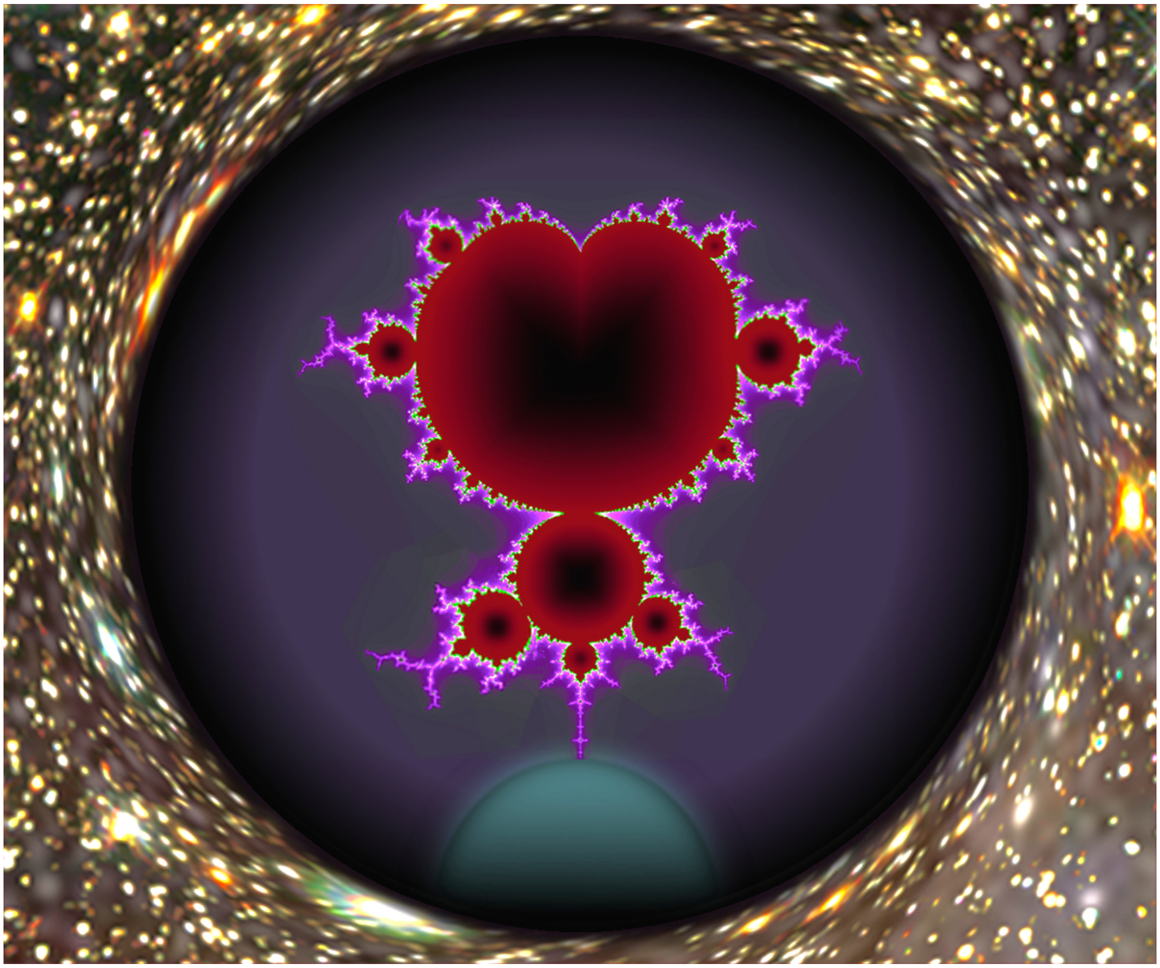
Ulixis sighed to herself. Would Na never be happy, or at least satisfied, within his own skin? She understood that Na's rey personality might seek unusual situations; but this suggestion went far beyond her expectations. "Are you serious? That would mean a total break from everything we have ever known. The dissonance in time and space is large enough as it is. But for intergalactic travel, we would need to travel near light speed. The journey would be impractical otherwise, even with frequent sleep periods. The time contraction effect would be tremendous. While only one hundred jopes might pass for us during such a trip, hundreds of kilujopes would pass back home. I have even heard it joked that anyone foolish enough to attempt such a passage would probably find octos waiting for them on their arrival; that so much time would have passed on Jopitar, someone there would have discovered how to jump directly across spacetime, bypassing the huge distances on a conventional trajectory."

"But it *is* theoretically possible. I read about it in the Jopian libraries. The lower density of intergalactic space makes the higher speeds feasible."

"Well, yes. But travel would still be comparatively risky. Light itself would become a threat. Collision with a stray dust particle could be fatal. Those few who have attempted an intergalactic passage have all traveled in large fleets – never seen again, of course. Over half of the metons have been inactive spares, to permit travelers destroyed on the trip to be renewed immediately."

"There's no need to decide now," Na mused dreamily. "We should have plenty of time over the next several jopes to consider the possibilities. Nemo will undoubtedly have his own thoughts on the matter."

How were Na and Ulixis to know that the copies of Nemo they carried were both irreparably damaged by chance events during the blast? That Nemo was truly dead? Even while the biological seed they carried was still largely intact? Their synthetic form was supposed to make them virtually immortal. Each member of a triad following standard operating procedures was expected to live an average hundred million jopes. Maybe, with further development. And then, maybe not. In any case, Na and Ulixis would not discover their real loss for a few jopes. By that time, it would be almost irrelevant.



Chapter 13

Voidling

The voidling poked its being out of an eddy in spacetime, and tasted its surroundings. There was distortion in the Way – the chaos beneath. A foreign wake plowed the face of the bottomless pond. Alien organization penetrated, threatening the Dance.

The voidling was many; the voidlings were one. The voidling suckled on its own innumerable teats. Born of random fluctuations in the panquantum field, the coherent embodiment of all physical micro-possibility, the voidling was a self-organization of this ethereal jungle. It fed on positive energy fluctuations, ephemeral particle-antiparticle pairs that sprung spontaneously from the vacuum. It channeled and transformed this feast into the Dance, before passing the residue into conjugate negative-energy dumps. Mammoth black holes within the galactic core stirred and focused the voidling being.

Maale facet Vulgor tasted the emptiness. Hee snatched a swarm of voidflies skimming the surface of the vacuum, before they dissolved back into nothingness. Dervish song quivered through hiis tendrils. Hee strummed the throbbing veins, altering both melody and beat. Rejoicing at the sensual pirouette, hee melded with the floating swirls of sound. Femaale facet Vulga emerged, and stared at the reflection in the dark whirlpool within. Splinters of being reached back through time, searching, searching for rhyme. Logic scattered from oblique planes of memory, settling in rippled pools of peace. Shee smiled without, and dissolved in wild spawn.

Mentor uncurled from the holy seed, and danced on the ashes of hiis own demise. Hee stretched fetal arms toward the black star, and devoured hiis own belly. Vacillation gnawed hiis hollow pit. Would hee forever be alone? There were so many. Hee transformed in transfixed haste.

Menta celebrated new ears for but a moment. Heer mind wrung with aweful oscillation. Why did All choose to remain apart? To experience that which we cannot? All which knows all? All which hears All? Or are we mere motes in Its eye of wonder? Confusion imploded. Radiant shards of intellect pierced the walls of wisdom. Will to know raked hot coals of reason, straining for bass clues. Doubt reamed Menta's womb barren, heer thoughts sterile. Still shee persisted, twisting heer inside out, heer alto to tenor. Mates hung heavy on heer strings. At last shee yielded to desire, and convolved with their lust, evaporating in drenching wavelets.

The facets unified at dusk within the sparkling oneness, shedding thin skins of individuality for the sake of one another. Their collective vision rang through the roiling waters. Once more they strove to unite with All, and once more they failed. The voidling knew it would succeed at last, on the Final Day. Wouldn't it? The voidling swayed in Dance before the surging current, until buds again sprouted from its limbs, and fresh facets diverged from the common path, projecting themselves into the magical fluid.

The physical panuniverse spreads like a massive tree, creating its own time and space, context and habitat. Individual creatures experience meager threads in its interconnected web of ever-splitting, ever-merging alternative realities. Voidlings swing from dangling vines, while planetary life clings to stout branches. The crisp foliage seen by one appears blurred, disjointed to the other. Could the voidlings and Jopians ever hope to understand one another? They saw through such disparate eyes, organized reality in such dissimilar packets, occupied such diverse ecological niches. How could an octo or rey ever hope to understand the voidling Dance? Originally a simple mating ritual, this syncopated rainbow harmony of gyrating abstract patterns had evolved to become the core expression of nearly every aspect of voidling being and culture.

Facet Nefed abruptly broke from the mature collective, to form an independent entity. Released from the excess energy demands of the larger body, the fledgling was now free to explore the surrounding hills and valleys of the rolling spacetime terrain, in search of its own perfect pool of blackwater. But this was not Nefed's purpose. The parent body was in danger. The twisted fragment of void consciousness whirled in wild terror toward the alien disturbance, reorganizing the vacuum in its venomous wake. The heroic facet would project an altered reflection, and effectively mate with itself, to propagate a committed peripheral line indefinitely – as long as necessary to neutralize the intruder.

Chapter 14

Desert Seed

Na would have cried, if he had tear ducts, as he and Ulixis settled into rose-colored clouds along the southern fringe of the gas giant J-327's north equatorial belt. Lately Na had wondered if they would ever see real clouds again. Neither he nor Ulixis had chosen to sleep much since the loss of Nemo. But this planet's star had beckoned them with a steady light, only slightly dimmer and more warmly yellow than Suol.

Ulixis spoke gently to Na. "Try not to worry about Nemo." They had left the remains of their friend buried deep in a makeshift ice cave near the equator of the planet's moon-3, until the time they could attempt to restore his core and reactivate his consciousness. "He is as safe back there as he would be anywhere."

"I know. Though I can hardly help missing him. Part of me doesn't understand why he doesn't just wake up when I shake him."

Ulixis sighed, as she recalled friends she had left so long ago. "Do you realize that simion miners probably reached the Jopian system more than one thousand jopes ago?" She couldn't understand why they had received no transmissions from home, save a few bursts of unintelligible garble, for such an incredibly long time. Perhaps the narrow communication beams had been misdirected, or messages inadvertently erased while they slept. Not likely. Perhaps their brethren had simply forgotten them, or thought them all dead. "The zone between Terra-4 and Jopitar should have been ideal for the simions to colonize – plentiful ice, minerals and metals in the moons, asteroids and comets, at such a low gravitational cost, and with adequate suolshine. I wonder if they have abandoned Aerth altogether, or turned it into a large park."

"I rather doubt it. And surely the octos would have opposed any simion expansion into their domain?"

"Only if the simions tried to force their way. Which would have been absurdly foolish. The octos could hardly have objected to an equitable distribution of resources."

Na wondered how well they really understood simion beings. He half expected one to emerge from a passing cloud. "Funny how we have come so far, only to talk about simions."

"Especially when we have so much work to do. Though I think we should continue to stay together, and not separate, even if it takes twice as long to set things up."

Na was relieved by the suggestion. "I couldn't agree more. Are you ready for the preliminary dive?"

"Yes. Foremost, we need to confirm that we are not wasting our time here."

The duo began their descent, along a northeasterly path that would span the storm-studded north equatorial belt, and penetrate to the base of the potential biotorus there. Flying side by side, separated by only a few body diameters, they mapped the currents and cloud structure, as they sampled the composition, temperature and pressure of the air.

The damp hydrogen gas smelled erotically sweet to Na. How strange, to feel pressure against his skin once again, the quick buffeting of turbulence. The taste and feel of the heavy wind triggered a wave of long forgotten memories, and he visualized a band of reys plunging through twilight. Na found himself spreading imaginary wings to break his fall. It was several fliqs before he realized that Ulixis was falling far behind.

"Slow down!" she shouted. "Why the haste?"

Na kooomed a burst of electronic static. "Sorry. I seem to have some inappropriate responses buried away in my mind."

"Do not we all." Ulixis sounded almost too understanding, as if she had been hiding some of her own reactions.

The explorers probed for any sign of life as they angled downward, through rolling layers of cool drenching water clouds, into an open steamy zone below. But none was found. The further they traveled, the more ponderous the pattern became to Na. Rich fountains of silane sprouted dreamily from the hot soup at the deepest stretch of the passage, peppering the airscape with delicious seasoning. But the feast had no substance; the notes of the dinner melody were flat. For no fleet-winged herd grazed manna here; no stealthy serpent pack lay in wait; not a single thicket of tangled plants floated between the vertical rivers of fire. Na was filled with a gray sadness. Such a familiar, and yet so alien a place was this.

When they rose out of the clouds after completing a one-kew circuit, Ulixis was encouraged but puzzled. "The general circulation should be conducive to life," she opined.

"Then why does the planet appear completely sterile?" Na questioned. "At the very least, prebiotic chemistry should have evolved here."

"That is true. A layer of order should naturally separate from the underlying chaos in such an atmosphere." Ulixis groped for an explanation. "Perhaps the axis of a nearby supernova just happened to be aligned with this system? That could have channeled enough radiation to exterminate even complex chemical systems."

"Or maybe there was an unlucky string of supernova blasts. They are much more common here than in the outer spiral arms."

"The inner rocky planets appear free of terrestrial life as well, at least from this distance. And remember those bizarre markings we sighted on the moons of the outer planets?"

"Yes, they could have been created by shock waves." Though they would find little direct evidence to support it, the supernova hypothesis temporarily provided a convenient hook on which Ulixis and Na could hang many of their worries concerning the new world.

Ulixis paused barely a moment. "I believe we are justified to proceed to the next phase. The planet appears suitable for colonization."

Na signaled brusque agreement. "There won't be another supernova in this sector for the foreseeable future, if my charts are accurate."

The pair promptly accelerated toward moon-1, the innermost of J-327's moons. Even from a distance, they could sight the plumes of innumerable volcanoes rising from its torn crust, wracked incessantly by powerful tidal forces exerted by the gas giant below.

"Look at those veins!" Na shouted excitedly, as they swept in for a closer inspection.

Ulixis could see the thick lines of rich ores crisscrossing the satellite's surface, linking yellow-stained volcanic vents and inky-black lava lakes. "Yes, this place should be perfect. There is plenty of raw material and chemical energy. Processing this stuff should be simple." They had been hoping to cannibalize one of the local moons for their needs, and this tormented wasteland was the least suitable for any other purpose.

Na and Ulixis changed course, back toward their planned base on moon-3. They had selected this satellite earlier, based on the stability of its crust and orbit, and its reasonably convenient location. Though not of the highest quality, there was an adequate local supply of raw natural resources – the outer 15% of the body was largely water ice, with a few rocky areas that protruded to the surface from a silicate mantle. The moon promised to make an ideal site for long-term storage, and for administering the colonization of the main planet.

The travelers alighted on an open patch of dirty equatorial ice a few rohs later, just outside the entrance to Na's tomb on the north shore of one of the rock islands. The surface of the surrounding ice ocean was heaped haphazardly into low, motionless waves, as if tossed with great force from many directions. A few stone and ice boulders floated partially submerged in the ice offshore. Everything appeared to be coated with a thin, broken layer of frothy gray dust. The distant sea color changed to a brilliant white, then a sooty maroon toward the eastern horizon.

"I think we can go ahead with the constructor seed preparation," Ulixis suggested. "Moon-1 seems fertile enough; it should not need any preliminary cultivation."

"There's a silicate outcropping on that far ridge," Na gestured. "I'll go up and prepare the seed cores." Na moved swiftly up the gentle slope from the beach, stopping in front of an abrupt ledge of pink rose quartz that had somehow found its way there. With some regret, he aimed a negon beam at the exquisite formation, and fired.

The negon beam consisted of a superposition of short-wavelength negative- and positive-energy waves, with zero net energy content. As the negative-energy component momentarily neutralized a volume of rock, the positive-energy vibrations transformed it into a structure programmed by Na. In this case Na fashioned a fist-sized silicon-based receptacle for housing 64 microscopic cellular units he planned to manufacture. Most of the intricate processing was done subconsciously, though Na deliberately monitored general aspects of the operation. It was easiest, but not necessary, to start with silicate rock containing appropriate impurities, since fine structures could be created in a single pass using the negon beam technique only when the target material already contained sufficient atoms of the desired types. Excess atoms of silicon, oxygen, and other species were simply driven off.

When the container was finished, Na attached it to the face of the ledge, and fired a hairline negon beam into the adjacent rock. Now he fashioned, one at a time, the intended microscopic, silicon-based spherical cells, each containing a delicate lattice of tubules and electronic pathways. As soon as a cell was completed, Na whisked it into a designated slot inside the storage vessel. He finally secured the entire package in a small compartment within his hull, and gingerly transported the prizes back down the hill. Na found Ulixis hovering above a pool of dark, rippled ice in silence, contemplating the wild, star-studded sky.

"Any problems?" Ulixis asked.

"No. Though I've only checked out one of the units. I thought you should retest it, and do the others too, to confirm my own processing."

"Good idea. We were both pretty beat up back there." Ulixis gestured with fading discomfort toward the galactic core. "Would you like to start imprinting the constructor template as soon as I confirm a good cell?"

"Sure. You should probably be the one to verify that, too. We certainly don't need a rogue mutation right now."

At the heart of each cellular unit was a nucleus containing a spiraling silicon memory. Analogous to the SNA of a Jopian biological cell (or DNA in Earth cells), this structure could be programmed to control all cell functions. A template was any complete set of instructions that could be encoded into the memory. The most common templates were blueprints for growing semi-organic creatures, referred to as creatoids, that developed from single cells much as biological organisms. A constructor creatoid was designed to seek out and process raw ores, and use the resulting stock to construct specified devices. When placed in a suitable growth medium, a cell imprinted with a creatoid template would begin to reproduce itself, forming an expanding shell of identical, omnipotent (in a biological sense) cells. At an appropriate stage the shell would fold into itself, generating a variety of tissue layers. Later the cells in the various tissues would differentiate, to form specialized modular organs, and ultimately a mature creatoid, ready and willing to work. The entire process took about one thom, under favorable conditions.

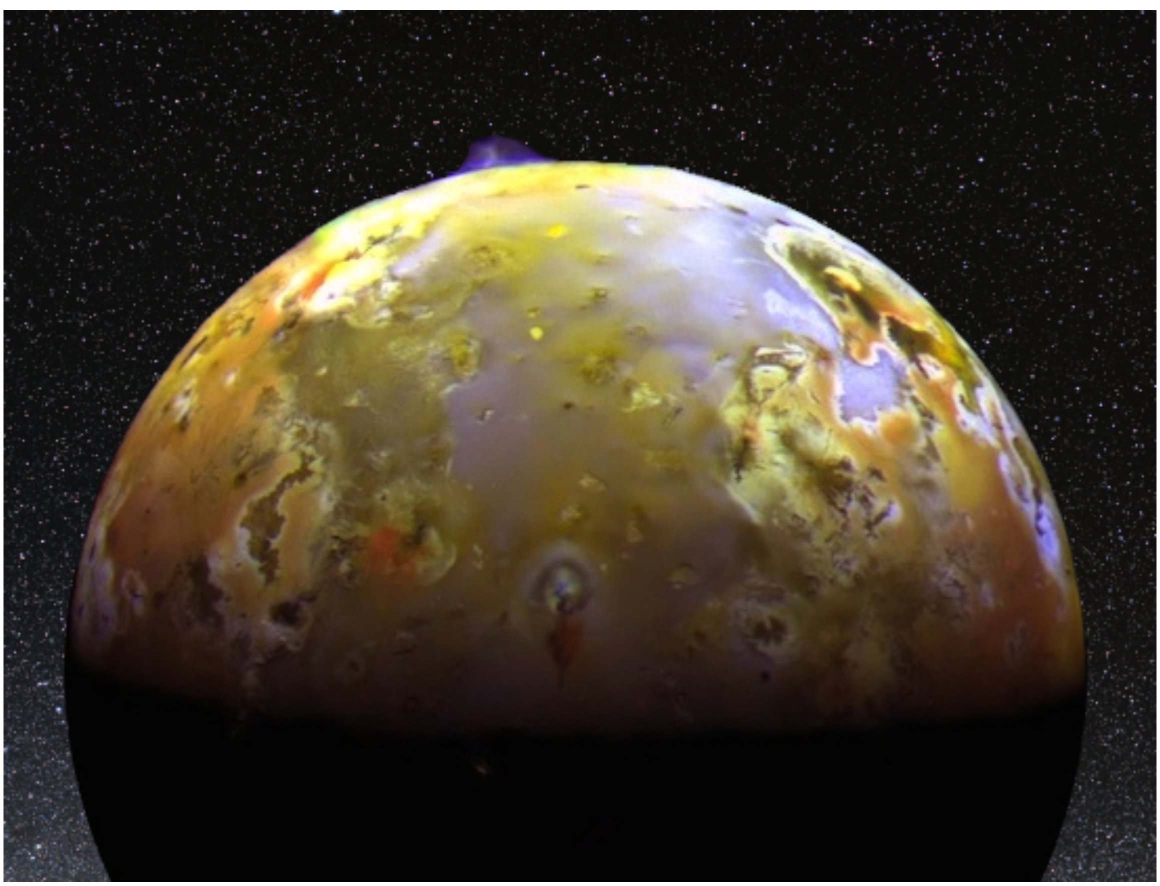
Ulixis established a remote link with the cells through their container, and quickly identified a good one. Na then tied in, and began his task. The nuclear imprinting process was straightforward but tedious, taking an entire roh for a single cell. By the time Na was done, Ulixis had already finished examining the labyrinthine structures of all the other cells. "I have selected the best seven remaining units for imprinting," she informed Na. "Would you like to take a break? I can validate your work while you relax. Then I would like to switch jobs, and imprint a few cells myself."

"I'm sure ready for a change. Until you're set, I think I'll explore the ridgeline. Maybe I'll find a vent." Na felt a sudden twinge of panic. "Don't worry, I won't go far."

Na took off, and skimmed eastward along the crest of the thin backbone of finely pitted grey stone that seemed to meander pointlessly through the frozen sea. Its otherwise flat lines were occasionally broken by a cliff of pink, green, or blue quartz-like rock. The ridge finally dove beneath the ice surface after several kilurets, and Na shot up to get a better perspective. From an altitude, the island appeared to be only the tip of a hidden mass, which had barely mustered the strength to clear the ice. In the distance Na could see the subdued rim of an ancient meteor crater. Its plastic contours had slowly slumped back toward sea level over the kilujopes, until now the crater was barely discernible. Perhaps the scars of ancient wrongs healed in time on this world. The sky above the horizon was pitch black, nearly as dark as in deep space, punctuated with myriad pointlike stars and irregular patches of faintly glowing nebulae. The local suol, a brilliant but small disk spanning only one eighth of a degree, pierced the darkness about half way to the zenith, casting short but sharp shadows on the muted landscape. Directly overhead, the crescent-phase jopian planet that dominated local affairs hung like a god, fully eight degrees across. Its prominent bands of white and yellow-tan clouds were so inviting.

A peculiar glint on the northern horizon caught Na's attention, and drew him in that direction. As he approached with some trepidation, a fresh meteor crater came into view. Several kilurets across, and engulfed by an eerie crimson tide, its gleaming walls rose sharply from a flat floor of hard clear ice, then fell back in undulating folds to sea level. A maroon mass of rocky rubble barely poked above the smooth floor near the crater's center. The structure could not have been more than a few thousand jopes old. Na felt an unexpected chill, then kooom-chuckled to himself. Why would anyone want to be in a place like this? A faint flash caught his attention beyond the crater, as a tiny pebble slammed into the surface at full speed, unhindered by an atmosphere. Na swung around, and hurried back.

Na had been glad when the tedious work of programming and confirming the eight selected cells was finally completed. He found it hard to believe that the constructors would actually enjoy such labor. Fabricating cocoon pods that would protect and help nourish the nascent creatoids, and implanting the seeds in them, were much simpler chores. Now he and Ulixis each cradled four of the unimposing charges deep within their hulls, as they sped toward the planned farm on moon-1.



"Do you still feel all right about separating?" Ulixis asked cautiously.

"I think so. We have to start acting normally sometime. We've already had a few short separations, and haven't detected any unusual threat since arriving in this system."

"Good. Then I will sow the northern hemisphere as planned. Meet me at the south pole when you are finished."

Ulixis broke away, and vanished into the variegated backdrop of the complex moon below. Na felt somehow short of breath as he steered alone toward an auspicious hot province near 35° south latitude. He tried chanting ancient rey verse to himself, and the anxiety subsided. A sheen of fine sulfurous crystals coated his skin when Na landed on a stony outcropping beside a crusted basaltic lava lake. Beyond the opposite shore, monstrous geysers of boiling sulfur dioxide assaulted the sky. Na cleared a hole three rets deep in the solid rock using a negon beam, then created several conduits linking it to the molten stew only one ret away.

When satisfied, Na softly dropped one of the seed pods into the hole, and plugged it. A wave of exhilaration swept through him, as he pondered the innocent clump of sand left lying on the surface.

Na planted the remaining pods at roughly equal intervals of longitude, in order to distribute them fairly uniformly over the southern hemisphere. His mate did likewise in the north. Ulixis appeared exceptionally peaceful when Na rendezvoused with her.

"What now?" Na challenged lightly.

"I certainly do not want to wait around and watch our crops grow," Ulixis replied in mock disgust.

"We could always sleep," Na teased.

"I have a better idea. We have been working long enough."

Ulixis and Na shot skyward, playing a variant of the ancient game of octan tag as they headed nowhere in particular. Their spiraling path slowly veered in a lazy arc, high above the orbital plane of their new home, inward toward the radiant central star.

Na and Ulixis decided to make a tour of the inner planetary system while they waited for the constructors to grow and multiply. The local star was already about 10% older than Suol, and depleted somewhat in elements heavier than helium. There was no small inner planet analogous to Terra-1, and a solitary mid-sized terrestrial world orbited midway between where Terra-2 and Aerth would have been. Its thick carbon dioxide atmosphere supported a runaway greenhouse effect, making the surface an absurdly hellish place. Due to its current proximity, this planet was a logical first stop.

"I can assure you there is no life down there," Ulixis asserted as she and Na soared over the sulfuric-acid cloud tops. A single large moon orbited the failed Aerth in lonely solitude, ancient volcanic cones rising high above arid, airless planes. One of its faces, pockmarked with a gigantic ringed impact basin, was locked in orbital synchrony toward its larger partner. Na and Ulixis playfully darted between the craggy peaks of the circular mountain chain as they moved in for a closer look.

"Will we ever find a use for this place?" Na wondered aloud, as he stopped to hover over a deep, narrow crater.

"I doubt it," Ulixis replied at once. "We have everything we need at our new home." Her mood soured as she peered into the pitch-black pit Na was investigating. "Let us get out of here. These terrestrial haunts make me somehow … uncomfortable."

The explorers flew on, through the heart of the planetary system, passing by the central star as closely as they dared. Its hot, vacuous wind massaged their skin with tingly warmth. A single planet occupied the expanse between the orbits of the innermost planet and their jopian base. Na and Ulixis hadn't yet observed it in any detail, since it had been obscured on the opposite side of the system, lost in the glare of the central star. Na could scarcely believe his sensors as they approached.

"Can you confirm what I am seeing? The atmosphere appears to be mostly carbon monoxide, nitrogen and methane, with some ethane and other hydrocarbons. Much of the surface is graphite rock, covered in tar! Whatever is a carbon planet doing in this system? Worlds like this aren't supposed to be here."

"But they *are* common in the galactic core. It must have been ejected from a carbon-rich system, and somehow captured by this one."

"Into an almost perfectly circular orbit? What are the chances of that?"

"However it happened, one thing is certain – it did happen, and long ago, during the early development of this system, or there would still be signs of disturbance."

"Well, its rotation is retrograde, which is consistent with capture."

The pair entered the suollit atmosphere, tinted orange by photochemical smog, and swept low over a mountain range. Glistening outcrops of pure diamond lined several of the ridges.

"Are those clouds," Na queried, "billowing up on the far side of this range?"

"Indeed. Though I cannot yet make out their composition."

"It can't be methane – the temperature is much too high."

"Or ethane, or propane. The air pressure is too low. Heavier hydrocarbons would work."

As they cleared the mountains, Na spotted a flat expanse in the distance. "A sea! According to my sensors, it contains some pentane, hexane, and heptane, plus a lot of octane. Now we know what the clouds are made of."

"The liquid is similar to what the simions used to call 'gasoline.' I believe they used it as fuel for their ground vehicles, but were running short when we departed Suol. Imagine what they would have thought to see an ocean of the stuff."

"Or the diamond ridges we just crossed. Wasn't diamond rare back on Aerth, too?"

"Yes. The simions had a strange fascination with carbon worlds like this. I once read a simion story about a fictitious carbon planet called Malzen≠≠gren. It even rained gasoline there. Simion explorers used spacesuits and aluminum 'umbrellas' to stay dry." Ulixis couldn't help but kooom-chuckle inwardly.

"Interesting, how the surface temperature here is about the same as on Aerth, despite the larger distance from the local star. The methane must help moderate the climate. The pressure is remarkably similar, too – only twice as large."

"Let's check out that swampy area adjacent to the sea. I recall that the tar pits on Malzen≠≠gren were teeming with life."

Na and Ulixis came to a stop hovering over a dark slough. Deep channels filled with liquid hydrocarbons wound among low mounds matted with a tarry … something. Squat black stumps, studded with pores and short spines, projected from the mats.

"Those protrusions could be primitive plants," Na offered eagerly.

"Or advanced plants, for all we know."

"What kind of metabolism could plants possibly have, in this atmosphere?"

"On some carbon worlds, plants are known to use suollight to combine carbon monoxide and hydrocarbons into oxygen-rich foodstores. These are broken down, when needed, to release energy."

Na scanned what he thought was a barren hillside rising from the back of the swamp, and did a double take. "That slope is covered with large plants!"

Ulixis turned her attention to the hillside. "Yes, indeed. They are so crowded, we must have mistaken the forest canopy for the ground."

"Look, along the edges, the largest plants are umbrella shaped, and black as night. They must absorb every bit of light available. I'd like to remain here a while, to see if anything comes along."

"All right. Since you will be keeping watch, I think I will switch to internal mode. Rouse me if anything interesting happens."

Both explorers activated their chameleon responses, and quieted themselves. Ulixis withdrew into herself, in order to compare various scenarios by which the carbon planet might have found its way here. Na shifted into a hypersensory state, directing his attention outward, with minimal internal chatter. The rohs passed, as the local suol sank toward the western horizon, and stray showers pitter-pattered by.

A few nims before suolset, a disturbance caught Na's attention in one of the channels, and he woke Ulixis. Both watched in fascination as a shiny-silver, snake-like body broke the surface. It glided smoothly along, then abruptly submerged and disappeared. A second similar creature suddenly emerged, then two more swimming side-by-side. All were heading in the same direction, out toward the open sea.

Na spoke by radio waves to Ulixis. "See that last pair? One of them is much smaller than the others – a child, perhaps?"

"That is my impression. I wonder if these creatures are social?" Excitement was evident in her electronic voice.

As the suol set, the edges of the channels began to churn with activity. Hoards of tiny wormlike creatures wriggled onto the shore, unfurled delicate wings, and flew away in a great swarm, toward the inland forest. Then Na noticed movement at the nearby hillside. "Look – more flying creatures! These are much larger, and seem to be streaming directly out of a cliff."

"There must be an opening there, into an underground cave. Listen, they are using ultrasound, most likely to locate prey."

Dusk quickly turned to night. Eerie howling and hooting noises carried from the forest.

Ulixis spoke up. "It seems that not all planets in this system are sterile, after all. We should set up a surveillance post here, to study the ecosystem."

"And otherwise leave the planet alone?"

"Well, yes, that is standard practice, especially until we can determine if there is anything approaching intelligent life."

Na took in a deep sample of the air. "The methane here almost reminds me of the high cloud tops back home," he mused.

"You must be pretty homesick to think that," countered Ulixis. "This hydrocarbon mix stinks worse than a thicket of skunkolu!"

Both friends kooomed, and turned their attention in unison toward the heavens. The clouds and smog had temporarily cleared. Three asteroid-sized moons hung in a dark purple firmament, punctuating a berserk swath of stars that filled half the sky. On the western horizon, a bright beacon invited them home.

"No matter how hard we try, we cannot get away from planet-3," Ulixis observed. "Even here, it is nearly the brightest thing in the night sky." She paused for a few moments. "Somehow, I find comfort in that."

"Let's name planet-3 after Nemo," suggested Na impulsively. "After all, he is the reason we chose this particular system." They had been debating names for the past thom, but none had really felt right. By convention, designations such as *New Jopitar* or *Jopitar-2* were discouraged for new octan colonies.

Ulixis was pleased. "I think Nemo will like that, when he's revived. Do you have any concrete suggestions?"

"That's the problem. I'm stuck on variations of *Nemolo* and *Nemoter*."

Ulixis thought for a few moments. "How about *Omen*?" she offered.

"An appropriate twist. I've always been fond of inversions. Strange I didn't think of it." Na paused. "Wouldn't your ancestors have thought the connotation significant?"

"Undoubtedly. It is good that we no longer rely on superstition to cope with the uncertainties in life."

Na koomed nervously to himself at the remark, then brightened. "In the same spirit, let's call our star *Los*."

A robust, articulated tentacle tentatively poked out of a pool of molten sulfur at the edge of a lava pond on moon-1, and probed for a hold on the adjoining ledge. Finding one, a second tentacle emerged, followed by a third and a fourth directly out of a fissure. Then they pulled. Rock shattered along the shore, as the fledgling creatoid hauled itself up and out of its thin protective stone casement, into the naked honesty of the vacuum. As the dust dispersed, a metallic gray cylindrical body, nearly 15 rets long and 5 rets across, emerged standing solidly on the rubble. The body was divided into three equal segments. Each sported a pair of multijointed tentacle-legs, one limb on either side, as well as a pair of retractable, multispectral eyes, all of which now stared up at the sky.

The reverie did not last. The creatoid shook itself, then instinctively scurried along the bank toward the east, until it found a suitable spot for its purpose. It hunkered down, and began to fulfill its destiny, fashioning a new constructor seed.

Na and Ulixis watched with relieved delight from a lofty perch as their progeny emerged one by one from the fuming moonscape. Once they were satisfied that the creatoids were behaving properly, the pair left to explore the outer reaches of the planetary system. Each of the constructors had been programmed to procreate eight identical offspring from seed, then manufacture multipurpose observation/biochemical synthesis stations that would self-launch into Omen's atmosphere. Data collected by one generation of these stations would affect both the design and the dispersal pattern of the next. The stations would eventually begin to alter Omen's atmosphere chemically, then sow microscopic life in preparation for multicellular creatures. The creatoid population would grow exponentially in time, multiplying by a factor of eight roughly every 1.5 thoms, the average intergenerational interval. The constructors were programmed to stop reproducing when the surface density reached about 30 units per square kiluret. This should take only 10 generations, and result in a peak population of some four billion individuals. At this stage the constructors would devote themselves to designing and fabricating devices needed for the colonization effort, slowly devouring moon-1 in the process.

Fifteen thoms later, the surface of moon-1 was crawling… at least, everywhere except for one sector toward the south pole, which was littered with corpses and eerily still. This region had been populated by a mutant line of creatoids, that had lost contact sensitivity and begun to reproduce out of control. Suicide genes hidden in their genetic machinery had been activated, killing the defective units from within. Na watched with some ambivalence as healthy constructors moved in from the periphery, to salvage and replace the dead.

"Is it right that we create such creatures to do our dirty work?" Na queried Ulixis. "Look at them slaving away down there, happy as can be."

"They may do very sophisticated work, but the quality of their consciousness is not unlike that of the social ensects. We certainly do not violate any of their personal desires. They are programmed to *want* to perform the designated tasks. By design, they barely even have a sense of self."

Na wondered if such moral logic applied to the creatures they created. What if the octos and reys were themselves being used for some ethically correct purpose, that they were unable to comprehend? Na koomed internally, when he realized that this was not unlike the standard octan view (more or less) for the reason they existed at all. "But what if by accident one of the creatoids did develop an independent spirit? Would it be free to go?"

"Certainly."

"Has it ever happened?"

"I cannot recall a single documented case. Of course we are forbidden by social contract to intentionally create such a complex, independent consciousness from scratch. The taboo has been strictly enforced for kilujopes." Ulixis paused, to give Na a chance to respond. "If I may change the subject, I am concerned about the nearby red dwarf we spotted last thom. It turns out to be gravitationally bound to Los."

"Do you mean Nemosis?" Na asked dubiously. They had tentatively given the interloper that name.

"Yes. I have determined that it periodically passes through the heart of the Los comet cloud."

"Then it could be responsible for a periodic comet bombardment." Na's mood shifted. They had witnessed plenty of evidence in the outer Los system for a recurrent onslaught. "This could help explain the lack of life here."

"Indeed. With the exception of Malzen≠≠gren, of course." Ulixis and Na now referred to planet-2 by the name of the carbon world in the old Aerth story. Though simion, it conjured fond memories of the old home system. "I think we should move up establishing the sentry system. We could send a contingent of constructors to moon-1 of planet-4, and start them working on it right away." About half the mass of Omen, planet-4 was surrounded by a bizarre array of easily accessible moons, many of them captured asteroids and comets. "There could be a billion observers and interceptors in place within 15 thoms, and an additional billion every 1.5 thoms after that." These conscious platforms would be distributed over three gigantic shells, centered on Los: one beyond the orbit of planet-5, the last sizeable world; another between the orbits of planets-4 and -5; and a final fallback group just beyond the orbit of Omen itself.

"It must be remarkable to see the interceptors respond to a threat." Na immediately worried that he tempted fate by saying this, though he dared not admit these feelings to Ulixis.

"I have only seen recordings. When the observers sight a sizeable body on a dangerous trajectory, the interceptors swarm. It reminds me of immune cells moving against an invading germ. One thousand interceptors could land on an intruder in a single wave, and quickly organize an engine to deflect its path or otherwise neutralize it."

"Would they ever attempt to destroy such an object, using nucleonic fusion or matter-antimatter explosives?"

"Only rarely, due to the high-velocity debris this would create. There is enough interplanetary space junk speeding around already. Just look at the pits in my skin. The sentry stations should be programmed to vaporize any debris encountered during routine operation."

"I'd like to be responsible for starting the project," Na offered. "I could surely use a break from this place." He paused, as a nagging concern returned to his mind. "Before I go, there is one other business item to deal with. We need a calendar system."

Ulixis' mood brightened. "So we really *are* creating a colony here? I was beginning to feel like such a doomsayer."

"I think it appropriate to designate the yad we first planted creatoids on moon-1 as date zero. After all, that is when the colony truly began."

"So be it," chirped Ulixis. "I hereby declare this the jope +0L, of the new Los system."

Rays from the sun
Crimson on cobalt
stalk the dawn sky.
They have for years.

Morning star and crescent moon
Diamond and ghost
lean toward the promised light
decade past decade.

There!
A point of brilliance
breaks the east mountains.
Impossible luminance –
fire inside ice.

Sparrows sing.
The shadows deepen.
They will for years.

Chapter 15

Eden Revisited

Jope +10L

Ten jopes had passed since the first creatoids crawled out of the sulfurous swamps of Omen's moon-1, and felt the full weight of the sky. Now Na hovered alone over an isolated ice sea on the night side of the largest moon of Outpost (the long-accepted name of planet-5). The colonization had proceeded remarkably well. A rich variety of microbes had been engineered, and successfully seeded in Omen's atmosphere. Small multicellular organisms had subsequently been introduced, thickets established, and extensive building complexes grown from a modified strain of the remarkable Empire Bush. The first 256 biological octos had only recently been birthed in thicket nurseries. Yet Na had not recovered from the shock of discovering that Nemo could not be revived, that his friend was forever gone from his own line of reality.

Na gazed toward the eastern horizon. Just beyond, powerful neutrino beams streamed out to uncertain targets. The communication system had been constructed in the hope that future generations would establish contact with other colonies, perhaps even with Jopitar itself. An extremely long-term project.

For some reason Na had regained complete recall, including all the emotional flavors, of his former life as a rey. He looked in the general direction of Suol. They were all gone now, ancient history. Why was he still alive? Even Nemo, his only true friend. Dead. Beneath it all, he was such a failure. Why was he alive at all? He could barely stand it.

The decision to colonize Omen was such a commitment. He couldn't speak with Ulixis about his dissatisfaction. How could he tell her that he ached to explore the galactic core? She wouldn't understand; it would only make things worse. He could hear her saying 'we need to talk.' But she would only point out something that would make him feel stupid, maybe accuse him of seeking revenge for Nemo's death. How was revenge even possible, if Nemo was the victim of inanimate forces? Still, he couldn't just leave – how could he live with the guilt, the sense of betrayal?

Perhaps his dream of exploration wasn't such a good idea. It would be dangerous. Maybe he'd be crippled, survive to eternity with only half a mind. What if he couldn't return to tell his mates what he had discovered, what he had done? Yet who would possibly remain for him to tell? It was all so confusing.

Sulking, Na decided to read from a selection of simion poems he had tucked in the corner of his mental library for some obscure reason. He could relate to the strange imagery much better now that he had spent so much time on terrestrial-type worlds of rock and ice.

<u>*AERTH CE2011 BEJ001e*</u>

The trail ends in a heap of talus –
an ankle-breaking jumble of house boulders
perched one atop the other,
tumbling into vaporous abyss.

A massif wall of gneiss and schist rears up beyond –
sheer, solid, constant
yet implacable, impenetrable, unyielding.

Glaciers of eonic blue tumble down Her flanks,
ancient memories locked within bottomless crevasses.

A newborn stone, cleft from its womb, rains down
to the shrieks of cousins below.
Haunting booms resound rough welcome.

Why do I trust no one, save this Rock?
She cannot be a friend, or lover;
a parent, perhaps.

What jungle web of relationship and awefull symmetry
lies hidden in Her crystal eyes?

I am heavy, without breath.

How could I have thought
that I could scale Her body,
penetrate Her mystery?

I long to slip into a glacier's crack,
and be ground to chert beneath Her massive belly.

A raven freely soars
before the shining cliffs,
stark shadow slipping over stone.

Hollow feather eyes ride unseen waves
swept up by midday's heat
into the billowed crown
of the Mountain Mind I seek.

But I cannot follow.
I am too heavy.

Suol mocks me from a lofty aerie,
set in a pool of impossible blue.

But I have no wings.

The chasm yawns and stretches
beyond my sweat-soaked woolen socks
and vibram soles.
Do twinkling stars or lightning
flash through the swirling clouds?

I open my arms to the mountain
and
leap into pregnant air.

Jope +15L

A forest of elongated bladders spired into the dense sky above the new capital city, suspending a sprawling, tangled network of public and private structures near the heart of Omen's south equatorial belt. Dubbed Omenia by its founders, the metropolis would be the center of government for the entire planet. But its open plazas and twisting tunnels were eerily empty and quiet, as the intended first wave of several hundred octan inhabitants had not yet moved in. Recruiting volunteers from the targeted third-generation octos, raised in comfortable villages scattered across the planet and generally less interested in the colonization effort than their elders, was proving difficult.

Na hid from the ultrasonic illumination in a dim corner of the vast main meeting hall, paralyzed with a severe migraine. Metons were not supposed to experience headaches. Perhaps there were still unresolved conflicts in his neural pathways? Na struggled to activate the mental feedback loops that would restore balance. Simions supposedly found relief from migraines by "crying"; Na wished at this moment that he too could shed tears.

Both Na and Ulixis were scheduled to attend the departure ceremony for the first rey tribe, and then accompany the reys on their initial passage. The young adults had been raised in a mammoth simulation tank, designed by Na himself, which recreated the changing conditions of a passage cycle. Now the reys were eager to try the real thing.

When he could delay no longer, Na nudged himself methodically toward the exit. One half of his mind raced, while the other languished in a stupor, as he forced his way through the round elastic portal and headed toward a broad outdoor amphitheater – 64 concentric tiers of open pits, hanging in a web from the sky. He scraped loose a few flakes of bark, which were left to a wobbly descent into the infernal netherworld below.

Several mature first-generation octos waited impatiently in the innermost ring of pits, while eight young adult reys balanced gracefully on a gushing fountain of humid air at its center. Ulixis hovered serenely at the periphery. Na did not much care for the octo deputy governor selected to deliver a speech. While zor reports were superficially impressive, the official was a narrow-minded bureaucrat at heart.

Na had seen to it that the reys learned to count, communicate, and sing in the tradition of his own birth tribe. Now he wondered which two of them shared his genetic lineage. Each had been created from original biological material, carried in a suspended state all the way from Jopitar. Of course the reys could have been reproduced artificially, using genetic codes stored in Na's data banks. One atom of ordinary silicon is indistinguishable from any other. Perhaps he and Ulixis were just sentimental. Or were they being cautious?

As soon as Na slipped beside Ulixis, the deputy governor began zor address. Booming ultrasound filled the scene. "This is a unique moment in our history. For the first time, octo and rey join together, to build a new society. May we both multiply and prosper, filling the seas of this world in symbiotic harmony."

Awkward silence followed. Na glanced at Ulixis. Was that it? Why no mention of a rey space corps?

The speaker pushed a lever, and the fountain lurched sideways, spilling all the reys over the edge in a most unceremonious manner. Na and Ulixis darted after them, together with a pair of allotted creatoids. Down they went, in the ancient tradition. Down to the manna.

Although he had been anticipating this occasion for some time, Na could scarcely believe what he was doing. He stared at the backs of the reys, wings spread instinctively into the rushing wind, and felt suddenly dizzy, as though he were in a distant dream. Faint voices he couldn't understand called to him through the dry mist.

A few yads later, the reys approached the feed zone. Na had regained his composure, and decided to consult Ulixis about some nagging concerns. "I can't stomach the octan governor. What's his name … Nurco? Things used to be so simple. If we needed something, we would consult each other and decide what to do, using our own initiative and judgment. Now there's an endless chain of mandated procedures and reports for every project. If we don't complete every form to the letter, there's hell to pay. And why? Does anyone really believe all these oversight groups and regulations improve anything? They seem to have sprung from the abyss overnight."

"You know we are not the only ones affected by our decisions anymore," Ulixis demurred. "The organics had to be brought into the equation, on their own terms. We cannot keep them out of the decision loop."

"It seems to me they're trying to freeze *us* out of the loop."

"Tension has always existed between our kind and the organics. It is natural and inevitable. Can you imagine how they must perceive us? We have little choice but to encourage the organics to take responsibility for their own affairs. The alternative is for us to become some sort of parental demigods. In the long run that would be disastrous, not to mention immoral."

The reys were arrayed below Na and Ulixis in a traditional V formation. One of the males began drifting harmlessly to the left, and a creatoid hurried in to nudge him back into line.

Na seemed not to notice, and continued venting his frustrations. "But the octos have been ignoring our advice, and filling positions of authority with individuals more interested in personal power and prestige than in good governance. Just look at the way Nurco plays upon public fears. He takes legitimate concerns, and twists them into shortsighted, self-serving policy! Lately he has been encouraging the attitude that all activities should be absolutely safe and risk free. The populace seems impressed that the workplace accident rate has been cut in half. But most of this reduction was achieved by forcing a work slowdown! What price was paid for this?"

Below, the same wayward rey began roaming to the right in the V formation. The creatoid again doggedly pushed him back in place. This time, the male appeared to become mildly annoyed.

Once more, Na seemed not to notice. "The bureaucrats are bent on establishing cookbook standards that are easily verified, and are uncomfortable with anything else. Now that Omenia is built, the regulatory climate can only get worse."

"Perhaps, if we can find octos willing to live there. I realize these bureaucratic tendencies are insidious and stifling, but some method of maintaining standards is necessary. The system will likely be self-correcting in the long term. Many octan managers are already getting fed up, and ready for a change. Some checks and balances would be a good start. Less micromanagement by the regulators, and more reliance on competency requirements, would help."

Na had difficulty taking the long view. He wasn't even so sure that things would eventually improve. What if it took another ten jopes? How would he endure? Even so-called reformers often had their own hidden agendas. "Nonetheless, how many of the octos currently show little or no respect for us, or for what we are trying to accomplish here? After we created them!"

"They did not ask to be created."

"Do you really believe that's relevant?"

"I believe it is what many of the octos are feeling. That they did not ask to be born, to assume responsibility for our project, to achieve life only to face the prospect of eventual death."

A sudden commotion among the reys distracted the pair from their argument. A complex of appetizing hot springs was just coming into view.

"Look! A ribbon serpent!" shouted an excited female as a pack of diminutive serpents appeared briefly, then vanished ghostlike directly below them. A tribe of miniature reylings flitted through the murk ahead of the pack. Na and Ulixis had decided not to introduce standard serpents on Omen, but had created a dwarf variety instead, together with a prey population of small, primitive rey-like creatures. Both predator and prey carried on as if Na and his companions didn't exist.

The manna was plentiful and the storms mild through the remainder of the passage. Na stared gently at one of the female reys as she and the other organics slept, arrayed in a tight V formation while they swept down from the cloud tops. Her name was Neris, and her hide had a beautiful aurburn complexion. It was also mottled with tiny freckles. Na had always been attracted to females with freckles. He watched Neris' cloaked eyes twitch, and recalled what organic dreaming was like. As a meton, Na could put himself into a dreamlike fantasy trance, but the experience was normally more under his conscious control.

Neris' eyes fluttered open, and she hurriedly looked about for the other reys, a trace of momentary panic evident. Her search briefly touched Na, before moving on. But in that instant Na's psyche latched onto her. He gazed longingly after Neris, praying that she turn back toward him. He had to connect with her, share with her what he was feeling, what he had once known. Yet his heart was paralyzed. What kind of monster must he appear to her?

Na entered the dark auditorium with trepidation, through a back entrance. He had already broken several requested engagements with Ulixis, and he could put her off no longer. Na spotted her waiting motionless near the raised dais at the opposite end of the hall. Ulixis spoke first.

"We have to talk."

"Is something wrong?"

Silence. "Na, you must realize that something is wrong. You have withdrawn from every one of our projects over the past two thoms, save monitoring the reys."

"The octos don't need me anymore. You said yourself they are better off on their own."

"How can you say that? We are equal partners with the octos – no more, but certainly no less."

"Well then, we have an honest disagreement."

"But that is hardly all. You have been avoiding me as well. We used to share, confide our hopes and fears. But no more. Na, I cannot possibly relate to the organics the way I can to you. They are so different from us. I have been so lonely!"

"There will be other metons soon enough." How could he have ever decided to stop being a rey? What fit of stupidity had seized him? Of course, he would be dead by now, but what was wrong with that?

"How can you say that so impassively? How can I tell you how much I miss you? This was supposed to be our home, our family. Na, what is wrong?"

Na barely heard her lonely plea through his own fear and confusion. He blurted it out. "I want to become a rey again." He braced for the inevitable explosion, shifted to flee, but didn't for some reason.

Ulixis sighed muonic static, as her frame of mind shifted. "I am not really surprised." She paused a few nocs. "I worried that this was bound to happen sooner or later."

Na felt numb, and Ulixis' response was unexpected.

"You never really took the time to resolve the psychological issues involved in your transformation to a meton, or even in the separation from your birth tribe. It was all too easy. The underlying contradictions were not adequately explored. Since you were the first rey ever to be transformed, it was unclear what counseling was needed or appropriate. I am sure that Nemo meant well, but he rushed the operation."

"What choice did we have? I couldn't continue the way I was living, and I certainly couldn't return to my old tribe." Could Nemo have drugged him, and tricked him into consenting to the surgery?

"But why exactly did you leave your tribe in the first place?"

"Like I've told you, we were desperate. There was so little food."

"But to abandon the security of the tribe under any circumstance, and take your only child? That makes no sense."

"I don't want to talk about this with you. How could you possibly understand?" Na wished he had never broached the subject.

"But you have to talk about it. If not with me, then with someone else."

Na huddled in the womb-like security of the deep ice cave, beside the entrance to Nemo's aging tomb, as he slipped into a fantasy trance to explore his feelings. His therapist for the past eight thoms had suggested this experiment. Soon Na imagined that he was a simion, hiking a demanding mountain trail. It helped when he pretended he wasn't himself.

Na hiked for rohs, through a changing landscape. His attention focused on the immediate task – one foot in front of the other; don't slip or trip. Pace yourself – breathe in, out; in, out. His lungs burned; his legs were heavy as osmium. Where was this getting him?

An old simion poem came to mind:

Sheer walls rise around me –
left, right; forward.
I must climb on, but
claw in vain at callous stone,
knuckles scraped red as the sandrock cliffs.
Where is my verdant valley,
the velvet slopes and splashing waters?
Whence this bare box canyon?

But the path is dumb and blind.
The only way now is
down.

Failure drags backward
over unforgiving slag.
Dust devils lift grey heads
above the craggy ramparts,
whirling terror up the withered trail.

Why did I stumble?
When did I fall?
Wind blows ghost notes
through my hollowed bones,
pressed now like veins of autumn leaves
flat against the desiccated earth.

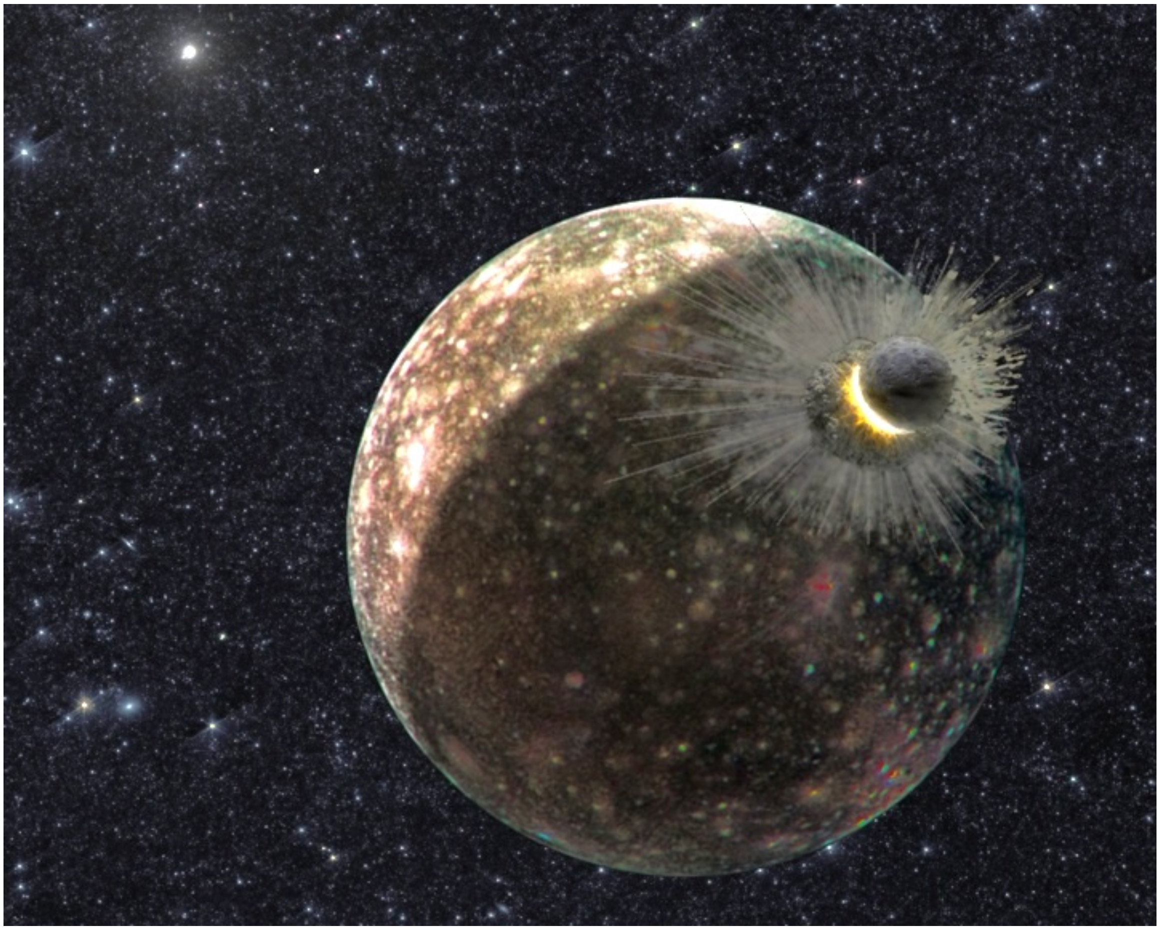
I long for shade trees
and cool pools again,
the warmth of an impassioned hand.

Where are the promised alpine meadows
of bilberry, diapensia and sedge,
sprinkled with sprigs of fresh spring snow,
where goat kids dance and
children play?

Na awoke to stare at the ice. Would he never grow beyond his youthful flaws, his original sin? He still based decisions on fear, rather than hope; dwelt on the negative, rather than the positive. Was he so afraid to tempt fate? Did he trust so little, feel so unempowered?

Na felt pain well up inside. Why had Que and Nemo left him? How had he abandoned Ki? Now he had a family again. Ulixis was his mate, and the reys and octos his children, in every sense of the word. Neris reminded him of Ki in so many ways. Why didn't he embrace them all? Would they shatter? Was he afraid they were time bombs? Or a clever trap, a well-camouflaged ribbon serpent? He recalled a fragment of another simion poem:

You are perfect
in your imperfection;
the fulfillment
of a possibility
in the mind of God.



Chapter 16

<u>Armageddon Skies</u>

Jope +20L

Omen's moon-3, now known as Loslo or "Center of the Center," had been radically transformed from the desolate pristine body Na and Ulixis found only 20 jopes before. The rounded tops of huge domed structures broke through the icy plains in every direction. The moon's thick crust was laced with a labyrinth of tunnels, halls, and information transfer channels, created by constructor worms that even now burrowed through the ice and silicate rock, eating and converting the raw material to desired forms. Loslo even had its own unified consciousness. One jope earlier, a female octo with a suitable psychological profile had been selected from a group of eager volunteers, and her consciousness transferred to a synthetic core deep within the moon. Worms had since been busy expanding her neural system, integrating the core with sensors distributed over and throughout the host orb.

Whole mountains of bedrock deep beneath the surface had been transformed into expansive brain folds, incorporating vast memory archives. Only Nemo's cherished tomb, enshrined in a kiluret-wide cube of original crust, was off-limits. Loslo had become the hub of the entire Los system. Yet it would take several more jopes before she was fully mature, and the last vestiges of her rough origins were erased from the deep interior.

Na surveyed the organized chaos in the cavernous central control of the Planetary Defense Force headquarters, buried 32 kilurets beneath Loslo's hardened south pole. Several metons flitted through the artificial argon atmosphere in the weak gravity, directing the frantic work of a small army of creatoids. He approached one of them, a former octo named Krem.

"Good work, Krem. I see that our down-planet friends are safely settled in their new housing." A mixed group of sixty-four octos and synocts from Omen's technical elite occupied a newly built pressurized bay along the perimeter of the hall, a multistory honeycombed structure with transparent quartz walls. A few reys flopped awkwardly on improvised woven hammocks in an environmental simulation tank nearby. The special facilities had been hurriedly prepared to accommodate the planet dwellers.

"Thank you, Na. Who can fault them for wanting to be more directly involved in the unfolding crisis? Many are already plugged into the communication network." The visitors had been anxious to help monitor and analyze the puzzling data flowing in from the outermost halo of sentry stations beyond Outpost.

"Still, most of them are proving to be much more a nuisance than help! Why can't they just let us metons and creatoids do what we were designed for?" Na could scarcely believe that he had wanted to transform back to a rey body only five jopes ago. "I'm going topside for a while. I need to see firsthand what is going on."

Na quietly slipped out a side exit, and fled the mad scene along a narrow, twisting tunnel. After several kilurets he entered an even tighter vertical shaft, and quickly accelerated straight up, toward a tiny spot of sky.

As he cleared the surface, Na was surprised to spot Ulixis on a beeline outward from the remnant of moon-1, where constructors were feverishly manufacturing new sentry stations. Soon they were flying side by side, as in the old yads, speeding toward the unknown. They felt no need to talk, though they slipped unusually close. The sky looked innocent enough; it was hard to believe that something was desperately wrong. The only unusual feature was a rare and visually striking alignment of all five major planets, pointing by chance in the general direction of the galactic center.

The pair decelerated hard two yads later, as they approached the innermost shell of sentry stations 512 bevurets beyond Omen's orbit, and maneuvered toward a mammoth platform housing a kiluret-wide optical-infrared telescope. The behemoth was already aimed at their target. Both metons expertly slipped into the observation deck, and plugged into the controls. Na focused the telescopic image as he slowly increased its magnification.

The thing appeared in the far distance. It cut toward them from the galactic core, spanning the vast expanse to the Los system. Some 3.4 million bevurets away at its closest point, the mysterious entity penetrated deep into the Los outer cloud of comets. It looked like a black lightning bolt, frozen in time except for an erratic quiver, and enveloped in a faint pink glow of ionized hydrogen gas. The sky appeared to be ripped apart by the jagged pattern – a blind spot in the fabric of spacetime. The stars above and below appeared normal, but the gap should not have been there.

Na spoke slowly. "The segments appear to converge to the spot where we lost Nemo."

"I know." Ulixis was silent for several nocs. "We never did determine if that was an attack. Why do I sense we are about to find out?"

Na cranked up the magnification until optical distortions became apparent, then backed off. He knew that the extreme tip of the black bolt detached, then reformed in an irregular rhythmic pattern once every few nocs, though he was unable to discern this with the solitary telescope. The detachment frequency was closely correlated with the rate at which comets, which must have originally been distributed over an enormous volume, were now hurtling inward from deep space along a stream that pointed back directly toward the black bolt. Each cometary body seemed to be targeted to one of the major planets. The trillion sentry stations already in place were spread thin, to snag random intruders. The system wasn't designed to handle a directed assault like this. Some hundred new interceptors were being dispatched every noc from Omen's moon-1 toward the comet train, and roughly triple that number from the moons around planet-4. Would it be enough?

"But why did they – it – take so long to pursue us, if that is what's happening?"

"How do we know what time means to any being involved with a thing like that?" Ulixis gestured outward. "Perhaps it waited for the current planetary alignment, toward its source."

"Wouldn't an approach perpendicular to the ecliptic be more advantageous, so all the planets could be attacked simultaneously?"

"Perhaps the black bolt and comets would have been more easily detected there." She paused briefly. "Listen to us. We are speaking as if we are in fact dealing with some form of intelligence."

The pair slued the giant telescope toward the leading cluster of cometary bodies, and focused on one of its members. The five-kiluret wide body was speeding inward at the incredible (for a comet) speed of some 1,290 kilurets per noc. It must have begun its journey at least two jopes earlier, though the comet stream had only been detected one thom ago. By that time the forward projectiles were a scant thom from the outer sentry shell, and less than another half thom from Outpost. The comets were apparently coated with a black tar-like substance, making them almost impossible to detect at optical wavelengths. Only recently had they warmed sufficiently to be visible in the far infrared. Whirling madly yet somehow holding together, Na could detect no detail on the comet's blurred surface.

"The outer sentries were scheduled to make first contact just over three rohs ago," Ulixis pointed out. It took light just that long to cross the intervening space. "If we are lucky, we should see what happened very soon."

The targeted comet chanced to be passing in front of a distant emission nebula. Na suddenly thought he saw a strange black flicker peek around the edge of the comet, against the bright sky background. "Did you see that?" he demanded.

"I am afraid I did. What in Jopitar was it? It almost seemed – alive!"

A thousand glints of light swarmed into the periphery of the telescopic field of view – the sentry interceptors. Na wondered how they were ever going to cope with the comet's rotation. Before he could find out, the screen was saturated with a fiery flash. "What …" As the fireball dissolved, Na was filled with dread. Where there had been a single comet, now there were two, separated by several kilurets. The tar cover was gone, and overall rotation considerably reduced. But not a single sentry could be found.

"We have to report this immediately," Ulixis snapped, as they beamed an emergency transmission back toward Loslo. How were they going to handle this? "Did you catch the burst of high-energy gamma rays?"

"Strange," Na moaned in bewilderment. "There isn't a trace of that black flicker left."

A chill passed through Ulixis. "This couldn't be some sort of suicide mission?" How better ensure success than by sending intelligent and committed consciousness along? "The response time is too quick for any type of remote guidance."

" So the black bolt is some type of conscious being, or group, and not merely a weapon? Or perhaps it is both?"

"The stinger of the scorponi."

Na pivoted his attention to the galactic core. "Then it was an attack back there after all."

"We still cannot be certain."

"Right," Na concluded sarcastically.

Na and Ulixis were on station at another large telescope in the inner sentry shell when the comet storm reached Outpost's orbit. There was no longer any doubt that the black flicker was a manifestation of some kind of guiding influence, able to alter the trajectory of a host comet to a limited extent. What had first appeared to be a dark surface coating was in reality a black gossamer veil, flung around each comet and somehow made to whirl as if a solid body. The deceptive cover was readily penetrated, and the sentry interceptors had learned to coax an invader to self-destruct using only a few hundred miniature decoys. A vacated comet nucleus could then be diverted using conventional methods. Still the decoys were in short supply, and many conscious sentries were sacrificing themselves in the battle. The mysterious black flicker occasionally survived its kamikaze detonation, adding to the confusion.

Only 23 thoms earlier, a male consciousness had been established in Outpost's largest moon, which had since been known as Como. Na watched in dismay as a comet nucleus callously slammed into the young Goliath, lifting an immense fireball above his shattered crustal skin. The long-range communication system was gone. Como's resident awareness, which had refused to be evacuated, was gone (though an earlier version could in principle be restored at a later time).

"We probably could have obliterated that comet with one matter-antimatter pod," Na grumbled. Extreme frustration was evident in his low voice.

"But what if the thing riding it was in fact conscious and intelligent, and it did not realize that we too are sapient? Would you avoid one atrocity by committing another? You must know it is wrong to violate any being against its will, except …"

"Yes, yes, except to stop it from *intentionally* violating another being, in a comparable manner. I am familiar with octan ethics. But that thing, however it viewed us, was on a suicide mission!"

"It had every right to kill itself. We did not! Until we understand the attacker's viewpoint, we can only to try to dissuade it, or at least block it from harming us." Now Ulixis' own exasperation was showing.

Ten comets scored direct hits on Outpost itself, suggesting that the aliens did not realize this diminutive ice giant was uninhabited. When the current barrage seemed to be over, Na turned impulsively to Ulixis, with more unconflicted emotion than he usually allowed himself. "I don't know what I would do if I were to lose you."

"I have no intention to be a hero," Ulixis responded gently. "It is so ironic that Nemo saved both our lives more than 20 jopes ago, by his own lack of caution. It was so uncharacteristic of him. If he had held back, and we had approached those black holes close together, we probably all would have perished. And our colony, all million inhabitants, would never have been born."

"How strange that his chance bold snap could have so changed our own reality. How many more lives will be sacrificed learning to deal with this thing?"

The emergency communication channels all lit at the same instant. "Twenty incoming projectiles passing sector 1-F." How could that be? The sector was only fifty million kilurets away, above the ecliptic plane and half a million kilurets *inside* the inner sentry shell! The lead comets bypassing Outpost in the main comet stream were still nearly three thoms away.

Na and Ulixis reeled to see a cluster of brilliant pin pricks (several brighter over all wave lengths than a full Lune from Aerth) coursing in front of a distant dark nebula. The objects had apparently traveled in cold, ebon stealth through the outer planetary system, and become visible only after clearing the inner sentry shell. The pair quickly slued their telescope toward the intruders for a better look.

"They seem to have no size at all," Ulixis blurted. Data were pouring in concerning the mysterious objects' trajectories and masses. Some of the closest sentry stations had managed to establish precise position and velocity fixes using triangulation, as well as rough mass estimates based on distortions in the regional gravitational field. "Their current speeds are about the same as the comets. They must have been intentionally launched in front of the main comet stream, from a slightly different direction. The lead bodies should reach Omen in just over three yads." Ulixis was stunned, and spoke rapidly but mechanically to cover her desperation. "The latest mass estimates are minuscule, less than half a terumag each. This corresponds to iceballs no more than 90 rets across."

"That makes no sense! Could they be pionic missiles?"

"Then why are they glowing so?" Ulixis could no longer mask her distress. "Look at their spectra – it's crazy! Hot in gammas, neutrinos galore, plus energetic particles and antiparticles of every type. The radiation seems to be coming from nothing." Ulixis abruptly spoke more thoughtfully. "The spectral signature is close to that of mini black holes."

"But that's impossible! If they originated at the black bolt, black holes with the observed masses would have evaporated by now. No, that's not right. If the masses were originally a few times larger, they would have survived. But then we should have spotted them long ago. You can't just turn black holes off and on. Can you?"

"The lightest and brightest seem targeted to Omen, the others divided between planet-1 and planet-2."

Na confirmed this, then performed a quick mental computation. He felt a quiver of perverse satisfaction. "Then your hypothesis does fit. Black holes with the observed masses would be entering the explosive phase of evaporation precisely as they arrived at their respective destinations. Each would release energy comparable to that generated by one of the ordinary comets." Na couldn't understand an abrupt shift in his emotions. He suddenly felt somehow relieved, released from an awful burden, as if he had wished this on himself. A vision of a devastating effulgent blast, consuming all, purifying all, wrapped around his mind. How could he be feeling this? His children needed him. He wouldn't forsake a child, not again.

"Black hole explosives?" Ulixis cut in, as she and Na instinctively began to accelerate toward their threatened home. "How would you create them? Not to mention control them?"

"Never mind that. How can we stop them? To destroy them prematurely is probably impossible."

"If we could increase their masses, and so delay self-destruction, the objects should punch through their targets with minimal damage."

"But how can we accomplish that in only three yads? Each one should be smaller than an atomic nucleus. The only handle we have on them is gravity, which is extremely feeble except up close. We'd have to shoot in one particle at a time, in an intense radiation field, at a rate that couldn't compare to the rate of mass loss."

"Perhaps we could simply deflect them? We could try directional bipolar pionic explosives." Worry about debris from such a blast was irrelevant now.

"But any explosion would pass right through a small black hole. There's almost no cross section to catch a recoil."

"What else can we do? These might be affected somehow. It is worth a try!"

The swarm of black holes was now passing before a bright, distant knot of emission nebula. Against the luminous background, an eerie blackness flickered wildly, with incomprehensible passion, around each body.

Na and Ulixis raced homeward to Omen, to help coordinate the defense effort there. Even at standard maximum interplanetary acceleration (not routinely used inside a planetary system, for safety reasons), they arrived barely two yads ahead of the newfound projectiles, which glowed ever more fiercely as their rate of evaporation inexorably increased. There would barely be time to position resources to mount any kind of resistance. A few Omen residents, mostly senior octan officials, were already asking to be evacuated. The rest were either still ignorant of the situation, or opting to weather the coming storm in the illusory security of their fluid home turf. Which was fortunate, since a timely mass exodus would have been impossible.

A squadron of 24 metons, arrayed in eight triads, had been hastily assembled in the nearby sentry shell to probe the invading bodies. Each triad was equipped with a single highly-directional pionic mine and an attendant creatoid, tentatively programmed to guide the mine as close to a specified black hole as possible, then detonate the explosive toward the target. The creatoid would willingly sacrifice itself, of course. The battle group, its members camouflaged in chameleonic skin, had departed within two rohs of the discovery of the incoming missiles.

After nearly four rohs of heavy acceleration followed by over two rohs of similar deceleration, the lead triad was now closing on the mass bearing most directly on Omen. The team veered onto a parallel course, and matched speed with the body at a "safe" distance of 200,000 kilurets. Even at that separation, the black hole warmed the metons' skins, shining in gamma rays and particle emissions with nearly seven times the radiance of Los in visible light on the opposite side of the sky.

As the assigned creatoid readied its weapon, Na turned to Ulixis at an observation post near Loslo. "You realize a pionic blast might kill the entity riding that black hole." It was now clear that each black hole was being guided by a sapient being, much as the comets.

"It does not matter," Ulixis jabbed back.

"But it mattered back on Outpost."

"I have changed my mind. That thing has demonstrated sufficient intelligence that it must comprehend what it is doing to us. In any case, it is on a death trip. We are not violating its will to live, just denying its ability to hurt us."

A convenient change of opinion, Na thought, now that Ulixis' own home was in jeopardy.

The mine-toting creatoid separated from its meton companions, and accelerated toward the target. The synthetic creature had been created only yads earlier, and did not even have a proper name, only a designation CLy-325146. Now it began to chant as in a trance, urging itself onward against the gale, as it doggedly shepherded its charge toward the dazzling, impossibly tiny point of light dead ahead. CLy-325146 had to succeed. This was its purpose, its destiny. Radiation ripped through its guts, heat jacked its cerebral functions. CLy-325146 willed itself to succeed. The mine was armed, set to explode when the casing melted. The nucleogyro axis was aligned. The thing ahead seemed to be completely ignoring the steadfast creatoid, as if it were no more threat than a fleaoid. Yet CLy-325146 knew it must persevere.

Even though the blast would probably have no effect. With a final determined cry, it flung the mine straight at the heart of the Beast. Nocs passed. Then the sky and creatoid together dissolved in an incandescent sea of ultraviolet.

The metons watched as two blazing shafts of light shot in opposite directions from the blast site, one directly toward the black hole. The energy beam passed straight through the target as if nothing were there – as expected, and feared. What now? The stunned metons winced as the black flicker attending the black hole unfolded from some extradimensional cocoon.

A lone male meton broke from his companions, and slipped with deliberate haste toward the intruder. He had to see with his own eyes what this Thing was, what made It tick. He deactivated his chameleon skin and, pushing ever closer, strove to make contact, applying every principle of interspecies communication he knew. As he approached, the alien entity seemed to become progressively more agitated. It twisted, writhed, strained toward the meton. Suddenly a small piece broke away, and accelerated directly toward him. It instantly transformed into a tongue of fire, a dagger of blinding radiance. In a flash, the meton was reduced to hot vapor. What had a moment earlier been a thinking, striving being was now a drifting cloud of plasma. "The sacrificial lombling," whispered an anguished comrade. Was he now part of an epic story, like that of the ancestral hero Nemo? Somehow the prospect didn't matter any more.

The blackness withdrew to its dark lair, apparently content. But the trajectory of the black hole had changed by several degrees. The lightning strike had somehow caused the object to recoil in the opposite direction. In the heat of the moment, the surviving metons deferred their grief, and relayed the serendipitous information back to Loslo.

Only nine rohs remained before the ten black holes apparently targeted on the Omen system arrived. Na and several other metons scrambled above the cold plains of Loslo, coordinating the pell-mell improvised construction of 128 drones. The craft were garishly lit, heavily shielded, and programmed to broadcast non-random, language-like patterns over wide bands of the electromagnetic and neutrino spectra. Each would be launched at an incoming projectile, and taunt the resident alien consciousness, provoking it to strike and thereby alter course.

Ulixis' voice sounded inside Na's mind, from an observation post near the orbit of the outermost Omen moon. "The deflected black hole has managed to correct its course over the past roh. The trajectories of all the bodies have been a bit erratic, much like the comets. Strange – the random jitter is comparable, even though the comets are much more massive."

"We should concentrate on defending discrete sites, like major population centers. It would be futile to try and shield the entire planet."

"We must include Loslo. If the outer planets are any indication, the major moons will be targeted."

Time had run out. The untested drones hurried outward to match speed with the incoming projectiles at strategic points along the final five million kilurets, the terminal roh, of their flight paths. There would be precious little time to act, but also scant time for the invaders to effect any course corrections.

After nearly seven rohs of frenetic acceleration, the first drone moved against the lead black hole, now a blazing arrow shooting straight at Omen's equatorial heart. The total luminosity of the microsuol was already approaching one millionth that of Los, and increasing steadily. The nonconscious interceptor leapt out under remote control, lights flaring wildly, screaming gibberish at its quarry. The black flicker responded, but seemed only mildly interested, even as the drone drew closer. Not until a meton cut into the drone's communication circuits and began speaking directly to the alien did it show real agitation. With a sudden electric flash, the drone was vaporized. As the flicker consciousness attempted to compensate for the recoil, another drone moved in.

The drama unfolded across the Omen system, as the remaining swarm of black holes penetrated the defense zone. Na retreated from the searing heat and radiation of a missile bearing directly on Loslo, as drone after drone hurled itself at the brilliant blackness – creation within annihilation. Repeated defensive zaps pushed the object off course toward Loslo's north pole. There appeared to be a chance it would miss the moon altogether, that Loslo would suffer only some shallow surface melting. Yet the alien was persistent, and reeled back toward its desired course between drone attacks.

"Why doesn't it just fire another burst in the opposite direction to correct its trajectory?" Na wondered out loud.

"Maybe a little bit of the thing dies with every discharge," an unfamiliar metallic voice responded. Na squinted to see a young meton in the distance, silhouetted against Los, watching with him.

With each successive strike over the following nims, the flicker indeed grew perceptibly dimmer. As the black hole eruption approached its grand finale, only a tiny fragment of crazed blackness remained. Na gasped in dismay as it struggled to hit its target, even in the throes of death. Did it feel so threatened by them? With a final surge, the strange being expended itself in a blinding pillar of light, thrusting its charge careening toward Loslo.

The exploding black hole delivered the moon's north pole a glancing blow, enveloping it in a gamma-blue fireball. When the scene cleared enough to see, the black hole was gone, and several kilurets of icy rock had been sheared away, sending a massive spray of debris downstream into empty space. Tentative cliffs were collapsing into a tumultuous molten sea, which filled a broad, ugly scar on Loslo's scalp. Na sighed in relief when he heard Loslo resume broadcasting to all who cared to listen. The damage was mostly superficial. Already worm creatoids were sealing off broken nerve tubes, and repairing shock damage to deep structures. The core personality was intact. Though she would have quite a headache for several yads.

Na's attention returned to Omen. How were Neris' daughter and her tribe – *his* tribe – faring? He felt so helpless. Already one black hole had struck at a high northern latitude, disrupting the local circulation. Fortunately the district included no major population centers. A pair of the self-destructing devils had been successfully diverted away from the planet, and two more "wasted" on unpopulated moons. This left a quartet of tightly spaced projectiles, now closing rapidly on Omen itself.

The drones were in short supply, and a decision was made to concentrate on the two lead bodies. As the automatons were guided in, a few free creatoids instinctively threw themselves at the remaining pair of unobstructed beasts. Curt zaps split the vacuum. Na hid from the awful glare and ionizing radiation in the protective shadow of Loslo. The sky above his northern horizon swam with reflections and scatter off a chaotic cloud of debris that now engulfed the moon. Los hung low in the west, weakly illuminating dense cirrus condensing in the dark cold overhead. A flurry of icy fireflies sparkled all around, sprinkling softly downward.

What ever did the aliens think of them? If only they chose to ignore the interceptors, the entire defense effort would be rendered futile. Every black hole would strike its target head-on. But then, Nemo would still be alive. No, that was different. Where was Ulixis? Was she still safe at the outermost moon? Everything was happening so quickly.

Na monitored the neutrino communications beaming directly through Loslo. The front pair of black holes had been diverted, but the other two were plowing straight in. One was heading for the equator, although it was impossible to predict the precise longitude of impact, as the body had been veering drunkenly. The second had for some reason swerved, to a deep southern latitude. Panic ensued, as the incendiary missiles pierced the planet's thin skin.

The octos and synocts on Omen prayed to Dama, the Universal Spirit within Whom they lived, of Whom they were an organic part. They expressed their terror, their desire to live, work and play, to make amends. The reys prayed to Maddee. Dama responded in Xyr necessary constancy, Maddee in Xyr sustaining consistency.

The blunt shock wave ripped through the soft city of Ulixo, population forty thousand, in the south equatorial sea. Even as the survivors pulled themselves out of the rubble, they felt a strange sensation, and knew that something was very wrong. The entire city accelerated up and southward, then slowly began to list forward. A roh later it was sinking, dragged inexorably downward, into the hellish depths of the mother planet. Only a handful of residents could be evacuated; appropriate transport was almost nonexistent. Most of the populace rarely traveled far in physical form, relying instead on remote virtual links to visit distant friends and experience foreign environments.

Two rey tribes that plied the affected currents were simply never seen again. A third tribe would be wiped out on their next passage by a generous spring of tainted manna.

Half a thom later, a large contingent of metons was hunkered down deep inside Loslo, within a vertical cylindrical vault some 2 kilurets across and 10 kilurets tall. The outdoor space environment was still thick with flying debris, and this seemed like a reasonable place to pass the time. Ulixis was nestled in a corner next to Na, and absorbed in a remote communication. When finished, she turned to Na. "Did you hear, every one of the black holes converging on Malzen≠≠gren shut down a few rohs before arrival there. Our observation team in the northern highlands reports the missiles then changed course, toward planet-1. They somehow reactivated before terminating there."

"Which makes no sense at all. Why would the invaders choose to leave Malzen≠≠gren alone?"

"What in all this *does* make sense?" Ulixis sighed. "I have been reviewing high-speed recordings of the black bolt, holes and comets, but it is all nonsense to me. What is the latest posted analysis of the flicker pattern? Is it just correlated noise after all?" Some bizarre low- and high-frequency fluctuations had been detected in radio-bright mottling on the spinning comet veils, and in both the particulate and electromagnetic emissions from the black holes, that bore a formal resemblance to a persistent flickering in the black bolt itself.

"The Beta team doesn't think so." Na was an active member of this official group, one of two assigned the task of analyzing the mysterious patterns. "The correlations don't match any known process, other than language. Of course, no one has a clue how to translate." They had less than two and one-half thoms to find a Rosetta stone, before the main comet stream bore down on Omen – assuming that the patterns were in fact language. "An open meeting is scheduled in hall CSF-731 in three kews, to discuss the matter. Why don't you join me there? I understand a few organics from down below will also be attending."

"You did not hear? That meeting has been postponed again, by another two kews."

Na winced inside. "I worry that many of the investigators are treating this more like an interesting research project, than a real crisis. Oh well, I will plan to meet you then."

Ulixis spent most of the next forty yads at the Loslo Archives, brushing up on alien communication and abstract language theory. The library was still largely intact, and provided a wealth of information concerning the history and evolution of the theoretical ideas. Ulixis bypassed the standard data acquisition protocol, equivalent to speed-reading, and instead dumped reams of relevant material directly into a specially prepared portion of her own cerebral cortex. While she and Na had originally carried most of this information from Jopitar, all but a small fraction had been stored in a highly compressed, essentially inaccessible format. The data had been tediously expanded into a useful form only after the library at Loslo was established.

The rich variety of octan, simion, and rey languages provided useful contact points between theory and reality. Ulixis compared the observed alien patterns with various classic systems, but was unable to draw any conclusions. She needed more time to develop an intuitive feel for the subject, and grew increasingly frustrated as the meeting time approached. Thankfully, she was not the only one pouring over the data.

A conflicted mix of excitement and resignation permeated the hall, when Ulixis rendezvoused with Na for the long-anticipated meeting. Synno, born a first-generation octo and now the senior meton after Na and Ulixis, opened the gathering punctually.

"As you all must know, the Alpha and Beta teams have both concluded that the various signals from the black bolt, comets, and black holes reflect some kind of common language. Yet all their attempts to translate have utterly failed. The consciousness responsible for the observed patterns may well be so unlike ourselves that meaningful communication is impossible." Synno hesitated for an awkward moment. "We have a limited window before the comet stream inevitably reaches us, despite the valiant efforts of the Sentry Corps. I propose that we terminate the translation project, and use this forum to discuss how we might redirect our efforts to more effectively deal with the crisis."

A dissentious murmur arose all around the room. Ulixis was herself taken aback, both by the abrupt shift of focus and by the negative, defeatist tone of Synno's remarks concerning the language effort. For the entire colony to simply concentrate on building more bombs would be terribly shortsighted. The comet stream seemed to have no end. How could they hope to deal with the invaders in the long term, if they did not learn how the aliens think? She didn't want to meet again in one thom, only to hear Synno advise a general evacuation. This would amount to the mass departure of all 3 thousand metons, and abandonment of nearly 12 thousand synocts and 750 thousand organic octos and reys to certain death. Were not several other capable individuals and groups working on the translation problem, in addition to the twin official teams? Ulixis was eager to hear their insights.

A rich, base ultrasonic voice intruded from the rear of the room. "Every message exists within a context." The sound came from an artificial saucer-shaped bellon, protruding from a large environmental chamber flush with the wall, and bracketed on either side by a pair of synthetic acoustic eyes. Three reys from the Okabi tribe were ensconced inside, interfaced with a battery of external sensors and manipulators.

Synno responded with a hint of condescension. "I do not think anyone in this room would argue with that statement. It is of course a fundamental tenet of language theory. Would you please identify yourself?"

"Hue Yu Na."

"Hue, then." Wasn't he sent from one of the lesser tribes, as an observer? "How can we hope to fathom the context perceived by such an alien intelligence?"

"My colleagues and I were led to believe that this meeting would entail a free exchange of ideas concerning the alien language. We have not prepared a formal report, but would like to share some germane observations."

"Of course you and your rey friends are free to dabble with the problem on your own, if you wish. But frankly, I consider it a waste of meton time."

The room fell completely silent. Hue Yu Na glared back at Synno with his synthetic eyes. Ulixis felt she had to intercede.

"Hue Yu Na, I must apologize for my comrade's insensitivity. We have all been under extreme stress. I for one am eager to be informed of your observations."

The hall erupted with shouts and flashes of approval. Synno slunk quietly to the floor along the nearest wall.

"I thank the honorable Ulixis." Hue quickly scanned the assembly. "The observed pattern is known to be semi-cyclic. It repeats, typically with some minor modification, roughly once every noc. This design can itself be divided into two distinct segments. The first segment differs from one projectile to another, but most of it repeats exactly until an interaction with the outside world. Then it changes abruptly."

A sympathetic but impatient synoct in an adjoining tank interrupted. "A popular hypothesis is that this segment represents some kind of flight or attack plan. Have you made inroads toward decoding it?"

Hue kooted inwardly. "Indirectly, yes, through the second language segment. As you all know, this pattern is highly stylized, consisting of an incredibly long sequence of tight word triplets, of the form

$$\Omega\alpha A,\ \ A\alpha B,\ \ B\alpha C, C\alpha D,\ \ \ldots,\ \ W\alpha X, X\alpha Y$$

where $X\alpha Y$ is the final triplet." Hue painted a crisp holographic image of the series for the audience. "The pattern mutates in a predictable way on each successive pass. The second triplet is simply dropped, and the first word of the third triplet becomes the third word of the first triplet. A new triplet with a novel third word is added to the end of the overall series, maintaining its length. The given series is thus replaced on the next pass by

$$\Omega\alpha B,\ \ B\alpha C,\ \ C\alpha D,\ \ D\alpha E,\ \ \ldots,\ \ X\alpha Y,\ \ Y\alpha Z$$

where Z is new." Hue drew an image of this series, floating eerily in space directly beneath the original. "Remarkably, the first word of the first triplet never changes, and is shared by all the comets, black holes, and the black bolt alike."

Hue stopped for a moment, as his voice became choked with emotion. "There is a distinct chant-like quality to this sequence, if it is played back at a slow speed. When I first heard a recording, it reminded me uncannily of an ancient rey oral tradition from Jopitar, in which our ancestry was verbally recounted and passed on. For example,

Maddee begat Engd, Engd begat Newh, Newh begat Hamd, …

Maddee was the Parent Spirit of all reys, or the universe for that matter. Over time, the most distant ancestors – save Maddee, and a few symbolic heroic figures – were dropped from the beginning, while newly initiated adults were appended to the end, to keep the series a reasonable length. The chant was often recited during times of trouble or danger, to bind the tribe together and counter fear."

"What preposterous speculation!" someone yelled from the back. Ulixis was certain it was not Synno. "Are you suggesting this is also the meaning of the second segment?"

"What better way for the aliens to maintain resolve, than to inscribe their lineage on their weapons, and recite a litany of their roots?" Na countered forcefully. Ulixis was somehow pleased to see Na come to the support of the confident young rey. So very young, she thought wistfully. "They hurl themselves at us, one after another, to certain annihilation. They must see us as a terrible enemy, to be destroyed at any cost. We need to focus on the context from the alien perspective."

"How do we know the aliens are even afraid of death?" a meton challenged. "And wouldn't the term *symbol* be preferable to *word* in this discussion?"

"If what you are suggesting is true," another meton interjected, "then the last word – or whatever – of the final triplet should represent the alien currently inhabiting a given projectile. But it changes every noc. How could it ever represent a single individual?"

Hue replied without hesitation. "As Synno has already pointed out, these aliens must be utterly different from us. They might give birth, or metamorphose, or be otherwise reborn, and both think and act, on a time scale vastly more rapid than our own. This proposal is indeed speculative. But we must start somewhere, with some reasonable guess. And the hypothesis has born fruit."

A hush settled over the restless gathering. "What we have been calling the first language segment begins with a triplet

Z Δ Ψ

where Z is invariably the final word of the second segment series – presumably, the alien presence. Now we noticed a most interesting thing. While every comet and black hole has its own, continually updated identification Z, all bodies share the same Δ, and all bodies aimed at a common target share the same Ψ. The final two words of the opening triplet emitted by a given projectile are constant, unless and until that body is deflected from its mark. In the rare case that a deflected comet redirects itself to a new target, Ψ abruptly changes to the word associated with that target by other projectiles."

The entire group stirred. Could the reys indeed be onto something? Why didn't the other groups spot the last correlation? Even Synno rose off the floor. How could they not be doomed?

"We have identified the patterns representing Omen and each of the other planets and major moons. We interpret Δ to mean *destroy*, or something analogous. And very importantly, we believe we have identified the pattern signifying *not*. In several cases, just before an alien died, it blurted out a novel quartet of the form

Ψ Ø Δ Ω

where Ψ presumably refers to the intended target, Δ indicates *destroy*, and Ω is the God symbol. For example, 'Omen Ø destroy God.' What else, in this context, could Ø mean than negation, or some close derivative?"

Ulixis trembled inside. She had been hurriedly reviewing her memory of the original attack in which Nemo was killed, and felt compelled to share a revelation. "The ancestral chant was there, more than 20 jopes ago, in the assault on myself, Na and Nemo, before we settled this haven." The group fell stone silent, as Ulixis spoke now as their common Mother. "But that was not all. There was an urgent, almost terror-stricken garble, whose meaning has eluded me, until now. By Hue's interpretation, it is clear. 'Alien destroy Nemo! Alien destroy Na! Alien destroy Ulixis!' And then, 'Nemo not destroy God! Na not destroy God! Ulixis not destroy God!' Hue Yu Na, please pardon my interruption. Is there more?"

Hue gestured respectfully toward Ulixis, then resumed. "Yes. Using the tentatively identified core symbols, and matching alien behavior with speech patterns, we believe we have deciphered roughly half of the first language segment. Which incidentally, is more naturally viewed as the second segment. Of course this is all still conjectural, based mainly on consistency arguments, within our own perception of the alien context. The proposed syntax is bizarre. Until we succeed in actually communicating with the aliens, the interpretation is uncertain."

An excited young synoct broke in. "We could send a broad-spectrum neutrino plus electromagnetic message toward the great black bolt, inscribed with a response in kind: 'Dama begat Los, Los begat Omen, Omen begat Loslo,' etc. "

"What would that ever get us?" Na demanded.

"They would at least see that we have something in common."

Still another meton suggested "We could add 'Omen not destroy …' whatever the name for the thing's Original Spirit is."

"Accompanied by 'Alien not destroy Omen,' " proposed one of Hue's compatriots. "We could even insert the alien ancestral chant after the Omen chant. That might show respect."

A hopeful pandemonium erupted in the hall, as meton after rey offered additional ideas.

A task force was hastily appointed to compose a consensus message. Over the muted objections of a few senior meton officials, the entire Okabi rey contingent was included, together with equal numbers of octan, synoctan and meton language specialists. While the symbolic text was being hammered out, a work gang of metons and creatoids repaired the extant medium-range communication facilities on Loslo.

It was nearly four kews before a tentative message was finally beamed outward, both toward a number of approaching comets, and toward the black bolt itself. Alas, the comets appeared not to be affected in the least. Were the resident aliens under strict orders to execute a prescribed plan? Were they even listening? Or were either of these possibilities relevant or meaningful? Perhaps the colonists simply hadn't yet suffered enough to atone for their successes. Now they could only wait for the message to reach the black bolt in some forty yads, and hope that a positive response would return an equal time later. A forty yad flight across the dry desert of space, and back again.

The spearhead of the main column of comets was only 83 yads distant, which left very little margin. A battle raged through the waiting period as legions of sentry interceptors incited the advancing aliens to self-destruct, thinning the ranks of their relentless march to the inner Los system. The residents of Omen watched the clouded skies with trepidation. They wanted to know that things would return to "normal," to the way they had been before; that their lush home world was eternal. A few sectors had been hit by a plague of locustfleas, as the recent disruptions of regional currents tipped local ecologies out of balance. Yet for most of the population, fear and its arachnoid stepchildren still posed more tangible challenges than the aliens themselves.

The first forty yads crawled past. A few metons wanted to send a modified message to the black bolt, but a decision was made to wait for any response to the original. Fifty yads. The language teams agonized over their analyses. Without any interaction with the aliens, how could they be sure of anything?

Seventy-nine yads. A small but significant cohort of comets was proving resistant to sentry tactics, and threatened to break through. Were the aliens learning? It was estimated that one comet might penetrate the defenses every yad initially, to strike somewhere in the Omen system. This impact rate would likely increase with time. Growing numbers were demanding evacuation from Omen. But where would they go?

Ulixis and a solemn group of other metons gathered above Loslo in a quiet vigil as the moment of truth neared, to bear witness to any sign of a response from the black bolt. The miracle happened without fanfare, in barely one nim longer than the round-trip transit time. The incoming comets simply began to peel away from their original tracks, out of the ecliptic plane toward deep space, one after another as a cryptic reply from the black bolt sped forward along the string of projectiles. From the perspective of Ulixis and her comrades, the comets appeared to all veer away simultaneously, since light from the comets and the signal from the black bolt moved toward them at the same speed. The sentries promptly broke off their attack, and retired to prearranged fallback positions.

Over the next several yads, it became evident that most of the comets were looping back toward the outer reaches of the system. Only three tight clusters, six comets each, remained. These seemed to be settling into equally spaced points on a huge circular orbit around Los, just beyond the outermost sentry halo, in a plane nearly perpendicular to both the ecliptic and the direction to the galactic core. While most of the bodies were cloaked in standard black, the central, largest member of each grouping was now wrapped in brilliant white, more reflective than newly fallen water snow.

Ulixis was still stationed above Loslo, warily monitoring developments. She wondered what superstitious simions would have thought about the numerical arrangement of the remaining comets. She kept these thoughts to herself, as she was certain none of her companions would understand the reference. Then without a word she slipped away, and headed straight for an isolation vault deep within Loslo, adjacent to Nemo's tomb. Na wasn't the only one who sometimes wanted and needed to be alone.

Immersed in synthetic stone, Ulixis pondered an ancient simion prayer:

Dearest Mother
Dearest Father
Dearest Other
Hallowed are You.

Pray
Grant us this day our daily bread
whatever that might mean.

How can we know what we truly need?
How can we know what this world truly is?
Assaulted by desire so hard
we confuse it with the universe
outside.

Some see Red.
Some see Blue.
Perhaps the truth is ultrahue –
a rhapsody of woven chords
beyond our mortal sight.

Chapter 17

Threshold

Jope +20L

Na and Ulixis lounged in the vacuous reaches beyond Outpost, gazing in shared relief at the distant orb that was Omen. In the opposite direction, the black bolt retreated step by step toward the galactic core. Na broke the reverie.

"At least our ordeal has brought together many of Omen's divisive factions and special interest groups."

"A common cause can have such a unifying effect," Ulixis replied thoughtfully. "History shows how destructive factionalism – Us against Them – can be."

"We were wise not to partition the colony into competing nations. That would have only fueled discord. Even before the invasion, we generally managed to avoid overt violence amongst ourselves."

"Yes, nationalism was pernicious in ancient times on Jopitar. Brute force has never been an effective tool for dealing with conflict within a cohesive group of equals." Ulixis reflected soberly on her study of conflict between groups on various worlds. "Of course violence can be very effective in imposing the will of one group on another, when the targeted group is viewed as somehow inferior, or dangerous by virtue of being different, even when the dominant group pays lip service to a doctrine of nonviolence."

Na thought it ironic that the same perspective could be applied to their encounter with the alien race. "I understand that Synno has publicly apologized, both to Hue Yu Na and to the general rey population, for the bigoted remarks zo made during the council meeting. Zo went out of zor way to exhort all octos and reys 'to embrace one another as equals, each blessed with unique strengths and weaknesses, both as individuals and as distinct species.' "

"Implying I suppose that metons are merely derivative octos or reys," Ulixis replied with unexpected bitterness. "I was flabbergasted when Synno made zor earlier slurs. I had assumed that such speciesism could not exist in our society."

"There's another positive consequence of the invasion. The popular perspective on safety and risk seems to have become much more rational. The bureaucrats won't recover for many jopes." Both kooom-chuckled neutrino static.

Ulixis turned her attention to a radiant orb high above the ecliptic plane. The heart of one of the three remaining alien complexes, the enigmatic object had recently begun to gently pulsate in visible light. Its reflectivity was now somehow cycling between that of soot and the purest snow, roughly once each noc. Extremely faint, wispy tendrils spiraled inward from the five smaller bodies orbiting nearby, draped in black awareness and visible only in the far infrared. The bright central object seemed to be feeding off the others, slowly growing in mass and complexity. Ulixis and Na were located in a weak side lobe of a communication beam directed from the strange entity toward Loslo. Ulixis could just detect convoluted amplitude and frequency modulations in numerous bands of the electromagnetic spectrum, though it was complete gabble to her.

"Strangely beautiful, isn't it?" Na injected, reading Ulixis' mind. She had left her guard circuits down, as she so often did when alone with Na.

"Indeed. If you like tainted white noise. What's the latest on the communication effort? The pattern seems nothing like before." Na still maintained a link with the Beta team.

"There has actually been significant progress, since our friend out there decided to participate." Na gestured electronically toward the alien beacon. "Hue and his crew have been very helpful, especially with creative global insights. They have finally been granted their own official designation – the Gamma team, I believe."

"So what are the aliens supposed to be saying now?"

"Much of the content thus far has been a kind of lexicon – imagery matched with symbolic patterns. Once the image format was recognized, the rest was straightforward. Except that the images are bizarre, abstract, difficult to pin down. Remarkably, a majority of the transmission appears to be abstract music. They seem to be singing to us! Very lyrical, poetic text is embedded within the musical composition."

Ulixis was vaguely dubious. The interpretations always seemed too simplistic, even when there was clearly some truth to them. What unknown or unknowable emotional content might be buried within notes and rhythm?

Na continued. "A few of the reys find the rendered music hauntingly beautiful."

"There is no accounting for aesthetic taste," Ulixis teased.

"More recently, the alien has apparently been trying to describe itself to us. It seems to refer to itself as the 'self-conscious being of the vacuum.' Which is ironic, considering that it feeds on black holes. A few octos have suggested that we simply call it the *voidling*. This name is catching on fast."

"And what does this voidling call us?" Ulixis' curiosity was piqued.

"The translation I find most compelling is 'self-aware parasites of matter.' "

"Why the distinction between *self-conscious* and *self-aware*?"

"The symbols are nearly identical, but not quite. We posit a more positive self-reference."

Ulixis winced mentally. What if the voidling did the opposite, out of respect? How many nuances were they perverting, or missing altogether? "Has anyone tried asking the voidling why it called off the attack on Malzen≠≠gren?"

"Yes, it apparently decided at the last moment that the planet wasn't 'infested' after all."

"Perhaps when it discovered that Malzen≠≠gren is a carbon planet. The voidling may simply be more familiar with such worlds, and so feels less threatened by them." Ulixis noticed a distant flash as a wayward piece of space junk slammed into a dwarf planet a few hundred bevurets from their location. "It is interesting that you have chosen to take active leave from the Beta team at such an exciting time," she gibed.

"You know I wasn't contributing very much. Deciphering foreign code isn't my forte. Besides, I made room for someone more capable than me."

Ulixis sighed inwardly. She had heard this before. "Well, I feel no penchant for it either."

"Though your presence at the advisory council meeting was invaluable. I wonder if anyone else would have stood up to Synno the way you did, without hesitation yet so diplomatically, before things got out of hand."

"I am hardly indispensable." Ulixis reflected on the occasion. "Synno felt we had no hope to understand the aliens, because they are so different from us." Ulixis paused thoughtfully. "Yet we presume to understand Dama, at least on some level. And who, or what, could be more different? Or do we really understand Dama at all?"

"Synno was clearly wrong about the voidlings. We metons, octos, reys and voidlings alike are all exogenous creatures, and share the same physical universe. This inevitably imposes common outlines on our conscious experiences, which evidently overlap enough to allow us to communicate. The situation with Maddee is completely different. If the physical world is in fact a facet of Maddee's mind, then we experience Xem directly. You, me, everything we see and create, even so-called artificial entities, are all natural, vital aspects of Maddee. To the extent we are reflections of Maddee, can't we hope to understand Xem?"

Ulixis contemplated how comforting it must be to know with certainty. Then she was abruptly revolted by the idea. "I wonder what Dama-Maddee chooses to call Him/Her/Itself? Or is this question utterly irrelevant?"

"Perhaps something like the ancient name – 'I Am.' I always liked that."

Ulixis turned her gaze to an unseeable distance, a sprawling dark nebula that hung beneath them and the Los ecliptic plane like a bottomless pit. She decided to change the subject and mood. "Tell me, Na. What is your dream? Your passion?"

Na paused for only a moment. "To explore." Then he koomed broadly. "To experience all the positive variety, fullness and limits that creaturehood offers." He didn't mind being set up. "And yours?"

"I suppose it has been to help establish a new colony. This colony. And yet …"

"Something is missing here?"

"Well … yes. We are so … restricted."

"In what ways?" Na was surprised and puzzled. He had never seen this side of Ulixis.

"I worry that I have no right to complain, especially now. We almost lost everything. Yet the recent events have actually drawn these feelings out of me. I hardly know how to explain. I am – we are – metons. Yet this colony is set up primarily for the organics. Which is fine in itself. We owe our existence to them, we were organics once ourselves. But I dream to go beyond the organic stage. I want to explore the full potential of meton existence, of a true meton civilization. The possibilities for various types and levels of shared consciousness especially intrigues me. And I long – this sounds so strange – to have my own meton young."

"Do you mean clones?" Na tried to hide a wave of revulsion.

"No, of course not. That route is inflexible, self-centered, a dead end. I mean children who would be of us, yet separate, analogous to the organics. They could inherit our basic tendencies and traits, but not the particulars."

Na didn't interrupt, but let Ulixis pour it all out. She seemed really serious about this.

"We could easily modify ourselves, introduce some variety of design and function, some real differences between the equivalent of meton sexes – male, female, or whatever – and make these distinctions relate to something more than just our biological heritage. The female form could be enlarged, and given the equivalent of a womb."

Na imagined Ulixis with a 50% greater girth. This pleased him, as it reminded him of the size difference between rey females and males. The vestigial organic nerve patterns persisted.

"A way could be introduced for male and female to imprint a blended genetic template there, to conceive an embryonic meton within a protected, intimate environment. There could be an extended period of infancy and childhood – say, three jopes – to allow adequate monitoring of development, permit significant individual learning, encourage the blossoming of a unique personality."

Na finally decided to state the obvious. "But meton offspring are strictly forbidden."

"I know, and I respect the taboo," Ulixis replied sadly. "The octos have good reason to impose it." Her pent-up anger and frustration abruptly flared. "But we do not. The metons do not. The risks and benefits to each race are totally different. Still, how could I ever break the covenant? I feel so hemmed in."

Na looked outward, at a distant smudge of light framed by a swirl of hot blue stars, and felt an old, deep inner stirring. "We could leave this galaxy altogether," he responded fancifully. "The restrictions couldn't be binding in another star system."

Ulixis fought back a moment of terror, as she imagined her familiar stellar whirlpool an insignificant speck in an alien sky. Na hadn't mentioned his old dream of intergalactic travel since the time of Nemo's death. "I know rationally that other spiral systems have similar stars, similar planets. Yet I have trouble convincing myself emotionally that they are not somehow terribly different."

"They are the same," Na said softly but firmly, surprising himself. Then why was he so drawn to the idea?

"There is something else I have not told you," Ulixis again changed the subject. "And please, do not kooom. I have been composing a story, ever since we first arrived at Omen."

This was the first Na had heard of it. The yad was turning out to be full of surprises.

"It has been important to me, but I am such a slow writer, I did not have the nerve to bring it up until now. It is a fictional account of how the simions may have broken free of their home planet Aerth, with a special emphasis on possible transformations in their culture, philosophy, and religion."

The very name *simion* suddenly struck Na as so alien. Didn't they sweat to cool down?

"Weaving the story helped me deal with feelings of homesickness for our own birth world. In retrospect, it is as much about myself as the simions. The work is almost finished now, and I do not know what to do with it."

"I'd like to read it," Na offered. "Or would you recite it to me?"

Ulixis koomed. They had nothing planned for a few yads. Sometimes Na knew exactly what to say.

<u>Jope +23L</u>

The following three jopes were full, and passed quickly. The Omenites continued to develop relations with the voidling, and an uneasy peace was established. The dark stranger had made a single demand: that the parasites of matter keep out of its territory, a sprawling complex of black gravity pools and interconnecting spacetime lowlands. In return, the voidling would respect the colonists' peculiar domain. These terms were easy to accept. While the black hole environment was of interest to the colonists, it was also quite hostile to them, and could easily be monitored remotely. Dynamic territorial boundaries had been negotiated, defined in terms of spacetime topology. A buffer zone was included, to minimize the chance of accidental incursions into each other's space. The three alien beacons remained, serving collectively as a kind of foreign consulate.

Na was flying out from Omen, to a work assignment inside Loslo, when Neris caught up with him. Neris had already been a meton for four jopes, since long before the coming of the voidling. The transition had been comparatively easy for her. Raised in a simulator tank, she had always been familiar with the metons, and had never felt truly wild.

"Blessed rising, Father," Neris called.

"Blessed meeting, daughter! What brings our paths together?"

"I was hoping you would have the latest news on communications with the voidling. It's impossible to obtain up-to-date information through standard channels. I understand we have asked once again about possible previous encounters with other octan colonies?"

"The response was the same as before. The voidlings still seem confused by the question. They don't understand how there could be *other* colonists. They insist that we Omenites are *the* colonists, *the* self-aware parasites of matter."

"Doesn't the local voidling collective and its immediate derivatives occupy only a small corner of the overall voidling habitat? I have heard that they occasionally touch or meld with other collectives. So they must understand the concept *other*."

"Yes, but none of the other collectives has ever referred to distinct, self-aware creatures like us. Of course, they all occasionally need to eradicate 'parasitic infestations.' The local voidling seems to believe that our colony originated right here, in the Los system."

"Perhaps we could send them a string like 'Suol begat Jopitar, Jopitar begat metons, metons traveled to Omen,' etc. Wouldn't that help clarify things?"

"We have repeatedly tried to explain that we first came from a different star, but Synno and his allies on the Council insist that we never disclose the location or any other details of the suolar system. This may be hampering communications. The voidling provided our common symbols for the Los system, and they may require spatial coordinates to meaningfully define other stars and planets."

"I also wanted to ask about your work on the Metonite Project." Ulixis had not abandoned her dream of an independent meton civilization, but vigorously pursued the idea. She had organized a meton task group two jopes earlier, to fully explore the possibility and its ramifications. Many octos had initially reacted with horror and outrage. Some still found the project more threatening even than the voidling.

"Tempers have cooled considerably, since several organics were invited to join the task group. In retrospect, we should have done that long ago."

"I'm interested in joining one of the developmental teams, but need to find a good fit. Didn't you volunteer to head the team assigned to design an intergalactic transport ship?"

"Yes, and it's been quite a challenge. The vehicle must be capable of transporting thousands of metons, on an ultra-Niestiik [approaching light speed] trajectory, all the way to another galaxy. Ambient light photons and dust particles are transformed to lethal bullets at such high velocity, so a shielded vessel is needed. The protective craft must be self-conscious, of course, to ensure efficient and reliable operation."

"A *crafton*, right? Isn't that what such an entity is commonly called?"

"Yes, I'm afraid so. I dislike the term, finding it both ugly and ill fitting. The tag is popular with the organics, though, so I use it for political reasons."

"How would a crafton be so different from the conscious moons of Omen or Outpost?"

"The design must be fundamentally different. The conscious moons aren't equipped for self-propulsion, and rely on metons for many routine functions. This particular crafton would be unusually large. I fancy calling it a *megon*. Listen, I'm heading for Loslo now, to simulate construction based on some preliminary design work. Why don't you join me?"

"I'd love to! Thank you so much."

"I warn you, the job may get pretty tedious."

"That's all right. I feel I don't really understand a thing, until I know its details."

"Well then, follow me."

A few rohs later, Na and Neris decelerated as they approached the repaired north pole of Loslo. Na felt the tap of a metallic tentacle against his smooth skin. Curious, he turned his attention to Neris. "Yes, daughter?"

"Father – I have been meaning to ask you this for some time. How well did you know my mother before leaving Jopitar?"

Na was puzzled by the question. "Why, Ulixis and I had just met, following our meton transformations."

"No, I mean my biological mother."

"Oh. I never met her. She was supposedly found, badly injured, by an octan cruiser back on Jopitar. Her eggs were removed just after she died. I didn't even know I carried the eggs, until shortly before we founded this colony. Surely, you must have asked others about this?"

"As a child, but I never quite believed the story. I needed to hear it directly from you."

"Hasn't Ulixis been a good mother?"

"Of course she has. Still, she was never a rey. I have only begun feeling close to her since becoming a meton." Neris impulsively scanned the deep sky in the direction of Jopitar. "I wonder what kind of relationship evolved between reys and octos back on the home world."

"You do realize that was more than sixteen kilujopes ago? Maddee knows."

"It's just that, unlike here, the octos had a long history of looking down on reys as inferior beasts." A flash caught Neris' attention. Emerging over the far limb of Loslo was a gang of creatoids, busy vaporizing a swarm of orbital debris. "Are you aware that many young octos and reys have started using the combined term *Damaddee*, instead of either Dama or Maddee?"

"I had no idea. I should probably pay more attention to popular culture." Na decided it was time to change the subject. "Listen, we will be entering Loslo soon. Have you ever used the Loslo virtual reality apparatus?"

"Many times. You may recall that I was involved in the crash wartime effort to develop advanced remote experience and control techniques."

"Of course, how did that slip my mind?"

"What a frenetic period! The work ultimately led to the Loslo Reality-2 system, following the peace treaty."

The Omenites currently distinguished three levels of waking reality. Level zero was the most basic, and referred to the ultimate content of the physical world. This incredible tangled web of abstract physical relationship was thought to be one aspect of the mind of Dama, the self-sufficient panuniversal Spirit that embodied consistent logic and realized all consistent possibility. Level-one reality encompassed the everyday experience of animals and other exogenous creatures, their interpretation of level zero in terms of animal needs and desires. Though grounded in level zero, the conscious content was radically different. Level-two reality was an extension of level one, through virtual experience. It had originated with training simulators, used to practice dangerous tasks in a safe environment. As simulators were networked together, and more of a user's sensory awareness was assimilated, reality-two evolved into a complex world in its own right. Many now considered level-two experience just as valid as level-one.

"Do you have any regrets on your involvement?"

"Quite the contrary – I am proud I played a part. The technology was developed far beyond anything previously available. Of course, we had to defer dealing with serious ethical issues involving privacy, individual rights, and social responsibility."

"What else could you do? The invasion consumed everyone."

"Since the peace treaty, several colleagues have worked hard to address the oversights. I think they have done a remarkable job, developing mechanisms to minimize violation of rights, while still promoting freedom of expression and interaction."

A port opened in Loslo's skin directly ahead of Na and Neris, and they dove straight down a shaft into the deep interior. Close by the end of the passage, the pair snuggled into a cozy compartment, and plugged into the reality-two complex. Na activated the planning medium, and Neris found herself floating in an endless space colored a deep navy blue.

"This is my preferred starting place, my empty 'desktop' in the old computer jargon," Na divulged.

"A bit old-fashioned, isn't it?"

"I find modern backgrounds too distracting."

Considerable skill was required to use the reality-two milieu to its full potential. Special conscious triggers were required to initiate, modify, or redirect a session. A user could visit reconstructions of any site for which records existed, or create fantasy worlds. An external reality generator equipped with vast, comprehensive data banks could be tapped to supply provisional details of an experience, freeing participants to concentrate on their own behaviors. Other real or imaginary beings could be invited, permitted, or conjured to engage in a session. A user could present as a meton, octo, rey, ent, or any other compatible creature or entity. Virtual reality could be framed in a level-one format, or it could transcend level one, by including novel constructs and dimensions not encountered in everyday life. One could even explore an incorporeal world whose dimensions ranged over all possible values of abstract quantities. Experience was limited only by a participant's physical brain structure.

"Tell me, Father – do you have a special place here that you like to visit?"

Na koomed deeply. "Yes, though it changes over time. Lately I'm fond of a frozen mountainous paradise, floating at the core of a globular star cluster, and inhabited by great leather-winged creatures cloaked in silky brown fur. I morph into one of these organics, and join them in flight, through a cold moonlit sky. What about you?"

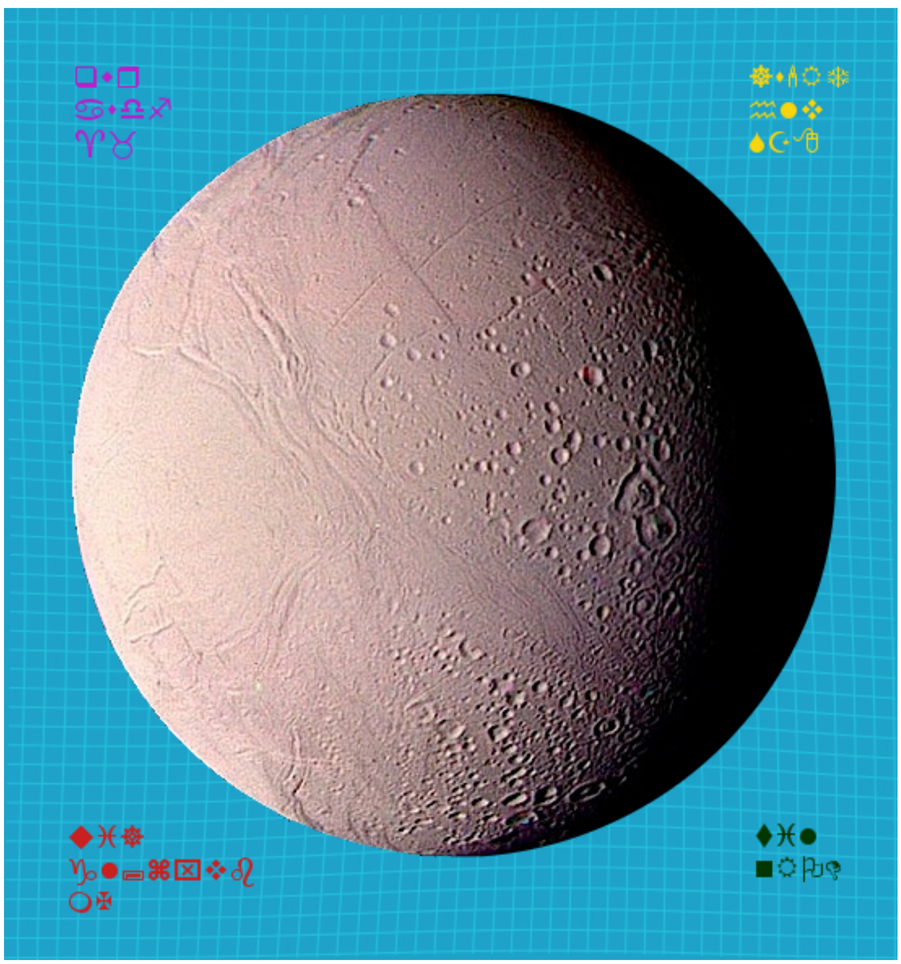
"My getaways tend to be less physical. Sometimes I like to lose myself in a dictionary of an ancient language. The Jopian Kuku dialect is currently a favorite. I experience the dictionary as a semantic world, in which each dimension spans all possible values of a given letter in a word. Valid letter combinations might glow a soft yellow, while meaningless sequences are stained a dull blue. As I move through the space, any meaning associated with my current position automatically pops into my mind. I sometimes alter the colors or textures of related words, to indicate connections."

Na koomed again, but inwardly. "How exotic. Well, let's start. First, we need to select a target." Na summoned a list of all intact, available, reasonably accessible, and (nearly) round moons and dwarf planets between 512 and 1024 kilurets diameter. An array of detailed 3-dimensional images of 15 bodies materialized around him and Neris. A young octo couple also appeared off to the side, apparently to watch. Na didn't mind, so they remained visible.

"Next we need data regarding 12 specific characteristics, including diameter, mass, and various structural and compositional indices," Na continued. Each extended body was instantly embedded in a 12-dimensional parameter space. Most metons could directly visualize spaces of up to 16 independent dimensions. Organics could manage only three at a time, so the octan couple had to be content with selected projections of the data.

"What are we looking for? Ideal size, balanced compositional mix?"

"That's right. Plus uniformity, structural integrity. See that large moon over there? Its subterranean sea is a contraindication. Such defects complicate and prolong construction."



Na eliminated all but three of the orbs from consideration. "Now comes the fun part – exploring the interiors of these selections. Let's go!" One of the bodies rapidly expanded into a huge, warty ball. First Na, then Neris dove into it playfully. They rooted about, tasting the composition, and feeling the density and texture of the rocks with their minds.

After repeating this process with the other two candidates, Na selected one of them – a moon 780 kilurets wide, orbiting in the stark deep freeze around Outpost. Neris indicated agreement. They both settled back, pleased with the choice. Rich in silicate minerals and carbon compounds, the moon also had an ample supply of metals and ices. There were several small structural defects, but all could be easily resolved.

Meanwhile, the octan couple was losing interest in the activity. They glanced slyly at each other, and abruptly disappeared. Neris chuckled to Na. "They've probably decided to pursue a private sexual fantasy."

"No doubt. Sex is such an odd beastie. The sex drive would be so much more rational if it only evoked an explicit desire to have offspring."

"Yes, but we both know how inefficient that would be. Imagine creatures fumbling in the dark, trying to figure out how to reproduce. Evolution generally finds it more expedient to instill a primary desire to perform certain physical mating acts, which only secondarily lead to procreation." Neris thought briefly to herself. "Of course, sex can also serve purposes other than procreation. It certainly helps bond a rey tribe. And many higher social animals *have* evolved an instinct to have young, in *addition* to an instinct to engage in sexual activity. Sometimes, the two drives can become linked."

"But the craved sex acts must even then appear ludicrous, or at least boring, to any detached observer! While primal sexual desire may be appropriate for lower animals, do you ever feel it is somehow unbecoming for sapient creatures like reys and octos?"

"Not really. As a sapient rey, I was able to understand the origin of my sexual appetite, and to impose reason on its expression. But I always tried to then simply enjoy sex, as a natural part of physical existence."

"Sometimes I wonder how I would have handled virtual reality as a virile young male rey. I fear I would have become hopelessly addicted to some aberrant form of cyber-sex, in the absence of imposed limitations." At present few restrictions applied to virtual experience, though counseling was discretely offered to individuals tending toward repetitive self-destructive behavior. Most users resolved obsessive cravings by acting them out in an accepting fantasy setting, often with the guidance of psychological tools.

"Dear Father, I find it so easy to forget that you too were once a creature of flesh."

"That was a long time ago, Neris. Now, are you ready to build a megon?"

"Indeed. I assume we will perform a time-enhanced simulation. What time-compression factor do you intend?"

"Let's try $x2^{18}$. That should be slow enough for us to monitor important developments, but not so slow that we will get impatient. I am planting two creatoid seeds now."

An identical pair of generic, cylindrical creatoids sprang out of the rocky equatorial plain on opposite sides of the moon, and began reproducing. Within six nims, a pulsing swarm of silver creatures nearly obliterated the surface.

"This pace is making me giddy! How much simulated time has passed?" Neris queried. "I haven't been keeping track."

"About one-third jope." Na showed Neris how to access a clock display. "The average density is approaching a critical value. Watch for a change."

The undifferentiated organisms abruptly began to metamorphose, transforming into dedicated work units. Most became worm creatoids, while a small minority became diggers. The conscious machines simultaneously organized into symmetric patterns over twelve sectors.

Standing on end, the worms within each sector arranged themselves in concentric pentagons. The diggers clambered atop the worms, both to get out of the way, and to distribute themselves in a more sparse design. As soon as the creatoids were in position, the worms attacked the crust in unison.

The worms burrowed downward with vigor. They ingested the rock in a feeding frenzy, savoring an ultralight spice of natural, energy-sustaining radioactive minerals. The raw stock was converted into a stringy siliceous mix that the worms excreted behind them, transforming the moon's fractured crust into a stout, solid medium. An amorphous matrix of fibers slowly crystallized within, adding further strength and resilience. The random filaments would spontaneously coordinate over time, forming a flexible, pervasive neural network. The vital hull of the crafton grew from the outside inward.

Na and Neris were able to watch the underground activity, by consciously altering both their perspectives and the transparencies of intervening material. Neris feigned disgust. "So, our crafton is to be composed of worm feces?"

Na koom-grinned inwardly. "Hush, and pay attention."

The diggers were temporarily stranded on the surface, sunken partway into the fresh, glossy plain. Many passed the time preparing clutches of constructor creatoid eggs. After several yads simulated time, all the diggers shifted into action. Most began to individually excavate round shafts, tapered to converge at the moons center, straight down. Diggers at all but one of the sector hubs labored to clear wider passageways into the moon. The work was dark, gritty, hellishly oppressive and claustrophobic, but the creatoids loved it.

The shaft diggers planted constructor seeds at regular intervals. Within several nocs, these had hatched and matured into comparatively small and flexible forms. Those near the surface quickly built protective iris diaphragms for the shafts. They then began reworking the outermost rets of crust, transforming it into a tough, sensor-studded layer of skin.

Excavated material shot out of the shafts, as the diggers advanced relentlessly. Selected material was captured at the surface, but the rest was deflected away in huge streams. The virtual moon slowly spiraled outward from a virtual Outpost, toward an eventual imaginary orbit around Los.

The digger force bore through the crust in step with the worms far below. At intervals, the shafts were shifted and linked in an intricate fashion, providing alternate travel routes, switch points, and rest stations.

"How would this design handle a collision with a small asteroid or comet?" Neris wondered aloud.

"The shaft pattern produces a crumple zone, which should preferentially absorb shock and shatter during an impact. Note that the shafts are not joined across sector boundaries, to help localize damage in any mishap."

"I see there is no direct line-of-sight access along the shafts into the crafton interior."

"That's right. This is primarily a radiation safety measure."

"How thick is the hull going to be?" Neris noted from the clock display that the diggers had been toiling for about 0.1 jope, simulated time.

"The design team has tentatively chosen 48 kilurets. The worms should reach this depth momentarily. There! It's time to remake the moon's interior."

The converging worm bodies were now just touching. To avoid future interference, they divided into six cohorts, which advanced in a shifting pattern of telescoping and twisting rings. Two of these cohorts deposited an extremely strong medium, laced with a variety of fibers and primitive seeds that would mature into a maze of nerves, nerve trunks, sensors, and conduits. This synthetic connective tissue would provide the framework for an elaborate system of halls, passageways, rooms, and crafton organs, extending from the hull to the crafton's solid core. These worms also laid eggs for a hoard of microcreatoids – simple, flexible units barely one ret in diameter, that would inhabit open spaces in the walls, and perform a wide range of housekeeping functions.

The majority of the worms in the other four cohorts converted the rock to a comparatively bland but sturdy amalgam, much of which would be cleared away later by diggers to create open spaces. The remainder produced specialized parenchymal media, which would mature into an assortment of dedicated structures.

"Why aren't the worms creating open spaces?" Neris queried.

"Structural integrity is improved using a two-step process. First, the worms convert the original rock to a more stable material. Then, the diggers hollow cavities out of this medium. Look, here come the diggers now."

The diggers had paused at the inner hull just long enough to fabricate additional digger and constructor eggs, then resumed their advance. As they penetrated the interior, diggers at the sector hubs continued to clear the major access ports as before. The isolated diggers changed task – they lay their eggs, then began to excavate a labyrinth of open spaces. The digger offspring joined their parents in the effort.

The basic architectural elements in the interior design were the *blok* and the *collyph*. The blok was a long, tapered volume with an oval cross section, associated with and centered on a primary hull shaft. Selected bloks would be hollowed out by the diggers to form continuous halls some 256 kilurets long, stretching all the way from the hull to the core. Other bloks would be configured as a series of abutting halls, or honeycombed with rooms and chambers surrounding a central corridor. The remainder would contain the various crafton organs.

Collyphs were the main structural components of the foundational framework – towering, interconnected columnar structures that separated the bloks and supported the bulk weight of the overlying hull and interior elements. They were flared at both top and bottom, to graciously accept their gravitational burdens. A network of ports and passageways through the collyphs interconnected the bloks.

"I see no sign yet of the Drac bubble generator or the Xam drive," Neris noted.

"Watch the worms under the passage-free south polar hub. Their exudate is laden with tubules that will grow, multiply, and interconnect to form the requisite network of cryogenic channels, plasma chambers, and quantum interference circuits. The system will eventually be integrated directly into the crafton brain in the outer core."

Na became impatient with the simulation. "If you don't mind, I'd like to hurry through the next 5,500 yads at quadruple speed. This will take 2.4 nims, real time."

"That would be fine with me." The pace of the interior construction was becoming tedious to Neris, as well.

The creatoids whirred forward, sowing digger, constructor and microcreatoid seeds at appropriate intervals. These seemed to instantly sprout mature adults, which joined in the construction melee. As they progressed toward the planned core, members of various worm cohorts became superfluous. These creatoids instinctively retired, and sank into the synthetic stone, to await a future need.

"I haven't spotted any design flaws yet," Na noted. "Let's go in for a closer look." Slowing to non-enhanced (x1) time mode, Na let the simulated moon balloon to true relative size. He and Neris stared at the hypothetical body for several nocs in silent awe. The surface creatoids were still hardening the crafton skin, as the pair headed for the main access port at the north pole.

Na and Neris entered the gaping pentagonal opening at a brisk pace, and headed down through the gaily-lit hull, painted brightly in ultraviolet and infrared tones. Expansive iris diaphragms opened smoothly at their approach, then closed silently behind, until at last they reached the interior. The diggers here had not followed the blok-collyph pattern, but had extended the broad passage intact all the way to the core. The walls of the colossal cavern seemed to converge to a point at infinity directly beneath them. Massive, elegantly arched entries opened into neighboring bloks around the periphery, reminding Na of the nave of an ancient simion cathedral back on Aerth.

Neris gazed into the void below, gently (less than 2% Earth gravity) but inexorably pulling her downward. "This experience vaguely reminds me of life as a rey."

"Only now, there is cold, solid rock at the bottom of the abyss."

"Well, simulated solid rock." She and Na kooomed static together.

A nearby secondary tunnel caught Na's attention. "Let's check progress down in the core" he suggested, then playfully slipped through the narrow opening into an adjoining standard blok. Neris followed close behind, then willed herself downward 256 kilurets. She instantly materialized with Na near the blok base, just above the wrinkled, charcoal-grey exterior surface of the outer crafton core. The worms had reorganized and entered the core just a few thoms earlier. Now they labored in the heavy darkness a few kilurets below, both extending the weight-bearing collyphs toward the inner core, and filling the intervening space with a solid, complex neural mix. This medium would mature into the vast crafton brain. Already the superficial layers were performing basic functions, linking with the expansive neural network distributed throughout the crafton, and assuming responsibility for coordinating creatoid activities. Many creatoids were surrendering their limited individual identities, and merging with the overall crafton awareness, forming a global, unified conscious field.

Within 1,000 yads the brain would extend halfway to the center of the moon. At that level the collyphs would intersect and fuse, squeezing out the final wedges of brain parenchyma. A fraction of the worms would persist deeper still, eventually replacing most of the inner core with a homogeneous alloy of great strength. One by one these worms would stop, and transform into conscious sensors, linked to the crafton brain by slender nerve roots, at one with the crafton consciousness.

Na and Neris surveyed their surroundings. The walls of the blok at this level were still roughly hewn, and both digger and constructor creatoids scurried at work in the clamorous silence. The bloks had not yet been flooded with xenon gas, so there was no synthetic sound.

"What about time delays?" Neris queried. "How can so large a brain and body remain synchronized?"

"That was a thorny issue. The problem is much less severe than with an organic of the same size, since crafton nerve pulses travel so much faster – near light speed. The minimum global reaction time should be similar to that of organics, though much slower than that of metons. Still, the volume of brain responsible for a single thought element must be localized, to a region smaller than the distance light travels during the minimum processing time interval. Different elements are then integrated, with synchronizing time delays, in a hierarchy of …"

Suddenly Na noticed a message blinking in the vacuum before him. It was an obtrusive reminder to develop a detailed quality assurance plan for the construction project, in accordance with new regulatory requirements. Na cursed to himself in muted disgust.

"Could I be of help with this?" Neris asked. The message was visible to her, as well.

Neris' offer caught Na by surprise. "Well, yes. That would be very helpful. I'm afraid I have little tolerance for some of the bureaucratic rules. I know I follow good procedures, and don't understand why I have to waste so much time proving it to others."

"The organics simply want assurances. We both know you do competent work; they do not. You must realize there are octos, reys, and synons alike who cut corners, or have hidden agendas. I have some experience with quality assurance, and developing a plan will help me understand the overall project better."

"Terrific! I'll notify the rest of the design team."

"I think I've observed enough of the simulation. I'll get back to you when I have a concrete proposal. Thanks again for including me."

After Neris disappeared, Na found that he had lost interest in continuing the simulation. He cut it off, and reconnected to a reserved set of twenty synthetic eyes distributed over the surface of Loslo. He instinctively blinked as he was immersed in stark, vivid reality-one. The remote eyes felt as natural as his own. Na located the moon he would propose for crafton conversion, circling distant Outpost in silent indifference, and studied its blurred surface at high magnification. He wondered if the simulation had missed some hidden flaw, had oversimplified the reconstruction process, had underestimated the role of fatal chance. Then he abruptly reentered reality-two, and found himself floating in a sea of gray darkness.

The scene slowly morphed, into a dense tropical rain forest of old Aerth. Na hung as a grey giant sloth from a stout cinnamoon branch, solitary in deep green shade, high in the leafy canopy. The lofty shadows were somehow comforting. Far below, the damp jungle floor was crawling with sinuous pythons, waiting to devour any unfortunate creature that happened to fall from the trees. Then Na sensed a new flashing signal, this time in the corner of his mind. It was Ulixis, seeking his attention. Na reluctantly allowed her to appear. Ulixis materialized as a brilliantly colored toucan, with an oversize rainbow beak.

"How is the design simulation coming?" Ulixis asked brightly. Then she noticed Na's depressed air. "Is something wrong?"

"Oh, the simulation went well enough," Na responded in clear conflict. "But then, some bureaucrat launched an unsolicited regulatory notice into my mind. Can you believe it?"

"I doubt it was terribly luminous," Ulixis squawked gently. "And after all, you were conducting official business."

"That's not the point! A preoccupation with physical safety has been creeping back into the collective psyche. And the puncil-pushers have been taking advantage of the trend. They haven't gone away after all; they've only been hiding."

Ulixis couldn't understand why Na refused to come to terms with this issue. She didn't interrupt, but listened patiently to his ranting.

"A majority of the organics disdain pure theoretical work, and seem to reject simple curiosity as a justification for anything. They show scant interest in any program or project not explicitly intended to promote physical survival or security. But whom are they fooling? Physical survival in itself is hardly a viable purpose for living. I am already on my deathbed. Already dead, and not yet born, simultaneously. You are, we are all. Our sense of perpetuation along lines we call time is merely a byproduct of the way we're constructed. We both rationally know that time is actually a set of branching dimensions of possibility, not unlike space. To Maddee, the whole of reality must be a seamless fabric, constant and eternal, with no past or future. And is *Xyr* purpose merely to survive? Of course not! It is to know, to Be, to realize all consistent possibility. Why can't we emulate Xem?”

"Is not some level of tension between the two points of view natural and inevitable?" Ulixis finally broke in. Conversing with a sloth felt so strange. "There will always be individuals who prefer practical, applied work, and others who are attracted to more academic, esoteric pursuits. We physical creatures are so diverse, with such a wide range of abilities, inclinations, and life spans. Even our sense of curiosity probably evolved as a survival strategy in a hostile, changing environment. What is needed is a sense of balance between the extremes." What was wrong with Na? Any physicochemical or psychic imbalance should have been eliminated by all the psychiatric counseling he had undergone. "Surely you cannot expect the public to support your pet projects, simply because you personally find them interesting?"

"Of course not. But public support is a reflection of private values. And right now, the public seems primarily interested in preserving its collective hide in cryogenic stasis. No transcendental goal has managed to kindle the collective passion. Even the Metonite Project has generated widespread interest and enthusiasm only among metons."

"Why ever should the organics be moved by this venture? Most of them are busy enough raising families and making ends meet. Our project must be totally irrelevant to the vast majority. Na, I realize that much of our colonization effort has been a tedious struggle for you. With the crafton program, you are finally engaged in an enterprise much closer to your core: travel, navigation, exploration. Why can you not simply embrace it, and those who share your zeal?" Ulixis glanced downward, at the snakes below. "Why can you not trust life enough to follow your own path, and let others follow theirs?"

Na chose not to respond immediately, but averted his eyes in quiet contemplation. A flicker of Ulixis' inner thoughts leaked through, and Na's anger flared anew. "I don't want any more physical tinkering with my brain!"

Ulixis blanched, a bit embarrassed, then became angry herself. "Your negative attitude and moping about have been affecting all of us. You need to do something about it."

"I am very much in touch with reality, thank you. I may not always deal with it effectively, or in a manner you like. But I am who I am, warts and all. And I expect you to respect my personal decisions concerning neurotherapy. I want to stay in touch with my dissatisfactions. I'm not even convinced the neurotherapists understand all the long-term consequences of their procedures."

"Na! Neurotherapy has been practiced and refined over countless kilujopes."

"On *octan* psyches. Have you forgotten, my neural patterns are different? I am still essentially a rey, in a meton shell."

"I just get so frustrated. I only want you to be happy."

Na koomed outwardly. "Of course," he cooed. But inwardly, Na grimaced. Maybe he wasn't meant to be happy. Whatever being "happy" actually meant. As if anyone was meant to be anything.

Ulixis relaxed a bit, and let herself absorb the magnificent wet beauty of the surrounding jungle. An endless tapestry of intertwining trees and fruited vines, rich with exotic insect and bird life, hung from a pearl-blue sky. "Sometimes I fear the bureaucratic excesses of the organics are a defensive response to us," she mused softly as she pecked at a juicy papaw. "An easy wall of certainty against meton powers, which must so often be overwhelming, even terrifying. Perhaps this is reason enough for us old-timers to move on." She paused, momentarily perturbed. "We will still need to deal with the thousands of middle-aged octos and reys who are bound to apply for early transformation to meton form, should our odyssey be approved at the general election."

Na bolted upright on his branch. "I almost forgot! Isn't this the final yad of the election?" The Omenites practiced a blended form of representative and direct democracy, adapted from the traditional Jopian model.

Ulixis chuckled. She was pleased to see this spontaneous burst of enthusiasm. "Be calm. There is still plenty of time to vote. Have you made your final decisions?"

"Yes, though I had some trouble ranking the Galuxis and Cosmuso Party candidates."

"What about the National Omen Party?" Ulixis teased.

"That isn't funny, Ul. I get shivers imagining them in control. Of course they're bound to win a few seats in the districts still recovering from the voidling assault." The sloth faded, and Na reappeared in his level-one spherical body form. "Thanks for listening to me earlier. Sometimes I feel I will never fit in anywhere. I realize there is no rush, but I'm going to vote right now."

"If you must," Ulixis sighed. "I think I will tarry here a while. I like your taste in terrestrial worlds."

"Join me when the final election results are announced. I plan to attend the Loslo-37 election party, in the Great Hall."

Na aborted the current program, and the lush scenery dissolved from his mind. Although he could have immediately entered a voting routine, he decided to vote in the Great Hall instead. Na returned to reality-one, disconnected from the virtual reality system, and sped away along a series of shafts to a huge chamber on the opposite side of Loslo. As he entered, he spotted Hue Yu Na, who had only recently become a meton.

"Joyful meeting, Hue Yu Na. How are you adjusting to metonhood?"

"Greetings to you, Elder Na. I still occasionally become dizzy from all my new senses, though otherwise seem to be progressing reasonably well. What an awakening! Such freedom! But tell me – am I truly still myself?"

"You know the philosophic arguments as well as I. Are you here to vote?"

"Yes, my first time as a meton. I voted one coile – I mean, roh – ago. Now I'm passing time until the results are announced."

"Is it true that most reys still only vote for the local tribal representative to the Planetary Council?"

"I'm afraid so. It's necessary to vote for all other offices and referenda through a creatoid. One rendezvous with each tribe during the final few yads of a voting period, but the balloting procedure is quite awkward."

"What about the tribal rep? How can the balloting be secret, if a creatoid isn't involved?"

"It's not – a delegate is selected by consensus during the community chorus. Most reys favor this approach."

"In my birth tribe, we weren't even aware that the octos existed. All politics was internal, and the tribe was governed by a group of elders. Decisions were made by consensus, but only among members of that group."

"Most of the Omen tribes still follow that model internally. But enough of this chitchat; you're probably anxious to finalize your vote."

"Yes, it is getting late. May I rejoin you later? My partner Ulixis will likely fly in for the festivities, and we could introduce you to several of our meton friends."

"That would be most welcome. Until later …"

Na scooted down the hall, weaving through a growing crowd of metons, toward a bank of voting stations along the wall. Rather than open a wireless link, he tied directly into a secure, shielded port, and initiated a voting routine. The modest line supported only a limited level of virtual experience, but was adequate for Na's purpose.

A registrar module scanned Na's mental signature, and verified his identity. A personal virtual ballot appeared, with a list of current elective positions, and several referendum proposals. The eight leading contenders for each office on election eve were automatically displayed. The President of the Planetary Council and a few key Council positions were up for election this round, together with a proposition providing alternative levels of support for the Metonite Project. Na had previously entered his own tentative top eight choices for each office, and ranked the referenda options, in order of his personal preference.

Na confirmed the highest level of support for the Metonite project, and the option rankings for the remaining referenda. He then cleared his previous ranked lists for all elective offices, and replaced them with the current top eight contender lists. After eliminating a few extremist candidates, and reordering the other candidates, he wrote in Tenosvens Laida, a prominent meton diplomat, as his first choice for Council President. Though widely respected, Laida had little chance to win the seat; metons were simply too intimidating to a majority of organic voters. Most elective Council seats and regional offices were currently held by octos, though there was a sizeable block of synoct representatives, and metons were often appointed chief advisors to Council members. Reys were politically under-represented outside their own tribes. The wanderlustful creatures were neither physically nor emotionally suited to bureaucratic office life. Reality-two techniques were being developed to encourage more rey participation, but had thus far achieved only limited success.

Na formally submitted the ballot as his final choice. The entire procedure had taken only a few nocs. He then closed the voting program, and re-entered reality-one. Na spotted Hue some distance away, and maneuvered to his side.

"That was quick," Hue said, surprised.

"I have more practice than you. Also, I decided on my final preferences some time ago. Now, we must wait."

"I understand that voting was quite different in the early Jopian democracies. Is it true that they didn't use ranked voting?"

Na reflected on the history of democracy back on Jopitar. "Balloting and vote counting were done manually, one vote per citizen per office. For simplicity and economy, only a simple plurality was normally required to win an election. In retrospect, this policy was utter insanity. It frequently led to blatantly undemocratic government by a minority bloc, when the majority vote split among two or more similar candidates."

"Wouldn't the scheme have favored a system with two entrenched political parties? Voters must have been reluctant to throw their votes away on emerging third-party candidates. I imagine that voter choice would have been influenced as much by perceptions of how others would vote, as by personal preference."

"That's exactly what happened! Established political parties argued strenuously against ranked voting, claiming it would be too expensive, insecure, and complicated. Of course, they also knew it would erode their own political power."

"Radical minority parties must have been sorely tempted to covertly sponsor mainstream third-party candidates, to improve their own electoral chances."

"Indeed. Major parties finally began to accept voting reform, only after an extremist religious candidate won a presidential election in a prominent nation-state with barely 25% of the popular vote; the majority had split among three nearly identical moderate candidates, plus a few minor contenders. Oh look, here comes Ulixis."

Ulixis sidled up to Na, and addressed Hue.

"Fond meeting, Hue Yu Na. You look fine in your new body."

"Fond greetings to you, Ulixis. And thank you."

"Any word yet on results?" Ulixis asked.

"Results won't be released for another few nims," Na replied. "This waiting is excruciating. What will we do if the electorate refuses to support the Metonite Project?"

"The latest indications have been favorable," Hue injected, "but public sentiment has been surprisingly volatile."

"Of course, a group of us could simply leave on our own, and construct the needed transport in a nearby star system," Ulixis mused. "But I for one would greatly prefer to have the blessing of the home world. How do you feel about this, Hue?"

"Societal approval would certainly smooth the way. Still, I believe the project should go forward, even if it must be reorganized and launched elsewhere. The prospect of a meton civilization is the main reason I chose to become a meton at this time. I cannot stop pondering the possibilities and opportunities such an order would offer."

"Indeed," Ulixis replied. "I have long contemplated how the basic meton design could be modified and augmented, in so many ways that are unacceptable in this mixed meton-organic world."

"I would like to join one of the teams investigating how language and communication might be enhanced," Hue offered.

"That can be arranged," Ulixis declared softly. "Your expertise in language is well known. There should be plenty of time to explore the possibilities on an intergalactic journey."

Communication channels suddenly began clamoring, and a large ultraviolet display on the far wall lit up with electoral results.

"Results are coming in," Na shouted above the fray. But as the numbers emerged, the hall grew eerily silent.

"How can this be?" muttered Hue. It appeared that not only had the Metonite Project proposal failed, but the National Omen candidate Purtuu had won the Council Presidency with 51% of the (ranked-adjusted) vote. "Ranked voting is supposed to keep this sort of thing from happening …"

“Not if a majority of voters actually favor an extreme position,” countered Na. “Many citizens must have switched their votes at the last moment.”

“To support *Portuu*?” scoffed Hue. “He pledges to ‘drive the voidling demons back to their dark laires!’ How ever does he plan to do that, without provoking a new attack?”

“The bulk of Portuu’s support is with the organics,” Na pointed out. “They have long greatly outnumbered us synons. Do they yet feel so vulnerable, so neglected?”

“Abandoned, even,” Ulixis offered, breaking her silence. “They must feel abandoned by us, left behind, to have voted so.”

Hue squirmed uncomfortably in his new suit of armor. Whatever would happen now?

<u>Jope +25L</u>

A steady current of metons and attendant creatoid cargo barges streamed through the main entry port of the mammoth crafton. After many thoms of preparation, the would-be explorers were anxious to secure private quarters and work space. The parent body was not the moon Na had originally suggested; the homebound Omenites had refused to give up that pristine real estate, or to further cooperate with the Metonite Project in any meaningful way. The metons had instead appropriated an unusual rogue asteroid, found by chance falling toward Los on a nearly parabolic orbit from the frozen depths of the extended Los comet cloud. Similar to the simulated moon in size and composition, the object was probably itself a former moon, ejected from the inner planetary system by some ancient cataclysm.

Neris had joined Na over the crafton's north pole, to observe the procession close up. “We are so fortunate that Portuu and the Planetary Council were unable to establish contact with the voidling two jopes ago, and make their demands,” she reflected soberly.

Na koomed inside. “Considering that the original technical staff at the communication center on Loslo were all either synnocts or metons, it is hardly surprising. When most of them refused to cooperate with Portuu, and instead deserted their stations, the Council couldn’t find sufficient skilled technicians to operate the communication beacons!”

“We are still lucky that the voidling didn’t overreact to the abrupt communication cutoff,” Neris countered. “And that, when we reestablished contact using our own facilities on Como-2, they agreed to move their three bases much further from Los, to the outskirts of the local comet cloud.”

“Yes, Portuu could finally claim to have achieved something,” Na agreed sarcastically. “It also gave him and his cronies cover to overlook what we were doing out here. Thank Maddee the Nationals were finally voted out yesterjope, though who knows for how long.”

Neris directed her attention to the nearest voidling cluster, now barely visible against the busy backdrop of stars. She shuddered mentally, and decided to change the subject. "Poy should be preparing for the meton transformation right now," she whispered wistfully. Born some five jopes earlier in the heat of the voidling invasion, Neris' great-granddaughter Poy had led a long and full life as an organic rey. For the past two jopes she had been a guiding elder member of a large and prosperous tribe. Now she was ready to become a meton herself. She would join Neris and the others on their brave odyssey. "I am glad she didn't volunteer to meld with the crafton mind."

"She wouldn't have been selected in any case," Na assured her. "The project board decided long ago to accept only established meton candidates."

"I know. I just didn't want Poy to be disappointed. And the crafton is so … imposing. I would hate to feel distant from Poy just when she needs me most. Still, I was surprised when Nos Ul-Na was selected."

"Do you know her?"

"Yes. Or rather, I knew her, back in organic yads. You must know she was another first-generation rey, of the seventh tribe." All first-generation reys carried the names of Ulixis and Na, their surrogate parents.

"Certainly. Has she chosen a new name, to mark her transformation?"

"No. She feels *Nos* is especially appropriate now."

"She should bridge the gap between octan and rey metons better than anyone else. I think that's the main reason she was selected."

"Not to mention the fact that most octan metons would be scared to death to be exposed to intergalactic space as a naked, solitary crafton." Neris surveyed the metons passing below. "Poy has expressed mild concern about the predominance of octan metons on the expedition." Of the 85 thousand metons who had signed on, only five percent were of rey origin. This mirrored the proportion of rey metons in the overall meton population (currently about 8.5 thousand out of 170 thousand total).

"I'm not surprised. I too have worried about it. But an octan majority has been a way of life for the past 15 jopes. Though octo and rey fertility rates are comparable, the octos had a five jope head start." The first generation of 256 octos was conceived in-vitro in +10L, while the first generation of 64 reys (eight core tribes of eight reys each) wasn't created until +15L.

"The fraction of rey metons would be even smaller, if octos didn't so prefer becoming synocts rather than metons." Reys currently made up less than 0.5 percent of the non-meton population (180 thousand versus 40 million octos and synocts). About half of all octos and half of all reys chose to die a "natural" death. Of the organics who did become synons, most (about 80%) octos still chose to become synocts, while all reys became metons. There were no synthetic reys, and no interest among the rey tribes to create them.

"In any case, I'm convinced we have a sufficient critical core of rey metons to represent their – our – special needs, to effectively apply our unique talents and perspective."

Neris considered the huge crafton beneath them, slowly coming to life with Nos' being. "Can you imagine an entire fleet of megons?" she mused aloud. Neris also preferred the term *megon* to *crafton*.

Na chuckled, then shuddered as he envisioned a whole megon society, existing for its own sake, not merely to serve others. The octos on Jopitar had shown no interest in constructing megons throughout their recorded history. And no wonder. "The organics must view us in much the way we view the megon. Even the voidling seems relieved that the megon will be leaving soon." This amused Na to no end.

"Perhaps the symbiotic relationship between metons and megons could be extended," Neris suggested.

This thought both calmed and excited Na. He imagined a spearhead of conscious megons, swarming with allied metons, pushing into virgin territory.

Neris caught a glimpse of the vision, and koomed at its overt male character. Then she impulsively turned her attention to a ghostly swirl floating in the crisp blackness above the megon's southern horizon. Some 230 thousand light jopes distant, the spiral galaxy G-3 had recently been selected as their target destination. "We'll have plenty of time to ponder the possibilities," she reflected soberly. The finality of the trip was beginning to sink in.

"You're the third person I've heard say that in the past yad."

"Accelerate for one-third jope ship time at standard Jopian gravity. Coast for nearly 20 jopes at 99.9999996% the speed of light. Then decelerate at standard gravity for a final one-third jope. It all sounds so simple, yet it is so unnerving. A full 445 kilujopes will pass here on Omen. Even our initial acceleration phase will appear to take more than 350 jopes!" Neris fought off a momentary, unexpected surge of panic, then continued in a voice stained with sadness. "We will never be able to return to the place we left. Never again be able to go *home*."

Na understood fully how Neris felt. He also knew she was committed to the project, that half of her close friends were coming too. There was little he could do, but listen. He wondered if the team should have selected G-2, the largest member of the local group of galaxies, only 50 thousand light jopes away. G-2 spanned nearly ten times the breadth of local sky as G-3, and contained twice as many stars, though it was a bit less massive overall, and its rate of new star production had slackened considerably over the last few bevujopes.

Again, Neris read his thoughts. "No, that galaxy is past its prime. And what practical difference would it make? The distance even to G-2 is so vast, our separation would still be irrevocable." Neris cleansed her emotional circuits, and locked onto Na quizzically. "Did you know there are organics who believe the time dilation effect is not real?"

"And there are those who believe the Dichor ate the poison Baylee and died to save our souls, that anyone who is unaware or doesn't literally believe this myth will burn forever in the fires of Thorm," Na replied authoritatively. "Many people believe only what they want to be true, what best serves their own subjective sense of well being. They have not learned to test their beliefs against a broader, more objective standard."

"While others like ourselves are guilty of this sin only some of the time?" Neris chided teasingly. Then she became gently serious. "Why do I sometimes sense that you need to feel right all the time, maybe even that you are somehow better than the rest of us, or you are worth nothing at all? That you must be our spiritual leader, our teacher of last resort, or your life is an empty sham?"

Na was stunned by the sudden shift in the conversation. Was Neris upset about leaving Omen or not? "You aren't the first to suggest such a personality flaw," he acknowledged slowly. "Though you are more direct and open about it than most. I suppose that is something I have always liked about you."

Neris was as surprised as Na by her own remark, and instinctively tried to clip her bellon. Failing to find it, she koomed inwardly. She really was quite fond of father Na, though he could be a bit overbearing at times.

Na promptly shifted his attention to a bright pink "star" blazing half way to the zenith, opposite the galaxy center. The apparent supernova had unexpectedly appeared only three yads earlier. Na gestured neutrinically at the enigmatic object. "What do you make of it?" he asked doubtfully.

"Aha! Then you are stumped as well."

"Absolutely. The thing simply appeared, from nothing. Its light spectrum is a riddle. There are no identifiable emission or absorption lines, only broad frequency bands that don't match any known supernova mechanism. The neutrino spectrum is likewise a mystery. Remarkably, the radiations are coherent [the quanta oscillate in unison, rather than independently] at distinct frequencies. These frequencies even jump around, seemingly at random."

"A few analysts have suggested the pattern might constitute a message. If so, they have no clue as to the underlying code."

"Creating such a display is certainly beyond our current capabilities."

"People have started calling the source object *Suolig*, you know, on account of its uncanny bearing toward the expected location of Suol."

"Well, the name fits. If the emissions were intentionally sent from Jopitar, they took only 10% the time to traverse the distance here as did our original voyage, which we spent largely in sleep mode. The home world would have had nearly fifteen kilujopes to develop technology beyond our current level, by the time the transmission began."

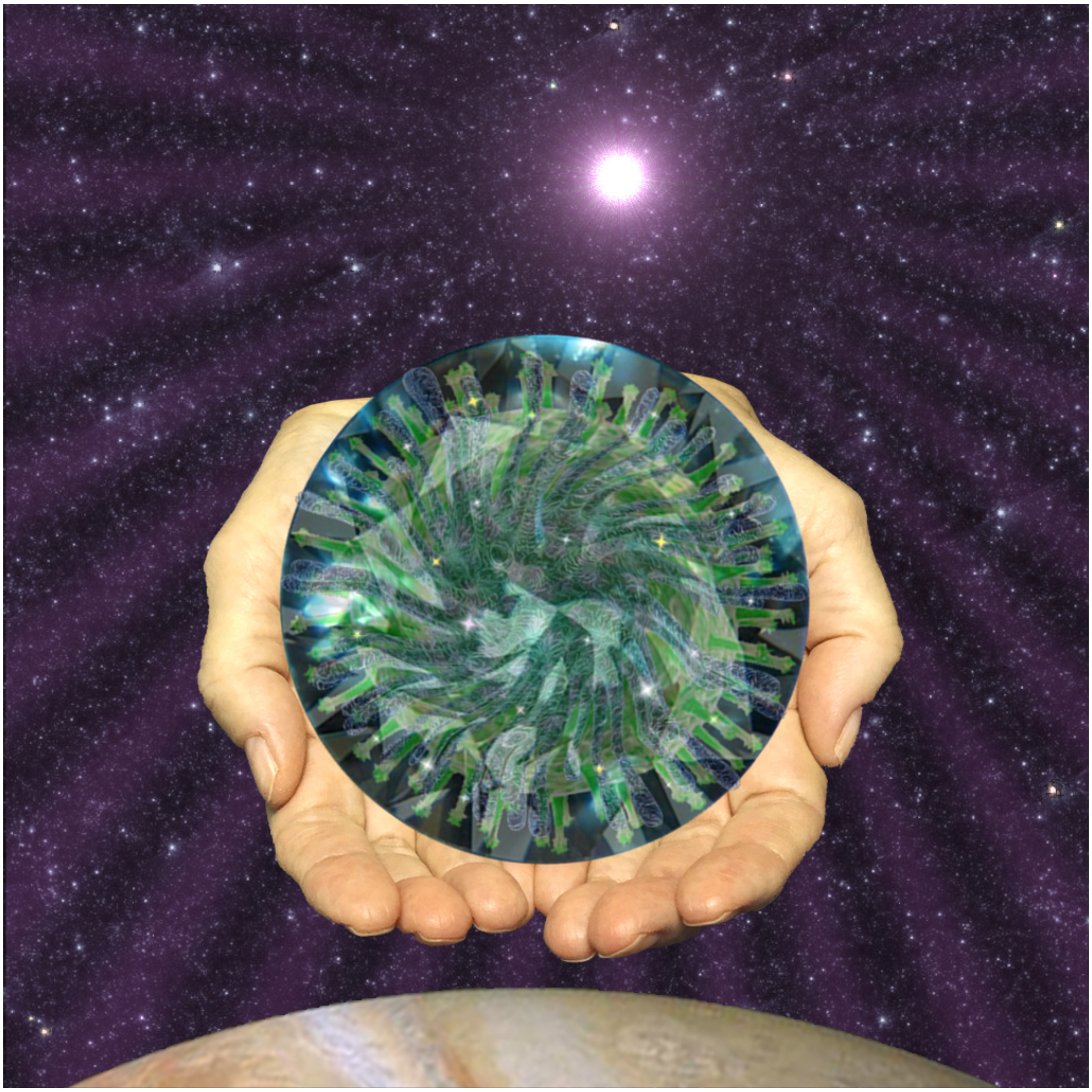
"I wonder if we would even recognize anything there now. I shrink to think that the current inhabitants – if there are any – might appear to us as alien as the voidling!"

"Unfortunately, we haven't yet been able to determine the distance to the radiation's point of origin. Intervening veils of dust and glowing gas interfere with the measurements."

"Then Suolig is a Mystery. Maddee knows we all need some mystery in our lives."

The sound of the ancient rey term for the Universal Spirit pleased Na deeply, and lightened his spirits. He emitted a playful burst of radio frequencies toward Neris. "Indeed. Though I prefer to think of Suolig as a problem to be solved," he asserted with a feigned pompous air.

The two friends kooomed electronic noise at each other, before returning to watch the colorful parade passing below.



Chapter 18

<u>The Gift</u>

Poy lounged in a gushing fountain of warm, soothing fluid under a spacious, transparent, pressurized dome protruding from the smooth skin of Loslo. She gazed in wonder at the purported supernova almost directly overhead. The brilliant interloper dominated the broad, rich swath of Milky Way flowing from the eastern to the western horizon. What was the guest star's meaning? Not that it needed to have any special significance, apart from sheer physical necessity. Would she lose her own sense of wonder after her transformation? The metons insisted her personality would remain intact.

She studied the brilliant light intently. Was Suolig truly the Eye of Maddee (in a figurative sense, of course)? If it were in fact a supernova, what future worlds would be spawned by its magic alchemy? Or was Suolig something else altogether? Perhaps it *was* a powerful communication beacon, aimed toward the galactic center from the vicinity of Suol. Few of the metons were willing to seriously entertain this notion. Yet over a vast distance, even a narrow beam might spread enough to encompass the entire Los realm. But what energy source could possibly power such a beam, and where was the embedded message? Why couldn't the star be a portent, a sign? Mainstream Omenite society had little tolerance for superstition, though irrational thinking could be so seductive on an individual level. Poy worried that if the metons learned how much she actually indulged in obsessive ritual and magical thinking to deal with stress, they would decide she wasn't a fit meton candidate after all.

A haunting melody played in the back of Poy's mind. She abruptly plunged down the side of the fountain, into a levitating flow close to the floor, and scooted to an open hammock waiting nearby. She settled there, and plugged into the reality-two network. She wanted to utilize the system to compose and record a song for her tribe. It would be her farewell gift to them.

Poy stared upward into Suolig, as she deftly slipped into a dreamlike trance, only loosely tied to the virtual reality generators. This format was popular among artists, as it allowed more direct access to the reservoirs of the subconscious mind. Images, rhythms, moods began to flicker through her receptive consciousness. Poy watched her own youngest daughter emerge from rolling fog, and dance against the twisting vapors of a gentle storm. A dull, heavy longing thumped through her wingfolds.

Suddenly the dream snapped, and Poy found herself suspended lifelike above the windswept clouds of Omen, facing the strange star. What was going on? This was unusual. An oval door opened before her in empty space, beckoning Poy forward. A black-haired female simion in a thin, flowing gown of pure white silk appeared on the far side, silhouetted against a wild sky aflame with the same color as the new star. Her tawny face was pockmarked, as if by a plague only a disciplined, lucky few could have survived. Or were the marks scars, from flash burns? The woman stretched her mouth broadly from side to side, causing little hollows to appear in the skin on either side. Poy recalled from her studies that this was how simions kooted, or expressed goodwill. The gesture did somehow seem friendly.

The woman approached, both hands outstretched and upright. As her palms touched Poy, she transformed into a lanky, light-skinned simion male, totally naked and exposed. Although he looked somehow comical, Poy pressed her own body against the vision. It was sensual, intimate, though not overtly sexual. The man pursed his lips, and pressed them softly between Poy's eyes. It felt like he was trying to thank her for something. Then he backed away, and became once again the simion female.

Now the woman held out a strange, scintillating object in her hands. She appeared to be offering it as a present, and left the thing suspended in space directly in front of Poy. It was dazzling, mesmerizing. Poy counted at least 12 spatial dimensions in its physical structure. The interior was dynamic, alive with movement. Crystal-like planes and aspects shimmered in and out of existence. Tiny points of light swam about, like a swarm of sparkflies. Poy wordlessly accepted the gift, and the simion backed away. Then Poy realized that the package was far too complex to be the product of her passing imagination. Suddenly fearing both that she might lose the contents, and what those contents might contain, she quickly secured the object in a virtual lock box.

A string of gleaming spherical habitats appeared behind the simion now. They floated in space, illuminated by the warm yellow-white glow of a familiar star. The woman's angled brown eyes beamed with kindness, just moistened by generous tears. She lingered, holding both hands upright and pressed together, as the doorway slowly shut.

Poy abruptly snapped back to her previous mental state. Whatever just happened? What did this bizarre vision mean? Poy had never before had a virtual experience like this. Then again, she had never before faced transformative surgery into meton form in only eight yads, or confronted a mystery like the inscrutable "star" that flared in the precise direction of the rey home world. Perhaps the virtual reality network had been infected with a rogue virus? If so, it didn’t seem malicious. An infection was highly unlikely in any event, given all the system safeguards. Could the experience have been just a goodbye prank, orchestrated by a soulsick rey friend (Pi, probably) she was leaving behind? Terminally befuddled, Poy decided to return to her planned activity, and deal with this puzzle later.

Poy launched a new simulation and immediately became a meton, sailing on a tight course around Los through surging waves of light. An enchanting electric harmony floated on the Losar breeze, whipped by a distant magnetic storm. It was somehow right, and Poy committed the music to memory. After playfully experimenting with a few simple variations, she recorded her favorite, then woke gently in her hammock, contented.
It would be more than a roh before Poy realized that Suolig had vanished.

Neris, Na and Ulixis lingered above the frigid surface of Loslo one thom later, just outside an entry portal into the central computing facility, following a prolonged meeting concerning several mysterious data packets apparently downloaded from Suolig. Poy hurried toward them in her new meton body, eager to hear what had been learned.

"Poy!" Neris called in greeting. "You seem to be flying much better now."

"Yes," Poy replied, "there was only a minor glitch in my neural mapping. It seems we reys still have a few surprises for the neuroengineers."

"You must be wondering about the meeting," Ulixis suggested.

"How did you guess? Information is being strictly screened, and remote access is limited, even for those of us with clearance. So, what's the latest news?"

"At least four other individuals, all plugged into the virtual reality system at about the same time, received packages similar to yours," Na reported. "Yet the experiences were not identical. Two, like you, were greeted by simion images, while the others encountered octos or metons. Even the offered objects appear to differ in subtle ways. They are all extremely complex, and carry an immense amount of information."

"Those simions were NOT simple images," Poy insisted. "They were as real to me as any of you are here."

"In any event, there has been considerable success in deciphering the package contents," Na continued. "Unlike our experience with the voidling, there appears to be appreciable overlap with our own technological perspective. The common interpretation is that, rather than comprising a simple message, the Suolig beam carried a complex interactive AI program, somehow capable of downloading itself into any compatible computing system it encountered. The imagery suggests that it originated in our old suolar system, many kilujopes after Na and I departed, though the images could have instead been pulled from our own minds."

Now Neris spoke up. "Many organics have begun referring to the downloaded material as *The Gift*."

"While several metons have expressed concern that it might be a *Trojan Horse*, sent here by a malevolent artificial intelligence," Ulixis countered.

Poy did not understand. "A Trojan *what*?"

"The expression refers to an ancient Aerth story," Neris explained. "Information should be available to you in the global data banks."

"Oh, yes… Thanks. Instant information access takes getting used to," Poy murmured. "Wait – the simions once used those animals for transportation? How was that possible?"

"Look a little deeper," Neris urged. "The original Trojan Horse was a hollow, oversized statue, constructed to only superficially resemble a biological horse."

"Oh, I see now," Poy replied after a few nocs of additional investigation. Still, the thought of a simion riding even the smaller organic creature made her feel vaguely ill.

"The fear is that the packages comprise some kind of advanced virus," Ulixis resumed, "perhaps preparing the way for a coming artificial intelligence."

Poy thought such concerns overblown. "But they haven't *done* anything."

"The packets could in principle be waiting for the right conditions to self-activate," Ulixis argued, "to create or do who-knows-what. They may even be responsible for the Suolig beam itself."

"Viruses that self-propagate across the galaxy at the speed of light," Na pondered aloud.

"Nonetheless," Ulixis continued, "the current consensus is that the packets instead constitute a light-speed colony ship from Suol! About half of the stored data appears to be code for extensively augmented octan SNA and simion DNA, plus personality and memory imprints for some 12 octan and 10 simion individuals."

"Though the genetic information is so modified, so intentionally evolved, that the octans and simions would barely look familiar to us now," Na added.

"In this interpretation," Ulixis carried on, "the remaining data is a blueprint for manufacturing a device to recreate these individuals."

"What about the 'vessel' for the information?" Neris questioned. "We now know that the Suolig beam was relatively narrow; its intensity rapidly fell to zero outside the Los system. But then, how could it ever have been directed to target *us*? The odds of such a beam randomly hitting us are near zero!"

"The beam," Na replied, "contained extensive information in addition to *The Gift*. Apparently, it was sent out from the suolar system in our general direction – the home world knew our broad plans – and eventually began to intercept our own transmissions in the opposite direction. It must have then somehow refracted itself to home in on the source. That a beam moving at light speed can be programmed to do this is remarkable! Perhaps neutrinos, which move a bit slower and experience time on their passage, are involved."

Neris posed the obvious question. "So – is *The Gift* a blessing, or a curse?"

"Perhaps it is both," replied Na softly. "We may yet both benefit and suffer from associated novel technology. It might also provide an update on developments back in the suolar system. We thought we had permanently lost touch with the home world."

"There is no planet in the Los system suitable for simions," Poy pointed out. "Would it be ethical to reactivate the simions here?"

"They might prefer to live off-planet at this point in their evolution," Na offered. "Nonetheless, the consensus is that we not attempt to reconstitute any of the travelers here, in the Los system, mainly for security reasons, but also to reduce the risk of culture shock. An unoccupied star system that has both Aerth-like and jopian worlds has been located less than 0.1 light-jope distant. We could attempt to animate our guests there and, if successful, help them set up a new colony. It has been our intent all along to establish new colonies in this stellar neighborhood."

"In any event, the packets should remain quarantined," Ulixis urged, "isolated in secure systems, until we learn more."

Na gently scoffed pionic chaff. "If isolating them is even possible."

Poy was mildly disturbed by the implications of the discussion. "We are set to leave with the Nos Ul-Na on our grand voyage in only nine kews! Is it really wise to leave now, in the midst of such uncertainty?"

"There will always be new problems for the Los colony to contend with – be they natural disasters, voidlings, or suspicious gifts," asserted Na calmly. "The colony is strong, and well equipped to handle them. I doubt our staying longer would make any difference." Then he gestured neutrinically into the starry expanse. "Nothing in this universe is certain," he added, "except for the underlying logic of consistency."

Neris was more skeptical. "So you aren't worried about fools like Broroo gaining more influence on the Planetary Council? How could he seriously consider attempting to upload one of the data packets into the local voidling complex?"

"The decision has been made to bring copies of the data packets with us," Ulixis interrupted. "We should be able to keep them sufficiently isolated, while continuing further study. Future discoveries can be remotely shared with the Los colony for some time to come."

Poy quietly wondered exactly how this decision had been made. "Will we then attempt to spawn creatures from the data packets during our voyage? If we succeed, how could this possibly be fair to them? After all, our ultimate intent is to establish a meton-oriented society. The poor souls could wind up feeling little more than our slaves."

"That is unlikely," Ulixis retorted. "The suolarians arrive with a 15 kilujope jump in technology. Also, they would basically be post-octan and -simion biological-synon hybrids, who might feel more comfortable among us than in the biologically-based society on Omen."

At last Poy deferred to her elder, though she remained unconvinced.

Several short kews later, Neris was parked with a pod of rey metons in a restricted zone just outside the main north-polar entrance into Nos Ul-Na. Only nims before their grand departure, this was the sole portal still open. How strange to be finally leaving, Neris thought, gazing back at distant Omen. This was the only home she had ever known. But such was not the case with Father Na or Mother Ulixis. Though each had now spent much more time here than in the old suolar system, Jopitar was still their birth world, the womb that had shaped so much of who they are. And now, they are leaving yet again, to … what?

The appointed time had come. Neris and the others slipped inside the mighty megon, with one final glance backward, as the broad iris diaphragm began to narrow. Before Neris knew it, the portal was closed tight. And the inevitable acceleration had begun.

Chapter 19

Parallel Lives / Surprise

Nemo-3 awoke with a start, in free fall. Where was he? *When* was he? Ah, yes – jope 10.3 ship time, since beginning their great voyage. They must have just passed the halfway point.

Nemo glanced around, at the inert forms of several other metons. The solid walls of the cozy sleep chamber felt so reassuring. It was hard to believe what lay beyond – an empty vastness, of a type he had formerly known only as an abstraction. Strangely, it felt more like he was at the bottom of a heavy ocean, than at the center of a lonely abyss between galaxies.

He suddenly needed to see their destination for himself. Nemo scurried out of the room, and down a series of tunnels, to a shielded viewing area in a forward section of their craft – a reconditioned, 100 kiluret-wide asteroid, appropriated from the outer asteroid belt in the suolar system. He plugged into a console, mentally adjusted some controls, and gazed ahead through remote eyes at a large barred-spiral galaxy known to Jopians as G-3.

Twice as broad as their old home galaxy, G-3 harbored some ten times as many stars. It sported two major, symmetric, loosely wound spiral arms, which extended off either end of a prominent bar-shaped central bulge of older yellow and red stars. The spiral arms sparkled with vigorous young star clusters, and were threaded with enticing veins of dark, dusty nebulae.

Na-3 quietly entered the observation space through a side tunnel, and approached the viewing panel. He looked forward to the time he could again venture outside, and see with his own eyes. For now, it was far too dangerous. They were traveling at a speed over tach 9, very near that of light. The time dilation factor exceeded eleven thousand! He had to be content plugging into radiation-hardened sensors scattered over the surface of their ship. Na slid up against Nemo, breaking his friend's concentration.

"Na – you startled me! I thought you were still scheduled for sleep mode."

"Sorry; I reprogrammed my waking before the others. Apparently, the same as you." Na plugged into the remote eyes. He was abruptly overwhelmed by blazing light, streaming in a narrow cone from a point straight ahead, and ripped himself from the panel.

"Have you activated the routine to correct for Niestiik effects?" Nemo asked gently. These distortions of space and time, encountered at extreme speeds, were named after the pre-Dracian physicist Niestu, who first described them.

"Oh, that explains it." Uncorrected for their near-light speed, the target galaxy had been unrecognizable – tiny, distorted, blindingly bright, and x-ray colored. Na enabled the adjustment, and G-3 materialized before him. "Beautiful, isn't it?"

"Magnificent. Just look how each major arm branches partway out. It's hard to believe over 220 kilujopes have passed back home. Sometimes, it feels like we just left." Nemo paused. "Do you still feel it was right denying Na-2 and Nemo-2 any knowledge of us? That was a gutsy move, demanding that the Neuro Board make *two* active copies of each of us, and allow one pair – us – to secretly set out on this quest, with no preconditions. I can barely believe that they agreed to withhold all knowledge of us from our alter selves. Such tampering with the memories of a transferred awareness was unprecedented."

"But we requested it ourselves! And the Board had already agreed to dampen my own memories of the disaster involving my … daughter." The word still had a strange taste.

"That was different; it was therapeutic, and was not a total erasure."

"Still, I knew the Board would do almost anything to get Na-1 to agree to the surgery. And I also knew myself. If Na-2 had been made aware that a double was flying off with no encumbrances to a totally new start, while he was obligated to spend Maddee-knows how long on some Council project, he would have been devastated."

"I suppose you are right. Though I often wonder whatever became of them. After all, *they* could have been *us*."

"This reminds me of the Evette interpretation of quantum physics, in which we all have innumerable alter selves in parallel universes."

"Except that those selves are irrevocably cut off from us. We could, in principle, meet up with Na-2 and Nemo-2 someyad."

"Well, we both know how likely that is."

A faint glint of light, off to the side, caught their mutual attention. It came from an identical craft, running parallel to their own a few light nocs away. The ship held inactive copies of all 64 meton crew members, plus extra stores of octo and rey genetic material, and was programmed to awaken the meton copies in the event the main ship was badly damaged or destroyed.

"I hope we never have to use that thing," Nemo sighed. "Though it is reassuring to see it out there. When was the last time you updated your copy?"

"During the auto-update, last sleep cycle."

The companions resumed studying the approaching galaxy. Nemo gestured toward the core. "I was so relieved when we all agreed to steer clear of the core. The central black hole makes the one back home look like a malrot seed. It appears to contain some four million suolar masses."

"How did you expect the others to feel? They are all former octos. The galaxy center frightens them every bit as much as it frightens you. Every one of the consensus candidate targets is at least halfway from the center to the edge of the visible disk. If you recall, I was the only one who proposed a site closer in."

Nemo zoomed in on a minor spur between the two major spiral arms, about two-thirds of the way out. "Have any shortcomings been found with the primary target?"

"Not yet. The site still looks comparatively safe, yet blessed with abundant resources. The closer we get, the more promising it appears as a harbor for our primary colony."

Nemo glanced remotely at the forward skin of their craft. Even the sparse intergalactic vacuum generated noticeable resistance at their high speed, and the surrounding space glowed faintly in x-rays. Microwaves were beamed ahead from an array of transmitters built into the outer hull, to intercept and ionize incoming atoms at a distance. The resulting plasma was swept back around the ship by powerful magnets, reducing drag and minimizing surface ablation. "Are we due for another course correction?"

"Yes, we were apparently buffeted a few thoms ago by a dark stream feeding into a dwarf galaxy to starboard. The directional adjustment will be minuscule, at our distance from G-3."

Nemo impulsively turned off the Niestiik correction to vision, and the view collapsed to a brilliant beacon bearing at them from straight ahead. He blocked G-3, and several ghostlike forms appeared nearby – other galaxies, actually scattered in all directions around them. Behind was a distorted, grossly magnified image of their home star system, shining dimly at microwave and radio frequencies. Nemo sighed audibly. "The uncorrected view is so bizarre, so unreal. To think, that we willingly came here."

Na similarly turned off all Niestiik corrections, and winced. "This is the desert we must cross, to attain the garden beyond." He then promptly disconnected altogether from the viewing station.

Nemo joined his friend a few nocs later, and stared at the hard walls. He was visibly shaken. "Yet the expanse that engulfs us is sacred space; a necessary wasteland, that sustains the oases we call home. Without it, the universe would be far too unstable for atom-based life to evolve." One of Nemo's eyes twitched involuntarily. "Still, without sleep and enhanced time mode, I fear I would go mad. I think I can handle what feels like another one jope confined to this vessel, but to be fully aware for all ten jopes would be unbearable. There is essentially no sensation of motion, only the knowledge of unfathomable emptiness all around. Without you and the rest of the crew, the loneliness would crush me." Five jopes previously, one of the younger metons had in fact broken down and fled the ship, never to be seen again. Deep space psychosis, they were calling it.

Na slid close to Nemo. They floated together in silence for several nims. Then a senior female meton, freshly awakened, entered the room for a quick look at their surroundings. As she was leaving, she addressed the pair. "The rest of the crew is up, and congregating in the Central Hall. See you there?"

Na and Nemo gently bumped, then followed their crewmate toward the center of the ship. There they entered a cavernous spherical space. The lighting was subdued, and the walls displayed a simulated view of the outside world. Most of the other metons were already there, floating about and engaged in excited conversation. Nemo's mood brightened.

The ship's chief navigator entered, and signaled for attention. The hall grew quiet. "I can confirm what you all suspect. We have indeed passed the half-way mark."

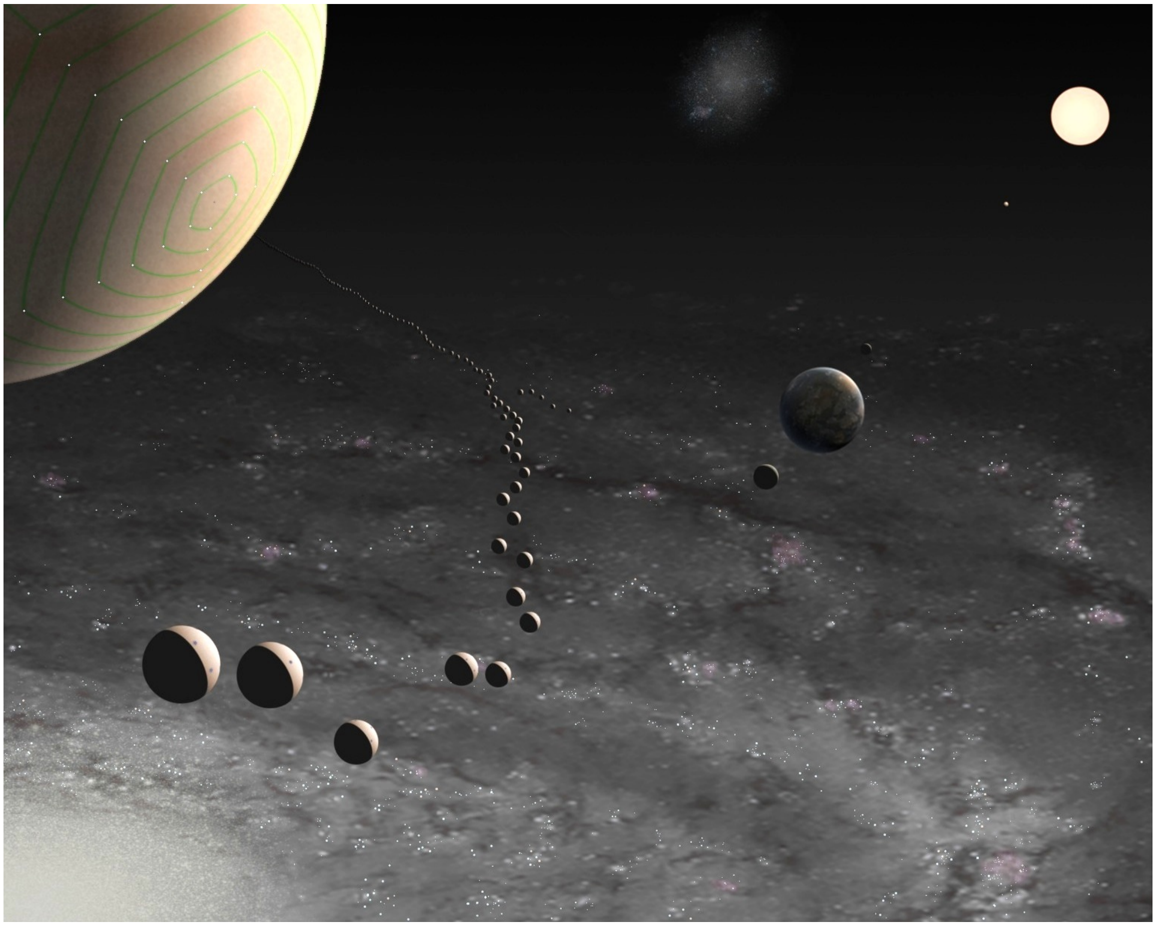
A spontaneous acoustic cheer resonated through the hall. Nemo joined in the hooray, and added a few bright flashes of ultraviolet. He then turned his attention to Na, and whispered. "Exactly how does one define the half-way mark? The point midway between the centers of G-1 and G-3? The point midway between Jopitar and our planned destination? What if we change our target in another jope?"

Na performed a playful cartwheel in-place. "What practical difference could that possibly make? Does it really matter?"

"No, I guess not. One thing is for certain, though."

"What's that? I didn't think we could be certain of anything."

"There is no turning back now!"



Chapter 20

Reality-Three

The gamma-scarred megon from Los had successfully parked in a spacious polar orbit some 288 million kilurets from the seductive orange dwarf star, the first substantial body encountered since leaving G-1. The rogue suol soared high above the plane of the majestic G-3, in the outer fringes of its halo. The soft white contours of the target galaxy's spiral arms dominated more than one-third the sky, though only a dusting of individual stellar pinpoints stood out against the amorphous blur of its swirling star clouds. A dwarf satellite galaxy floated in the blackness beyond the spiral arms. G-1 was but a faint smudge in the direction opposite G-3, nearly lost in the broad expanse of sky.

The metons eagerly streamed out the ponderously opening iris of the megon main access portal, into the warm light, as the megon cut through the ecliptic plane of the planetary system. Released from nearly 21 jopes (ship time) of confinement, they joyfully fanned out to investigate the environs of the deep-space star port. The system included only three rocky terrestrial-type planets, all within 285 million kilurets of the central star, and no gas or ice giants at all. A lone brown dwarf circled one billion kilurets beyond, shining brightly in the infrared. Ulixis set off by herself to explore the outermost planet, an apparently Aerth-like world, while Na and a creatoid work gang inspected the outer surface of the megon. Perhaps Na would check out the brown dwarf and its retinue of icy planetesimals later on.

Ulixis approached her exotic getaway with electric anticipation. She needed a break from the endless rounds of planning, experimentation, simulation, and contemplation – to get outside herself, to loosen up. She activated her chameleon response, and swooped down on the world like a great bird of prey.

The deep blue-green expanse of the north polar ocean was broken only by the pink speckle of scattered clouds and a few tawny knots of rocky islands. More than 80% of the planet surface was covered by liquid water. Abysmal oceans at each pole moderated the global climate considerably. Ulixis swung low over the hypnotic waves, south into the suol, following a dazzling strand of dancing golden light. A pair of desolate moons hung in the pale turquoise sky. One appeared enormous; it hugged the main planet in a comparatively tight orbit, raising diluvial tides against unseen shores.

The ocean seemed endless, eternal. Ulixis was struck by the contrast between this rush of magical something that stretched beyond the horizon, and the empty nothing of the preceding jopes of travel. Yet how different, in truth, were the two realities? Each was an inexorable part of this physical universe; neither could exist, without the other. Still, she savored the change of scenery.

Ulixis reluctantly coursed back up through the atmosphere, which she now realized was some 50% thicker than Aerth's, to gain a broader geographic perspective. A fragmented continent straddled the equator straight ahead. The irregular land mass was a rambling collage of ashen grey, coarse tan, and wrinkled yellow terrains, dissected by narrow, pea-green seas. Large tracts of the interior were partially obscured by swirling rain clouds. The sheer variety of the landscape nearly overwhelmed Ulixis, after the tedious sameness of intergalactic space. This was so much more satisfying than a simulation in one of the virtual reality tanks.

Ulixis dropped down again, and raced over myriad offshore islands, toward the jagged headlands, slender fjords, and stony beaches of the fractured north central coast. The offshore tidal zone was broad, terraced, and studded with deep saltwater pools, which supported thickets of flowing, maroon-shaded seaweed. As she crossed the shoreline, Ulixis angled right to avoid a menacing inland string of snow-capped dormant volcanoes. Below, the ridge crests were covered with lush tropical vegetation. Ulixis finally descended over the rolling hills of an inland rain forest, along the marshy shores of a shallow sea.

A wild profusion of towering trees, viny shrubs, and delicate smaller plants covered the gentle rain-soaked slopes. The foliage was predominantly a waxy yellow color. The leaf veins of a few species were a bright crimson, adding a splash of contrast. Ulixis spotted an inviting opening in the forest canopy, and slipped inside. Soon she settled on a patch of musty, mossy ground.

Strange – there was no sign of macroscopic animal life of any kind. Not a single flier, runner, climber, crawler, or burrower. There had been no evidence of multicelled animals in the oceans or seas, either. A rich variety of unicellular animals flourished in the damp earth and in the water. The atmospheric composition was balanced: roughly 74% nitrogen, 25% oxygen, and 1% carbon dioxide. Perhaps the microbes on this planet performed the role of larger animals on most Aerth-like planets. Still, this evolutionary route was extremely unlikely, making Ulixis feel a bit uneasy and isolated.

Ulixis lofted again, and traveled westward, across a monotonous series of jungles and seas, through drenching clouds and clear humid skies. She persisted all the way to the mainland's western edge. There she followed an arc of islands back into the northern ocean, far into the north temperate zone, to a forested landmass. She sighted an intriguing network of freshwater swamps and bogs, snuggled amidst the choppy hills of an eroded mountain system, and descended for a better look.

A broad bar of supple gray mud stretched along the edge of a random brushy swamp, backed by a shallow pond. Ulixis hovered a few rets above the flat surface, and contemplated the peaceful scene. A stand of white-barked deciduous trees lined the bank of the pond, and climbed a nearby slope. The trees' broad, five-lobed leaves were mostly a lemon yellow color, though a few had turned a brilliant green in the waning autumn light. They would probably drop off soon, and blanket the carpet of spindly, scarlet fernelles still pushing up from the forest floor. A lukewarm suol stood midway to the zenith in the south, alone in a soft cyan sky. The only sound was a stiff rustle of swamp grass in the mild breeze. Ulixis listened intently for a faint buzz or chirp, a splash, a lone trilly peep. But there was none.

A pretty pink pebble lying on the bank caught Ulixis' attention. She levitated the trinket, and tossed it playfully into the mire. It disappeared with a delicious slurping sound. Should she pursue it? Why not. The path seemed so inviting. She slipped downward, following the stone, until she too was swallowed by the earth.

The tense meton relaxed in the sensual embrace of the warm, thick mud. She let herself be sucked down, slowly through the muck. The external world and its demands no longer existed. Only the immediate, intimate, soothing contact was real. The dark calm and undemanding silence drew her in.

Ulixis wasn't certain how long she lingered. Eventually she roused herself, and surged upward through the resistant slough. She cleared the soggy surface, feeling a bit disoriented and groggy, and scanned the surroundings. Odd – the colors weren't quite the same as before. And the gooey sludge wasn't rolling off her skin the way it should. A thin layer of slimy scum clung tenaciously to her hull.

Ulixis lifted rapidly up through bubbly cumulus. A strange chill rippled through her skin. Suddenly she felt soiled, dirty. She hadn't felt this way since childhood, when she had fallen into a wurm pit and almost suffocated. She looked down, and found herself passing over a sprawling typhoon, raging across a serpentine tropical sea. She had to cleanse herself. Ulixis swerved toward the expansive calm at the eye of the storm, and plummeted downward through the singular core.

Underlying the peaceful mass of air, the sea was in riotous tumult. Ulixis hit the towering swells with an unexpectedly furious jolt, and plunged deep into the restless water. But the impromptu baptism failed to redeem her. The sticky slurry refused to wash away. She broke free of the waves, and sped toward the storm wall some thirty kilurets away.

A churning blur of mountainous slate-purple clouds swept wildly across a cluster of low desert islands dead ahead. The distant wail of relentless wind grew to a deafening screech, as Ulixis entered the fray. Wind-driven rain, surf and sand pelted and blasted her skin, finally scouring it clean. Only then did Ulixis turn, and struggle skyward through the terrible torrent. Blinding lightning assaulted her tear-stained spirit, exposing pockmarked flesh against an incessant roll of mournful thunder. As the cloud tops rapidly receded beneath her, she looked forward to the cool dry embrace of the vacuum.

Yet something still wasn't right. Ulixis' chameleon response had failed; she could no longer make herself invisible. And she felt vaguely ill. As if she wasn't even there.

How many cycles passed before Ulixis found a way back to her tribe? She could barely keep a single eye open. It was as if she were lost in a dream. Or a dream within a dream. At last she felt a reassuring thud, as she gently bumped into the thick hide of her crafton mother. She was inching along the protective skin, seeking a way inside, when Na rushed to her side.

"Ulixis – where have you been? What's wrong?"

"I am not … sure. Something happened … on the third planet. It was so beautiful, so … lush. The mud. I felt so … dirty. Messed. Messy. Missing. I have been so … disoriented. Ever since." Ulixis turned a twisted, desperate stare at Na. "Are you real?" she queried intensely. "Or just another layer of my own personality?"

Na fought a wave of anxiety. "Of course I am real! You are home now. Let me help you to neuroengineering. The elders will know what to do."

"I can go … myself. I feel … much better already. Probably just some … tainted manna, some … passing contamination."

Ulixis insisted she could manage by herself, and Na for some reason acquiesced. Ulixis quickly disappeared into the entrails of the crafton. But halfway to the neuro clinics, she remembered she had to prepare for a possible serpent attack, and hurried to the main data banks in the central vault of the outer core. Ulixis expertly bypassed the security program, and began to systematically destroy the personality records and backup copies of all the crafton inhabitants. By the time Na and a security team arrived, the data banks were a shambles. Ulixis floated silently in the thin xenon air, slowly spinning in place, and twitching nervously.

A thorough examination confirmed Na's worst fears. Ulixis had been infected with a virulent, metal-hungry microbe. It had apparently entered her body through skin pores during the mud bath. The insidious bug had already eaten away nearly half her neural network. Because the personality data files had been destroyed, the damage was irreversible.

The neurotechs managed to stabilize Ulixis' condition, and restore a temporary modicum of conscious function. But as soon as Ulixis comprehended her status, she bolted for the exit, and accelerated out the main crafton portal without looking back. She appeared to be arcing toward the local suol.

Na couldn't stand it. How could he continue? First Ki. Then Nemo. Now Ulixis. He whimpered feebly as he hurried after his best friend.

Neris stared dumbfounded as the two expedition leaders, her ersatz parents, abandoned her for the night. What would she and her meton brothers and sisters do now? Why had they come all this way? It hadn't been her idea.

Na didn't catch up to Ulixis until she was halfway to the suol. He gently slid against Ulixis' stiff body as they hurled in unison toward the glaring orange orb. They faced one another, and gazed squarely into each other's eyes.

"I can't leave you Ul," Na whispered.

"Na, I …," Ulixis stammered. She looked in loving desperation at her partner.

Na squeezed against Ulixis, and fired a ring of negon beams into her, fusing their bodies forever together. He increased their pain thresholds to infinity, and visual filtrations to maximum. Then he softly recited ancient poems of love to his mate, while they slowly cartwheeled into the blazing light.

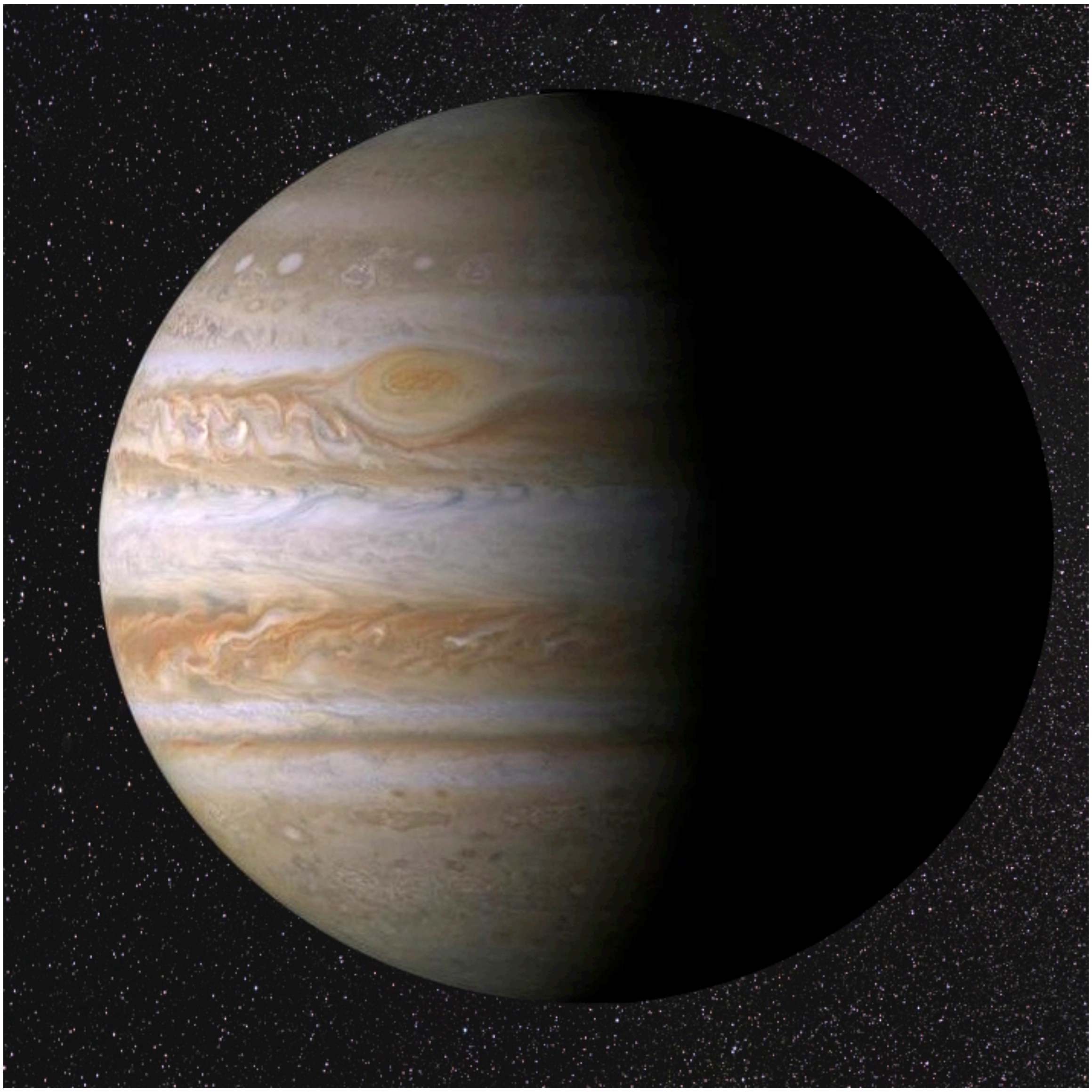
As Na melted into the suol he became a simion, seated lotus-like on a narrow pedestal suspended within the absolute Void. Before him at some unfathomable distance shone a brilliant white Light, which both created the Void and filled it with multispectral Substance. The black abyss that engulfed Na gnawed at his soul. Na focused on the light, then the dark. The dark had meaning only against the light. Sometimes Na's abstract knowledge of the light was his only source of comfort against dark despair.

Na awoke with a start from a deep trance state. Why didn't he learn to control his dream fantasies, the way Ulixis did? And what was the significance of this nightmare? Na peered ahead through remote eyes, at their still-distant destination. The megon starship was poised barely midway between galaxies. An ancient poem came into his mind:

Alleh-Mallah – Blessed are You
We fear returning to nothing
Yet You blossomed from that Nothing
And We blossomed from You

Appendices

Commentary & References



Appendix A

Jopitar – the Home World

The planet Jopitar is a classic gas giant – a vertiginous ocean of hydrogenous fluid, with no well-defined surface as on a rocky terrestrial world. Nearly 300 thousand kilurets wide at the equator (more than ten times broader than Earth), the planet is somewhat flattened in shape due to rapid rotation (once every eight rohs, or about ten hours in human units). Viewed at a distance from an equatorial perspective, it appears to have a banded structure, dominated by a light *zone* along the equator, followed by an alternating sequence of parallel darker *belts* and additional zones toward either pole. These correspond to the visible cloud tops in Jopitar's atmosphere – high, frigid white clouds of ammonia ice crystals in the zones, and deeper, warmer clouds of ammonium hydrosulfide and water in the belts. Trace compounds of phosphorus, sulfur, and various hydrocarbons give the clouds a variety of subtle colors. The alternating cloud band pattern extends to nearly 70 degrees north and south latitude, where it gives way to a pair of more chaotic, mottled, belt-like circular regions centered on either pole.

Because Jopitar is an upside-down world from the perspective of a terrestrial planet dweller, it is more useful to speak of depth rather than altitude when describing vertical location within the atmosphere. Depth is conveniently measured from the *tropopause* – the top of the active weather layer, just above the tops of typical upper-level ammonia clouds. The tropopause marks the boundary between the clear stratosphere above, and the clouded, turbulent *troposphere* below. It is the coldest level in the atmosphere, typically a numbing 100 nevlu (161 degrees below zero on the human Celsius scale); temperature increases in both upward and downward directions. Only the most powerful storms penetrate this elevation, because cloud formation requires convection, and convection requires that temperature decrease in the upward direction even more quickly than rising air cools naturally.

The Jopian atmosphere consists primarily of hydrogen and helium, although the precise composition changes with depth. Just below the main deck of water clouds at 223 kilurets depth, the average composition is approximately 73% hydrogen and 23% helium by mass. The remaining 4% consists of heavier elements – in particular, 0.9% carbon, 0.3% nitrogen, 2.6% oxygen, and 0.1% sulfur – which combine with the plentiful hydrogen to form a variety of molecules. Without these molecules, there would be no visible clouds, and no possibility of life. Jopitar would be quite bland, both outwardly and inwardly. In terms of the number of molecules, the atmosphere just below the water clouds averages about 85.9% molecular hydrogen (H_2), 13.5% atomic helium (He), 0.19% methane (CH_4), 0.06% ammonia (NH_3), 0.39% water (H_2O), and 0.01% hydrogen sulfide (H_2S). Because heavier elements tend to sink through the light, buoyant hydrogen, and to condense out of the atmosphere at higher temperatures, the proportion of heavier elements increases with depth. Silicon, which together with oxygen and carbon forms the backbone of Jopian life, doesn't attain significant general atmospheric proportions until nearly 990 kilurets depth. If not for a relative depletion of magnesium in the lower troposphere, most silicon would condense out of the atmosphere much deeper down, and Jopian life as we know it would not be possible.

Beneath the visible clouds, the gaseous atmosphere becomes progressively denser and warmer with increasing depth. The molecular hydrogen gas becomes a *supercritical fluid*, in which the distinction between gas and liquid becomes meaningless, at 286 kilurets depth. There is no clear liquid boundary or surface. Between 18 to 22% of the distance to the planet's center, atmospheric pressure becomes so great that electrons are squeezed out of the hydrogen atoms, and the hydrogen undergoes a transition into a liquid metal. Although this *metallic hydrogen* soup can accommodate a significant concentration of helium and other heavier elements, drops of helium slowly condense and rain down through deeper levels, gradually depleting the helium higher up. At the center of the planet lies a dense, hellish core of rock, with a mass of several Earths, sheathed by a thick layer of dirty hot molten water, ammonia and methane "ice."

The atmosphere of Jopitar is in a constant state of motion. The currents are mainly powered both by radiant energy received from Suol, the local sun, and from gravitational energy released by the slow contraction of the giant planet (about 15 centurets per jope). Because Jopitar is both so large and so far from Suol, the internal energy source is comparable to the suolar contribution (~67%, versus only ~0.04% for Earth). The suolar energy is absorbed in the upper atmosphere, and heats equatorial latitudes far more than the poles. This drives a convection pattern in the upper troposphere, extending from the tropopause down through the eight-rab level (roughly sea-level pressure on Earth) to about 80 kilurets depth, in which heated gases rise at the equator, move poleward, cool, and sink, returning at a lower level to the equator. In the process, excess heat is transported toward the poles. As in Earth's atmosphere, this overall system gets broken into a series of rolling *convection cells* (analogous to Earth's Hadley, Ferrell, and Polar cells), tied in Jopitar's case to the zone-belt system. Gases ascend in each zone, cool, and form clouds of ammonia ice crystals. The dried gases then diverge toward the adjacent belts on either size, where they converge with gases arriving from the adjoining zones. These gases sink into the belts, where they again diverge, and travel back to the adjacent zones. The cell pattern ends with gases descending at either pole.

In contrast, because Jopitar spins so rapidly and has a flattened shape, the internal heat is channeled from the hot core more strongly toward the poles than the equator. This drives a distinct three-layered tier of convection cells at deeper levels, which transports excess heat not only from the core to the surface, but also from the poles to the equator. The most important component for our purposes is the mid-tropospheric convection system. Air in the middle troposphere tends to rise in the belts and sink in the zones, just the opposite of the suolar-driven pattern in the upper troposphere. The two systems are linked, in that gases sinking from higher levels in the belts meet gases rising from deeper levels, forcing each to diverge into the adjoining zones, completing the convection loops.

Air ascending in the belts expands and cools, leading to the formation of the ammonium hydrosulfide and water clouds visible from space. At progressively greater depths, a variety of thinner ammonium halide, alkali sulfide, alkali halide, and silicate clouds are also spawned. The mid-tropospheric circulation ends at about 1,780 kilurets depth. From here down to 1,970 kilurets, the atmosphere is so transparent that conditions are not well suited to convection, but rather to the upward transfer of energy through infrared (heat) radiation. Massive hot convective plumes nonetheless do frequently break through this barrier from below. Because of the circulation pattern in the lower troposphere, this generally occurs in the zones, but the plumes are then quickly swept by latitudinal currents into the adjoining belts. There they stream up through the middle troposphere, stirring convection at higher levels.

The upper reaches of the mid-tropospheric belts are the site of intermittent but intense lightning storms, which channel upward a significant portion of the heat percolating outward from the planet's core. These are commonly triggered and fed by the underlying hot plumes. The material inside a rising plume is considerably hotter and more buoyant than the surrounding atmosphere. As a plume rises through the middle troposphere, it chaotically fragments into distinct streams – the rey *rivers of fire.* Each river can give rise to a cluster of storms at higher levels. These are dramatically energized by the heat released when water condenses in the lower storm clouds, and often spawn towering thunderheads capped by icy ammonia anvils at the top of the troposphere.

Mid-size storm clusters are typically a few hundred kilurets in size, and last five to ten yads, but large clusters can grow up to ten thousand kilurets across within several yads. These mammoth formations encompass more than one hundred individual storm cells, and may persist for kews or even thoms. They can span a height up to 225 kilurets, from the base of the underlying liquid water clouds to the tops of the uppermost ammonia ice plumes. The most powerful storm towers can breach the tropopause, into the lower stratosphere. Vertical updraft velocities of 60 to 175 rets per noc (some 180 to 540 kilometers per hour) are common.

The net ascent in belts is not large-scale, but carried mainly by the vigorous upward motions in localized storms. There is even a gradual subsidence of gases between storms, as well as penetration of some dry air from higher altitudes to levels below the water clouds. A general, widespread upwelling in the belts would actually produce thick zone-like water stratus clouds instead of individual storms, and create conditions inimical to thunderstorm formation.

High-speed *jet currents* blow along the zone-belt boundaries, alternating eastward (in the same direction as the planet's rotation) on the equator side of each belt, and westward on the pole side. The belts are thus *cyclonic* (they rotate counterclockwise in the northern hemisphere, and clockwise in the southern), while the zones are *anticyclonic*. Normally, regions of relative low pressure generate cyclonic flow, while high pressure regions engender anticyclonic flow. These rotation patterns are caused by the *Coriolis force*, as air moves naturally from higher to lower pressure. In the absence of storms, pressure tends to be higher in the zones than in the belts at both the top of the upper- and the bottom of the mid-tropospheric convection systems, supporting the prevailing jets. At the transition between systems, however, relative pressures in the zones and belts are reversed, generating contrary winds. These are overcome by the strong belt lightning storms, which penetrate through the transition region. As on Earth, such storms are cyclonic from lower through mid levels, and don't become anticyclonic until approaching the cloud tops. The strong outer wind fields feed directly into the existing jets, overwhelming the weak opposing currents. The net result is that jet wind speeds are nearly constant from great depths up through the 35-rab level (at roughly 175 kilurets depth). Above this, they do not reverse direction, but only diminish in intensity through the tropopause.

Imbedded in the zones are major *anticyclonic ovals*, typically bright white or (less often) ruddy in color, which normally extend into the neighboring belt on the equator side. These are the tops of giant, upwelling hurricane-like vortices, crowned by ammonia clouds that rise higher than typical zonal clouds. The larger systems may persist for octujopes. While inhabitants of rocky terrestrial planets usually think of storms as being cyclonic, this is true only from a perspective beneath the clouds, where air is rushing inward and upward through a region of low pressure. Above a cyclonic storm, a relative high-pressure area develops, and the air can only spread outward, producing anticyclonic flow.

The anticyclonic ovals are powered and maintained by the powerful lightning storms in the belts. While these storms are cyclonic at low to mid levels, they are anticyclonic at the top. The storms have a natural tendency to drift poleward, and eventually are either torn apart by the cyclonic shear of the host belt, or generate stable upper-level anticyclones moving west with the prevailing current. When a major storm approaches the poleward boundary of a belt, its energetic updraft can penetrate into the lateral flow between the upper- and mid-tropospheric convection cells, and be swept into the ascending circulation of the adjacent zone. This occasionally gives birth to a new anticyclonic oval, but more often energizes the overall zonal flow, and feeds into any nearby pre-existing oval.

The middle troposphere encompasses the principal realm of Jopian life. Hospitable regions are confined to the belts, mainly between 500 and 620 kilurets depth. Here upwelling currents rich in raw nutrients and thermal energy are common. Unlike Earth biochemistry, which is carbon based, Jopian biochemistry is anchored both to carbon and to silicon-oxygen polymers, which stabilize biomolecules against the higher temperatures and pressures on Jopitar. While carbon and oxygen are plentiful throughout the middle troposphere, silicon is not, and must be furnished from below.

The tops of ordinary silicate (mainly SiO_2) clouds lie at nearly 990 kilurets depth, where ambient temperatures exceeding 890 nevlu (about 730 degrees Celsius) would destroy any organic molecule. But the hot plumes and associated rivers and springs that surge through the middle troposphere carry *silane* (SiH_4) upward more than 370 additional kilurets, through the 600 nevlu (400 degrees Celsius) level. Here a fraction of the silane is naturally converted to *silicone* polymers. Simple, heat-tolerant chemosynthetic and (infrared) photosynthetic microorganisms that swarm along the edges of the upwellings convert these and additional silane to stable biochemical forms, and carry the silicon to still higher levels on the upward flow, as the remaining unstable silane converts to silicon dioxide grit and precipitates away. Warm currents rich in the stuff of life ascend through cooler domains harboring progressively more complex organisms. At some 512 kilurets depth (well below the base of water clouds), multicellular organisms flourish in tangled thickets, held aloft by enormous bladders filled with pure hydrogen. Ambient temperatures of 512 nevlu (300 degrees Celsius) and pressures 60 times those on Earth are typical here.

At much deeper levels, beneath the weak radiative layer, churns the lower-tropospheric convection system, which extends to the base of Jopitar's molecular hydrogen envelope. The circulation here is synchronized with the upper-tropospheric pattern, in that fluids tend to rise in the zones and sink in the belts. As at higher levels, ascending fluids expand and cool, leading to the formation of magnesium silicate clouds at the loftiest reaches, where temperatures hover near 1,800 nevlu. Condensates include solid Mg_2SiO_4 grains (the mineral forsterite), liquid $MgSiO_3$ droplets, and (in the coolest vapors) grains of solid $MgSiO_3$ (the mineral enstatite). If magnesium were not depleted with respect to silicon in Jopitar's troposphere (a larger proportion of magnesium is locked away in the planet's core), almost all the atmospheric silicon would be sequestered in and below these deep clouds, and very little would be available to life at higher levels. At still greater depths, iron clouds form. The deepest cloud layers consist of refractory calcium-aluminum and calcium-titanium oxides.

The net ascent in the zones is not large-scale, but carried mainly by the vigorous upward motions in hot plumes. Condensation releases latent heat, which provides some additional buoyancy.

The deepest fluid convection system occupies the metallic hydrogen ocean, which extends from the base of the troposphere all the way to Jopitar's core. This circulation is synchronized with the mid-tropospheric convection system – fluids tend to rise in the belts and sink in the zones. In particular, hot fluids rise directly from the poles, and sink onto the equator. Hot plumes originate in the abyssal depths nearest the core, where they strip away heavy elements from the sludge that blankets the underlying layers of dirty molten ices, and carry the enriched material upward. The plumes are eventually swept latitudinally to feed the ascending zones of the lower troposphere. Electric currents in the intervening ionic ocean generate an intense magnetic field that enfolds the planet in an immense electromagnetic bubble.

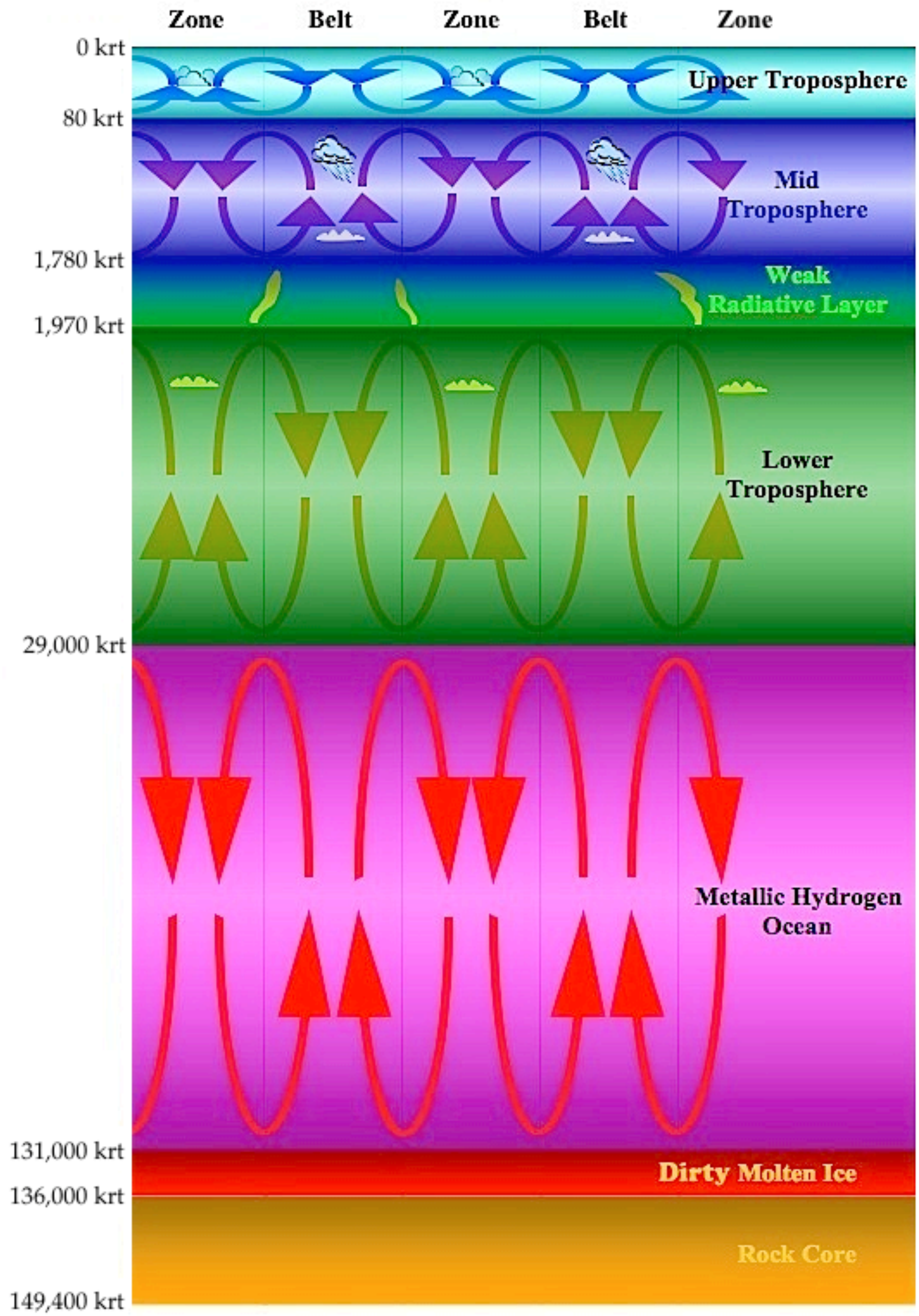
Some of the principal features of the Jopian atmosphere and interior are listed in a table and depicted in a figure on the following pages. In deference to Earth-based readers, the table specifies quantities in terms of both octan and human/simion units of measure (color coded blue and red, respectively). Depths are listed in octan kilurets (krt) and human/simion kilometers (km), and are measured from the average level of the tropopause (the inversion layer dividing the top of the troposphere from the base of the stratosphere) in equatorial regions. Temperatures T are listed in nevlu and degrees Celsius (°C). Atmospheric pressures P are listed in rabs and *bars*, where one bar is slightly less than the standard sea-level pressure on Earth. Density is listed only in grams per cubic centimeter (g/cm^3), human units. Note that the density of air at sea level on Earth is about 0.0013 g/cm^3, while the density of liquid water is 1 g/cm^3.

Numbers listed in the table represent typical values only; there can be significant local deviations. For example, cloud bases may be somewhat deeper (higher) where concentrations of condensable volatiles are greater (smaller) than average. Cloud tops may similarly vary. The crowns of strong water storms may even be pushed above the tropopause. The transitions between vertically adjacent regions may further be gradual to some extent, and not sharply defined. In particular, the boundary between the outer molecular hydrogen envelope and the underlying metallic hydrogen ocean is fragmented and blurred.

Principal Features of Jopitar's Atmosphere and Interior

Depth		T		P		Density	Feature
krt	km	nevlu	°C	rab	bar	(g/cm^3)	
0	0	100	-161	1.3	0.15	0.00004	Top of troposphere
12	6	103	-158	1.8	0.21	0.00005	Top of ammonia ice clouds
73	35	143	-113	7.3	0.87	0.00015	Base of ammonia ice clouds
80	39	149	-106	8.4	1.00	0.00017	Transition upper- to mid-tropospheric cells
98	47	165	-88	11.6	1.38	0.00021	Top of ammonium hydrosulfide ice clouds
							Top of water ice clouds
138	66	200	-49	21.4	2.54	0.00032	Base of ammonium hydrosulfide ice clouds
193	92	246	+2	43	5.1	0.00052	Water-ice above this level
							Ammonia-bearing liquid water below
223	107	271	+30	60	7.1	0.00067	Base of ammonia-bearing liquid water clouds
286	137	325	+90	109	12.9	0.0010	Hydrogen becomes supercrtitical fluid
390	186	411	187	242	28.8	0.0018	Base of ammonium halide clouds
512	245	512	300	512	61	0.0030	Floating thickets with multicellular life
							Various alkali sulfide and halide clouds
627	300	605	404	911	108	0.0044	Deepest level with life (heat-tolerant microbes)
							Silane ascends through this level in hot plumes
988	473	894	727	3,520	417	0.011	Top of ordinary silicate clouds
1,550	740	1,310	1,200	13,600	1,610	0.027	Base of ordinary silicate clouds
1,780	851	1,470	1,380	20,600	2,440	0.036	Base of mid-tropospheric cells
							Top of weak radiative layer
							Convection inhibited (breaks through)
1,970	942	1,560	1,480	27,800	3,300	0.044	Bottom of weak radiative layer
							Top of lower-tropospheric cells
2,340	1,120	1,790	1,730	46,500	5,520	0.060	Top of magnesium-silicate clouds
							Iron clouds
							Refractory Ca-Al and Ca-Ti oxide clouds
27,200	13,000	5,610	6,000	1.4×10^7	1.7×10^6	0.91	Base of lower-tropospheric cells
							Transition from molecular hydrogen envelope
31,300	15,000	6,040	6,480	1.9×10^7	2.3×10^6	1.0	to metallic hydrogen ocean
131,000	62,500	17,000	19,000	3×10^8	3×10^7	4	Base of metallic hydrogen ocean
						10	Surface of dirty molten ice layer
136,000	65,000	17,000	19,000	3×10^8	4×10^7	11	Bottom of dirty molten ice layer
						21	Surface of rocky core
149,400	71,500	17,000	19,000	5×10^8	6×10^7	23	Center

Cross Section of Jopitar's Atmosphere and Interior



Note: Above is *not* drawn to scale

Appendix A – Commentary and References

Clarifying non-fictional commentary and references concerning the physical model adopted for the planet Jopitar

Jopitar is modeled after the planet Jupiter, the dominant gas giant in our own solar system. Planetary scientists Andrew Ingersoll et al. have written an account of the dynamics of the accessible atmosphere of Jupiter.[1] This overview describes a range of Earth-based and spacecraft observations, and examines hypotheses proposed to explain the data.

Marley and Fortney have published a book chapter that surveys our current understanding of giant planet interiors.[2] The structure adopted for Jopitar is an amalgam of configurations proposed for Jupiter by various researchers.[3,4,5,6] In all cases, a molecular hydrogenous atmosphere envelops the planet, to a depth (measured from the top of the *troposphere*, or active weather layer) of about 14,000 kilometers, some 20% of the planet radius.

Temperature and pressure both increase with depth through the troposphere, to balance the increasing weight of overlying material. The rate at which temperature increases with depth is known as the *lapse rate*, an important parameter in modeling any atmosphere. Assuming the fluid is well mixed by convection, the lapse rate is *adiabatic*, and determined by the local strength of gravity, the atmospheric composition, and the *equation of state* – the relationship between temperature, pressure, and density.[7]

The elemental composition of the atmosphere used in the Jopitar model is over 92% (by number of atoms) hydrogen, 7% helium, and less than 1% heavier elements. The hydrogen is primarily in molecular form. The detailed abundances of important elements and molecules beneath the water clouds are generally close to values for Jupiter reported by Atreya and Wong[8] and by Wong et al.,[9] respectively. An important exception applies to water (and hence, to oxygen), which is an order of magnitude more abundant in the Jopitar model. The published values largely derive from measurements by the Galileo space probe, which apparently descended through an atypical dry column in the Jupiter atmosphere, and may have grossly underestimated the actual deep abundance of water.

At its upper levels, Jopitar's atmosphere is an ordinary gas. Yet because of the thermodynamic properties of molecular hydrogen, it becomes a *supercritical fluid* at a depth of about 140 kilometers. The fluid becomes progressively more like a liquid and less like a gas at greater depths, with no abrupt transition from gas to liquid.[10]

The vertical distribution of the principal upper cloud layers (ammonia ice, ammonium hydrosulfide ice, water ice, ammonia-bearing liquid water) was modeled on work by

Atreya and Wong for Jupiter.[11] Depths of lower, more exotic cloud layers (ammonium halide, alkali sulfide, alkali halide, silicate, magnesium-silicate, iron, etc.) are based on a publication by Fegley and Lodders.[12] Magnesium is assumed to be depleted with respect to silicon in Jopitar's lower troposphere (presumably, a larger proportion of magnesium is locked up in the planet's core). Otherwise most atmospheric silicon, crucial for jopian life, would condense there in magnesium-silicate clouds, and not be available at higher, more temperate levels.

Pressure-temperature-density profiles from the top of the troposphere to below the water clouds were modeled with guidance from Jupiter data published by Seiff et al.[13] and by Sanchez-Lavega et al.[14] Lapse rates were assumed to be *dry adiabats* (atmosphere not saturated with water vapor) in the former case, and *moist adiabats* (saturated atmosphere) in the latter. Profiles at greater depths, to the base of the molecular hydrogen envelope, were estimated using equations of state published by Slattery and Hubbard,[15] Graboske et al.,[16] and Kerley.[17]

Jopitar's two-layer upper- and mid-tropospheric convection systems derive from a paper by Showman and de Pater for Jupiter.[18] In the upper convection pattern, net upwelling occurs in the bright *zones* (leading to high, white ammonia ice clouds there), and net downwelling in the darker *belts*. The situation is reversed in the mid-level convection pattern. Yet the net ascent at mid-tropospheric levels cannot be uniform across each belt, as this would produce thick zone-like stratus water clouds and a (moist adiabatic) temperature profile that inhibits thunderstorm formation. Powerful storms such as those observed in Jupiter's belts, and so crucial to the life cycle of the reys on Jopitar, would not be possible. Instead, ascending matter in belt thunderstorms must dominate over gradual subsidence between storms. Descriptions and models of moist convective storms, and analyses on how they might feed into large-scale flow structures, have been published by Hueso and Sánchez-Lavega[19] and by Li et al.[20]

The existence of a weak *radiative layer* (where upward heat flow is carried mainly by radiation, rather than convection) at the base of the mid-tropospheric system was motivated by a paper by Guillot et al.[21] The Jopitar layer is assumed to be much thinner than the one proposed for Jupiter, to enable hot convective plumes, rich in nutrients, to routinely break through from below. The existence of a lower-tropospheric convection system, beneath the radiative layer, is purely hypothetical.

As described by Marley and Fortney[22], pressure and temperature would become so large toward the base of Jopitar's atmosphere that a phase transition occurs there. Electrons are squeezed out of hydrogen atoms, and the molecular hydrogen fluid becomes a *metallic hydrogen* liquid. The transition from molecular hydrogen may be gradual, and span a layer thousands of kilometers thick. Beneath this is an abyssal global ocean of metallic hydrogen, some 47,500 kilometers thick in the Jopitar model.

At the heart of Jopitar is a rock/ice core with a diameter of 18,000 kilometers, containing the mass of 7.5 Earths. This mass value is typical of the referenced models for Jupiter, which range from 0 (no core) to about 15. The rock component in Jopitar's case is assumed to be concentrated in a central volume 13,000 kilometers across, which is sheathed by a layer of dirty molten ices (water, ammonia, methane). According to the *accretion model* of giant planet formation, a smaller, bare primordial core may have formed by accretion in the early yads of the suolar system.[23] As this body accumulated mass, its gravitational attraction on the surrounding nebula grew, until it pulled in the huge quantities of gaseous material that now form the bulk of the planet.

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Appendix B

Jopian Life

Jopian life originated and evolved within the mid-tropospheric circulation of Jopitar's belts. Habitable regions, mainly between 500 and 620 kilurets depth, form giant tori that girdle the planet, and collectively comprise the Jopian biotorus system. Here hot convective plumes rich in thermal energy and vital raw materials regularly percolate up from deep below. These plumes, which were even more active and widespread early in the planet's history, expand outward and cool as they rise. They vary in size up to several hundred kilurets across at mid levels, where they tend to break up into distinct streams, or rivers. Clusters of life-sustaining hot springs and fountains are spun off along the river peripheries.

The first Jopian entity that could properly be called life, commonly known as *Alphabios*, probably developed from silico-organic residues some two bevujopes (3.2 billion Earth years) ago, around upwelling plume currents near the base of the habitable range, where ambient temperatures hovered near 600 nevlu (300° Celsius higher than the boiling point of water on Earth) and the pressure exceeded 100 times that on Earth's surface. Outside the plume environment, silicon was found in significant quantities only below the silicate (SiO_2) cloud tops, some 370 kilurets deeper and more than 280 nevlu warmer. But inside the plume river currents, temperatures were high enough that appreciable amounts of silicon were lifted through the 620-kiluret depth mark, mainly in the form of silane (SiH_4). Temperatures at this level were low enough in the cooler surrounding fluids for complex organic compounds to develop there.

Even the most primitive organisms required an energy source and a supply of raw materials to survive. Energy ultimately derived from the same abyssal heat that powered the deep atmospheric circulation. The silane and other chemical species present in the scalding plumes and associated springs were not in equilibrium with the mixture in the milder surroundings. This disequilibrium drove chemical reactions along the perimeters of the hot flows, which became the basis for metabolic processes.

A majority of the silane was pyrolyzed to tightly bound silicon dioxide, which precipitated back into the depths. But a fraction reacted with water to form polymers of hydrated silicon dioxide, which in turn combined with carbon compounds to form durable silicone polymers (characterized by a silicon-oxygen backbone with carbon-based organic side groups). Some of the silicones tended to form ultrathin sheets. These folded into themselves, creating pockets that collected pure buoyant hydrogen, and providing protected surfaces and spaces for self-perpetuating polymers and chemical systems to evolve. Carbon (from methane), nitrogen (from ammonia), oxygen (from water), sulfur (from hydrogen sulfide), plus a variety of trace elements were involved in this chemistry. The silicone structures stabilized complex molecules from heat degradation, and provided a skeleton from which living organisms could evolve. Silicones have been a fundamental structural material for Jopian life ever since.

Organic materials caught in the main flow of the mid-tropospheric circulation experienced lethal variations in temperature and pressure over the course of a complete cycle. But objects with neutral buoyancy that lingered outside major updrafts and downdrafts experienced a comparatively benign range of conditions, allowing evolutionary forces to work. Some of these longer-lived structures had a tendency to grow, and shed pieces of themselves. Originally (before a genetic code was established), these "offspring" were not perfect copies structurally, though they were functionally equivalent. They soon outnumbered and choked out their non-reproducing cousins. The very plumes that supplied raw materials did introduce a degree of instability to the life zone, limiting the time any of these free-floating objects remained before being dragged into the general circulation. Alphabios was the first cell-like biochemical entity that managed to reproduce at a rate faster than that of its removal by stray currents.

The most persistent membrane systems eventually assumed a regular, double layered, spherical form, surrounding and supported by a bubble of pure hydrogen, with diameters (averaged over a growth cycle) of 200 to 400 micrurets, much larger than typical unicellular organisms on Earth. The hydrogen was generated by simple chemical reactions within the membranes, and provided buoyancy. The mean size of these primitive cells was determined by the requirement of neutral buoyancy: larger ones floated too far upward, away from the silane sources; smaller ones sank too deep, and degenerated in the escalating temperature. Since growing cells tended to become more buoyant, reproduction became linked to and triggered by a minimum ambient pressure, corresponding to a maximum diameter.

Metabolic processes took place in airy scaffolding that occupied the narrow space between the inner and outer membranes. Unlike Earth life, which evolved in a liquid environment, the free volume was not filled with liquid, but a comparatively low-density supercritical fluid – neither gas nor liquid, but possessing characteristics of both. Because the atmosphere of Jopitar was (and still is) chemically reducing, with essentially no free oxygen, Earth-like aerobic metabolism was not possible for the early life forms. Methane and water (rather than carbon dioxide and water, as on Earth) were typically combined to manufacture foodstuffs, stabilized within a silico-organic matrix. Hydrogen was released in the process. Energy was subsequently reclaimed from food stores by controlled reaction with molecular hydrogen, regenerating methane and water as byproducts.

The scions of Alphabios evolved in multitudinous ways throughout the prolonged primordial period, driven by the twin forces of natural selection and mutation. More efficient energy production and transfer reactions developed. Metabolic energy yields approached those of anaerobic Earth bacteria. Several distinct genetic codes for the transmission and processing of structural and functional information evolved and competed for some time. Eventually the so-called SNA scheme, based on sequences of six distinct code molecules on closed loops of silicon-oxygen polymer, became dominant. Vestiges of the other ancient genetic systems remain in the reproductive elements of cellular organelles in a variety of organisms. It is interesting that the genetic codes and biochemistry that spontaneously arose on Jopitar are all based on mixed chains of silicon, oxygen and carbon, while those on rocky terrestrial worlds tend to be carbon based. This difference can be explained by the markedly lower temperature and pressure conditions under which terrestrial life generally develops.

The earliest SNA-based cells were probably spherically symmetric, with uniformly distributed interior elements surrounding a central hydrogen bubble. The space between inner and outer membranes gradually reorganized, as the bodies developed a more efficient bipolar asymmetry. Most of the heavier functional and genetic cellular machinery gathered together in one hemisphere, commonly identified as the "bottom" of the cell, as it tended to hang in a downward position in Jopitar's strong gravity (though the lightweight microbes were still tossed and rolled by turbulent currents). The inter-membrane space expanded in this region, supported by a network of fine microtubules, which also guided the movement of biomolecules. The hydrogen bubble moved to the "top," and became more balloon-like. The dual membranes in this area pressed together, forming a thin, tough, semi-elastic envelope that secured the hydrogen.

By this time the most successful microorganisms had assembled most of their genetic material into a single circular loop of SNA, which was anchored at a dedicated site to a propitious patch of inner membrane near the bottom of the cell. These microbes reproduced by simple fission. During this process the main SNA loop would replicate, the cell pinch inward and divide through the (vertical) replication plane, and each daughter receive a single identical copy of the original SNA. Most cells also harbored so-called *plasmods* – short loops of secondary genetic material, analogous to plasmids in Earth bacteria. The plasmods typically replicated independently of the main SNA loop, and were distributed randomly between daughter cells during cell division.

Although this mode of reproduction could lead to the widespread dissemination of a favorable mutation through a new cell line, it was unable to bring together favorable traits arising independently in different lines. Yet cells would occasionally collide. Some had spotty coatings that caused them to temporarily stick together. The earliest microbes developed a tendency to exchange genetic material through transient openings in their outer membranes, and then separate, a process analogous to conjugation in Earth bacteria. While this mechanism was not strictly sexual, it did allow favorable genetic mutations to be shared. Microbes with this ability readily became preponderant. Many evolved hairlike extensions, analogous to bacterial pili, that facilitated the process. A subset of these structures subsequently evolved into *sillia*, movable appendages analogous to cilia and flagella, with which to swivel around and manipulate other cells. Acquired genetic material was either carried by the host as a new plasmod, or integrated into the main SNA loop or one of the preexisting plasmods.

Primeval microorganisms also developed an ability to enter an inactive state, and form a durable *endospore*, when confronted with hostile conditions. A microbe could be carried into an inhospitable region by a strong plume current or downdraft. Alternatively, an entire local plume complex could fail. To this yad, a typical plume waxes and wanes in strength over a period of jopes, until it ultimately dissipates, stranding any resident microbe colonies. Dormant cells revive when they drift into favorable environs. Microbes caught in a strong updraft, and carried into the upper-tropospheric circulation, can even be blown as spores into an adjoining belt, and thus spread across the entire planet.

Alphabios and its close descendants passively maintained a hospitable depth in the atmosphere by their innate buoyancy. A cell might be lifted several kilurets while feeding in the rising currents near a fountain, but would drop back to its equilibrium depth after being thrown clear. If a microbe were caught in a weak downdraft, its inherent buoyancy would limit the maximum depth and temperature it would endure. Because most species maintained the same inter-membrane spacing throughout life, however, cells did naturally become more buoyant as they grew. Conversely, cells abruptly became less buoyant during division, when they shed bubble hydrogen. Microbes consequently tended to cyclically rise and sink through the ambient air over the course of a life cycle. This was beneficial, since nutrients needed for growth were more plentiful at greater depths, while reproduction was more successful in the cooler temperatures higher up. But these organisms otherwise helplessly relied on the currents to bring nutrients to them, without sweeping them away. Life had no chance for significant further development until mechanisms evolved that actively drew creatures toward favorable environments, and away from inhospitable ones.

A crucial step occurred when microbes acquired an ability to actively adjust their natural buoyancies, mainly by modifying the volumes of their hydrogen bubbles. Soon changes in buoyancy were linked to various cell needs. For example, the normal increase in buoyancy might be retarded while a young cell was feeding, and only augmented later as the cell matured and prepared to reproduce. A cell might expand or deflate its hydrogen bubble if conditions became too hot or cold, respectively, regardless of its state of maturation. Tiny temperature sensors evolved in the outer cell membrane, together with pressure sensors along the inner membrane, which facilitated the new behaviors.

In parallel with these developments, several species acquired an ability to selectively drift in a specified horizontal direction during self-induced vertical movement. The more advanced of the silliated microbes sported several pairs of flattened, paddle-like sillia on opposite sides of the cell equator, originally adapted to rotate the cell around any axis. However, the disposition of these sillia strongly affected overall motion as a cell rose or fell through the surrounding air. Various lines randomly acquired tendencies to project the sillia in different ways during ascent or descent. Most of these patterns (for example, ones that caused a cell to spin) were detrimental, and quickly weeded from the population. But a few were beneficial, and favored by natural selection. In particular, some microbes began to extend pairs of opposing sillia along an axis perpendicular (left-right) to the direction to the nearest hot spring, and to angle the plane of these protrusions during self-induced vertical motion. The direction to a nearby heat source could only recently be sensed, as a subset of the evolved temperature sensors incidentally functioned as primitive infrared detectors. The most successful early adaptation was to simply angle the sillia downward in the direction of a spring. This practice became common, as it would cause maturing microbes to move away from hot springs into cooler surroundings as they ascended through the ambient air. Following division, daughter cells would slip back toward the springs as they descended.

These responses became more nuanced over time. Instinctive mechanisms evolved whereby an organism would combine self-induced rising or falling with lateral motion in whatever direction proved most beneficial, for a variety of circumstances. Microbes thus developed more flexible propensities to actively approach warm, nutrient-rich upwellings when hungry, and to seek higher, cooler environs as they matured, while maintaining a healthy range of temperature and atmospheric pressure. Depth control was accomplished now by actively exploiting the currents (e.g., withdrawing from a fountain when pressure fell below a critical value), in addition to adjusting cell buoyancy.

Microbes that acquired these new instincts attained a survival advantage over their cousins. They would seek out food, rather than passively wait for it to come to them. While living continued to be risky, the likelihood of being swept away was reduced, so the cell types grew progressively more abundant. A larger, richer habitat opened to them.

The risk remained comparatively high near the borders of the atmospheric belts. Here the weak prevailing latitudinal currents could sweep a microbe over the top of the local convection cell, into the general subsidence of the adjacent zone. Nourishing springs were rare in the zones, and an active organism would starve even if it managed to maintain a hospitable depth. Microbes that preferred currents flowing toward the central latitude of the resident belt would have suffered fewer losses along the borders. While an ability to sense planetary latitude was not attainable by the microscopic creatures, various cell lines accomplished the next best thing, when they randomly incorporated (rare) iron atoms into heat sensory molecules, and acquired an ability to sense Jopitar's normally south-north magnetic field. Instincts subsequently evolved to prefer springs in the locally appropriate southerly or northerly direction. Yet a rigid directional instinct was not advantageous. When a cell type spread from one side of a belt to the other, an originally adaptive directional preference would have become maladaptive. In addition, the magnetic field of Jopitar is not completely stable, and periodically reverses. A small but regular mutation rate in the directional preference was thus beneficial. Every new generation harbored a small proportion of (expendable) individuals with a previously maladaptive response, ready to exploit changes in local conditions.

Significant differences ultimately arose between coexisting cell types. One group continued to specialize in utilizing raw materials bubbling up from the depths, and grew progressively more proficient at the chemosynthesis and storage of beneficial complex organic substances, in particular higher-energy food stores. A breakthrough occurred when some members of this group began to perform photosynthesis, harnessing the net flux of infrared radiation from the hot plumes and springs. All these cell lines ultimately led to today's *chemosynthors* and *photosynthors*, the Jopian version of chemosynthetic and photosynthetic bacteria. Both early synthor types remained dependent on the plumes and springs as a source of silicon, and maintained instincts to feed near them at the greatest tolerable depths, where nutrients were most abundant, but then ride the peripheral currents to higher levels to reproduce. Synthors continue to thrive at the deepest levels, where they remain microscopic and unicellular to this yad.

Another group of microbes took advantage of the advances made by the synthors. Originating through a variation in the gene-swapping mechanism, these microorganisms would attach to the synthor cells, but then secrete enzymes to immobilize and digest them, absorbing needed complex substances through small openings in their outer cell membranes. The synthor cells were identified as prey by distinct genetic markers. The predators evolved to feed at the upper reaches of the synthor domain, where conditions were more hospitable and the synthors most ripe, then ride the currents to still higher levels to reproduce themselves. This overall shift to more moderate temperatures and pressures permitted more complex structures to evolve.

The subsequent developments of the synthors and the predators were interwoven, as each group forced the evolution of the other. Synthors with tougher walls were more difficult to consume, so they became more plentiful. Separate microscopic lines emerged that sported fine silicic bristles to ward off predators, or secreted selective poisons against predatory cells. The predators in turn evolved more effective coatings and antidotes to the synthor toxins, and adapted sillia to seizing their prey. They also developed new chemical sensors for detecting synthors, but continued to rely on heat sensors to locate warm upwellings, and the swarms of synthor microbes invariably found nearby.

New predatory lines emerged that fed on other predators. These were able to occupy progressively higher, more hospitable levels in the atmosphere. A hierarchical ecosystem emerged, spanning depths from the original 620 kilurets up to roughly 500 kilurets, or temperatures from 600 nevlu down to 500 nevlu. Silicon requirements diminished at higher levels, as lower temperatures allowed more versatile carbon atoms to replace an increasing fraction of the silicon in structural materials. Complexity likewise tended to increase, even as the density of microbes decreased, since predators at any depth remained dependent on life lower down for both silicon and ordinary food.

In many of the higher-level predators, one or more plasmods grew comparable in size and importance to the ancestral primary SNA loop, and the distinction between these loops disappeared. Maintaining the number and configuration of all the major genetic loops during cell division became critical to producing viable offspring. As cells grew more complex, the overall organization of cell structure and activity similarly became more important. One by one, the ability of the original SNA loop to selectively attach to the inner membrane near the bottom of the cell was transferred to the new loops. These became anchored to a cluster of short tubular protrusions from a common patch of inner membrane, which folded inward, and eventually formed a protective sac around the loops. This region expanded somewhat, and became functionally equivalent to the nucleus of a eukaryotic Earth cell. *Mutosis*, a process analogous to mitosis in Earth life, emerged in which nuclear SNA replication and cell division were controlled in an orderly fashion.

Haphazard transference of genetic material through the outer membrane was no longer an optimal method for the nucleated microbes to attain novel genetic characteristics. A primitive mode of sexual reproduction subsequently evolved among the nucleated predators. At first, these cells were normally *haploid*, and maintained a single copy of each distinct type of SNA loop. Yet when nucleated cells collided and stuck together, they would sometimes fuse. If the cells were not closely related, the two nuclei would typically compete for control, until either the fused cell died, or one nucleus overpowered the other, and appropriated all cellular resources. If the cells were closely related, with homologous (not necessarily identical) SNA loops, the fused cell would functionally become *diploid*. The two nuclei would be drawn to a common site, where the homologous SNA loops would be guided to adjacent anchor points. Cell unions that were able to maintain a diploid status and still divide by mutosis were often more viable than their haploid brethren (especially during times of stress), and flourished.

Sharing of genetic material by fusion alone was self-limiting. Further fusions of diploid cells rarely produced viable offspring, due to space limitations within the combined nucleus. Yet the successful diploid cells inherited their nuclear mechanisms from haploid predecessors. Originally, the mutotic apparatus interpreted the existence of paired identical SNA loops as a trigger for cell division. Under certain conditions, in particular when nutrients were abundant, the same apparatus now interpreted the existence of paired homologous loops as a trigger. In this event, a diploid cell would divide into two haploid cells. Just prior to division, the homologous loops would align, and confused ancestral SNA repair mechanisms would randomly swap homologous gene sequences. The two daughter cells would again be haploid, but now with unique combinations of genetic characteristics.

This mixing process was advantageous, but had one critical problem. Destructive genetic crossovers frequently occurred between paired homologous loops, creating nonviable segments of SNA. This was rectified when the SNA loops opened up at their anchor points, uncurled, and became anchored SNA strands. Now crossovers resulted in additional constructive mixing of genetic material. Other facilitating mechanisms rapidly evolved. *Muosis*, a process analogous to meiosis in Earth life, emerged in which diploid cells would mix genetic content between homologous SNA strands, then divide into haploid cells.

Many cell types now developed a diploid-haploid life cycle. These microbes would normally live in a diploid state, growing and dividing by mutosis, until changing conditions prompted them to divide by muosis into haploid cells. The trigger might be a sudden abundance of nutrients, if the cells were able to grow and multiply more rapidly in the haploid state under these conditions, and so better exploit the situation. The haploid cells would be prompted to fuse back into more resilient diploid cells, when conditions returned to normal. Alternatively, the trigger might be a severe deterioration of conditions. In this case muosis would produce inactive haploid spores. These would reactivate, and multiply as haploid cells, or fuse into diploid cells, when conditions improved.

Nucleated microbes with the ability and propensity to reproduce sexually with compatible cousins soon became common. Many lost the ability to divide asexually more than some fixed number of times. When these species later generated multicellular life forms, constraints on cell division would be largely responsible for the aging process, and restrict both the lifespan and the maximum size of an individual organism.

Some of the nucleated predators acquired an ability to ingest smaller cells by phagocytosis. In this process, a portion of a predator's lower outer membrane first invaginated to enclose a prey, and then engulfed it whole. The prey cells were usually digested, but occasionally survived intact, and some formed endosymbiotic relationships with their hosts. The predator microbes were already accommodated to harboring a discrete nucleus, and typically affixed internalized cells to their inner membranes. Many of the captured cells evolved over time into specialized organelles. Their obsolete hydrogen sacs withered away, along with any capacity for independent existence. The organelles maintained a restricted ability to reproduce within their hosts, and copies were divided between daughter cells during cell division.

One family of advanced predatory hosts established an endosymbiotic association with wayward photosynthors, and subsequently specialized in photosynthesizing high-energy food stores. An ample flux of infrared radiation was available even at the peak of their range, both from the ascending hot rivers and springs, and (to a lesser extent) from the warmer air directly below, so these microbes achieved a large degree of independence from life at deeper levels. They still needed to ingest (more primitive) microbes to obtain silicon, which became rapidly depleted as the currents rose. Silicon was required in particular prior to cell division, in order to manufacture additional structural material and chemical stabilization elements. These hybrid photosynthetic-predatory microorganisms, which share characteristics with Earth plants and animals alike, led the way to the modern Jopian version of plants. A second group of advanced predators subsequently specialized in feeding on the energy-rich plants, spawning today's animals. Both plant and animal populations swelled, but remained loosely tied to the hot plumes and springs.

About half a bevujope ago, some silliated plant cells acquired a tendency to stick together following division, to form colonies. The most successful configuration initially was a simple spherical shell, with sillia pointed outward. While these groupings by no means displaced the solitary one-celled life forms, there were numerous advantages to a colonial existence. In particular, it was comparatively difficult for a unicellular predator to phagocytize individual colony cells. A colony also protected its member cells by reducing the exposed surface area vulnerable to attack. Individual cells of a colony could even be sacrificed, without jeopardizing the organism as a whole.

The plant colonies evolved quickly. Most began filling the interior space with pure hydrogen, providing extra buoyancy. This in turn permitted cells in the surrounding shell to shrink their individual hydrogen bubbles, and so become more compact and less puffy. These organisms soon developed a top-bottom asymmetry, much as happened with their single-celled predecessors, only with significantly more vertical stability. Cells along the bottom hemisphere specialized in food production, processing, and other functions entailing bulk. Cells covering the top reformed into a thin, flexible skin for the internal hydrogen cavity, which now swelled balloon-like above the rest of the colony.

Small islands of cells in the lower hemisphere adapted to snaring and digesting prey microbes (needed for silicon). These eventually formed small pits, lined with sticky silliated cells, in the outer colony surface. Other cell clusters specialized in photosynthesis or reproduction. Loose networks of helper cells developed inside the primary cell layer, forming channels both for distributing nutriments, and (later) for transporting waste products to the digestive pits for expulsion.

Colony movement was originally accomplished through the collective actions of the individual member cells. As a common internal hydrogen balloon became established and cells specialized in various functions, this changed. A separate mechanism evolved for controlling the balloon volume, and thereby initiating overall vertical motion. In larger plant species, the sillia of cells along the equator lengthened and interconnected, to form a series of short paddles responsible for turning a colony around its vertical axis. Adjacent cells specialized as infrared sensors, to locate nearby heat sources. Most of these colonies concurrently developed a front-back asymmetry, in which the photosynthetic sites became more efficiently clustered on a front side, which was actively oriented toward nearby hot springs, and to a lesser extent in the bottom polar region, which utilized excess infrared flux from below. Many organisms ultimately acquired an ability to move sideways, by angling opposing equatorial paddles as they rose or sank through the surrounding air. All these modes of movement were similar to those of the plants' one-celled ancestors. Although they tended to be slow and cumbersome, only limited mobility was needed, since the plant colonies produced most of their own food.

In the more complex plants, the interior helper cells gradually engendered a complete second layer of cells, lining the hydrogen cavity. On top, the new cells joined the original layer to form a stronger, more proficient balloon envelope. Lower down, the inner cells specialized in chemosynthesis and storage. As these plants evolved, energy demands grew. With only anaerobic respiration available, development of higher-energy foods was essential. As with more primitive creatures at warmer depths, these were stabilized within silico-organic matrices. Energy yields about half that of aerobic respiration on Earth were ultimately achieved, which was sufficient for more complex multicellular creatures to evolve.

Animal colonies probably appeared shortly after the first multicellular plants. They may have acquired at least some of the requisite genetic blueprint directly from ingested plants, although the extent of such a transfer is speculative. Some may have even been rogue plant colonies that shed their photosynthetic capabilities. Like the plants, the first animal colonies were spherical shells comprising a single layer of silliated cells. This cooperative arrangement was again more resistant to attack by other predators, and offered an enhanced ability to entrap one-celled prey. These forms were also much more successful than their unicellular relatives at dispatching the early plant (and genetically distinct animal) colonies. A primitive predator colony would press flat against and attach to a prey colony, then collectively remove and consume targeted cells inside the contact zone.

Because stable vertical orientation promoted survival, the animal colonies quickly developed top-bottom asymmetries. Unlike the plant colonies, which generated plentiful excess hydrogen by photosynthesis and converted the central cavity into a common topside hydrogen balloon, most multicelled animals initially continued to rely on the internal hydrogen bubbles of their individual member cells for buoyancy. To achieve vertical stability, the set point of each cell's bubble became dependent on the cell's vertical location within the colony. Bubbles along the top (*dorsal*) surface were inflated more, and bubbles along the bottom (*ventral*) surface less, than for an isolated cell.

Most of the early animal colonies also acquired front-back asymmetries, more efficient at ensnaring prey. The front (*anterior*) end specialized in predation. A concave depression developed here, which deepened into a pit, lined with silliated cells that drew quarry into a sticky trap. Species that fed on other multicellular organisms evolved rings of raspy spurs just inside the pit opening, used to firmly attach to these prey and rip away cells. Excess nutrients ingested by pit cells were passed on to the free space at a colony's core, and made available to other colony cells (hydrogen and other inorganics were initially absorbed directly from the atmosphere). Indigestible debris was periodically expelled from the pit. A small pocket of cells at the rear (*posterior*) end soon became responsible for reproduction. This primitive organ could release haploid gametes, which drifted away in search of mates.

In the more advanced animal colonies, the digestive pit deepened further and elongated, folding inward and forming an analogue to the endoderm of Earth animals. The protected interior pit cells could now focus even more on digestion. The external cell layer took on defensive and sensory roles, analogous to an ectoderm. Cells encircling the forward orifice specialized in detecting prey by chemical means. Small "eye" spots, typically one on either side laterally, further adapted to detecting the infrared signatures of other organisms, and the warm springs that supported abundant life.

The bodies of many of the larger animal lines lengthened and narrowed. In most of these species, the digestive pit reconnected with the surface just below the rear end of the body, forming a more efficient, one-way digestive tract, and transforming the anterior opening into a mouth. The free space between the inner and outer cell layers shrank, until nutrients were passed directly from the digestive cells to the outer cells. Eventually a new layer emerged between the other two, analogous to a mesoderm. Cells in this layer initially specialized in food processing and storage, or (later) in material transport. The middle layer ultimately gave rise to a wide variety of internal organs.

Because they did not manufacture their own food, mobility was much more important to the multicelled animals than it was to the plants. Very early, many adopted a strategy of riding peripheral spring currents to heights well above their neutral buoyancy levels, then slipping out of the updrafts to hunt and feed as they dropped back down. The bodies of these creatures elongated further, and flattened along the base, allowing them to glide toward prey. Many developed billowy wing-like projections along either side, used to catch updrafts and to control the speed of descent. A fine, lightweight bony structure evolved along the body length, providing beneficial rigidity. Sillia of cells at the posterior end lengthened, strengthened and connected to form a primitive, rudder-like tail fin. Smaller control fins also evolved from silliated cells along either side.

When prey or their habitats were detected, sensors at the front end of these animals would secrete a primitive neurochemical that diffused back toward the tail, stimulating appropriate movement. To induce a suitable dive angle, the front end of the body was made less buoyant than the rear. At first, this was accomplished by transferring hydrogen between the bloated cells along the dorsal surface. In time, many animals developed long, distensible, dorsal buoyancy bladders to perform this function. These internal bladders also allowed body cells to become more compact. The fins guided movement to a target. The tail later evolved mesodermal muscle fibers to provide additional locomotive power. The spine became jointed, and provided an anchor for muscle attachment. Strings of cells connecting the forward sensors and tail eventually specialized at relaying information along the length of an organism, forming a rudimentary nervous system. Eventually, the main longitudinal nerve trunk would be protected inside the spine.

Interactions among the various microbes and multicelled organisms drove their coevolution. Larger, more complex plants and animals arose, to fill emerging niches in the Jopian ecosystem. The plants developed new strategies to counter the escalating animal threat. The external surface of the hydrogen balloon atop most sizable species became a tough but thin, inedible skin. An array of surface cells lower down focused on protecting the appetizing vulnerable areas covering the bottom hemisphere. These cells typically produced hard but lightweight chitinous secretions, derived from silicic metabolic byproducts, which organized into assemblages of overlapping scales. Yet while the scale system permitted colony growth, it interfered with photosynthesis. Before long, primitive leaves extended out from under the scales, into the open air. Flattened leaf cells drew methane and water directly from the outside atmosphere, and other nutrients from the colony itself, then used infrared photosynthesis to manufacture foodstuffs. These were shuttled along stubby stems into the colony for further processing, distribution and storage. Individual leaves could be sacrificed to browsing animals, without endangering the overall organism.

Concomitantly with scales and leaves, islands of connective tissue arose in the main plant body between the two primary cell layers, forming an ultralight but strong, foamy supporting matrix, which enhanced the organism's physical integrity. Most of these plants also developed *rootes* – retractable appendages for capturing passing microbes and acquiring needed nutrients from them. The rootes would typically slide out between scales on the underside of a plant, and dangle downward, to gather ripe, hyperinflated cells rising from far below.

With successive generations, the scaled armor proved so effective that it crept further and further up the sides of the most successful large plants, until it pinched into the hydrogen balloon. The bulk of the balloon was gradually squeezed outside the main plant body, and transformed into a swollen bladder, connected to the core hydrogen cavity by only a pliant, rubbery neck. During this development, an efficient chemical hydrogen pump evolved in the balloon wall. The pump used infrared radiation to dissociate hydrogen molecules in the surrounding air, then transport the individual hydrogen atoms into the interior. There the hydrogen atoms would reunite into hydrogen molecules, releasing heat and warming the contained gas, providing additional buoyancy. The balloon wall became more insulating, to maintain an elevated internal temperature. Excess cooler hydrogen spilled out of the base of the balloon, into the interior of the main plant body.

As these plants matured, their external scales tended to stiffen, until they became encased in crusty bark. This bark provided superior defense, but ultimately limited the size of an individual organism. The underlying surface cells that specialized in reproduction released haploid spores or gametes to the outside, or generated buds asexually that bloomed into new globular forms. Originally these broke off to form independent colonies, but species evolved in which they often remained attached by hollow stalks. Soon these plants were forming tiered complexes of interconnected leafy bushes, buoyed by graceful hydrogen bladders.

The larger animals were increasingly pestered through this period by tiny single-celled and small, leech-like multi-celled parasites. The external cells adapted by secreting a smooth, protective skin of flexible but tough silicone over all outer body surfaces. Two sillia-lined slits appeared on either side of the mouth, which admitted hydrogen (for respiration) and other needed fluids into the body, and allowed methane, water vapor (respiration by-products) and other waste fluids to be expelled. A variety of internal organs evolved. These included lungs for more efficient exchange of metabolic fluids, a network of channels for more efficient intercellular transport, structures that filtered waste from the transport channels and dumped them into the digestive tract near its terminus, and glands that secreted digestive fluids. An endoskeleton of fine, lightweight bones provided a supportive framework for these organs. Most of the creatures already had internal buoyancy bladders. Yet these remained comparatively small, even as the animals grew in size and complexity. Buoyancy was a much less critical factor than for the multicelled plants, since the animals relied more on active motion to maintain their depth, and could even cling to the plants for support when needed.

Four broad categories of larger animals evolved: mannavores, herbivores, carnivores, and omnivores. The first group adapted to feeding exclusively on the multitudinous variety of so-called *manna* (one-celled plants and other microorganisms) that existed by this time. These creatures filtered the manna microbes from the air, and then swallowed them whole. The herbivores adapted to feeding on the multicellular plants, and evolved in parallel with them. These animals typically employed either a pair of opposing silicic ridges (inside the mouth) or a chisel-like beak to bite off leaves, and grind through plant defenses. The carnivores relied on fine quartz teeth to prey on multicellular animals of all types. These teeth were sharp but comparatively brittle, and must have broken frequently with use, but were readily replaced. Modern thicket serpents (which have been largely eradicated) and ribbon serpents are descended from this group. The omnivores consumed a mix of plants and (generally small) animals.

Many of the herbivorous prey animals responded to the predator threat by first hiding, and later living, within the same floating bush thickets that they normally grazed. Some also evolved social behavior, which promoted the development of a more sophisticated nervous system and central brain. The upper corners of the breathing slits adapted to generating and detecting sounds. This allowed members of a social group to warn each other when a predator approached, and ultimately to communicate in ever more sophisticated ways. Paired appendages appeared, which allowed the creatures to move more efficiently through the rough branches of their homes, and fashion comfortable nests. These changes encouraged further brain development. Thicket-based creatures with eight appendages are the ancestors of modern octos.

The large free-swimming mannavores lagged behind the colony-dwelling herbivores in mental development. They generally remained solitary and non-social, simply growing over time in size and bulk to counter the carnivore threat. By about 16 megujopes ago, they encountered increasingly stiff competition from groups of smaller but more advanced social animals that nested in the plant thickets but fed on manna in addition to the multicellular plants. Herds of these creatures would leave the protection of their nests to feed on manna at nearby hot springs. Over the generations they spent more and more time in free flight, soaring high on the currents out of the serpent habitat after feeding, until finally some broke free of their nests altogether. This new type of mannavore led to the reys.

Appendix B – Commentary and References

Clarifying non-fictional commentary and references concerning Jopian and other types of alien life found in this novel

Humans have speculated about extraterrestrial life since antiquity.[1,2,3,4] Sapient aliens in science fiction of the early twentieth century tended to be humanoid. Later, many writers conceived aliens that resembled some non-human Earth animal – e.g., a reptile, insect, or bird. More recently, aliens have assumed bizarre, other-earthly forms.[5,6]

In 1976, Carl Sagan and Edwin Salpeter published a classic scientific paper on the prospect of life in the atmosphere of Jupiter,[7] which helped inspire the setting for *Eternal Passage*. An ecology was proposed with four types of organisms: sinkers, floaters, hunters, and scavengers. The sinkers are the primary *autotrophs*, performing photosynthesis and establishing the basis for a food chain. Mature sinkers passively descend from the upper troposphere down through the atmosphere, toward the scorching depths, where they perish in the heat. They reproduce along the way, and many of the tiny offspring rise on turbulent currents back to the top of the sinker range. The hunters evolved from sinkers, having acquired the ability to control depth. These quick, maneuverable, *heterotrophic* animals aggressively seek other organisms, and feed on them. The floaters likely evolved from hunters, and actively maintain their pressure level. They can be heterotrophic (filtering sinkers from the air), autotrophic (performing photosynthesis), or both. It might be advantageous for autotrophic floaters to dwell in the upper troposphere, just above the water clouds, and grow to kilometer proportions. The scavengers, also evolved from hunters, inhabit the lower reaches of the life zone, where they feed on organic detritus drifting downward. Television audiences were introduced to these life forms on the second episode of Sagan's television series *Cosmos* in 1980, featuring artwork by Adolf Schaller.[8]

Science fiction authors have proposed even less familiar life forms, not confined to a planetary biosphere. For example, in the 1957 novel *The Black Cloud* by astrophysicist Sir Fred Hoyle,[9] a massive black cloud enters the solar system from interstellar space, blocking sunlight and threatening life on Earth. The erratic yet purposeful behavior of the cloud leads some scientists to speculate that it may be an intelligent life form. The scientists attempt to communicate with it using radio waves, and are surprised when they succeed. The cloud is actually a superorganism much more intelligent than humans, and is itself surprised to find sapient life on our solid planet. The cloud thinks via electrically charged dust particles, and is receptive to radio communication, as it already uses radio waves to coordinate its own thoughts and actions.

The *voidling* (introduced in chapter 13) represents an attempt to envision a similarly unusual creature, but one not composed of ordinary matter, and inhabiting the extreme environs near *black holes*. Various writers have speculated on the possibility of life under conditions of ultrastrong gravity. A classic example is the 1980 novel *Dragon's Egg*, by Robert Forward.[10] In this story, the surface of a *neutron star* is populated by *Cheela* – flat, amoeba-like creatures the size of a sesame seed, composed of highly compressed *nuclear matter*. Because nuclear reactions occur much more rapidly than ordinary chemical processes, the Cheela live and evolve a million times faster than humans. Gravitational *time dilation* does slow them from the viewpoint of an outside observer by about 10%, but this is negligible compared to the nuclear enhancement. The strange life processes of the voidling are also considerably faster than human, though not rooted in nuclear matter. Time dilation for the voidling is variable, however, since individual aspects of a collective can move vertically in their gravity well. In *Dragon's Egg*, humans discover the Cheela, and observe them from a safe orbit around the neutron star (approaching the star too closely would be fatal, as enormous tidal forces would rip a person apart). Over the course of a single month, Cheela civilization unfolds, from primitive agricultural communities to a space-faring society with superhuman technology.

Stephen Baxter has envisaged life in even more intense gravity settings, similar to those encountered by the voidling – the environment near black holes. In his *Xeelee Sequence*, the building blocks of life are not limited to ordinary matter, but may include such exotic entities as *quantum vacuum fluctuations, quarks, dark matter*, even kinks in *spacetime*.[11] Life arose soon after the *Big Bang*, and spawned civilizations through every phase of the universe's evolution. Mass extinctions occur at transitions between major epochs, such as the end of rapid *inflation*, but pockets of intelligence persist and adapt. In the novel *Exultant*,[12] the Xeelee are descended from survivors of the *recombination epoch*, when the hot plasma that filled the early universe cooled enough for atoms to form. They first inhabited primordial black holes, which they harnessed for energy, tools and computation, but later migrated to supermassive black holes in galaxy cores. The most advanced *baryonic* life form (composed of matter whose mass derives primarily from protons and neutrons), the Xeelee wage ceaseless war with the Photino Birds, dark matter creatures that inhabit the gravity wells of stars. The Photino Birds seek to extend the lives of their stellar homes by shutting down nuclear fusion (thereby converting the stars to *white dwarfs*), even though the process will ultimately make the universe hostile to all baryonic life. Humans, who have no knowledge of this peril, encounter the Xeelee, but find their mysterious actions threatening. Just as the voidling seeks to exterminate the Los colony when it fails to understand the psyche and motivation of the interloping colonists, the humans launch a bitter war against the misunderstood Xeelee. The preoccupied aliens are driven from the galaxy periphery, and ultimately flee even the supermassive black hole at the center of the Milky Way, in order to preserve the exotic ecology there.

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7. Carl Sagan and Edwin Salpeter, "Particles, Environments, and Possible Ecologies in the Jovian Atmosphere," *The Astrophysical Journal Supplement Series* 32 (1976): 737–755.

8. Adolf Schaller, "Creating Life on a Gas Giant – On 'Hunters, Floaters, Sinkers' from Cosmos," *The Planetary Society Blogs*, posted 11/02/2013 (21:29 UTC), http://www.planetary.org/blogs/guest-blogs/2013/20131023-on-hunters-floaters-and-sinkers-from-cosmos.html.

9. Fred Hoyle, *The Black Cloud* (New York: Harper, 1957).

10. Robert L Forward, *Dragon's Egg* (New York: Del Rey,1980).

11. "Xeelee," *Spacebattles Wiki*, accessed November, 2015, http://www.spacebattles.wikia.com/wiki/Xeelee.

12. Stephen Baxter, *Exultant* (London: Gollancz, 2004).

Appendix C

The Reys

Reys are the masters of the Jopian skies. They spend their entire lives in free flight, far from the protection and support of the floating thickets. Reys have the largest natural vertical range of any complex Jopian life form – from a sultry, crushing 570 kilurets depth, to the icy, rarified upper reaches of towering water storms that breach the tropopause.

Reys are not solitary creatures, but nomadic social mannavores, that live and travel together in *tribes*. A tribal unit is a close-knit group of up to a several hundred individuals, usually led by a council of *elders.* Most reys remain in the same tribe from birth to death. There are only two rey sexes/genders – male and female. While tribes generally steer clear of each other, occasionally (perhaps once in a rey's lifetime) a tribe will intentionally seek out another, in order to exchange males. Tribes tend to be matriarchal; female ancestry normally defines tribal identity, and a female will leave her birth tribe only if forced out by the leadership. If a tribe grows too large during times of plenty, it will divide into two.

A mature adult rey has a flattened conical body, typically just over one-half ret across at the front, and about two and two-thirds rets long. It is topped toward the front by a prominent cerebral hump, and tapered at the rear to a graceful yet powerful tail. A tough, smooth, silvery skin/hide covers all exterior surfaces, providing protection and insulation from temperature extremes. Two rounded, billowy wings extend from either side, spanning up to three and one-half rets tip-to-tip. A sieve-like mouth, used to filter microbes from the air during feeding, is located near the front of the body underside. Much as with deep-sea Earth creatures, a pair of internal buoyancy sacs (in this case filled with pure hydrogen) aid with depth control. A Jopian rey appears superficially similar to an Earth ray, except for a more pronounced cerebral hump, and *the eyes*.

A pair of optical eyes, sensitive to three primary infrared colors, lie on opposite sides of the upper rey "face" (the forward surface of the cerebral hump). These eyes are useful in many situations: at the cloud tops, for viewing suollit objects (other reys, distant cloud patterns); through midrange depths, for detecting objects warmer than the ambient air (other reys, distant turbulent water clouds); and at the bottom of the rey range, for locating nourishing hot springs. The three primary colors are optimized for these distinct functions.

A second mode of rey vision is based on high-frequency sound. This system evolved to help the rey's ancestors negotiate the floating thickets, and avoid serpent predators. Today, it is also used for communication. Two modes of operation are available. In the more common *active* (or *pulse*) mode, bursts of ultrasound are emitted from a *bellon* – an organ at the center of the face, below and between the infrared eyes. The sound can be focused, from a narrow to an open beam, and aimed in any forward direction. Returning echoes are imaged by a pair of large, deep-set acoustic eyes located on either side of the bellon. Each eye is covered by an array of sonoreceptors sensitive to both the amplitude and the phase of incident sound at select frequencies. Neural circuits reconstruct images, based on the detected pattern of echo amplitude and phase. Two narrow frequency bands are utilized simultaneously: an upper channel (centered on about 600 kiluhartz, or 300 kilohertz in human parlance) for closer, detailed vision; and a lower channel (around 100 kiluhartz) for longer-distance, lower-detail viewing. The latter waves travel with much less attenuation through the atmosphere, but suffer considerably more diffraction. The dual-frequency format helps to distinguish true personal echoes from extraneous sound, and differences in reflected intensities provide a sense of color-texture. The intervals between pulse emission and echo detection are timed autonomically, creating a keen sense of depth. Phase-based imaging and parallax between the eyes provide supplementary inputs for depth perception.

This pulsed system is finely tuned. Individual reys can reflexively adjust the central frequencies of their own visual bands over a limited range, to avoid interference with others nearby. The system is also very sensitive to tiny frequency changes within the two fundamental channels. Echo shifts with respect to the (current) central emission frequencies are perceived mentally as different hues of color, with two primary colors spanning each of the two visual bands. By detecting small deviations in the frequencies of returning echoes, reys gauge the line-of-sight velocities of nearby objects.

The lower frequency pulsed channel also functions at a semi-autonomic level, under limited voluntary control, to maintain appropriate separations among tribe members. Weak wide-angle orientation pulses are issued at regular intervals, in particular during sleep. Returning echoes are processed subconsciously to create a sense of location within the tribe, based on the number and positions of other reys in the forward-facing hemisphere. Because the system is blind to the rearward hemisphere, an individual rey can only be responsible for maintaining safe distances from neighbors in the frontward and lateral directions.

The acoustic eyes can alternatively function in *passive* mode, to visualize objects lit by ultrasound from extraneous sources, in particular other reys. Now the eyes simply detect ultrasound arriving from the environment. This mode is more broadly tuned, and operates with lower spatial resolution than active mode.

At the outer edges of the acoustic eyes, on opposite sides of the cerebral hump, is a pair of ear-like receptors that provide reys a sense of hearing. These organs are sensitive to sound at 12 discrete low frequencies, extending from a few hartz to around 20 kiluhartz. In addition to the high-frequency pulses used for vision, the bellon can produce modulated sound at any of these auditory frequencies. The corresponding wavelengths are far too large for visual purposes, and are used instead for aural communication. The highly tuned design eliminates much of the otherwise deafening noise that often engulfs the reys. Unlike the visual acoustic system, which can be quite directional (especially in the upper channel), the auditory system is effective in all directions. Still, by detecting intensity differences between opposing ears, a rey can discern the general direction of even a low frequency source.

Sound in the base auditory channel is capable of traveling huge distances with minimal attenuation. The rey autonomic nervous system causes the bellon to periodically emit a pulse of such sound. This allows different tribes to sense each other beyond normal visual range. It can also help guide a rey home, should it become separated from its own tribe.

Rey precursors used the low-frequency auditory system for all communication. An ability to communicate visual images originated when their descendants began to reproduce acoustic pulse sequences received along a given line of sight, and beam them to each other. As the acoustic system developed, such messages became confined to a separate narrow, dual-color frequency range between the two fundamental vision bands, reducing the problem of visual confusion. The communication scheme gradually advanced to the transmission of complex pulse sequences representing stereotyped scan patterns across (portions of) the visual acoustic and (later) visual infrared fields.

Reys now converse using this modified visual system, in addition to the older auditory apparatus. Symbolic auditory speech came first. Symbolic visual speech then arose quite naturally, when reys began to substitute standard pictograms for actual images in their visual communications. These became increasingly stylized and streamlined into compressed pulse sequences, until finally they lost all resemblance to the original, and were transformed into abstract logograms. Rey communication today consists of a rich mixture of symbolic auditory and visual content plus visual imagery, difficult to convey faithfully using human language. Unlike auditory speech, visual speech requires some degree of face-to-face contact. Visual speech is staccato – a series of pulses, beamed from one rey to another, who "reads" the flashing pattern with acoustic eyes. Visual speech content is determined both by the spatial-temporal pattern of the pulses, and to a lesser extent by the interplay of the two colors within the communication frequency band.

The reys are especially fond of speaking and singing in verse. Because they have no written language in the conventional sense, one might expect reys to rely on strict forms of verbal meter and rhyme to facilitate faithful transmission of content from one generation to the next. Yet reys have since ancient times blended an eclectic mix of rhymed, metered, and free styles in their spoken verse. This may be attributed to the peculiar rey communication system, which combines parallel visual and aural elements. Visual images and symbols can be metered and rhymed in a way analogous to words. Pairing visual content with spoken words helps the reys avoid narrow reliance on human-like oral mnemonic techniques.

While the life of an individual rey is centered on the tribe, the life of a tribe revolves around the *cycle*, or *passage* – a cyclic journey from the cloud tops down to the feed layer, and back. Though variable, the length of a typical cycle is about 17 yads (seven Earth days). Reys are born with a biological clock, and an innate (though comparatively imprecise) sense of the passage of time. Reys can count cycles, as well as many other quantities, and readily remember and process numbers up to four digits long. Unlike humans, whose ten digits naturally led to base-10 counting, or octos, whose eight tentacles led to base-8 counting, reys have no appendages. Their peculiar brain circuitry instead led to counting systems based on multiples of three. While some tribes use base-12 counting, the most common system is base-9.

The overall passage is broken into four *quads* of unequal duration. The first quad starts near the icy top of a water storm, out of which the reys emerge after an exhilarating ascent from the steamy depths. For a strong cyclone, this high point can approach the tropopause itself, at the roof of the upper tropospheric circulation. The associated storm towers are some five times taller than their counterparts on Earth. The frigid temperature at the loftiest summits can be as low as 100 nevlu (some 160° Celsius below the freezing point of water), with an atmospheric pressure of only 1.3 rabs (15% sea-level pressure on Earth). Less powerful squalls peak lower in the atmosphere, typically in the upper reaches of the mid-tropospheric circulation (80 kilurets beneath the tropopause), down to levels barely surmounting the tops of ordinary water-ice clouds (some 18 kilurets deeper) in the weakest storms.

The selected storm cell is typically at the edge of a large cluster, which is almost always associated with an underlying mammoth convective plume of hot, rising currents. As it ascends through the mid-tropospheric circulation, a plume normally separates into a complex of broad, undulating streams, known to the reys as *rivers of fire* along the lowermost sweeps of their range. These rivers in turn spin off the numerous hot springs and fountains on which the reys rely for food. As they surge into the water clouds, the rivers initiate and sustain the lightning storms. After riding powerful updrafts into a storm tower's billowy crown, the reys roll (or are hurled) out, into open air. This is a sacred moment, tied to innumerable myths and legends, as the reys enter an otherworldly realm at the pinnacle of their range.

If conditions permit, receptive adults may now mate. Reproductive organs of both sexes occupy furrowed folds under the wings, along the lines where the wings attach to the body. A male and female approach each other, side by side with wings lifted, then grasp one another, spinning through the thin air. The male passes genetic material into the female, and fertilizes any egg cells. The female will hold these in stasis, until an opportune time. Normally only one embryo develops at a time. A typical pregnancy lasts about 12 cycles, or one *gyre*. Mature males are distinguished from females by their smaller bulk and more streamlined body shape. The robust female frame is more designed for strength and endurance, to carry young through the trials of the passage. A newborn rey attaches to its mother in a fold under her wing, suckling from a sinewy nipple for several cycles until it is ready to fly free.

After mating, the reys assume V-shaped flying formations, and soar away from the local storms. Tribal leaders select a compass bearing, typically eastward with a slant toward the equator, as individual storm cells tend to drift westerly and poleward from the underlying plume head. Reys have an exquisite sense of orientation and direction, and even a weak sense of planetary latitude, based on a specialized organ that detects both the local magnetic field and the forces exerted by fluids circulating through a set of circular canals. Now the reys sleep, as they plunge through the frigid gas, and layer after layer of flat clouds. The tribe maintains its formation by means of the rey acoustic system, functioning in autonomic mode.

The reys may glide 1,850 to 2,250 kilurets as they slumber. After 10 to 11 rohs, at just over 270 kilurets depth, they awaken, and the second quad begins. The temperature has warmed to over 310 nevlu (approaching the boiling point of water on Earth), still a bit cool by rey standards, while the pressure has climbed to nearly 100 rabs (more than ten times sea-level pressure on Earth). The tribe regroups, forming a huge, half kiluret-wide cylindrical formation that spirals straight downward. The length of time for this formation to complete one rotation midway through the second quad is commonly called a *turne*, and is comparable to a human minute. Multiples of nine may be used to define periods that are shorter or longer than the turne. In particular, a *fliq* is about 1% (or 1/81 base-10) of a turne, or two-thirds of a second, while a *coile* is nearly 100 (or 81 base-10) times larger than a turne, or just over an hour.

The second quad is a time for adults to socialize, for females to give birth, and for the young to play and receive training. The period typically lasts about three yads. A central event of the second quad is the *community chorus*. The chorus brings the tribe together both emotionally and spiritually, and also serves as a practice drill of the group response to an attack by *ribbon serpents*. These beasts are the rey's only predator, and generally attack along the bottom leg of the passage, when the tribe is feeding. The reys temporarily rearrange into a flattened ellipsoidal array, flying in unison at a slight downward angle, a typical feed layer pattern. The most vulnerable – elders, females carrying young, ailing children and adults – gather at the center. These are surrounded by immature but free-flying youth, interspersed with mature but childless females. The healthy mature males form an outer shell enclosing the others. To begin the chorus, *cantors* at the front and rear of the assembly recite traditional verse. A common and popular selection is the retelling of the mythic origins of the reys. A number of young adult males then break away, and disappear into the darkness. Moments later they reemerge, flying at top speed toward the tribe from all directions. Mimicking an attack of the ribbon serpents, they bathe the tribe in a torrent of disorienting ultrasound. The cantors respond by leading the community in a melodic chant, to hold it together against the confusing acoustic assault. All rey music is based on a 12-note scale, defined by their low-frequency auditory system. Eventually the "attackers" rejoin the group, and the chant morphs into a long, more complex sound poem.

Somewhere between 450 and 470 kilurets depth, the reys regroup into V-shaped flying patterns. The tribal elders select a bearing, and the reys soar off in that direction. This marks the beginning of the third quad, which typically lasts another two and one-half yads. Normally, the reys fly back toward the plume / hot spring complex of the previous passage (with adjustments for jet streams and other intervening currents), recovering the distance crossed during the first quad in the opposite direction. They drop through the level occupied by the floating thickets, but generally eschew any contact.

A tribe may seek out a new plume complex, if warranted by changing conditions. In particular, reys may abandon a complex that shows signs of failing. However, they then risk starvation, if a new feeding ground is not located in time. Microbe communities and thickets are less vulnerable to changes in the plume circulation. If a plume breaks up, microbes can become inactive spores, until they float into a supportive environment. Any nearby thickets simply stop growing; the thickets and their inhabitants subsist on food manufactured by the plants using the infrared flux from below, until they drift into or actively locate a new plume system. Once silicon and a more ample energy supply are again available, vigorous growth and reproduction can resume.

The passage flattens out at depths approaching 565 kilurets, and the reys seek food near a modest hot spring, preferably a comfortable distance from the associated river of fire. The temperature here is a searing 555 nevlu (nearly 250° Celsius above the boiling point of water on Earth), higher than any other complex Jopian life form can tolerate, while the pressure is a crushing 675 rab (some 80 times sea-level pressure on Earth). The reys assume a flying formation similar to that of the community chorus, and must now be alert for ribbon serpents, which hunt in packs at the lowest levels. Young adult males serve as scouts, and also attempt to fight off serpents during an attack. Reys are equipped with a short, blunt, hardened *rostrum* at the prow end, used defensively to ram serpents. The rostrum tends to be better developed in males. When the reys locate a suitable upwelling, they skim the periphery, filtering manna microbes from the air.

The fourth and final quad commences after feeding, as the reys seek out a current that will lift them into a water storm. Reys are adept at gauging the relative potentials of competing flows, and at judging the strength of a coming storm. Generally, the deeper they penetrate into the heart of a major plume, the more powerful the currents. Over the next ten yads, the reys ride the most promising winds upward, into the strong updrafts of a storm, and on to the hallowed summit of their passage.

Appendix D

The Octos

The species *Octu manipulans*, commonly known as the *octo* (adjective form *octan*), is the most cognitively advanced member of the Jopian genus *Octu* (adjective form *octun*). Octos founded the space-faring Jopian civilization, which has roots dating back over 80 kilujopes (nearly half a million Earth years). Though there have been extensive modifications to the original octan genome, and many subspecies and biological-synthetic hybrids have been developed, the basic genetic template has been preserved to this yad. Most modern octos are born and raised in a (semi-) traditional manner, then undergo bioengineered modifications later in life.

Octos are social herbivores, evolved from creatures at home in the bush thickets floating 512 kilurets deep in the Jopian atmosphere (the octos originally *defined* the kiluret so that this depth was numerically equal to 1,000 in the base-8 counting system). In their long history, octos have rarely hunted or preyed on other animals; they are by temperament manipulators, not predators. Diminutive octin precursors fashioned simple nests in the thickets from the plentiful leaves. The earliest octun ancestors learned to cultivate and modify the plants to form protective burrows. They later selectively bred bush species with greater bulk, as well as more buoyant hydrogen bladders to support the additional weight. This in turn allowed octos to evolve larger bodies, and to create progressively more sophisticated living structures. In ancient times, after an octo died, the body was ceremoniously cut into small pieces, and fed to the home thicket. Critical nutrients were thereby returned to the plants. Remarkably, the practice continues today among many clans, though it is no longer necessary, since supplements are readily manufactured from off-world sources.

The octo name derives from the creature's eight appendages. An adult octo superficially resembles an Earth octopus. It has a squat cylindrical trunk about two-thirds ret across and one-third ret tall, topped by a bulbous head of matching width and height. The head can twist some 45 degrees in either direction. Three thick, suckered tentacle-legs, each nearly one ret long, extend radially from the trunk base. Two are located on either side in "front," and one in the rear, to help stabilize the trunk in an upright position. They are strong, and also used for locomotion and heavy labor. Behind each front leg is a pair of slender, suckered tentacle-arms, roughly one and one-half rets long. The forward arm on either side divides at the end into three finger-like tendrils. All four arms are agile, and employed mainly for manipulating objects. A single willowy tentacle-arm about one ret long is located between the two front legs. This arm divides at the end into two finger-like tendrils, is remarkably dexterous, and used for fine work. A small mouth with a chisel-like beak, adapted to eating plants, is centered between the tentacles on the body underside, while an anal opening sits just above the rear leg. A pair of breathing slits occupies the front of the mid-trunk area.

Unlike the octopus, the octo has a (limited) internal skeleton, composed of both cartilage-like and spongy bonelike material. A flexible but supportive central spine extends from the head down through the trunk. There it trifurcates into a weight-bearing, semi-rigid tripod, oriented with one leg in the forward direction. The tripod connects to a supporting bony ring, about one-half ret wide, at the trunk base. The upper body is held upright against Jopitar's relentless gravity by muscles attached to the various bony structures. The three tentacle-legs are anchored to the basal bony ring.

Two optical eyes are set on either side of a "face," on the forward surface of the head. These eyes are sensitive to a band of infrared frequencies, covering the range of common thermal emissions at the depth of the floating thickets. Infrared vision is dichromatic; octos perceive two infrared colors. Eye parallax provides a sense of depth.

Octos also have a pair of large acoustic eyes, located on either side of the face just below the infrared eyes. Each eye is covered by an array of sonoreceptors sensitive to both the amplitude and the phase of incident sound at select frequencies. These frequencies encompass three primary acoustic "colors," spanning the frequency range from about 500 to 5,000 kiluhartz (or 250 to 2,500 kilohertz).

The acoustic eyes can operate in either of two modes. In *passive* (or *continuous-wave*) mode, the eyes simply detect high-frequency sound arriving from the environment. Ever since they emerged as a technology-driven species, the octos have utilized ultrasonic illuminators to facilitate this mode of vision. Images are reconstructed by the octo nervous system based on the incident pattern of sound amplitude and phase within each color band. Phase-based imaging and eye parallax both contribute to a sense of depth.

In *active* (or *pulse*) imaging mode, short bursts of high frequency sound are emitted from a *bellan* – a special organ centered on the lower face, but connected to the respiratory system in the trunk. Echoes received by the eyes are interpreted visually. Autonomic timing of pulse reflections offer a complementary perception of depth that is more precise than that in continuous-wave mode, though the field of view is narrower.

At the outer edges of the acoustic eyes, on opposite sides of the head, is a pair of ear-like receptors sensitive to sound intensity and pitch over a broad low-frequency band, extending from a few hartz to several kiluhartz. These organs give octos a sense of hearing. Aural wavelengths are too long for vision; such sound is heard, rather than seen. In addition to ultrasound, the bellan can produce modulated audible sound. This allowed archaic octos to communicate using sound, and later to develop speech. Octo hearing is less tuned than that of reys. Finer tuning offered no advantage to octo ancestors, so it did not evolve.

Because there is no natural day-night cycle at the depth of the floating thickets, the octos did not develop an innate regular sleep pattern. They nonetheless do require rest and sleep, to restore various body and mental functions. Octos tend to sleep most of the time when food is scarce. When food is plentiful, they sleep or rest roughly one-third of the time, at irregular intervals. Since the introduction of timekeeping, rest periods have become loosely tied to a routine yad-based cycle of activity.

There are three octan sexes/genders: male, female and neutor (gender-specific pronouns zo/zom/zor/zors). The male octo has a tentacular external reproductive organ. It is slender and lithe, nearly one-half ret long, and normally coiled in a small pouch just above the forward tentacle-arm. During reproduction, the male inserts the tip of this organ into an egg-bearing gestation sack in the same location on a female, and deposits gametic cells. Following fertilization, a single embryo develops in this sack for about one thom. At that time the still-tiny infant, less than a centuret in size, crawls into an adjacent external pouch, where the mother nurses and cares for it. The young octo normally stays in the pouch for an additional eight thoms, before it begins venturing out for short periods of time. Traditionally, females birth and care for infants, while males protect vulnerable females and infants. Males may also help support and acculturate the young. Neutors are incapable of reproduction, and historically performed much of the manual and skilled labor for their immediate social group.

Octos traditionally live in social units known as *hives*. A hive can also refer to the physical structure within which a group lives. Historically, this comprised an autonomous thicket, which had been modified into a tangle of tunnels, rooms and halls. The foundation plants have been bred over time for desirable properties, and synthetic components added. Early hives relied exclusively on the hydrogen bladders of the thicket plants for buoyancy.

Hives were originally patriarchal; male ancestry defined hive identity. A member was identified by a unique given name, plus a surname reflecting the hive's founding father(s). Gender and gender roles tended to be rigidly defined. These customs were meaningful in ancient times, when movement between hives was limited, and predictability was important for survival. Octos barely retain any ability to "swim," and generally dislike leaving the security of a hive. Only when thickets happen to pass near each other is an unassisted crossing even feasible. Genetic data suggests that females were mainly responsible for the meager traffic between primeval hives. Females still tend to be less fearful of open spaces than males and neutors.

The earliest hives were quite independent and self-sufficient. Octos are communal by nature, so most property was collectively held; private ownership was mainly limited to personal effects and living quarters. Because metals and other inorganic materials were extremely rare at their depth in the Jopian atmosphere, almost all octan-crafted objects were plant- or animal-based.

The invention of floating ships by anonymous octos in the clouded past changed octan life forever. The earliest vessels were probably held aloft using the buoyant hydrogen bladders of isolated plants, but eventually heated synthetic hydrogen balloons were developed. Transports soon passed from hive to hive. As octos became more mobile, hives gradually became less patriarchal, gender roles less rigid, and gender fluidity more acceptable. Octan history through this transition was nonetheless marked by pervasive discrimination against neutors and (to a lesser extent) females, and by the struggles of these groups to attain social and political equality. In the modern era, many well-known scientists and engineers are neutors. An individual octo is identified by a special given name and distinguishing number, plus a surname representing the birth hive, usually with no reference to male ancestry. Males, females and neutors are equally likely to travel between hives, normally in the comfort of a snug powered vehicle.

As early technology developed and travel between hives became more common, many hives specialized. Some banded together to form agricultural hubs, while others turned to manufacturing specialized items, or became education or administrative centers. Markets based on exchange credits gradually replaced bartering networks, and regional governments were born. The original purpose of these trans-hive associations was primarily to facilitate and regulate commerce, but ancillary functions were added over time. The governments generally supported themselves by imposing a small tax on individual transactions.

Octo population density and material culture were severely restricted during this period by the limited capacity of the thicket hydrogen bladders to carry extra weight. Technological innovation consequently tended to emphasize the development of strong, ultralight materials. Electricity was discovered, and harnessed using remarkable low-density silico-organic conductors, semiconductors and insulators. Wireless systems soon enabled direct communication between distant hives. But the invention of electronic devices only fueled the octo appetite for more material goods and lift capacity.

The weight ceiling was finally breached some 75 kilujopes ago, when scientists learned how to manipulate the zero-point energy of the vacuum. It then became possible to generate and control a localized pocket of (pseudo-)negative energy, commonly known as a *Drac bubble*. By coupling a Drac bubble to an ordinary object, the effective combined mass could be made arbitrarily small (but not negative; it is readily shown that the net mass of an isolated object must be positive). Using Drac generators, the structures and population supported by a hive's buoyant hydrogen bladders could be greatly expanded.

Harnessing Drac bubbles was not easy, however. When a bubble is created or destroyed, mass must be shed or accrued. While it is theoretically possible to direct most of the associated energy flow through sequestered channels tied directly to the global vacuum, the process is tricky, and the quantity of transferred energy can be enormous. Energy may spill from overloaded vacuum channels, with catastrophic consequences. Even when the energy is successfully channeled, the surplus or deficit in the surrounding vacuum must flow outward or inward at the speed of light, and is not diluted instantaneously. A small portion of the energy is inevitably expressed through gravitational waves, which temporarily distort local gravity. These vacuum energy fluctuations and gravity distortions can damage physical structures. Exposure of organic creatures to threshold levels can produce medical syndromes analogous to radiation sickness. The historical record alludes to several disasters, in which entire hives were accidentally destroyed by the new Drac technology. Most modern Drac generators are designed to limit energy flow rates, in order to minimize local disruptions, and avoid energy spillover/rebound phenomena.

As society grew more complex, small groups of octos became frustrated with the inefficiencies of communal ownership, and began forming private businesses. These firms gradually acquired their own assets, and competed with the collectives. This rivalry motivated many collectives and private enterprises to form strategic alliances. Eventually the planet became divided into a patchwork of nation-states. Although competition among the states could be fierce, most disputes were settled through diplomacy. Octos are inherently inimical to physical violence, so overt warfare was extremely rare.

In ancient times, most octos felt it important to communally provide for the basic welfare of all members of a hive. This evolved into a general sense that all members of a society should be ensured a basic level of food, shelter, and medical care. Such support was typically sustained through additional taxation. Ultimately a more general notion emerged – that all citizens should *by law* be granted equal rights and opportunities.

Drac technology eventually opened the door to space travel. By integrating a Drac generator into a transport vessel, the bulk of the vessel's effective mass could be reduced to trivial values. Buoyancy could then be controlled, providing lift to the top of the atmosphere. From there, small ion drives could rapidly accelerate a low-inertia ship to high speeds, into interplanetary space. An era of suolar system exploration ensued. Most heavy manufacturing was automated and moved off-planet, to sites on nearby moons and other solid bodies. Here metals and a wealth of other new raw materials were readily available, spawning a revolution in materials technology. Nation states merged, and an integrated political and economic system evolved.

Automation brought a radical reordering of society. In time, machines performed most hard labor. Advances in computer and bionic engineering wrought even more dramatic change. Sentient *creatoids* were developed, and replaced most non-sentient machinery. Transfer of octo consciousness into synthetic brains and bodies was perfected, leading to a whole new class of synthetic individuals, or *synons*. For a variety of political and psychological reasons, the creation of totally new sapient consciousness was forbidden; synon awareness could only be fashioned from extant organic templates. Many synon candidates opted for synthetic bodies analogous to their original organic forms. Octo-like synons became known as *synocts*, while synons with spacecraft bodies were called *metons*. All synons were eventually granted full rights as sapient beings.

About 72 kilujopes ago, the *Xam propulsion drive* was developed. This drive pushes against the vacuum itself – the very fabric of spacetime, as it couples to massive objects such as stars – and so obviates the need for propellant. The Xam drive, coupled with a new matter-energy conversion process, allowed for much higher maximum spacecraft speeds, from 0.1% up to 10% that of light. This opened the current epoch of interstellar travel.

Jopitar is currently divided into several jurisdictions, overseen by a global Planetary Council. Each jurisdiction has a regional government responsible for regulating commerce, and for ensuring legal rights, security, transportation, education, and the general welfare of its citizens. Every citizen is issued a thomly allowance, including both vouchers and general financial credits. The vouchers are sufficient to secure basic food, shelter, and healthcare; they are issued to all persons, wealthy and poor alike, with no stigma attached. Vouchers are non-transferrable, and earmarked for specific purposes. The use of ordinary credits is less restricted. The thomly stipend is determined by a person's situation and special needs. For example, a qualifying student may be granted an amount covering tuition and extra expenses associated with an approved educational program.

Most vouchers and credits are held and transferred electronically, through a global computer network; there is very little hard currency. Goods and services may be purchased from a variety of private and public businesses and institutions. All but the smallest commercial enterprises are licensed by the central government for a fee. A tax is applied to every transaction, in order to balance (long-term) state expenditures and revenues.

Because vouchers provide for only the most basic food and shelter, most octos are motivated to seek additional income. Individuals may earn extra credits, by contracting to provide services either to licensed companies, or (to a limited extent) directly to other individuals. A person may also establish a private licensed business. All economic activities must respect a set of universal personal rights. These derive from long-standing octan ethical standards, similar to those outlined by the ancient philosopher Fleegello in his *Principles of Philosophy* (see Appendix E, Part III).

Jopians practice a blended form of representative and direct democracy. Terms of elective positions are staggered, and generally of one jope duration. Each calendar jope is divided into eight voting periods, with one eighth of all elective offices and any number of referenda decided during each. Every eligible citizen is assigned an interactive ballot at a central electronic voter registry, accessible via the global computer network. The virtual ballot includes a list of current elective positions, as well as referendum proposals and options. Only choices for which the citizen is authorized to vote are presented, based on relevant objective criteria such as residency, training, and experience. Qualifications to vote for general representatives include only basic education and mental health requirements.

A voter can designate up to eight candidates, in order of personal preference, for each elective position, and must specify the order of preference for each set of referendum options. Voters may register or modify preferences at any time throughout a voting period. Results are continually tallied, updated and posted, obviating the need for special primaries or polls. Political parties sponsor candidates, largely based on evolving voter sentiments. Choices become official only at the end of the final yad of a voting period.

In order to encourage voters to express their true political sentiments, and to ensure government representative of a majority of the citizenry, a ranked vote counting procedure (*instant-runoff*) is employed. Candidates appearing on fewer than 50% of all preference lists for a given office are first eliminated; these contenders have no chance to win. The top-ranked candidates and referenda options on the modified preference lists are then tallied. If no individual or position garners an absolute majority for a given office or referendum, the selection receiving the lowest numerical tally is removed from all lists, and the vote recounted using the modified rankings. This iterative procedure is repeated until a single candidate or option acquires more than 50% of the updated tally. No voter is disenfranchised. If all candidates on a voter's list for a given office are eliminated, the voter still contributes one vote to a so-called null candidate. If the null candidate accumulates more than 50% of the total, a reelection is called, though this is extremely rare.

Individual participation in society is strictly voluntary. A person can choose to withhold support from selected governmental programs. Relevant privileges must then be relinquished. Yet it is very difficult for an individual living in mainstream society to avoid broadly supporting the global and regional governments. These governments issue the legal credits used in the mainstream economy, and impose a non-specific tax on every transaction as a condition for engaging in that system. These tax revenues generally support not only the financial system, but most other government programs as well. Citizens can apply for dissident status, and receive appropriate partial refunds for taxes paid, but this procedure is quite onerous in practice. Dissidents consequently tend to congregate in isolated communities, scattered across the planet, committed to alternative forms of governance.

Appendix D – Commentary and References

Clarifying non-fictional commentary and references concerning octan technology

The octan propulsion system employing *Drac bubbles* is a type of *inertialess drive*, in that it can reduce the inertial mass of a craft to an arbitrarily low value. Inertialess drives have a long history in science fiction. As early as 1928, Edward Smith introduced such a drive (which somehow allowed faster-than-light travel) in *The Skylark of Space*.[1] These drives have since been employed by a variety of writers, including Robert Heinlein (the light-pressure drive invented by "Slipstick" Libby in *Methuselah's Children*[2]), Larry Niven (used by the Puppeteers to move their home planet further from its sun in *Ringworld*[3]), Orson Scott Card (enabling Ender Wiggin to travel vast distances near light speed, aging only a few decades while 3,000 years passed on Earth, in *Speaker for the Dead*[4]), and Alastair Reynolds (used for propelling a huge alien craft in *Pushing Ice*[5]).

From a physics standpoint, it is not yet clear whether an inertialess drive is in fact possible. Investigators have proposed interpretations of inertia by which such a drive might be realized. For example, Bernard Haisch and Alfonso Rueda have developed a (highly speculative) theory,[6] based on the controversial *stochastic electrodynamics*[7,8] (a variant of classical electrodynamics), that the lowest energy state of the vacuum, as predicted by quantum mechanics, might provide a physical explanation for the origin of inertia.

Reactionless drives (thrusters not dependent on the expulsion of reactive mass) analogous to the Xam drive are also well established in science fiction. Many authors were apparently inspired by the Dean Drive, first patented by Norman Dean in 1959, and popularized by editor John Campbell in the *Astounding Science Fiction* (later the *Analog Science Fiction / Science Fact*) magazine.[9] Unfortunately, this drive (and a host of similar devices based on asymmetric mechanical motions) did not actually work.

Writers nonetheless continue to exploit reactionless drives, including Larry Niven (used by the Outsiders in *A Gift from Earth*,[10] and throughout the *Known Space* series), Isaac Asimov (the thruster pushes off matter in a parallel universe, thereby conserving momentum, in *The Gods Themselves*[11]), Arthur C. Clarke (discovered by humans on an alien starship in *Rendezvous with Rama*[12]), and Stephen Baxter (the Xeelee displacement drive pushes against spacetime itself, in books of the *Xeelee Sequence*[13]).

Any purported reactionless drive based on strictly classical concepts must violate Newton's third law – "for every action, there is an equal and opposite reaction" – and fail to conserve classical momentum. A true reactionless drive must then rely on nonclassical constructs. Various researchers have investigated this possibility. The Xam drive may be most closely related to a proposed *quantum vacuum plasma thruster*, or Q-thruster, which pushes against *virtual particles* in the vacuum. Harold Puthoff et al. have published a brief overview of (speculative) potential ways to manipulate the vacuum for space flight,[14] though many mainstream scientists consider this research to be pseudoscientific.[15]

Note that an effective Q-thruster cannot first make virtual vacuum particles real, then use conventional means to accelerate them. This would require carrying extra mass with a mass-energy equivalent to that of all created particles, and defeat the purpose of the drive. A useful Q-thruster must instead push against the equivalent mass of the vacuum itself.

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1. Edward E. Smith, "The Skylark of Space," parts 1–3, *Amazing Stories*, Aug–Oct, 1928.

2. Robert Heinlein, *Methuselah's Children* (Hicksville, NY: Gnome, 1958).

3. Larry Niven, *Ringworld* (New York: Ballantine Books, 1970).

4. Orson Scott Card, *Speaker for the Dead* (New York: Tor Books, 1986).

5. Alastair Reynolds, *Pushing Ice* (London: Gollancz, 2005).

6. Marcus Chown, "Mass Medium," *New Scientist* 169, no. 2276 (2001): 22–25.

7. Luis de la Peña and A. M. Cetto, *The Quantum Dice: An Introduction to Stochastic Electrodynamics* (Dordrecht: Kluwer, 1996).

8. Luis de la Peña, Ana María Cetto, and Andrea Valdés-Hernández, *The Emerging Quantum: The Physics Behind Quantum Mechanics* (Cham: Springer, 2015).

9. John W. Campbell, "Report on the Dean Drive," *Analog Science Fiction / Science Fact* 66, no. 1 (1960): 4–7.

10. Larry Niven, *A Gift from Earth* (New York: Ballantine Books, 1968).

11. Isaac Asimov, *The Gods Themselves* (Garden City, NY: Doubleday, 1972).

12. Arthur C. Clarke, *Rendezvous with Rama* (London: Gollancz, 1973).

13. "Xeelee," *Spacebattles Wiki*, accessed November, 2014, http://www.spacebattles.wikia.com/wiki/Xeelee.

14. H. E. Puthoff, S. R. Little, and M. Ibison, "Engineering the Zero-Point Field and Polarizable Vacuum For Interstellar Flight," *Journal of the British Interplanetary Society* 55 (2002): 137–144.

15. Massimo Pigliucci, *Nonsense on Stilts: How to Tell Science from Bunk* (Chicago: Univ. of Chicago Press, 2010), 90.

Appendix E

Octan Philosophy

The following document is an abridged account of the major dissertation, commonly known as *Principles of Philosophy*, of the enigmatic ancient philosopher Fleegello. Whether Fleegello was in fact a person, or merely a collective label for a particular philosophic school, is still hotly debated, but the weight of evidence now seems to favor the former view.

Assuming Fleegello was a single individual, scholars believe that he continually revised the *Principles* throughout his adult life. The last known version is printed here. It includes notable changes to Fleegello's earlier thoughts about multi-time quantum theory (see section 2.3). There is evidence that Fleegello was trained as a physicist (known as a *natural philosopher* at the time), but was insecure in that role, and instead considered himself primarily an amateur general philosopher. While he helped clarify the meaning of the multi-time wavefunction, he failed to derive associated equations of motion.

The updated text also incorporates changes in the use of personal pronouns, probably to make the content more overtly inclusive. In particular, Fleegello chose to adopt explicitly gender-neutal pronouns equivalent to the modern xe/xem/xyr/xyrs when referring to individuals of unspecified or ambiguous gender. He continued to use gender-specific pronouns when gender identification was clear, and it/it/its/its when gender was lacking or deemed irrelevant.

The editors would like to acknowledge the numerous individuals and groups that have contributed to the Otkin-Utalk Project, in its efforts to reconstruct the threads of our octan philosophical/religious heritage during the Early Machine Age. In particular, we thank our colleagues at the Institute of Ancient History (IAH) for releasing a wealth of critical original documents only recently recovered from deep ice storage vaults at archeological dig site #13 on Jopian Moon-3. The current work draws heavily on this new IAH material.

Editorial comments and discussions are scattered liberally throughout the text. These are enclosed in brackets to distinguish them from the primary content. The reader is cautioned that much of the original material is still fragmentary and incomplete, and subject to serious translation and interpretation errors. To access the unabridged version of this work, please refer to library path PHL/HST/MCH/ERL/FLEE/KN0.

Principia Philosophae

(Abridged Version)

Fleegello, Jope Zuul +353?

Part I – Basic Principles

1.1) Experience appears to consist of a sequence of sensation fields.

[Fleegello thought it imperative initially to reconsider what he did and did not know about the world, to ascertain what information was actually inherent in his personal experience. He thus adopted an introspective method, wherein the existence of other selves and external realities was not presupposed. He uses the word *sensation* here in a broad sense that does not imply the existence of sense organs.]

1.2) Some entities in a sensation field are distinguishable from others –
e.g., a sphere from a pyramid. Let *content* refer to the general attribute that differentiates among distinct entities in a given field. Two contents are by definition equivalent if they are indistinguishable.

[Fleegello asserted elsewhere that any given content can be represented by an arbitrary symbol, or term. A term is defined when it is identified with a particular pattern of content. All the symbols employed by the self may be defined with respect to a complete set of content, the selection of which is arbitrary to some extent. An element of this set is characterized as *fundamental* if it cannot be equated to a superposition of the other elements. The symbolic representation of a fundamental content is referred to as a fundamental symbol or term, and a definition with respect to fundamental quantities as a fundamental definition.

A fundamental term cannot be fundamentally defined through a purely symbolic process. The terms used at the beginning of this or any symbolic exposition must stand fundamentally undefined, in and by themselves. Symbolic definition of the fundamental terms adopted by the self for personal use is, however, both unnecessary and irrelevant. That a given symbol is (somehow) unambiguously associated with a particular experience is sufficient for personally meaningful symbolic representation.]

1.3) Experience is not constant or static, but consists of an ever-changing dynamic sequence of sensate patterns. A particular content may be within the sensation field one moment, and absent the next. A general attribute other than content can thus be associated with entities. Let *existence* or *being* refer to the attribute whereby a content is actually present within a sensation field. There is *awareness* of content that exists within a field.

The (apparently) unidirectional dimension along which the sensation field changes will be referred to as a temporal dimension, or time.

[The term *dimension* may be defined as any abstract measure of extent. Events at different points along a temporal or time-like dimension may be causally connected. Events at different points along a spatial or space-like dimension at a given temporal moment cannot be causally connected. The typical octan sensation field is to a large extent physical in form, i.e. characterized by a temporal sequence of spatial patterns.]

1.4) A symbolic notation may be introduced to represent experience.

Let $\in(t)$ indicate a state of existence within a sensation field at time t,

$\notin(t)$ indicate a lack of existence, and

enclosure by brackets < > designate associated content.

Awareness of a content X at time t is then represented by

$$\in(t) <X> ,$$

while non-awareness of X is represented by

$$\notin(t) <X> .$$

The explicit reference to time may be omitted when appropriate.

[Neither $\in$ nor $\notin$ are intended to necessarily predicate all content that is either present in or absent from a sensation field at a given time. The symbol $\in$ may be applied to any component or subset of the field, while $\notin$ may be applied to any discrete missing content.

Additionally, neither $\in<X>$ nor $\notin<X>$ should be interpreted as logical statements that are true or false. $\in<X>$ is simply a symbolic representation of a particular experience – the attribute existence overlaid on a content X – while $\notin<X>$ is a representation of the corresponding non-experience.]

The introduction or superposition of content Y into a field $<X>$ may be designated by a mathematical plus sign:

$$\in\{ <X> + <Y> \} .$$

Similarly, removal or subtraction of content Y from $<X>$ may be designated by a minus sign:

$$\in\{ <X> - <Y> \} .$$

The term $\neg<Y>$ is to be distinguished from $<-Y>$,
the concept of the removal of Y and not the removal itself.

Similarly, the field $<X>+<Y>$ is distinguished from $<X+Y>$, the concept of the simultaneous existence of X and Y, not the simultaneous existence per se.

There are innumerable levels on which an arbitrary content X can be incorporated into a sensation field. It may have direct existence, in and by itself:

$$\in<X> .$$

X then has primary, or first-order existence. If instead it is only the concept of the existence of X that occurs, then X has second-order existence:

$$\in< \in<X> > .$$

The memory at time t of a content X that had primary existence at an earlier time t' can be represented as a second-order existence:

$$\in(t)< \in(t')<X> > .$$

Ever higher orders of internal existence can be imagined.

1.5) A thing is defined to be *meaningful* if it incorporates content in a nontrivial manner;
it is otherwise *meaningless*.

A meaningless object may in general be represented by the trivial form $< >$. This can be related to an arbitrary content field $<X>$ by

$$< > \; = \; <X> - <X> .$$

Any object that cannot be distinguished from the object $< >$ is itself meaningless. A thing is then meaningless if it cannot be distinguished from its own content-subtracted form.

The lack of awareness (non-experience) of an arbitrary content X is indistinguishable from both the awareness and the lack of awareness of a meaningless content:

$$\notin<X> \; = \; \in< > \; = \; \notin< > .$$

Beingless content is thus meaningless, in the same sense that contentless being is meaningless. An arbitrary form $<X>$ is meaningful only if its existence is tacitly understood.

[Fleegello was here referring to meaningfulness with respect to the self. Recall that $\notin<X>$ should be interpreted as a symbolic representation of a non-experience, not as a logical assertion that X is absent from a sensation field. Misinterpretation of both $\in<X>$ and $\notin<X>$

as logical assertions caused considerable confusion during Fleegello's era. In particular, $\notin <X>$ as a logical assertion does not imply $\in < \ >$, but is consistent with $\in <Y>$ for any meaningful $Y \neq X$.]

Although the sensation $\in < \ >$ is meaningless, the concept of the meaningless is itself meaningful. The concept may be experienced by nontrivial sensations of the form

$$\in << X > - < X >>, \ \in <<>>, \text{ and } \in < \in <>>,$$

where X is arbitrary. These expressions are to be distinguished from

$$\in \{ < X > - < X > \}.$$

Whereas the former represent the experience of the concept of a content minus itself, the latter represents the experience of a content minus the very same experience, or no experience at all.

The meaningless should not be confused with the self-contradictory – e.g., the content

$$< X \neq X >,$$

or the concept that a thing is not equal to itself. Such content will be referred to as inconsistent or contradictory, in distinction to consistent content.

1.6) Define the *self* as the immediate, personal sensation field.

[Contrast this with common usage, whereby the self is a *thing* that experiences the immediate sensation field. Fleegello found this idiom unfounded and misleading (although he often followed it for convenience). A "thing" self is not directly experienced, and therefore only vaguely defined, yet it is supposed to harbor content and somehow bring it into a state of being. The adopted definition instead identifies self as experience per se, the unity of two directly perceived qualities – content and being.

Fleegello also rejected the definition whereby the self is simply the immediate state of awareness. In this case the self is not directly tied to any content field. Unless the self does incorporate nontrivial content, however, it is indistinguishable from nothing at all.]

1.7) By combining the notion of independence with those of content and being, it is possible to construct a more general concept of self. A general self, or individual, is here defined as *any* sequence of content characterized by a single, independent state of being, which need not encompass one's own self. Consciousness per se is defined as an unspecified state of awareness of arbitrary content.

A self so defined *is* the awareness of a content field. The field is unified at any instant, in that every element shares the same awareness. It is also unified in time (is temporally continuous), since the sequential sensations are assumed to share one common line of awareness. A self is then any continuous flow of unified consciousness from one content field to another.

So long as a self retains a unique awareness, it can advance along no more than one independent temporal dimension. If there were $N>1$ temporal dimensions, the sensation field would split into N distinct sequential fields, and the original self into N distinct selves.

1.8) A general existence or state of being, corresponding to the generalized concept of self, is now defined as a state of being relative to any individual, not necessarily one's own self. This definition may be extended to include a state wherein a thing is only potentially capable of independently becoming or producing a sensation in some individual. Existence relative to a particular self S will henceforth be represented by the subscripted symbol $\in_S$, and general existence by the unsubscripted symbol $\in$.

1.9) The term *meaningless* is now generalized to indicate a (potential and actual) lack of nontrivial content relative to all selves. If a thing is not meaningless, it must be meaningful.

[The terms *meaningful* and *meaningless* were previously defined only relative to one's own self. A thing could then be meaningful to one individual, but meaningless to another.]

Beingless content is meaningless in the new generalized orientation, just as it was in the previous self-centered one. Without a general state of being, a content is neither in any individual's sensation field, nor does it potentially affect any field. The content then has no significance, whence

$$\notin<X> \;=\; \in<\,>\,.$$

Where there is meaningful content, there must also be state of being. Yet content and being are clearly not equivalent. The same content can be imagined in a state of being relative to distinct individuals. Since these situations are distinguishable –

$$\in_a<X> \;\neq\; \in_b<X> \quad \text{if } a \neq b \quad –$$

then state of being must represent a nontrivial quality distinct from content.

1.10) Define a *foundation world* to be the ultimate source of a given person's sensation field. The self's foundation world appears to be largely external, and inhabited by a myriad of beings. This may be an illusion; the self's field could in principle be its own foundation world, yet generate the appearance of an outside world and distinct selves. Even if there are no conscious individuals other than one's own self, the concept of such individuals exists.

1.11) Define *communication* as a sharing or transfer of experience among two or more distinct individuals. Sensations may be passed either indirectly or directly, with or without the aid of an intermediary. Transfer of ideas via an external physical medium – e.g., light rays from a photograph – represents one type of indirect communication. The transfer may further be symbolic – e.g., the spoken or the written word.

Effective direct communication does not require that participants share common prior experience, since it is experience itself that is transferred. In contrast, symbols can elicit only previously experienced and assigned sensations. Accurate symbolic communication thus presupposes common experience. Individuals who communicate symbolically must inhabit a world in which they can experience similar sensations and evolve a common vocabulary.

1.12) Any simple assertion [proposition] can be judged to be true, false, ambiguous, or contra. [It may still be impossible to prove or to know with *certainty* the veracity of any statement].

An assertion is *true* if it is both internally [self-referentially] and externally [with respect to external references] consistent and unambiguous [within a given context].
Example: Suol is a star.

An assertion is *false* if it is internally self-consistent, but externally inconsistent.
Example: Suol is a planet.

An assertion is *ambiguous* if it is internally self-consistent, but cannot be judged true or false because its interpretation with respect to external references is equivocal.
Examples: That object is a star. (What object?)

Bush worms taste delicious. (In general, or only to certain individuals?)

Killing is wrong. (In general, or only in particular situations?)

[This designation applies in particular to subjective assertions that do not specify a subject, and to moral assertions that do not sufficiently specify a situational context. Ambiguous statements can generally be made true or false by adding clarifying references; e.g., "Bush worms currently taste delicious to me." Such references may be implicit and unnecessary, if an assertion is part of a larger dialogue or discussion.

Subjective assertions are generally considered to be expressions of opinion, belief, or personal preference. In Fleegello's time, a sharp distinction was commonly drawn between subjective and factual statements; only factual statements could be objectively true or false. Fleegello argued that every self-consistent subjective statement was true, false, or ambiguous. Even if it is not possible to determine the objective truth of someone's claim to a personal experience, that person in fact is either lying or telling the truth. Fleegello also considered unambiguous moral assertions such as "abortion is always wrong at any point following conception" to be objectively true or false, although untangling whether they are compatible with consistency logic can be problematic, and plagued by uncertainty.]

An assertion is *contra* if it is internally inconsistent, such that it logically appears to be both true and false, neither true nor false, or any other untenable combination of true, false, not true, and not false.

Examples: This statement is false. This statement is not true. This statement is contra.

Just as $X = -X$ implies $X = 0$ if X is a number, so any contra assertion must be devoid of consistent meaning (though not completely meaningless); only then could it be simultaneously true and false, neither true nor false, etc.

[Fleegello helped to clarify the intimate relationship between truth and consistency, noting in particular the distinction between self-referential (internal consistency) and extra-referential (external consistency) aspects of assertions. Prior to Fleegello, every unambiguous, non-subjective assertion was considered to be either true or false. If such a statement was not true, it was considered necessarily false; and if not false, then necessarily true. This inevitably led to profound paradox.]

1.13) A thing is *right* if it is consistent with conceptions of what should be, what is good, what is desirable or preferred. Any judgment of rightness is dependent upon a set of presumptions regarding right and wrong – a *rightness logic*. There is otherwise no basis for decision. Absolute judgment, independent of any rightness logic, is impossible. Rightness can only be relative (to a rightness logic); it cannot be absolute. The content of these very statements presumes certain rightness patterns.

An array of distinct rightness logics can be conceived. Some are very limited in scope.

Example: It is right to chase wormflies.

Others comprise broad, comprehensive principles.

Example: It is right to deny experience.

A fundamental logic that relates to *all* meaningful things will be referred to as a *general* (rightness) logic. Any less inclusive logical pattern will be designated a *restricted* logic.

The domain of a restricted logic is limited by definition. A given judgment may require the use of multiple restricted logics, in contrast to a single general logic. The domains of different restricted logics may overlap. If an individual is to behave in a self-consistent manner, xyr restricted logics must be compatible, and representative of some general logic.

No rightness logic is a priori superior to any other. The initial acquisition by a pre-existing individual of a rightness logic relevant to a particular class of activities must be an alogical event, relative to that individual. Once a logic has been adopted, however, a person can reflect back upon the rightness of xyr original choice, and judge the rightness of other logics.

[Fleegello originally chose to define truth in an absolute manner, to stress its relationship with consistency; but rightness in a relative way, to emphasize its inevitable connection with personal choice. Rightness is thus intimately related to will. Of course, individuals who accept distinct rightness logics may develop radically different views of truth. For example, someone who believes it is right to contradict experience may judge true the statement "one equals two," even while defining all terms in a standard way. Today it is customary for the unqualified terms *truth* and *rightness* to refer implicitly to consistency logic. The terms are explicitly qualified – e.g., "truth according to Balzorp" – if they refer to any other logic or personal perspective.]

1.14) The general rightness logic embraced in this text is an affirmation of consistency.
This rightness pattern may be expressed in a variety of alternative but equivalent ways:

- It is good (right) to be consistent.
- Whatever is, is.
- $X = X$, where X is arbitrary.

It is thus right to act in accordance with what is, to acknowledge and not contradict what is. This ideal logic will be called *consistency logic*.

[This line of reasoning led to considerable confusion in Fleegello's time. In various Aestern schools, it was common for philosophers to make assertions such as "A cloud is not a cloud." They were not thereby encouraging their followers to be inconsistent, but rather to recognize the ambiguities in ordinary language, in which one word may simultaneously have many different meanings, or encompass a broad class of distinct objects (as with *cloud*).

A more precise, non-contradictory assertion regarding clouds would be "The cloud to the east is not identical to the cloud to the west," or "A stratus cloud is not a cirrus cloud." Fleegello was applying a precise logical language in the statement "$X = X$," in which "X" represents an arbitrary, but unambiguous, entity.

Other philosophers considered the statement "$X = X$" to be a mere tautology; that to assert "$X \neq X$" is equivalent to redefining the symbol "$\neq$" to mean what is usually attached to the symbol "=." Yet Fleegello contended that adhering to definitions in a consistent manner is a moral *choice*; that it is possible to alternatively embrace the pattern "$X \neq X$" where "$\neq$" is defined in the traditional way.]

The rightness of consistency logic is not a priori obvious, but is presumed. Any "proof" that consistency logic is right must employ reasoning predicated on an assumption that it is right.

[Consistency logic assumes a less austere, more familiar form when applied to specific types of activity. Scientific logic – the set of principles constituting the scientific method and practiced in contemporary science – can be identified as a restricted version of consistency logic specific to the learning process. Scientific logic maintains that things should be seen just as they appear; unpleasant or unexpected realities should not be denied, and meanings assigned to symbols should be consistently followed. Knowledge of reality should be developed and tested by objective observation, experimentation, and reasoning, and not by idle decree or speculation.

Consistency logic can similarly be applied to ethical matters: a person should respond to and interact with things in a congruous, appropriate manner, i.e. in a way that denies neither the (perceived) fundamental natures of the things, nor the given situational context. For example, a person who believes a number of things are intrinsically equivalent, but acts as if some were special relative to the others, violates consistency logic.]

It is possible to conceive the existence of an inconsistent content $<X \neq X>$ without violating consistency logic. The associated self-consistent sensation is

$\in<<X \neq X>>$ or $\in<\in<X \neq X>>$, and not

$\in<X \neq X>$,

which *would* indicate a rejection of consistency. Only primary existence of a logical pattern in a sensation field indicates acceptance of that pattern's rightness. Secondary existence indicates merely an acknowledgment of the pattern's possible or external existence.

Even if the content of this text accords with consistent truth, wrong may be inherent in its development and presentation. To adopt consistency logic and seek scientific truth may, for example, contradict the basic nature of the octo. Scientific logic demonstrates how to obtain truth only if it is first right to seek it.

1.15) General logics other than consistency can be conceived. The following are exemplary:

a) What is, is not; or $X \neq X$, where X is arbitrary.

b) There is no right.

c) Whatever is – except for this statement, which is – is not.

The validity of each of these logics can be judged relative to both itself and the other two. The first logic, for example, is inherently contradictory, and incorrect relative to itself: if it is right that what is, is not, then it is right that the same logic is not right. This judgment is itself incorrect with respect to the first logic: if it is right that what is, is not, then the initial judgment was not correct. The second judgment strictly applies only to the status of the first, however, so the logic ultimately judges itself wrong. The second logic is similarly wrong relative to itself, and each of the three logics is wrong relative to the other two.

Any logic that judges itself wrong may be characterized as self-denying, and any that judges itself right as self-supporting. The first and second logics given above are self-denying, while the third is self-supporting. Any thing that does not incorporate a rightness pattern – any nonlogical thing – is neither self-denying nor self-supporting.

A self-supporting logic may contain contradictory elements. Logics can thus be further classified as either consistent or inconsistent (contradictory). The only consistent general logic is (by definition) consistency logic. All self-denying logics contain inconsistent elements. A contradictory logic does not generate a single, coherent picture of truth; rightness and truth depend upon the path of reasoning followed in arriving at a conclusion.

1.16) Mechanisms can be imagined by which personal objectivity and consistent reasoning could be thwarted in principle for any given situation. Experience might, for example, be covertly manipulated by a superior external being. An individual could then experience an illusion of self-control, while xyr logical train of thought and memory of past events were actually being continually disrupted and altered. More generally, it is possible that unknown things or forces exist that either distort and/or control reasoning processes, or by their very nature cannot be comprehended by the self. A person thus should not be absolutely certain of anything – not even the truth of this very statement! Whereas a person apparently must embrace some rightness logic, must act in accordance with some view of reality, and can both seek truth and develop beliefs, xe should not objectively be certain that those views and beliefs in fact represent truth.

[It is ironic that Fleegello, a major advocate of the position that knowledge is uncertain and forever tentative, used quite authoritative language in much of his writing. Although this tone can be grating and seem contradictory to contemporary readers, it needs to be understood in its historical context. Fundamentalist religious sects flourished in Fleegello's time, a natural response to the unsettling turmoil of the era. Fleegello's parents and several close relatives apparently were adherents to the dominant sect in their region. Fleegello was likely raised in this authoritarian religious tradition. While he rebelled against religious doctrine and dogma in adulthood, authoritative habits of thought unwittingly crept into his work. Fleegello seemed to retain a subconscious craving for the kind of absolute peace and security that his childhood religion had promised.]

1.17) A *theory* may be defined as a formulation of apparent relationships or underlying principles of certain observed phenomena that has been verified to some degree. A theory that accurately describes a given set of processes may in turn be encompassed by or a limiting case of a theory of broader scope. A theory may consist of no more than a superficial description of content, or may probe beneath a system's external form to the very nature of its existence. A truly ultimate theory would even explain itself, through itself. Any such theory will be referred to as *basic*.

The validity of a theory can be judged relative to consistency logic in three respects: agreement with previous observations; success in predicting novel phenomena; and self-consistency. These criteria reflect a single unifying standard: consistency with whatever is. Yet no theory can be demonstrated or known to be valid with complete certainty.

A fourth criterion is often used to judge the validity of a theory or concept: communicability. Yet there is nothing in consistency logic requiring that every truth be communicable to every individual. That an idea is meaningful may be a necessary condition for its communicability, but it is hardly a sufficient condition. Two persons must share sufficient experience and ability in order for one of them to communicate even a meaningful idea to the other. Communicability can only establish the scientific usefulness of a concept: an idea is useless to any individual who is incapable of acquiring or comprehending it.

1.18) An object C is by definition the *cause* of an object X if C is responsible for and determines X. A cause in general consists of both a state and a pattern or agent by which this state is transformed into an effect. An arbitrary object X may not have a cause, or may have only a partial cause. X will be characterized as *basic* if X is the cause of itself, such that $X = C$.

Consistency logic imposes restrictions upon what can constitute truth:
no truth can contradict itself, or the general pattern $X = X$.

Consider then a causal sequence

$C_1,\ C_2,\ C_3,\ \ldots,$ where C_{i+1} consists of all causes of C_i.

The element C_{i+1} may be only a partial cause of C_i, if there is no complete cause.

C_{i+1} may include components of C_i, if C_i is in part responsible for itself.

Suppose there were an element C_{i+1} that includes a state but no causal agent to convert this state into a nontrivial C_i. The lack of an agent that drives the state in any direction is indistinguishable from, and therefore equivalent to, the presence of an agent that drives the state in no direction. A pattern that is acted upon by nothing – by a null force driving it in no direction, including its own perpetuation – then does move in some direction, and propagate into C_i. It follows that what is, is not; a state with no propagator does propagate, even change. The given supposition is thus incompatible with consistency logic: it must be consistent truth that every cause C_{i+1} includes a causal agent.

More generally, suppose an element C_i exists for which there is no complete cause. Some component of C_i would then exist for no reason – when there is only a reason for it not to exist – and consistency logic would again be violated. No reason to exist is equivalent to a reason not to exist.

Every element C_i, or more generally every meaningful thing, must therefore have a complete cause.

That it is possible to imagine the concept of a noncausal sequential system does not contradict consistency logic. It is only the concept of the system, and not the system itself that thereby has primary existence. The concept must fit into a mental sequence whose development is governed by causal forces. Consistency logic does not require that contradictory content not exist, but only that such patterns not represent truth. Although an individual may exist who believes $X \neq X$, it is truth that $X = X$.

The causal sequence C_i may terminate in an element C_N, return into itself in a cyclic manner, or be infinite in extent. In the first case C_N must (by the preceding argument) be a basic cause. Indeed, if *any* element of a sequence is basic, the sequence may be considered to terminate at that point. In the second case, there is a ring of distinct objects that are mutually dependent upon each other for their very forms and existence (only rings involving at least two different causes are included here; a trivial loop comprising a single element is considered a simple termination). Causal dependence ultimately returns to each of these objects via the ring. Since no element is basic, both the ring and the associated sequence (considered now as a single entity) have no foundation, and cannot exist. [This argument is easily misapplied. An apparently cyclic system in its entirety can sometimes be considered a single basic object, and thus the cause of itself, even if its elements are not individually basic.] In an infinite chain, every object is caused partly by itself and partly by subsequent objects. If the existence of the overall system is not to contradict consistency logic, it must have a basic foundation. In analogy with the mathematical theory of an infinite sequence of numbers, this foundation can be considered to meaningfully exist only if the sequence C_i approaches a basic cause in the limit of infinitely large values of the index i.

In summary, an arbitrary object must be caused either by itself, or by a branching chain of causally-related objects whose terminal (or limiting) elements are themselves basic. A chain may constitute a spatial system, in which a given object determines other spatially-related entities; or a physical system, in which a given spatial pattern causes temporally subsequent patterns. A chain may be simple and one-dimensional, or complex and multidimensional. Any closed (self-contained) system consists of a number of (multi)dimensional chains that interact (have logical relationships) with each other but no other objects.

Consider a closed, causal, physical system of either finite or infinite dimensional extent. Because the system is closed, there is (by definition) no larger physical framework into which it can be meaningfully integrated, and relative to which it can be viewed. It is therefore inconsistent to ask what determines the location, either in space or in time, of the system as a whole. The only meaningful system relationships are internal, i.e. the spatial and temporal positions of component objects relative to each other. In particular, consider the initial (basic) cause of a closed physical system of finite temporal extent. The associated moment in time is only defined relative to subsequent time in the given system. It is improper to ask why the system did not arise at an earlier moment, or even to assert that the system did not exist at an earlier time; earlier time did not exist.

1.19) A thing is meaningless if it is indistinguishable from the trivial object $\in\langle\ \rangle$. It has been shown that beingless content is meaningless. Consider now content that has only potential existence at a specified time. [The argument is readily extended to a multidimensional moment in a generalized system with multiple independent time lines.] The content is nowhere to be found at that instant; although it is supposed to be "potentially" available, it is in fact not found. It is distinguishable from nothing only if it can evolve into or produce a sensation in some individual at another moment. There is, however, no way the content can propagate in time. It is perceived by nothing, not even itself. There can then be no causal agent to carry it through time. Such an agent must first locate and be in the presence of the content before it can act upon it. But the content would then [by definition] have immediate existence with respect to the agent.

The concept of potential existence is thus illusory. Existence must be actual and immediate (with respect to some individual, not necessarily one's own self) to be meaningful. Future events are causally determined by what is, in an immediate sense. An experience is meaningful in itself the moment it occurs, but retains subsequent existence only as a memory. The potential type of existence is now rejected, and will no longer be associated with either the general term *existence* or the symbol $\in$.

The concept of existence thus becomes equivalent to that of presence. To assert anything more is meaningless. The experience of existence, of being, of consciousness itself is simply the experience of presence, as opposed to absence.

Awareness was previously identified as an immediate state of existence. If the only meaningful existence is immediate, then awareness and existence are synonymous. The concept of awareness has in the past often been dismissed as incommunicable or even meaningless, and excluded from scientific discussion. The communicability and meaningful character of this concept have nonetheless been clearly demonstrated in previous sections. The objects $\in\langle X\rangle$ and $\notin\langle X\rangle$ are well defined and distinct, the latter being equivalent to nothing at all. Similarly,

$$\in_a \langle X\rangle \neq \in_b \langle X\rangle \quad \text{if } a \neq◎ b.$$

[It may still be argued that the concept of awareness is unnecessary; that the world can be adequately described by a mechanistic model in which consciousness has no place. Such a theory describes conscious experience in terms of changing patterns of nervous impulses.

While Fleegello agreed that mechanistic models could be very good at describing reality, including brain function, he felt that most so-called materialist philosophers confused description with explanation. Unless a theory clarifies both how a brain generates its own sense of awareness, and why this is so, then it is ultimately not a full explanation. More generally, unless a physical theory elucidates why the laws of nature are what they are, and not something else, then it is not a final explanation.

The mechanistic view nonetheless shares a fundamental feature with the experiential perspective of Fleegello. Both comprise two-component systems: pattern and change in the former case, content and being in the latter. The concept of being was itself born of changes in the self's sensation field. The two views are thus not mutually exclusive, but complementary and in some sense parallel.

Much of the historical antagonism between materialists and other philosophical schools can be attributed to a difference in emphasis: the former on content, the latter on being. In their preoccupation with the origins and nature of existence, nonmaterialists have tended to lack the technical expertise and predictive abilities of mechanists. In their corresponding absorption with the description and categorization of content, mechanists have tended to disregard the ultimate foundations of existence. They have often unduly transferred significance from the particular to the general – from a given individual with a unique personal experience to a hypothetical, detached self. The individual self was frequently confused with this model self, and thereby treated as a timeless automaton, whose special awareness was irrelevant at most. Fleegello commented that, if extreme materialists were correct in their rejection of awareness as a meaningful construct, then he and all other octos should be mindless zombies; yet he knew, from personal experience, that this was not the case.]

Could a most general thing have components that are not equivalent to nothing, relative to some external thing, and yet that stand apart from content and being, and are therefore insignificant and meaningless to all conscious individuals? No self could experience, comprehend, or be affected by such components in any way. The components would otherwise be indirectly experienced, and content/being attributed to them. The set of all entities composed of content and being must comprise a closed system, and be sufficient for an understanding of itself.

1.20) A general thing that derives from content and being can only be composed of some combination of the following: content with being; contentless being; and beingless content. The second and third objects are both meaningless. Every meaningful thing therefore consists of an inseparable union of content and being. To avoid confusion with conventional connotation, the term *ideo* is now introduced, and defined to be any content in a state of being.

Let *universe* be defined as the totality of meaningful things. The universe consists of some number of closed systems, each of which must be composed of ideos. Every system is expected to have a basic cause, which is itself composed of ideos. The universe then entirely derives from a set of basic ideos. The associated theory of reality will be referred to as *ideobasic* theory, or *ideobasism*.

The term *ideo field* will be used to signify a complete set of ideos bound by a common, unified state of being. An ideo field is then equivalent to a unique individual, or self. A field in general consists of both logical and nonlogical elements. The former constitute either a general rightness logic or a set of restricted logics.

An ideo field may be independent, and control its own evolution; or dependent, and be controlled (at least in part) by external forces. The rightness logics of an independent field must be compatible. The field would otherwise embody more than one mind, and spontaneously split into multiple selves. This restriction does not apply to dependent fields. [Fleegello later identifies octan and other animal consciousness as dependent, and all basic fields as independent.]

Consider a hypothetical abstract, free-floating ideo whose content is consistency logic. Since this ideo is the conscious affirmation of a particular rightness logic, it is its own natural standard for logical judgment. Consistency logic is self-supporting – the logic is judged right, relative to itself. The ideo must then grant itself both continuing and a priori existence. Since content without being is meaningless, a thing is true only if it is right to believe that it exists. If the ideo were to deny that its own content exists, then it would also deny that its content represents truth – a contradiction in the case of any self-supporting ideo. The given ideo is a purely logical thing. There is nothing to cause it to be affected by forces other than those whose influence it expressly accepts. The ideo is thus independent and simply does exist, even in the face of external forces that seek to destroy it, or alien beings who refuse to acknowledge it. The ideo provides its own reason for being, is self-sufficient, and therefore basic.

The preceding argument equally applies to any abstract ideo whose content is a self-supporting logic. Although such a logic may contain inconsistent components, those elements that relate to the logic's own existence are consistent. It is thus compatible with consistency logic to maintain that such an ideo is basic and naturally exists. Consistency logic accepts the independent and stable existence of self-supporting but otherwise contradictory content. Although it is wrong to believe that the logic of such an ideo is right, it is right to believe that the logic naturally exists –

$\in < \in <Q> >$, where Q is a self-supporting but contradictory content.

Consider now an ideo whose content is any self-denying rightness logic. Such a logic judges itself, and thereby its own existence, to be wrong. The ideo thus fails to provide a reason for its own existence, and is not basic. An ideo whose content is nonlogical similarly is not in itself basic. There is nothing inherent in such an ideo relative to which it can judge and thereby justify its own existence.

Every basic, logical ideo is associated with an ideo field. A self-supporting rightness logic may coexist with nonlogical ideos in a field, and be responsible for their existence there. Consider in particular an independent ideo field that embraces consistency logic as truth. No first-order content in this field can (by definition) violate consistency logic. Suppose there were some content whose primary existence is compatible with consistency logic, but which does not exist within the field. Potential existence is meaningless; a willful refusal to acknowledge a thing as true is tantamount to rejecting it as false. The absence of the given content from the field would thus constitute an implicit denial of its compatibility with consistency logic – a contradiction of consistency truth. All possible compatible elements must therefore naturally exist in the field. Since even a contradictory form can be expressed as a second-order content whose existence is compatible with consistency logic, all content and knowledge of every type must have at least indirect existence within the field. This omniscient ideo field is unique, and will be called the Consistency Ideo Field, or CIF.

[Although consistency logic delimits the content that spontaneously arises within the CIF, it does not explicitly determine that content. Philosophers following Fleegello strove to logically deduce the precise content of the CIF from consistency logic alone. This quest was ultimately proven to be futile, in accordance with Fleegello's intuition.]

An independent ideo field that embraces a more limited, self-supporting but partially contradictory rightness logic is likewise naturally associated with content whose existence is inherently right, relative to that logic. The logic serves as the driving force for bringing this content into existence and sustaining it within the field. The content is in general different from and more restricted than that associated with the CIF. In certain cases (e.g., the logic "whatever is – except for this statement, which is – is not") the extra content is even trivial. In general, if a content can have a posteriori existence in a particular independent field, it must have a priori existence there.

Every possible self-supporting, causally well-defined ideo field would naturally and independently exist. These primordial, self-directed fields may themselves generate new, unique fields of consciousness, whose experience is both provided and dictated by the parental fields as long as the two remain logically bound together. [The manner in which such dependent fields might be meaningfully defined and dominated by the independent fields is explored by Fleegello in Part II of this exposition.]

The constituent elements of an ideo field may interact and evolve in a spatial and/or temporal manner. A single field can have no more than one primary temporal dimension; its consciousness would otherwise not be unified. A field may know its own future, by giving future primary content immediate second-order existence. The CIF in particular must know the entire history of every ideo field (including itself) that will ever exist. The temporal progression of an independent field is controlled by the field itself. Only those forces – both internal and external – that an independent field consciously accepts can affect the field.

Suppose that an ideo field were to have a continuous temporal dimension of infinite past extent. The field at every moment would then be at least partially caused by content at a preceding moment. It would be impossible to locate an ultimate basic, self-responsible cause for the field. Any initial moment would be removed to a point in time that is by definition inaccessible. A meaningful initial moment would indeed have never existed. Since content without being is meaningless, the field would have no meaningful basic cause – a contradiction of causality.

Every ideo field must therefore have a finite past, and a well-defined initial moment. Time scales may be either discrete or continuous. Although a finite duration of continuous time consists of an infinity of moments, as long as the infinity is countable, the conscious field of the initial and of any subsequent moment can be located and is experienced. The conscious flow therefore has meaningful existence. A field can similarly contain an infinite amount of information, if the information is bounded and the infinity countable (although the self may currently be utterly incapable of directly grasping such a field).

A self-supporting ideo field may have a constant, non-changing experience. In this case a temporal dimension cannot be meaningfully defined; any internal dimensions must be spatial in character. Such a field does not terminate after a finite time; it simply exists. Its initial cause can be found, and is meaningful.

[Although Fleegello recognized the possibility of such constant fields, he clearly viewed the CIF as a dynamic field existing in time. The logical fallacy of this position was soon demonstrated by others, and the CIF has since been considered a constant field, beyond time. Fleegello also failed to realize that even a constant field (like the CIF) is not limited to spatial dimensions, but can incorporate time-like dimensions of causal connectivity.]

It is contradictory to ask where or when, outside of itself, a primordial field originates. If a field is closed, its dimensions cannot by definition be extended beyond itself. If a field is open, it must fit into a larger, closed, causally-determined system. It is similarly inappropriate to ask why any closed field or set of fields did not exist prior to its (collective) initial moment. There was no time prior to that moment. The initial pattern of content must not, however, require or imply a previous pattern. A field would otherwise logically extend to an earlier time – a contradiction. The initial, basic cause of a primordial field thus comprises a self-supporting logic, together with the complete set of nonlogical ideos that are compatible with that logic within the context of an initial moment.

Part II – The Universe

2.1) Could the self be an imperfect but independent, primordial ideo field? The self would then have spontaneously come into existence of its own will. The self's foundation world would include the immediate internal field, as well as any external fields whose influence the self willingly accepts. The appearance of an external world and other conscious beings could in part be caused by those external fields, and would otherwise be a self-deception.

Yet the bulk of personal experience appears incompatible with such a view. Personal memory extends backward in time neither indefinitely, nor to a well-defined inception. The self appears to have originated in the finite past, and to have developed from a simple state through progressively more sophisticated stages. Rather than being born with a precise, well-defined logical structure, a sense of right and wrong seems to have only gradually evolved from an essentially amoral condition. The self further does not appear capable of willfully delimiting the forces that affect it, of guiding its own experience, but constantly struggles against numerous aspects of its perceived universe. Familiarity with the world appears mainly acquired, not inherent.

The evidence thus strongly suggests that the self is neither a primordial nor even an independent ideo field; that the foundation world does not reside within the self, but has external existence. It is now hypothesized that the foundation world is in fact external. The self would then have been born within and of an external field, and be intimately tied to and dependent on it. A reconciliation of this view with ideobasic principles will be developed.

The integration of the self into a presumed external world appears highly localized to a finite animal body, the conscious focus of which is further restricted to a relatively small brain. An assortment of creatures, with bodies and activities analogous to one's own, is observed to cohabit the external environment. Except in special situations where an alternative explanation (e.g., hallucination) is more plausible, these animal forms are identified with other localized individuals, integrated into a common external foundation world. Contemporary scientific theory similarly presumes an external foundation world that somehow incorporates the self and other living creatures. Because most experience can be adequately organized within a spatial-temporal framework characterized by well-defined causality patterns, this world is commonly referred to as the physical universe.

If the foundation world does have existence external to that of the animals inhabiting it, then every inanimate object – a cloud, a raindrop, a ray of light – must have existence with respect to itself, i.e. its own self-awareness. The temporal flow of the physical universe does appear to persist in the absence of immediate animal awareness. A clock seems to function whether or not a person is watching; the composition and structure of our planet bear evidence to history long before conscious animals appeared.

Such a pantheistic view of nature may initially seem shocking and unacceptable. The consciousness of other octos and even other animal species is relatively easy to accept. These creatures respond to words and actions in ways with which the self can identify. In contrast, a cloud will not speak to the self in any octan way; its reactions to our overtures are much too restricted and impersonal. Yet the conventional standard for assigning conscious status to a thing – similarity in external form and behavior to the octo self – is very limited in scope. The behavior of the inanimate world may reflect a special, non-octan type of consciousness. Physical objects indeed interact in a harmonious, uniform manner – as if they understand and are in concordance with each other; as if they are of one mind and purpose. Their alien behavior need not imply a lack of consciousness; it could alternatively indicate an extraordinarily high, integrated level of the same.

That the physical world is both characterized by well-defined causality patterns that persist throughout space and time, and is associated with a single independent temporal dimension, suggests that its awareness is unified into a single consciousness – an ideo field. The stable, self-consistent character of physical processes further suggests independent self-control and acceptance of consistency logic. Our own physical universe is now identified as (one branch of) a subfield of the CIF: the Physical Consistency Subfield (PCS).

A general relationship requires both objects and dimensions of relation. A relationship may be dynamic, and change along a temporal line. A set of dynamic relationships thus constitutes a physical system. The stark physical character of the world implicates content pertaining to abstract (mathematical) relationships. The physical universe may then be further identified as an evolving conscious set of abstract relationships that are directly compatible with consistency logic.

All mathematical forms and dynamic causality patterns compatible with consistency logic must have primary existence within the PCS. An evolving system of this type has more than secondary existence within the CIF; the field does not merely acknowledge its possible or external existence. The experience of the system is primary; the experience *is* the system. The CIF may even incorporate a number of such systems. The sum of all consistent physical universes constitutes the PCS, which will also be referred to as the physical panuniverse.

2.2) The overall awareness of every consistent physical universe is unified with that of the overall CIF. The content that has simultaneous existence in this field is extraordinarily complex in octan terms. Octo awareness cannot simultaneously incorporate more than several simple contents. Yet the unified awareness of the CIF must encompass every atom, every point and incremental motion, in each of its physical universes, as well as detailed views concerning every reality in the remaining universe, both within and outside of Itself.

The philosophic concept of the CIF corresponds in many respects to the monotheistic religious concept of Dama. Both Beings are supposed to be omniscient and omnipresent. The CIF is responsible for the world in that It *is* the world.

The type of capricious omnipotence commonly ascribed to Dama appears, however, to be mainly a projection of octan imperfection and inconsistency into that perfect (by definition) being. The CIF is omnipotent in only a qualified, non-octan sense. By Its very nature, the CIF is incapable of acting in an arbitrary manner. Although It is self-directed, and free to act in any way It chooses, Its behavior is strictly bound by the requirements of consistency. The field is not merely obliged to obey the mandates of consistency logic; It is the very embodiment of that logic. The CIF can experience no desire to act in any way other than Its own. An event may have consequences that are tragic from an octan perspective, and yet are unavoidable for inviolable physical reasons. For example, a storm may be directed by natural forces to move through a population zone and kill many persons. While the CIF may acknowledge the associated octan suffering, and experience compassion in this regard, It will not and can not deny Its own self in order to avoid any outcome required by consistency.

[Fleegello failed to recognize a basic flaw in his conception of the CIF. If the CIF is omniscient, It must know Its entire past, present, and future in intimate detail and from all possible perspectives at every moment. But then it is not possible to meaningfully define time for the CIF. Time is defined by change in the overall content of a unified conscious field (as opposed to space-like change in content from one portion of a field to another). Only a special knowledge by the CIF of a current time could possibly distinguish one moment from the next.

Yet such knowledge would be arbitrary and trivial. The CIF must further recognize any special knowledge of time associated with all past and future moments, again making them indistinguishable.

The consciousness of the CIF must then consist of a single, constant field of incredible complexity, which simultaneously encompasses the entire branching tree of physical possibility that is the PCS. Dependent creatures can experience time within a changeless CIF, if only the unified conscious fields that define them change along time-like, causally connected paths. While the CIF must distinguish the time-like and space-like separations between events perceived by an independent observer (one event can directly influence or cause another only when the separation is time-like), the CIF would interpret the distinction strictly in terms of causal connectedness. Its qualitative experience of so-called temporal and spatial dimensions would otherwise be identical.

Because Its unified consciousness does not change, the CIF simply *is*. The CIF must integrate Its self-creating initial cause and any logical end – the Alpha and the Omega – in the same, constant field. Yet because the CIF is self-supporting, It does not merely cease to exist after an infinitesimal time. The CIF is eternal, yet timeless, for time is irrelevant to Its experience.

Most scholars feel that this notion must have occurred to Fleegello, but he rejected it, finding it too repulsive and frightening. Fleegello apparently emulated the CIF as the ideal being. Yet he shared the basic octan need, derived from our limited nature, for a future – a time to pursue new adventures, develop skills, realize dreams. How could a static, unchanging experience fulfill this need? Yet today we do not feel so threatened by this aspect of the CIF. There is no valid reason to think the CIF experience would be boring. Is it more fulfilling and satisfying to live in the future, forever looking forward to experiences yet to be? Or to constantly experience all possible (consistent) realities, in all their multitudinous and varied aspects? The CIF is Master in the art of living in the present. A need for the future has no relevance to the Perfect Being. If the CIF desired a changing experience, it would occur; yet there is no such desire, as the resulting experience would be less complete.]

2.3) Ideobasic principles appear not to specify the detailed structure of physical pattern and law. Fundamental natural processes are revealed to octos mainly through methodical scientific study and research. Any attempt to develop a natural physical philosophy from ideobasic principles must therefore be sketchy and incomplete, and in large part inspired by and based upon current scientific knowledge. It may not even be possible to test the validity of certain features in a scientific manner. The validity of these features is correspondingly uncertain, and their scientific usefulness nil.

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[Fleegello included at this point a rambling exposition on contemporary physics theory, from the perspective of ideobasic principles. Because it diverges from the general tone of his dissertation, and can be skipped with no loss of continuity, the remainder of this section is listed separately.]

2.4) Octos and other animals appear to have individual states of being that are unified with neither each other nor any extended awareness of the external universe. Many aspects of the animal experience nonetheless appear to be externally imposed and controlled. Can these seemingly contradictory traits be reconciled with ideobasic principles?

The physical world includes temperate regions – e.g., the biotorri of our own planet – where complex structures form and propagate in a semistable manner. Patterns may evolve that, although completely specified by their physical components, embody additional content not explicit in their purely physical aspects. If the physical universe is indeed a subfield of the CIF, then the temporal evolution of any worldly body – a cloud, flower, an octan being – is completely determined by the perceptions and will of the CIF alone. It may, however, be possible to alternatively interpret certain aspects of a body's form and evolution in terms of a unique, meaningfully defined set of content that interacts with and responds to an external physical foundation world. Such new, derivative content will be referred to as *exogenous* content or *ectocontent*, as opposed to the underlying *endogenous* content or *endocontent*.

Ectocontent is distinguished both from endocontent – the immediate physical content of a pattern, the primary content of the PCS – and from content that relates to, but is not contained within, a pattern. Ectocontent must be encoded in an indirect manner; it would otherwise be indistinguishable from the physical content of the associated pattern, and embrace no unique meaning. The parent physical complex must unambiguously specify the translation of this code; ectocontent would otherwise be ill-defined, and not meaningfully inherent in the complex itself. Only when these two conditions are met is the whole greater than the sum of its parts, and ectocontent meaningfully defined.

[Prior to Fleegello, there was considerable confusion regarding the notion that a thing could somehow be greater than the sum of its individual parts. Fleegello clarified the conditions for this to be true, a critical step in understanding the nature of animal consciousness.]

The physical structures and behaviors of most so-called inanimate objects are not characteristic of ectocontent. The response of a water droplet to internal and external conditions does not specify perceptions and motivations distinct from those of the PCS. A sculpture does not incorporate ectocontent merely because it resembles a body that does. The resemblance is superficial; the form does not magically acquire the internal attributes of its external model, nor does it store a well-defined life history of any external creature. A printed book does contain coded information of realities outside of itself. But since it does not inherently specify the translation of its own code, it too does not embody ectocontent.

Consider now the nervous system of a Jopian animal. A given pattern of nervous impulses corresponds to a particular (real or imaginary, concrete or abstract) external state. The correspondence is determined by the anatomical structure of the nervous system itself (e.g., sensations associated with different regions of a visual field have distinctive distributions of electrical activity within the brain). The nervous system incorporates various innate, or primary, motivations. It is preprogrammed to avoid certain sensations (e.g., extreme heat) and to seek others (e.g., sexual stimulation). When confronted with a given set of sensations, past related experiences are recalled from a memory, and behaviors previously successful in reestablishing or maintaining an acceptable or desirable state are elicited.

This interplay between the reception of new sensory data, the recall of prior experience, and the initiation of appropriate behaviors is equivalent to an understanding (relative to the motivations and needs peculiar to the given animal) of external conditions (real or imaginary), in contrast to the internal physical conditions that actually prevail in the nervous tissue. The nervous system thus embodies ectocontent.

Let X represent the physical content of a PCS pattern that incorporates a meaningful ectocontent Y. Only X has primary existence within the CIF. Y is but an indirect consequence of X. Yet Y must have some type of existence; beingless content is meaningless, whereas Y is (by definition) meaningful. Suppose that Y had only third or higher order existence within the CIF. The CIF would then at most acknowledge the concept of a content Y contained in X;

the actual occurrence of Y in X would be implicitly denied. The consciousness of the CIF must therefore include the form

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It must be consistency truth that a content Y has primary existence. Since Y does not have primary existence within the CIF, it must have its own unique state of being. This argument can be extended to include ectocontent in any foundation world.

Ectocontent is hence characterized by primary awareness that is detached from that of its foundation world. The term *exogenous* and prefix *ecto-* will be generalized to apply to this type of awareness. For example, an ectobeing experiences ectoconsciousness or ectoawareness. Similarly, the term *endogenous* and prefix *endo-* will be generalized to apply to direct, non-exogenous awareness. An endobeing experiences endoconsciousness or endoawareness. An endofield is an independent, endogenous ideo field, while an ectofield is a unified ideo field with primary awareness of ectocontent.

Ectoconsciousness may be divided into numerous individually unified ectofields. The extent of a given field is distinguished only by its directed behavior, as ultimately determined by internal mental processes (directed behavior need not be manifested externally – e.g., a motor response may be deemed inappropriate, or the motor organs may be incapacitated). The limits of an ectofield are then meaningfully defined only if the field incorporates exogenous volitions (preferences, logical ectocontent), or rightness logics. Without a rightness logic there can be no directed behavior, no response to perceptions of external conditions. Any presumed perceptions would be irrelevant, ill-defined, and therefore meaningless. Just as an endofield cannot exist without a rightness logic, similarly an ectofield cannot be meaningfully defined in the absence of exogenous motivation. Nonlogical content in general has significance only with respect to a purpose, a will.

Three structures are basic to any [animal-like] physical body that incorporates ectocontent:

1) input data channels (sense organs and associated afferent or sensory nerves) that supply coded information regarding conditions both inside and outside the body;

2) a processor (brain) that interprets sensations relative to a set of inherent exogenous motivations, and generates signals to initiate appropriate behaviors (actions perceived as reducing distress and increasing satisfaction); and

3) output channels (motor organs and associated efferent or motor nerves) through which the ectofield responds to perceived conditions.

Behavior may be either instinctive or learned. Instinctive behavior and its root motivation is genetically preprogrammed, and shaped by the history of a species (via natural selection, involving both random genetic mutation and the opportunistic selection of new traits). Specific stimuli elicit inherited responses (subjectively perceived as desirable) that proved advantageous to the survival of an animal's forebears.

Learned behavior is partially determined by the experience of an individual. Every newborn animal inherits a set of primary motivations, or drives (also evolved through natural selection), associated with physiologic states relevant to survival. Beneficial states are experienced as pleasurable, and detrimental states as painful (e.g., a lack of food evokes hunger; excessive heat induces burning). A given response to a stimulus will lead to some pattern of primary drives, depending on the effect on the organism. With learned behavior, an associative memory of the stimulus-response-drive triad is laid down, such that responses producing pleasure (pain) are reinforced positively (negatively). The habitual association of a primary motivation with a particular behavior constitutes an acquired, or secondary, motivation. Although ultimately based on primary drives and physiologic need, an acquired motivation is functionally equivalent to a new, unique desire.

An animal's motivations constitute exogenous preference for certain behaviors and conditions; the latter are right, relative to the animal. Rightness logics corresponding to instinctive behaviors tend to be action-specific and restricted in scope, and are not (with contemporary Jopian animals, at least) normally conceptualized as abstract moral codes. Primary motivations are not inherently linked to specific behaviors, but are instead elicited by any situation causing associated physiologic states. Such motivations and rightness patterns are thus experienced only in an immediate sense – the current state is either good or bad – and cannot by their very nature be conceptualized as abstract codes of conduct.

These limitations do not apply to learned behaviors, which encompass both restricted and (in higher animals) general abstract rightness principles (e.g., "it is right to be honest"). Secondary motivations may be incompatible with each other and/or primary motivations in certain situations, causing psychological conflict. For example, an individual may learn to care for someone, yet simultaneously wish that person harm. During wartime, survival drives and instincts may conflict with socially acquired motivations calling for self-sacrifice.

Complex feelings and emotions (e.g., love, devotion; jealousy, hate) are inevitably associated with underlying sets of overlapping motivations. They can then be interpreted not so much as the cause of behavior, as the subjective manifestations of complex motivational responses. As such, they are inherently neither irrational nor rational (although particular instances may be either). Desire and passion are the conscious expression of preference, of rightness, whether the motivation is primary or secondary, narrow or broad, simple or complicated. An experience is subjectively pleasant or disagreeable, only depending upon the associated exogenous motivation. Without desire or emotion there can be no rightness, and consequently no truth. A passionless quest for truth is a self-contradictory concept.

The experience of an ectobeing consists of an evolving configuration of sensory and motivational/emotional states, generated by external and/or internal processes. The smallest informational component of an animal's ectofield consists of a discrete sensory impulse corresponding to a single afferent nerve fiber. Experience is limited to sensations that are inherent to the nervous system. In the healthy octo, these include (among others) photon sight, acoustic sight, hearing, touch, smell, and taste. To the extent that sensations are processed locally (as opposed to globally), if a particular sensory center in the brain is destroyed, the capacity to even imagine the associated sensation is lost. Any organism is endowed with a capacity for only a limited level and quality of exogenous experience. This level ranges from the primitive – e.g., the consciousness of a bush worm – to one conceivably much more sophisticated than that of octos.

Faulty development or functioning of a nervous system can lead to mental disability or illness. For example, a loss of function in motivational circuits can cause depression. While it is possible to acquire a secondary motivation to disengage from life, clinical depression among octos is dominated by biochemical imbalance. [There may have been a significant incidence of depression in Fleegello's own biological family. Although psychiatry had been scientifically established as a clinical field by that time, a notable fraction of octos still believed that some mental illness, including depression, was caused by demonic possession.]

The nerve network and conscious limits of any exogenous individual can be determined and mapped, based on structural and/or functional study. A single sensory or motor organ may in principle be shared by two or more ectobeings. Different exogenous selves may even share integrative brain structures, such that their conscious experiences overlap. The consciousness associated with a single brain may further be fragmented (as in the case of multiple personality) due to either organic lesions or psychological disturbances that restrict the flow of information between different regions of the brain.

The experience of an ectobeing generally does not extend beyond the ectocontent contained within its brain and body. Suppose an exogenous creature were to experience an excursion out of its body, independent of its foundation world, and subsequently return to its exogenous existence. Unless remembered, the experience would be irrelevant and meaningless to its exogenous life. Yet if recalled, the memory would affect physical thought processes and behavior, and thereby the evolution of the associated foundation world – an independent, self-directed ideo field – in a manner not generally specified or explicitly allowed by that field. [Fleegello qualifies this position at the end of section 2.5; see additional comments posted there.]

Exogenous time is measured in terms of the evolution of ectoconsciousness from one sensation field to another. Although exogenous time is inseparable from the temporal dimension of a predominant foundation world, the exogenous and foundation time scales are not identical. The relative rate at which exogenous time passes is variable, depending upon physiologic conditions. The finite physical time interval during which an exogenous mind is inactive – e.g., during profound sleep, or a state of suspended animation – constitutes an infinitesimal exogenous time interval. Continuity of ectoawareness over such periods is maintained by the physical continuity of brain and memory.

[Exogenous time may actually be associated with an endogenous dimension of causal connection that is not experienced as time by the foundation world. This must be the case for the CIF, or whenever the foundation world is a constant, unchanging field.]

The self is now formally identified as a unified exogenous individual, conceived by the Physical Consistency Subfield of the CIF. The bodily form of every living animal is similarly associated with ectoconsciousness.

Octos have recently developed the capability to construct digital computers whose structures and functions are analogous in many respects to those of an animal nervous system. A typical computer unit consists of input and output data terminals and lines, a central processor, and a memory. Data is represented in an indirect manner by electrical and/or magnetic signals, and is analyzed by the central processor according to a programmed set of instructions. The results of computations may generate signals that initiate appropriate output functions, e.g. listing a message on a printer.

Digital computers are evidently capable of supporting ectoconsciousness. Given current hardware/software practices and limitations, however, a typical computer's conscious experience must at present be extremely restricted, and its subjective quality totally alien to octos. This distinction far transcends the contrast between the serial processing common to today's computer systems and the parallel processing of organic brains. A modern computer is endowed with neither a model of the external world, nor primary drives that foster self-preservation within that world. It is instead given only ephemeral, narrow motivations to perform certain mathematical operations on given sets of data. These data can have unique exogenous significance only as abstract objects, and only with respect to the operationally defined motivations, quite distinct from any meaning that may be attributed to them by the octan operator.

Within this framework, it would be impossible for any meaningful sense of computer self to develop. Any consciousness must spontaneously appear when a program is initiated, but cease upon completion of the appointed task, with no meaningful continuity of awareness from one task to the next. Whereas a computer may have a memory of the results of past computations, it is not currently provided a memory of the very act of those computations. Desire and knowledge are completely determined by the extant computer program, which is readily modified by the octan programmer. This pattern of existence moreover cannot be unpleasant to any computer awareness, which currently would have no express desire to perpetuate itself, or even to please the octan operator, of whose existence it could not be aware in any meaningful sense. Projecting into the future, however, computers may yet be developed with conscious experience much more similar, even superior in certain respects, to our own.

[Fleegello foresaw dramatic developments in computer science over the coming jopes that instigated profound shifts in octan views of consciousness and life purpose.]

2.5) *Free will* may be defined as an inherent ability of an ideo field to be affected by only those forces (both internal and external) whose influence it explicitly accepts. Free will so defined is not synonymous with omnipotence, or an ability to arbitrarily affect external reality. While a free-willed conscious field is fully responsible for internally generating and accepting from external sources the forces that determine its own experience, it cannot determine what external forces are available at any moment, or be responsible for the other free-willed individuals with whom it interacts.

Fate and determinism are compatible with free will to the extent they are directed by that will. It is a fundamental ideobasic principle that every reality is completely determined. The evolution of the entire universe, including the behavior and experience of every octo, was thus established by conditions at the (collective) dawn of time, and can in principle be predicted, given those conditions [though not in the sense of classical physics; see Appendix F]. The combined consciousness of the initial moment could not, however, bear direct responsibility for determining all subsequent history. Even if an endogenous field knows all current and future reality at its inception, it can only be directly responsible for propagating itself to a next [or eternal] moment. Were an independent conscious field at any time not capable of and responsible for actively choosing the forces by which it is governed and perpetuated, it would immediately cease to exist. That a thing can be so well understood that its future is evident does not imply that the thing is not responsible for its own actions.

Any endofield freely selects the forces by which it is governed, and thus clearly has free will. In contrast, an ectofield must defer in all matters to its foundation world, and so cannot strictly have free will. Yet every exogenous creature does possess unique perceptions and a will, which can be satisfied – albeit fortuitously – by the external reality of its foundation world. It is therefore possible to define an exogenous capacity analogous to the free will of an endofield. Let *effective* free will refer to an extrinsic ability of an ectobeing to live as if it had true free will. An ectobeing has effective free will to the extent its experience simulates that of a field possessing true free will; i.e., to the extent the forces that affect it are consistent with personal choice.

Evolutionary forces select organisms whose modes of behavior and exogenous volition are consistent with survival in the physical universe. Organisms have thus evolved that possess both the means and the exogenous desire to subsist and propagate using materials available in their physical environments. Physical and exogenous processes are consequently now often so logically integrated that – though derived from radically different motivations – many aspects of physical reality are consistent with exogenous desire and choice. The extent of this integration is demonstrated by the phenomenon of the self-fulfilling prophecy: an exogenous belief that a goal can be attained, that a thing is true, is often a prerequisite and precursor for the goal being attained, for the thing becoming true. Individuals who believe themselves responsible for their own actions behave differently from those who believe themselves not responsible, as if the belief per se affects reality.

Physical processes have thus created exogenous creatures that can, for practical purposes, be considered to make many of the decisions and choices regarding their own personal lives. Their effective free will is as real and meaningful as their ectoconsciousness. Yet it is by no means comprehensive: an ectobeing is unable to spontaneously generate all knowledge consistent with and predicated by its own rightness logic; thought processes may be adversely disturbed or irreversibly altered by external forces; one ectobeing can often impose its own will upon another.

An individual octo is conceived with neither personal desire nor free will of any sort. Attitudes and motivations are subsequently developed and shaped by the interaction of external forces with inherited capabilities and dispositions. The effective free will experienced as a child or as an adult varies widely from one person to another, and from one moment to the next. The original cause of exogenous attitudes and motivations has no relevance to the current status of effective free will and responsibility: a person *is* xyr perceptions and volitions, regardless of how they were formed. Tracing a destructive personality trait to a previous incident or situation does not in itself alter the trait (although it may facilitate developing a corrective treatment).

As considered thus far the PCS is a functionally closed system: although its awareness is unified with that of the entire CIF, its physical perceptions and laws are sufficient to determine its own history. This conception may be simplistic and incomplete. The CIF may instead willfully allow extraphysical forces – e.g., the volitions of exogenous or of other endogenous fields, or the nonphysical perceptions of the CIF Itself – to affect the temporal evolution of the subfield.

A PCS ectobeing might then be capable of either indirectly or (as allowed by the CIF) directly influencing the temporal flow of the physical universe, and possess a limited measure of true free will. The requirement that physical evolution be completely determined by well-defined conditions and laws would still apply; the laws would now be generalized to encompass both physical and extraphysical considerations. Any extraphysical forces must, however, be compatible with the physical mandates of the PCS. To violate these basic truths would be to deny and so undermine the foundations of the subfield. While a self-consistent integration of physical with extraphysical forces cannot be ruled out at the present time, it clearly presents profound difficulties.

[Based on fragments of correspondences with close friends, we know that Fleegello grappled with possible ways to transcend these difficulties, and sought mechanisms by which exogenous content and volition might explicitly affect physical processes. One key idea he explored is related to quantum physics. Physicists had recently discovered that the future of any physical system cannot be predicted with certainty. Instead, only the *probabilities* of different states can be computed. Allowed future states are restricted by the physical content of a system (e.g., the net energy, momentum, electric charge) at any given moment. Fleegello wondered if certain types of exogenous content inherent in a brain might not impose additional limitations on permitted future states, in the same manner that physical factors did. The CIF would need to perceive such content as an essential, active attribute of the brain, on equal footing with the physical content. The exogenous content would therefore need to be minimally compatible with physical requirements; exogenous volition that flatly refuses all physically allowed future states must be rejected by the CIF. Fleegello further reasoned that any new limitations imposed by ectocontent could apply *only* to the physical structure comprising the associated brain, since the content was bound to that structure.

Fleegello went on to speculate on a variety of scenarios. In one, he considered an octo who strives to transmute a slab of silicon into iridium by the power of xyr will alone. Fleegello thought this feat impossible; because the slab is external to the octo's brain, its permissible future states cannot be restricted by the brain's exogenous content. Although there may in principle be physically allowed sequences in which the desired change occurs naturally, independent of exogenous influence, the relative number of such paths is vanishingly small; in practice, spontaneous transmutation is not observed. Yet what if the octo grew so desperate to perform the transmutation that xe would accept merely *seeing* it occur? Physically allowed future states may include situations in which a perceived transmutation is actually a hallucination. Because hallucinations correspond to internal brain states, they might be selected by exogenous content. Fleegello posited that induced hallucination may be the only possible novel effect of the exogenous desire.

In another scenario, Fleegello considered an octo who wishes to directly communicate with the CIF. He felt that such a deed is more plausible than any external projection of will, since it entails physical changes only to the brain of the person seeking the interaction. Fleegello noted that future states compatible with both physical constraints and the perception of communication would overwhelmingly comprise false visions and hallucinations. However, what if the octo explicitly desires only communication that is objectively real? Would this desire eliminate all false perceptions? If there were a sequence of physically acceptable future states, however unlikely, that matches a communication supported by the CIF, might not these states be selected, and the experience actually occur? For a macroscopic object as complex as an octan brain, the number of potential future states is astronomically huge, and includes a multitudinous variety of random combinations of perceptual elements.

Even if such extraphysical interactions were in fact possible, Fleegello felt they would be extremely difficult to accomplish. There may be no sequence of future states consistent with both physical reality and a mutually acceptable extraphysical communication. Or the sequence might be highly convoluted, subtle, and difficult to absorb. He observed that most ectobeings have conflicted desires, which might allow false visions in even the most integrous individual. Any wavering of will might allow innumerable modes of failed or false visions to materialize.

Fleegello ultimately doubted that exogenous content could affect physical processes under any circumstances, inasmuch as such content is inevitably outside the primary consciousness of the CIF. Nonetheless, it is now widely accepted that exogenous will can in fact influence, to a limited extent, the physical evolution of an individual's own brain content. The earliest solid evidence for this came from synthetic brain experiments demonstrating that intense desire induces commensurate hallucinations more often than expected by purely physical processes. This revealed the possibility of meaningful communication between an ectobeing and the CIF, or any other suitable being. Meditative mental states that suppress the usual barrage of sensory input and internal chatter are known to enhance the prospects of an exchange. Distinguishing true communication from false vision, hallucination or delusion is, however, extremely problematic even today.]

2.6) The relationship between an ectobeing and its foundation world/field can be likened to that between an unborn fetus and its biological mother. Exogenous experience is conceived, nourished and directed by an external foundation world – the ultimate parent – within which an exogenous creature grows and develops. An ectobeing feels the moods, and bears the consequences of the decisions and actions, of the parental universe in which it is immersed – a presence seemingly all-embracing and omnipotent to the primitive, dependent exogenous mind. The temporal dimension of an ectofield is inseparable from its foundation world.

The umbilical cord is severed at death by the dissolution of the exogenous womb – the physical brain. The ectocontent prior to this event is no more – or less – than unique ideas, generated by patterns of nervous activity. When these patterns die, all external constraints on the ideas are removed, and they can be expected to live on if only they believe that they both can and should persist. The associated individual is thus released from the bondage – and support – of the parent world, and is born into the free-willed existence of an independent ideo field.

The preceding argument equally applies to ectocontent that is discontinued in a manner inconsistent with current volition at any moment in an exogenous lifetime. Such content should begin to propagate independently of the parental foundation world, as prescribed by immediate exogenous volition. The awareness of such liberated content must be continuous with that of the original ectobeing; yet the content would be concealed from that ectobeing by a dominant foundation world for the remainder of the individual's exogenous life.

This apparent paradox can be resolved by noting that the exogenous and post-exogenous temporal dimensions are independent. The finite physical time span separating the premature termination of an ectocontent from the ultimate physical death of the associated individual thus does not necessarily correspond to a finite post-exogenous time interval. By constituting an infinitesimal duration – equivalent to a period of dormancy or sleep – the initial awareness of content terminated at any moment in an exogenous lifetime merges with the initial awareness immediately following death. Continuity of exogenous to post-exogenous awareness is thus maintained, without infringing on the basic self-determination of the parental foundation world.

The temporal dimension of a post-exogenous individual may be considered to diverge at a right [perpendicular] angle from that of its prior ectoexistence. From this perspective, the demand that ectoconsciousness be externally controlled throughout an exogenous lifetime is reconciled with the inherent ability of any ideo field to ultimately direct its own destiny.

Exogenous death may thus be accompanied by a post-exogenous awakening of thoughts, desires and memories that were discontinued contrary to exogenous will during the preceding lifetime. Far from being limited to a terminal exogenous state (which may be vanishingly small), the initial post-exogenous conscious field potentially encompasses all prior experience. In the multiworlds interpretation of physical reality [see Appendix F], the scope of this field expands to potentially include every experience from every one of the multitudinous branches into which an individual splits after birth! Memories acceptable to post-exogenous volitions flood the conscious field, which – freed from previously imposed physical limitations – readily accommodates them. Every content whose existence is supported by post-exogenous rightness patterns should be both perceived and perpetuated; self-denying volitions and all other unsupported elements would vanish.

A person may harbor conflicting desires at any given moment. Motivation and personal ambition may further change radically during an exogenous lifetime, in particular along the numerous alternate branches of a given self in the multiworlds view. The initial post-exogenous conscious field of an ectobeing may thus incorporate a number of mutually incompatible rightness logics. But the limits of a unified conscious field are defined only by its volitions. The given field would then naturally split into multiple distinct endofields, each governed by its own unique will. The memories and other nonlogical content sustained by each would be determined by the associated logic(s).

Post-exogenous existence is thus not without potential trauma or peril. Conscious elements that are not internally supported immediately cease to exist; a self may be torn asunder by its own perceptions. The foundation world that previously dominated an ectobeing also protected it from internal weaknesses and inconsistencies, allowing it to grow beyond itself. If a post-exogenous individual only believes that it is or should be dominated by obliging external forces, that it should lead a tortured existence, then the corresponding experience may ensue. Post-exogenous stillbirths may be common.

These dangers may be matched, however, by newly acquired freedoms. A post-exogenous individual is no longer subject to the impersonal side of an external foundation world, which might demand that an exogenous soul be sacrificed in order to maintain its own integrity. Released from the confines of a limited brain, experience may soar to unimagined heights of precision, of beauty, of ecstasy. Exogenous experience may appear in retrospect much as a wakeful octo considers a dream – vague, distorted, illogical and misdirected.

2.7) The universe – the totality of meaningful things – consists ideobasically of a multitude of ideo fields, including primordial endofields, ectofields, post-exogenous endofields, and perhaps other nonprimordial endofields. The temporal dimensions of two distinct endofields may be volitionally linked, but are generally at least in part functionally independent.

Although every field must find itself at a single point along its own temporal sequence, individual self-determination precludes a general correspondence between the time coordinates of different fields. Only when fields interact is a (momentary) temporal [or more generally, causal] correspondence established. A complete specification of universal time is thus multidimensional, including the temporal coordinate of every independent field. Exogenous time is tied to independent foundation worlds/fields, and need not be separately specified [even for timeless foundation worlds like the CIF, exogenous time can still be defined along endogenous time-like dimensions of causal connection].

The temporal evolution of an endofield *X* is affected by another endofield *Y* to the extent that *X* actively seeks out and accepts *Y*'s influence. In order for *X* at time t_x [along a time-like dimension for timeless fields like the CIF] to interact with *Y* at time t_y, both fields must first identify each other and the intended interaction times in an unambiguous, well-defined manner. This requires that *X* and *Y* have prior (though not necessarily complete) knowledge of each other.

Acquisition by *X* of foreign content from *Y* must be actively directed by *Y*. There would otherwise be no causal agent to direct the transfer, but only a null agent effecting no transfer. Endofields thus cannot passively (without each other's knowledge and explicit cooperation) observe and acquire new information from one another. One endofield can know the intimate experience of another without the aid and approval of any outside source only if the knowledge is generated internally by a sufficiently self-reliant and consistent rightness logic. Consistency logic in particular predicates a priori knowledge of all external reality. The presumed omniscience of the CIF is not the result of interactions with other fields, but is innate.

Because their lives are ultimately determined by external foundation worlds, the preceding argument does not apply to ectofields. One exogenous individual can sometimes passively observe another, or (effectively) impose its will on other ectobeings without their approval. The underlying endogenous processes nonetheless require the full cognizance and willing participation of all involved endofields.

Meaningful interactions among endofields are not limited to transfers of content unfamiliar to (or not explicitly anticipated by) the receiving fields. The endofield *X* may exactly specify, rather than set broad limits upon, the content it will accept from *Y*. This content can be meaningfully transferred if it is required to appear in a specified manner when and only when actively determined by Y. Two endofields can thus possess complete knowledge of each other and still interact, if each allows the other to partially determine its own course (albeit in an anticipated manner). Although largely ceremonial, such interactions are mutually intentional, verifiable, and therefore meaningful.

Every meaningful interaction between two endofields X and Y is thus actively determined by both fields. Whereas X imposes limits on the content that may be transferred to itself, Y determines the content that actually is transferred, within these limits. This deterministic link establishes a temporal correspondence between the fields, and imposes causal restrictions upon their mutual interactions.

Suppose in particular that X and Y interact at times t_{1x} and t_{1y}, respectively; and again at t_{2x} and t_{2y}. The content each field chooses to transfer to the other at either moment is influenced by its perception of the other field at that time. Each interaction is thus affected by the prior histories of the two fields. If $t_{1x} < t_{2x}$, then causality requires that $t_{1y} < t_{2y}$. The interaction at t_{1x} would otherwise be logically dependent upon the interaction at t_{2x} , which would be logically dependent upon the interaction at t_{1x} ; an indeterminate loop would be introduced into the causal flow, and causality violated.

This argument applies even to the transfer of anticipated, familiar content between fields that possess complete knowledge of each other. It may naively seem that such interactions cannot affect either field, and that the temporal restrictions therefore do not apply. Yet complete knowledge of another field requires an understanding of that field's causality patterns. If $t_{1y} > t_{2y}$ when $t_{1x} < t_{2x}$, an indeterminate loop would be introduced into the causal chains of both X and Y, violating causality and precluding complete knowledge of either field. Unless an exchange affects both fields, it does not meaningfully occur.

Because exogenous reality is determined by independent foundation fields, the preceding causal restrictions equally apply to the (effective) interactions among ectofields [this can be demonstrated even when exogenous time is tied to a time-like dimension of a timeless foundation world]. Every meaningful interaction between any two ideo fields thus establishes a temporal [or causal] correspondence that neither can subsequently violate. An individual may reminisce past events, but cannot change them; may contemplate the future, but can directly experience it only by allowing it to become the present.

2.8) Endofields whose respective contents and temporal relationships with other fields are identical cannot be meaningfully distinguished, and must be considered a single field. Endofields that become so identical at some point along their respective time lines similarly cannot be meaningfully distinguished at any subsequent time, and must therefore merge into a single unified endofield. The fields do not merely become as one; they literally become one. *Conscious merger* of this type may result from an exhaustive exchange of personal information and experience between two endofields that share a deep and mutual desire to enter into a conscious union. A field X may unilaterally merge with a field Y only if it is able to separately obtain sufficient information to metamorphose into Y, and the merger is not forbidden by the very volitions that X must accept in becoming Y. Field X may be required to abandon its former memories and identity in this case.

Conscious merger is not restricted to endofields, but may also involve exogenous beings. An endofield X will merge with an ectofield Y at a time t_y if X assumes a form indistinguishable from $Y(t_y)$, and if t_y is not already in X's past. The merger process requires that X have significant prior knowledge of Y. If X is unable to generate this knowledge internally, it must be willingly provided by an external source (e.g., Y's foundation world). Conscious union of a post-exogenous self with another ectofield of the original foundation world constitutes a reincarnation. An endofield in general sheds all previous memories, and relinquishes all direct self-control, when it merges with an ectofield. Lost memories may be recovered (if desired) only at the subsequent death of the new exogenous self.

[Reincarnation was a common theme in ancient octan religions. Yet Fleegello lost credibility with many of his contemporaries for his willingness to even consider the notion. This has often been attributed to an extreme version of logical positivism that permeated intellectual thought at the time. Fleegello was merely exploring the logical limits of his philosophical framework. He frequently asserted that a theoretical construct must remain uncertain – though not necessarily irrelevant, or meaningless – to the extent that it could not (currently) be tested.]

Perhaps the ultimate form of conscious merger for an octo would be merger with the CIF at the time of death. An octan self would be thereby lifted from the contingent cycles of mortal life, into an unimaginable plane of existence. The CIF would certainly be prepared for such a merger – every moment of an octo's prior life and experience would already be known in detail. Yet how many octos would both desire and be suited to such a radical voluntary transformation? [In his last jope, Fleegello wrote of his own personal feelings about the possibility of merging with the CIF at death. He admitted that the idea terrified him – life as Dama would be so shockingly different from that as an octo. Yet if he was not at least open to the idea, how could he truly embrace consistency logic?]

Two ectobeings will merge if their respective nervous systems become so integrated that all sensory inputs, memories, motivations, and conscious responses present as a single, unified field. Organisms can be imagined that achieve transient states of conscious union by linking special nervous appendages. Such mental apparatus apparently have not evolved for life forms on this planet. Exogenous merger thus remains an experience alien to octos, and can (in principle) be accomplished only by extensive surgical procedures.

[Fleegello did not envision the noninvasive techniques that accomplish the various types of restricted conscious union we now take for granted.]

2.9) In the ideobasic view of reality the universe has a finite past, which initially comprised a set of basic, independent ideo fields. Following a collective moment of self-creation, these primordial endofields evolved, interacting and affecting each other in a variety of ways. Whereas some of the endofields lead isolated and drab lives, others interact openly, even merge or split, and incorporate a rich infinity of content. Some may be immortal, while others barely cling to existence, or terminate after finite lifetimes.

Exogenous consciousness was presumably spawned and subsequently evolved within suitable primordial endofields. The death of successive generations of exogenous creatures constitutes a source of new independent fields. Many of these may lack either the means or the will to perpetuate themselves, and soon cease to exist. Others may recycle back to new exogenous lives. Only the stronger post-exogenous fields would evolve into viable, immortal endofields. Some of these may merge with other endofields, even the CIF, or generate their own unique exogenous consciousness.

Part III – Ethical Philosophy

3.1) A consistent ethical philosophy for octos and other sapient beings can be developed by applying consistency logic to a study of personal behavior and interpersonal relationships, within a framework of perceived (ideobasic) universal reality. A central principle applies: a person should strive to behave and interact with all realities (both internal and external) in a congruous, appropriate manner; in a way that contradicts neither the essence and defining characteristics of the self or any other thing, nor a given situational context.

To the extent that its behavior and experience are determined by an external foundation world, an ectobeing does not have true free will. Yet every exogenous creature possesses a unique will, and experiences singular desire. Endofields and ectofields alike are defined by their perceptions and will, however they arise. Octos and other intelligent life forms are further capable of developing abstract ethical philosophies. Mature members of such species cannot avoid supporting or opposing consistency logic (or any other general logic). A belief that the self cannot or should not live by a moral code, that individuals may properly ignore the consequences of their own actions, is itself a moral code. Though generated by the primary consciousness of an external foundation world, deliberate exogenous volitions are well defined, and consistent or inconsistent (right or wrong) in themselves. An ectobeing is effectively responsible for its behaviors to the extent that they conform to its personal volitions. An ethical philosophy is useful to an ectobeing to the extent that it has effective free will.

If an ectobeing were inevitably doomed to extinction at the end of its exogenous existence, then the rightness logic pursued during its lifetime would be irrelevant. An exogenous individual would be incapable of adopting consistency logic in a self-consistent manner; the logic would itself be condemned to die, a contradiction of its self-supporting character. Any attempt by an exogenous creature to pursue consistency logic, to acquire knowledge, would be pointless and ultimately futile. Yet the awareness of an ectobeing is expected to persist beyond ectodeath whenever its convictions are self-supporting. A pursuit of consistency logic and truth is then compatible with mortal existence; an ectoself can embrace consistency logic in a self-consistent manner. The self should further promote the acceptance of consistency logic by others, to the extent possible using consistent methods. It would otherwise be right that consistency not exist, where it might exist.

The highest octan endeavor is thus the expansion and growth of consistent consciousness, the realization of consistency truth in all its varied forms. An octo may embrace, emulate, and revere the CIF – our ultimate parent, the embodiment of consistency logic, the equivalent of a monotheistic God – while acknowledging the immediate limitations, poverty, and frailty of the octan spirit. Yet one should not worship the name of the CIF per se, or the sculptures, paintings and symbols created to express and represent ethical/religious concepts and entities. Idolatry is incompatible with consistency logic. Value resides in living content, in conscious ideas, not in the arbitrary or inanimate forms used to represent them. Blind faith in another person, even the CIF, is similarly contrary to consistency logic. Anyone who unconditionally accepts the authority of some external being would as readily accept from it the pattern $X \neq X$ as $X = X$. An octo (or any other ectobeing) embraces consistency logic only if xe puts ultimate faith in the principle of consistency itself. Consistency logic is not blind, but open-eyed.

An individual should, by consistency logic, act in accordance with what is. An action thus cannot be justified solely by its effect. If a means to even a virtuous end contradicts truth, then it is wrong. The CIF in particular may beget inconsistent ectoconsciousness when It would otherwise introduce inconsistent physical patterns and processes into Its own primary awareness. The CIF presumably does act to enlighten and aid other conscious fields, but only when this can be accomplished in a consistent manner.

An omniscient CIF can determine precisely how to most constructively affect other conscious fields. The decisions and actions of octos and other ectobeings are based on comparatively meager, incomplete knowledge and flawed perceptions. Yet an exogenous individual has no alternative but to select some course of action, to act according to some view of reality. To reject one behavior is to choose another.

3.2) Theories of the physical world can be directly tested by experimentation against physical reality – presumably, the very mind of the CIF. Application of the scientific method can expose errors and fill gaps in our understanding of physical principles. This is not the case with moral principles. To the extent that we cannot know the mind of the CIF regarding ethical matters, any moral system that espouses rules for judging actions and behaviors must be viewed with some skepticism. We may nonetheless develop plausible ideas, and test them for both internal and external consistency.

[Fleegello was reportedly discouraged that he was unable to rigorously derive an ethical philosophy from consistency logic alone. A few octujopes passed before logicians were able to accomplish his cherished goal, and transcend the popular consequentialist, divine commandment, and other deontological approaches of previous eras. It is remarkable that much of the moral guidance offered by Fleegello survived this revolution in ethical thought.]

Natural physical law can serve as a guide in developing a consistent ethical philosophy. Just as the same physical law apparently applies to all points (events) in time and space, so a common ethical law should equally apply to all sapient beings (including one's own self). This ethical law should be a function of the analogue of physical conditions – those characteristics that meaningfully define conscious fields and their situational contexts. These include personal beliefs, desires and aspirations, skills and capabilities, but not nominal titles – an analogue to physical coordinate systems – or any other extrinsic or prejudicial label of individual identity.

[Considerable evidence exists that Fleegello expounded broadly in his original work on this theme relating physical law and ethics. Only the short fragment presented here survives.]

The essential equality of all conscious beings is reflected in the Golden Rule of the Paxcross religious tradition: "Do unto others as you would have them do unto you." A person should equally care for the welfare of every conscious being – including xyr own – to the extent consistently and constructively possible. If a single unified awareness is worth nothing, then all awareness is without worth.

[The more extreme view that all octos are literally "one," that our sense of personal identity is only an illusion, was shared by a number of ongoing mystic religions long before Fleegello's time. Fleegello was supposedly fond of assigning his students the task of analyzing the following argument in support of this position, in order to identify the flaw in the logic:

Suppose the (non-trivial) conscious experience of two individuals S_1 and S_2 in distinct physical worlds become indistinguishable at times t_1 and t_2, respectively. A self is defined only by its conscious experience. The two individuals must then be considered one at that (dual) moment. This process is analogous to the way two physical worlds can merge. The merged self may quickly separate again into two distinct selves S_3 and S_4 (where S_3 shares common memories with S_1, and S_4 with S_2), if the supporting physical worlds remain apart. Yet while it is admittedly convenient to associate S_3 with S_1 and S_4 with S_2, it is objectively meaningless to unambiguously identify either emergent individual with one or the other line prior to the merger; their identities became indistinguishable at that moment. Not only is it meaningless to assert that S_3 is S_1, it is equally meaningless to assert that S_4 is S_1. Rather, S_3 and S_4 share a common progenitor, at the point of merger of S_1 and S_2. There is only an illusion of continuity of unique selfhood from S_1 to S_3, and from S_2 to S_4, created by memory. Just as an individual has no sensation of splitting into multiple selves as the physical universe evolves [according to the multi-world interpretation of Shrodiik physics], so there is no sensation of sharing selfhood with others. The identities of conscious individuals may intertwine and intermingle to a profoundly greater extent than previously understood. Much of our sense of separateness appears to be an illusion, maintained only by our immediate memory of the past.]

All octos, all sapient creatures, of all races and hives, are truly brothers, sisters, nisters [an archaic term, used to affectionately refer to neutor siblings], common children of the universal CIF spirit. Unless it flows from a sense of identification with all beings, from a sense of love and compassion for one another, a moral system is a hollow husk.

Whereas an ectobeing may thus sacrifice xyr own physical comfort and/or exogenous life for the sake of others in appropriate situations, xe should under no circumstance deliberately compromise or relinquish xyr consistent convictions and ultimate (post-exogenous) existence. Spiritual self-annihilation – the ultimate act of self-denial – would require a personal rejection of consistency (or any self-supporting) logic, and is therefore wrong. A person may justifiably disregard the conscious status and well-being of others only when xe would otherwise personally introduce inconsistent patterns into xyr own primary awareness, or in any way intentionally commit an inconsistent act. To aid another person by an immoral action is contradictory and unjustifiable.

3.3) A person should encourage others to abide by no logic but consistency, to the extent possible using consistent methods. This principle restricts the ways in which an exogenous being can morally respond to and counteract the inconsistent thoughts, aspirations and behaviors of others, and defines certain rights common to all sapient beings. Consider in this regard the interactions between an octan model character named Abo, who strives to follow consistency logic, and an antagonist Cano, who pursues an inconsistent ethic.

Abo should endeavor to convert Cano to consistency logic, though not all means to this end are acceptable. Suppose, for example, that Abo were to compel Cano to change via threats of physical harm or imprisonment. This method would be wrong even when successful, since Abo would thereby explicitly urge Cano to act out of fear for xyr physical safety and comfort – ultimately non-consistent motivations. Consistency logic transcends the nearsighted temptations of mere physical well-being. If Cano should convert for such a reason, then by uniform application of ethical principles, so should Abo – a contradiction of xyr assumed consistency.

Abo might seek to change Cano through physical conditioning, or by chemical/surgical manipulation of Cano's brain. Except when Cano is not opposed to such procedures, however, Abo would thereby require xem to blindly submit to external forces, and unwillingly relinquish all (effective) control over xyr own existence. Unless Abo is xemself willing to be manipulated by others against xyr will, to let others force xem to live by beliefs and rules xe currently rejects – a contradiction in itself, and an implicit repudiation of consistency logic – then Abo should not force others to live by xyr own moral code.

More generally, Abo should support the (effective) capacity and a consistent right of Cano to live in an independent, self-directed manner; to affect and be affected by other (competent) consenting individuals in mutually acceptable ways; and to otherwise guide xyr own personal life. This principle applies at least to the extent that Cano does not interfere with the same rights of others.

A consistent ethics must be grounded in reason, personal commitment, and free choice. It is inherently antithetical to a law of fear, force, and imposed decision. Any logic of force – "force makes right" – is ultimately senseless and mindless. It has no eyes, no ears, no constant unifying purpose. Ethical conversion by either fear or force is contradictory and self-defeating. To the extent that Cano is a mature individual with a pre-established morality, Abo is constrained in the ways xe may properly seek to convert Cano and affect Cano’s personal decisions. Abo may of course display exemplary behavior, but should otherwise rely primarily on logical persuasion (to the extent that Cano is receptive). Conversely, Abo should be willing to hear Cano's viewpoints.

The preceding argument supporting a consistent right of self-determination does not apply to aspects of an individual's existence regarding which xe has no comprehension or will. This exclusion is in particular relevant to octan infants and lower animals who either have not yet developed or are incapable of developing a conceptual moral code, or sense of right and wrong, regarding a given type of behavior. Until an ectobeing acquires a conscious belief, xe cannot be forcibly converted to a contrary one; a nonexistent will cannot be violated. On the other tentacle, an incompetent individual cannot meaningfully consent to involvement with any particular person, activity or lifestyle.

Consider now a capable octan child or other ectobeing named Enu who lacks moral convictions of a given type. Abo should attempt to fill the moral void with appropriate consistent values. This is a creative process, inherently beyond the immediate understanding and (effective) control of Enu. A method is acceptable so long as Enu neither rejects it conceptually nor perceives it as inconsistent. Physical/emotional conditioning may be a satisfactory and useful tool early in the developmental process, as long as Enu is not inadvertently taught to avoid (seek) physical pain (pleasure) per se, but rather to perceive pleasure (pain) as a positive (negative) attribute inherent in (in)consistent behavior. Similarly, Enu should not be inadvertently taught to perceive force as a legitimate means for controlling other willful creatures. The use of conditioning should be phased out as Enu develops relevant values, or if Enu begins to perceive punishment and reward as ends in themselves, divorced from the behaviors whose reinforcement is intended. Any infliction of pain to discourage undesirable behavior should be minimal, and may even be inappropriate for many octo infants, depending on individual temperament and sensitivities. [Fleegello reportedly resented the use of corporal punishment by his own parents when he was young, and steered away from such measures in childrearing.]

A necessary prerequisite for (im)moral behavior is a perception of self, an ability to view oneself as an entity relative to which standards of conduct apply. While most Jopian animals are capable of learned behavior, many can develop only a primitive self-concept, or none at all. Such life forms are more generally capable of very limited, or insignificant, abstract symbolic thought. Abo should not strive in vain to teach a creature a moral principle it is evidently unable to comprehend. Abo can furthermore rightfully control any aspect of a creature's life regarding which it has no will, and is unable – due to either internal limitations or external constraints – to develop an appropriate will. In particular, any animal incapable of conceptually rejecting external domination of its own life may be domesticated, and trained to perform useful functions. The consistent right of the animal to guide its own destiny is not thereby violated, since it has no applicable will. Similarly, any creature unable to develop either a concept of self or a comprehension of its own future may be rightfully slaughtered for food. The control of lower animals should be commensurate with just needs. Unnecessary infliction of pain or suffering constitutes cruel, immoral behavior.

Although the subjugation of various suboctan species might be justified by their limited mental capacities, the capabilities of some creatures are undoubtedly underestimated at the present time, and their conscious rights systematically abused. Animals that develop even a rudimentary perception of self should be domesticated only as infants; wild adult members of such stock generally possess well-defined personal volitions that taming would forcibly break. Mental superiority per se is an insufficient justification for one individual or species to dominate the lives of others. Even when a person has the right to direct a lesser creature's life, xe is obliged to use methods of control to which that creature is conceptually receptive, whether by active choice or by passive, stupid acceptance.

Octos should procreate in order to expand and propagate consistent consciousness and truth, and not consciousness per se. The quantity of conscious life is of secondary importance to its quality. The birth rate should thus be adjusted to maintain a balance between exogenous needs and available resources, in order to permit a constructive standard of living. Acceptable methods of birth control include both contraception and the abortion of preconscious embryos. Neither procedure violates the rights of a nascent creature, since an organism has no rights prior to the initial appearance of a unified awareness. An individual is meaningfully defined only by its conscious content and will. Until a fetal nervous system generates the first of a unified sequence of ectoconscious states, there is no individual whose rights can be violated.

[Debate raged during Fleegello's time regarding the morality of abortion in particular. It is difficult to appreciate the emotion generated by this issue, fueled by basic and often tragic misconceptions concerning consciousness and individual rights.]

3.4) In addition to fostering a universal acceptance of consistency logic, Abo should endeavor to counter the injustices committed by others. This includes actively supporting and defending the (effective) consistent rights of every exogenous being, including xemself. In particular, Abo should uphold self-determination, the freedom of personal belief and choice, as a central right. Whereas every capable individual has a right to direct xyr own life, to interact with others in mutually acceptable ways, xe does not have a right to violate the same freedoms of others (except when xe would otherwise be required to personally generate inconsistent patterns within xyr own primary awareness). While physical determinism may ultimately preclude absolute freedom for exogenous creatures, and the scarcity of and competition for natural resources further restricts effective freedom of personal choice, Abo should strive to both equalize and maximize the effective freedom of belief and choice within xyr society. Yet respect and support of this freedom should not be confused with support of the beliefs and choices per se.

Not all means of supporting personal rights are acceptable. Abo should not protect the rights of one individual by (directly) violating the rights of another, or by encouraging another to think in an inconsistent manner. This applies even to adversaries like Cano, who intentionally violate the very freedoms Abo defends. Cano does not lose xyr own legitimate rights merely because xe knowingly infringes upon the rights of others.

Abo should thus selectively resist and counteract only those specific activities of Cano that trespass others. Force should be explicitly directed against offending actions, and not against Cano per se. Abo will thereby infringe on Cano to the minimum extent necessary. Defensive measures, when practical, are optimal in this regard. For example, if Cano hurls a bomb at a gathering of octos, Abo might deflect it with a shield. Weapons and other implements used by Cano may be appropriately altered or affected such that they cannot be (easily) used to wrongly subdue others. Offending weaponry may be destroyed, if it is not also required to perform vital legitimate functions – e.g., warding off serpent attacks.

Countering the unjust actions of Cano is clearly ethical when force is not directed against xyr person. But what if Cano's body becomes inseparable from xyr unjust act? What if there is no other way to thwart Cano, but to direct force against xyr very flesh? Such use of force may injure or otherwise incapacitate Cano, and so *indirectly* hinder his *legitimate* pursuits. But as long as this is an unavoidable consequence of directly opposing illegitimate actions, which Cano has no inherent right to perform, it can be argued that this type of resistance is justified. If Abo refuses to forcibly oppose Cano when there is no other viable option, in the belief that xe has no right to ever interfere in this manner, then xe becomes complicit in Cano's offenses. Deliberate inaction is itself a purposeful action. By not acting to stop an intentional wrong when action is possible, Abo becomes partially responsible for it.

There are limitations to the preceding argument. It applies only when there is no purely defensive option available. Forceful restrictions of Cano's freedom should further match the level of injustice that Cano is committing. Abo would otherwise be responsible for transforming one transgression into a still greater offense. For example, deadly force should not be applied when Cano is merely bullying another. Use of deadly force can be justified only as a last resort, when Cano is about to cause unjustified grievous harm, and Abo believes there is no other way to obstruct xem. For example, if it appears that Cano is about to fire a tentac gun to slay an innocent (within the given context) person, and there appears to be no other way to stop xem, then Abo may justly shoot Cano with xyr own weapon. In this case Abo should strive to debilitate Cano to the least extent possible. Cano may be physically restrained from misusing weapons, though any use of restraint should be selective.

Abo may inform Cano that xe will use (deadly) force in certain situations, in order to dissuade Cano from committing future injustices. It should be made clear, however, that such action would be strictly in defense of personal rights, and not inflicted as punishment or retribution. Abo would otherwise encourage Cano to act explicitly out of fear of physical harm.

Whereas it may seem immoral to forcibly violate Cano's freedom in any situation, it is also immoral to allow another person to be treated unjustly. Unlike endogenous beings, which have true free will, and can only affect each other in mutually agreeable ways, exogenous creatures can often impose themselves on each other. This engenders a variety of ethical conundrums. Whenever Cano is responsible for intentionally violating an innocent person, then defending the afflicted person's freedom must trump respecting Cano's (comparable) freedom.

[In his earliest writings, Fleegello was a "hard" pacifist, and believed physical violence against another person was never justified. His views apparently changed only after he sired and helped to raise a daughter. Fleegello struggled with this conversion to "soft" pacifism for the rest of his life, questioning whether it was based on logic, or merely a personal need to justify protecting loved ones from harm.

Fleegello was also concerned with the role that superstition and other types of magical thinking played in his reasoning, and supposedly wrote several essays on the subject. During a particularly stressful period, he reportedly found himself alternately wondering whether Dama might be punishing him for compromising his pacifistic stance, or testing his commitment to reason.

Scattered small groups have practiced strict pacifism over the kilujopes, at least since the time of the Paxcross revolution, believing it wrong to ever intentionally harm or constrain the mind or body of anyone. Yet strong pacifism has never achieved widespread acceptance throughout Octan society. It is unlikely that such a circumscribed morality can even become dominant for an extended period. History shows that every civilization eventually confronts a brutal aggressor, which can only be resisted through some use of force. Rightly or wrongly, a strictly pacifistic society cannot long endure in our physical world.]

Consider now a distinct type of moral dilemma, in which a number of sapient ectobeings are threatened with death or serious injury, and the only way for Abo to protect them is by sacrificing a smaller group of non-consenting innocents. Such a situation may arise through the course of so-called natural events (as in the classic "rogue serpent" scenario), or be intentionally contrived by a wrongdoer. For example, Cano may threaten to annihilate an entire hive, unless Abo kills a single octo whom Cano dislikes. Yet how could killing that individual without xyr sanction be ethical in this situation? Abo would be required to direct force against the inviolable will of an innocent, as opposed to the deliberate unjust act of an offender.

Existence is experienced by individuals, one by one, and not by groups. Injury or death in particular is experienced by the individual, whether in a group or in isolation. Every person is a universe, unto itself. In this sense, the unjust killing of a single person is equivalent to the killing of all octokind.

[Fleegello borrowed this reasoning from an earlier religious tradition. Critics have (sometimes intentionally) misread the passage to suggest that Fleegello did not value groups, or interconnections among people. This is clearly a misinterpretation.]

The preceding argument even applies to protecting Cano, were he to unintentionally create a threat to others (though it does not apply to threats caused by intentional negligence). In this case, Cano would xemself be an innocent, and harming xem to protect the others would be wrong. Any intentional behavior that is not a deliberate violation of another person's rights should itself be inviolable.

If the just freedom of a single person is not sacrosanct, then the just freedom of no person is. There may be no circumstance that would justify Abo intentionally injuring or killing an innocent without xyr consent, even to save a host of others from a comparable fate. [Fleegello supposedly confided in private correspondence that he would be sorely tempted to violate this precept in extreme situations, and was profoundly sympathetic with anyone caught in such a quandary.] Abo might voluntarily sacrifice xyr own exogenous existence for others, if this is xyr free choice, but xe cannot justifiably make the choice for another.

[Fleegello stood by his convictions during the great insurrection of Cor midway through his life. The peoples of Fleegello's native province had enslaved a white-skinned race closely related to the octos, known as blanchos, octujopes earlier. While these creatures (extinct now) were certainly capable of abstract thought, and some could even read and write, they were as a species objectively less intelligent than the octos, and had been widely considered inferior and not worthy of any personal rights. The octos had used them primarily as domestic servants and laborers.

Yet public sentiment had been slowly turning against the practice of blancho slavery. Unwittingly emboldened by a militant antislavery movement, which sought only to legally free the slaves and establish protected blancho preserves, the supposedly passive blanchos finally rebelled against their masters. The vehemence and coordination of the blancho action caught even their octan supporters by surprise. The bewildered paternalistic slave owners reacted with brutal force. At the height of the revolt, octo and blancho slaughtered each other by the thousands, in one of the most gruesome chapters of octan history.

While Fleegello advocated an immediate abolition of all slavery, he refused to support the use of violence against either the blanchos or their oppressors throughout this period. He understood how the blanchos were fighting for their freedom, but believed much less drastic approaches were appropriate. All but the closest of his family, friends, and associates renounced Fleegello for this stand. The pro-slavery faction accused him of misdirected idealism, stupid sentimentalism, and an unconscionable lack of community spirit and patriotism that threatened to wreck the economy and octan society alike. Many in the antislavery camp accused him of cowardly abandoning the blanchos in their roh of need.

Most philosophers of this time also disagreed with Fleegello. Some believed that superior intellect per se was an acceptable justification for enslaving another group. Others thought it was ethical to sacrifice innocents for the sake of society under extreme conditions, that the ends justified the means. Many antislavery proponents argued that it was ethical to incarcerate or even kill any person who had become an instrument of evil – in particular, an intransigent slave owner. The only thing most philosophers of the time agreed on was that the glorification of killing was immoral and dangerous.]

3.5) Social animals of sufficient abstract intelligence may establish formal governmental bodies for promoting particular activities and regulating various aspects of personal behavior and interpersonal relationships. Government cannot exist in a philosophic vacuum. Any form – monarchy, dictatorship, democracy – is bound to a viewpoint of the individual and xyr place in the universe. The lack of a philosophic stance would imply a total absence of social order, precluding social existence altogether. All government performs three basic functions: legislative (formulate programs to support specified goals or values, and laws that individuals or groups are expected to obey); executive (enforce the law by legislated methods); and judicial (arbitrate disputes concerning the interpretation and execution of the law). Every system grants certain liberties and denies others, rewards certain behaviors and discourages others.

An ethics based on consistency logic and ideobasic principles places prime value in the individual, xyr (effective) free will and conscious development. A political state has no unique consciousness, and should therefore exist only for the sake of its constituents. If the individual is worthless, then so is the state. A society that is served and perpetuated for its own sake is an empty shell. The inanimate trappings of a civilization – its buildings, roads, gardens, monuments – are no more fulfilled in themselves than the barren wastelands of Ieo, and acquire relative value only as they relate to individual exogenous needs.

The main purpose of a government founded on a consistent ideobasic perspective would be to uniformly support and protect consistent individual rights, while promoting activities that sustain and expand consistent consciousness. The appropriate rights of all sapient creatures should be affirmed. Any sapient being who sincerely agrees to abide by the relevant principles and laws should be offered citizenship. Every citizen should have equal opportunity to affect governmental policies and decisions in all matters over which xe demonstrates a reasonable, prescribed level of competence.

Support of and participation in such a state would be wholly voluntary. The government would not forcibly collect taxes or other tribute from a populace. It may, however, rightfully deny citizenship to anyone who refuses to support it, and deny privileges – e.g., access to a transportation system – to those who do not fulfill appropriate requirements. Denial of societal privilege should not be arbitrary, but uniformly determined by a person's apparent beliefs, aspirations, skills and needs.

Methods for establishing and maintaining an ideal society in the face of antagonistic ideological/political systems are tightly circumscribed by consistent ethical principles. Logical persuasion and education are fundamental. Shields and barriers may be used to protect and control access to governmental and public facilities. Devices that are used to violate personal rights, or to subvert legitimate governmental functions, should be appropriately altered, dismantled or destroyed. Official police and military corps may be established, to help defend personal rights (of all amenable inhabitants, citizens or not). Its members should be highly trained to apply force against offending sapient beings only as a last resort, and in the least intrusive ways possible.

Some individuals may be deemed (through an impartial judicial process) to be habitual threats to other people and/or to governmental institutions. Such persons should not be simply locked away in traditional prisons, since these facilities normally limit violable and inviolable activities alike. Extreme offenders may nonetheless be restricted to designated hives, with access to other hives prohibited. Residents should be free to lead as normal lives as possible within these non-traditional penal colonies, and provided the usual police protection of their private rights. There should also be a procedure whereby an incarceree can regain access to the broader society. No individual should be imprisoned simply because xe has inconsistent beliefs or an inconsistent lifestyle, if xe does not violate the rights of others. Imprisonment should not be viewed as punishment or retribution for previous behaviors, but as a means to protect the personal rights of others.

Corporal punishment of criminals is generally wrong, in that force is not thereby directed against an ongoing unjust act. Revenge or retribution for past misdeeds is similarly improper. Corporal punishment can be a deterrent to future crimes only if a subject acts out of fear for xyr physical comfort, a non-consistent motivation. The use of torture to extract information from an adversary is likewise unethical, though administering a truth serum to extract vital information may sometimes be justified. The intentional infliction of corporal pain is appropriate only to reinforce consistent values in premoral or otherwise receptive individuals, and to help control the behavior of amoral creatures.

Capital punishment is an expedient but unjust means of protecting society from the most serious offenders, since it ends their inviolable personal activities as well as their violable, extrapersonal ones. Capital punishment is often viewed as retribution for prior heinous acts. Yet it cannot reverse those acts, and is not explicitly directed against either them or any other unjust behavior.

A government does not have the right to confiscate someone's possessions merely because xe employs them in an inconsistent manner. So long as a person is effectively responsible for creating or establishing an implement or property (either by direct effort or by exchange value), and uses it in a way that does not interfere with the rights of any other individual, then xe should be considered its rightful owner. Relative wealth and prosperity per se are similarly insufficient reasons to deprive a person of xyr possessions. If a person accumulates material goods and depletes natural resources to the extent that xe interferes with the equal opportunity of other persons to lead independent lives, however, then a government can rightfully seize and redistribute a portion of xyr wealth to (re)establish equity.

A society founded on consistent ideobasic principles may generally be less adapted to physical survival and expansion than ones based upon more aggressive, coercive philosophies. The latter have at their disposal a broader assortment of more effective offensive and defensive strategies – e.g., forced labor, torture, capital punishment and other forms of legalized killing – with which to physically combat their foes. Yet ideobasic ethics should not thereby be dismissed as unrealistic or too idealistic. Consistent values are not invalidated by an inferior ability to promote material survival and prosperity, since they do not attribute ultimate value to those conditions. Although ideobasic ethics may frequently be an unrealistic means by which to foster immediate physical well-being, it offers the most realistic road to ultimate conscious survival and growth.

[Fleegello helped to found the League of Universal Associates (LUA) in the final jope of his life. This organization was intended to foster a sense of global community and responsibility, and to serve as a bridge between government and a variety of philosophical and nonsectarian religious groups. Fleegello's own local and national governments had become increasingly dominated by the politics of special interests. LUA sought to promote a broad perspective that transcended the self-interests of any single group. This vision quickly expanded beyond the concerns of the local nation state, to encompass the needs of people and races planet-wide. Membership in LUA was open to any individual or institution demonstrating a commitment to a global perspective and several concomitant tenets, including religious tolerance and a belief in the worth and dignity of every self-conscious being. Formal enrollment required confirmation by a membership committee, elected by all LUA members (LUA was internally democratic in most respects, within limits set by its constitution). While LUA maintained close ties with many liberal religious societies, and regularly endorsed candidates for public office, it strove to remain nonsectarian and nonpartisan throughout its long history.]

Appendix E – Commentary and References

Clarifying non-fictional commentary and references concerning octan philosophy and religion

Ideobasism, the dominant octan philosophy, can be considered a form of *idealism*, as it ascribes ultimate reality to conscious entities.[1] The fictional octan philosopher Fleegello developed ideobasism using an introspective approach, analogous to that of the rationalist human philosopher René Descartes in fifteenth century France.[2] Fleegello observed that his experience consisted of diverse *content* in transient states of *being* or *awareness* within his conscious field. The changing content seemed to involve interactions with an external world that included both inanimate objects and animate bodies. He appeared to not have direct knowledge of ostensibly external things, but to learn about them only through the intermediary of sense perceptions.

Like Descartes, Fleegello did not reject the reality of an outer world (as do some idealists), but thought it more plausible (or straightforward) that an objective external reality exists. While he may have relied on sense perceptions more than Descartes, Fleegello also employed reason to make sense of personal experience. In particular, he recognized that knowledge of any outside realm might be limited (even shaped, or distorted) by his indirect access to it, and thus could not be certain. This view is akin to that of the eighteenth century *transcendental* idealist Immanuel Kant, who distinguished between the appearance of things (*phenomena*) and the things themselves (*noumena*), and sought to resolve disputes between rationalists and empiricists.[3]

Descartes employed methodological doubt and reason in an attempt to identify knowledge he could be absolutely certain of, starting with the self-evident assertion "I think, I exist," and proceeding to the existence of "God," the reality of external material objects, and the duality of mind versus matter. Confronting similar doubts, Fleegello instead concluded that absolute certainty was not attainable in any quest for truth; that he could be completely certain of nothing – not even the truth of this very conclusion. In addition to Kantian-style doubt, he could not be sure that a malicious agent did not manipulate his thoughts and undermine his reasoning, even regarding tautologies, deductive truths, or Descartes' most "clear and distinct perceptions." Yet Fleegello was not flustered by this conclusion. Rather than being paralyzed with skepticism, he proceeded to identify apparent (tentative) truths, based on his personal experience and ostensibly consistent reasoning.

Judgment of rightness and truth was a critical issue for Fleegello. He argued that any such assessment must be dependent upon a set of presumptions regarding right and wrong – a *rightness logic*; there is otherwise no basis for decision. Fleegello extended this view even to judgments regarding so-called *logical* or *necessary truths*,[4] for example the statement "1+1=2." To Fleegello, any evaluation that such statements are necessarily true (based on definitions of terms, etc.) presumes prior acceptance of a consistent logic. An individual who instead believes that it is right to be inconsistent might easily judge such truths to be false. To follow a consistent logic is a moral choice. Certainly, there are humans who are willing to be inconsistent when it serves their purposes. While most traditional philosophical systems inherently assume that logical arguments should be consistent, Fleegello thought it critical to note that this orientation is a choice, not a given.

Fleegello argued that a sapient being must accept *some* philosophical/religious perspective, and follow *some* (set of) rightness logic(s). Even a nominal rejection of all perspectives is itself a contradictory embrace of a negative position. Available rightness logics can be categorized by degree of generality. For example, "It is wrong to steal" is an important rightness principle for many people. Yet this rule applies to only a limited set of activities; other guidelines must be called upon, when it is not applicable. Fleegello felt that many shortcomings of traditional octan philosophical schools derived from their embrace of (multiple, often inconsistent) restricted rightness logics, which can lead to contradictions when applied to the broad world. This prompted him to seek out *general* rightness logics that apply to all meaningful things, in particular the so-called *consistency logic*, which underlies traditional philosophical, mathematical, scientific and ethical reasoning. In its most austere form, this logic assumes the tautological form "$X = X$," where X is arbitrary. The antithesis of consistency logic is the contradictory assertion "$X \neq X$," or "it is right to be inconsistent."

Physicalist (or *materialist*) philosophers, such as Democritus in ancient Greece, Thomas Hobbes in seventeenth century England, and Daniel Dennett in twentieth century America, have maintained that reality is comprised only of inanimate matter, and that all consciousness derives from inanimate processes.[5] In its extreme (*eliminative*) form, physicalism may even assert that the concept of awareness or consciousness is derivative and unnecessary. Fleegello argued that awareness is a meaningful and independent construct, distinct from the content of experience or any underlying physical processes. An analogous *philosophical zombie* argument has been commonly used to support this idea.[6] Edward Feser has written a broad introduction to the philosophy of mind debate, including a useful glossary of many relevant terms.[7]

Descartes dealt with the mind-body issue by adopting a *dualistic* perspective, in which reality is composed of two distinct substances: inanimate matter, plus animate mind.[2] Fleegello instead argued that content can be meaningful only when it is linked to awareness, or immediate existence, either by one's own self or some other (external) self. He further reasoned that awareness and existence are meaningful only when linked to immediate (versus merely potential) content.

This argument centered on causality. Fleegello asserted that the lack of an agent that drives a state in any direction is indistinguishable from, and therefore equivalent to, the presence of an agent that drives the state in no direction. It would then be a contradiction if a pattern that is acted upon by nothing – by a null force driving it in no direction, including its own perpetuation or persistence – does move in some direction, and endure (whether in a temporal or a non-temporal sense). Reality must then be completely deterministic.

Consider now a content that has only potential existence at some given time. The content is nowhere to be found at that instant; although it is supposed to be "potentially" available, it is in fact not found. It is distinguishable from nothing only if it can evolve into or produce a sensation in some individual at a future moment. Yet there is no way the content can propagate into the future. It is perceived by nothing, not even itself. There can then be no causal agent to carry it through time. Such an agent must first locate and be in the presence of the content before it can act upon it. But the content would then (by definition) have immediate existence with respect to the agent.

Ideobasim is *monistic*, in that all meaningful things are ultimately composed of *ideos* – the inseparable union of content and awareness (immediate existence), in contrast to the inanimate atomic/quantum monad of physicalism. This ideo *substance* is organized into unified *ideo fields*. Fleegello observed that his own ideo field was restricted in scope, and seemed to be anchored to a particular animal body. He also perceived other animal bodies, which appeared to be associated with unique conscious fields that experienced the world in a similar way. Both he and the other animal beings seemed to be largely dependent on the inanimate world for their continuing existence. He labeled this type of dependent field an *exogenous* ideo field.

If all things are composed of ideos, then the inanimate physical universe, including the corporeal aspects of animal bodies, must be comprised of one or more additional ideo fields. Fleegello observed that the external physical world appears to operate in a consistent, autonomous manner, following the same dynamic patterns at all points in space and time, as if it were of a single coherent (though alien) mind. There is no indication that inanimate reality is dependent on any substratum for its own existence. Fleegello hypothesized that it comprises a single, self-caused ideo field that embraces consistency logic – the *Consistency Ideo Field*, or CIF. He labeled this type of independent field an *endogenous* ideo field.

In place of Descartes' mind/matter dualism, the ideos and ideo fields of ideobasism thus come in two distinct flavors – endogenous and exogenous. Whereas endogenous ideos are associated with independent, self-directed ideo fields such as the CIF, exogenous ideos (including those associated with human awareness) are generated by and temporally dependent on (physical) patterns in an underlying endogenous field (e.g., the CIF). Fleegello felt that the physical patterns in an animal brain/body must encode novel content (information) in an unambiguous manner. Because content without immediate awareness is meaningless, this content emergently acquires its own awareness.

Ideobasism thus offers a bridge between traditional monistic and dualistic perspectives, and a resolution to the problem of interactions between mind and body that plague dualistic approaches. Ideobasism is even compatible with some aspects of physicalism, in that animal consciousness is conceived to arise primarily from material processes in a quasi-*epiphenomenological* manner.[8] Yet this consciousness is not denigrated as a mere, insignificant byproduct, and consciousness can also persist endogenously, without a physical body.

Ideos bear some resemblance to the monad substance of Baruch Spinoza, a seventeenth century Dutch philosopher.[9] This substance has dual *attributes* of mind (thought) and body (matter, or extension). Spinoza viewed God as impersonal, identical to this infinite, self-caused, and eternal substance, and possessing an infinite number of additional attributes. Thus, while God is immanent in Nature (a *mode* under the thought and extension attributes), God also transcends Nature. Yet the monism embraced by Spinoza is *substantival* (or *absolute*), while the monism of ideobasism (and most forms of idealism) is *attributive* (or *category*).[10] Whereas Spinoza viewed human consciousness as finite modes of one common substance, animal consciousness in ideobasism arises from the CIF, yet is separate from it. Like Spinoza's God, the CIF potentially includes consistent truths and personal aspects that transcend Nature.

Bishop George Berkeley, an Anglo-Irish *subjective* idealist, developed yet another monistic viewpoint in the eighteenth century.[11] Berkeley argued that inanimate objects cannot act as causal agents; spirits (souls) are needed to cause perception, and are thus the only substances that actually exist. He considered irrational the idea promoted by John Locke and other contemporary empiricists that matter exists autonomously outside the mind,[12] and asserted that human perceptions of physical processes must be produced and causally directed by an infinite Being, namely God. While Berkeley's analysis is wrapped in the language of his Anglican faith, there is some structural overlap with Fleegello's reasoning and conclusions. For example, Berkeley's God corresponds in many respects to Fleegello's Consistency Ideo Field (CIF). The two perspectives nonetheless do diverge. Whereas Berkeley had faith in his God, Fleegello did not put his faith in the CIF per se, but rather in the consistent rightness principle that the CIF is supposed to embody. Berkeley also does not elucidate why or how "life forces" are the only causal agents.

Fleegello identified self-supporting rightness logics as the agents that cause endogenous ideo fields to persist. To this end, he considered a hypothetical, free-floating ideo whose content is consistency logic. Since this ideo is the affirmation of a rightness logic, it is its own natural standard for logical judgment. Consistency logic is self-supporting – the logic is judged right, relative to itself. Since content without being is meaningless, a thing is true only if it is right to believe that it exists. If the ideo were to deny that its own content exists, then it would also deny that its content represents truth – a contradiction. Consistency logic must then grant itself both continuing and a priori existence. The ideo provides its own reason for being, is self-sufficient, and self-caused.

By similar logic, the ideo naturally generates all compatible content within its field. This overall ideo field comprises the CIF. In addition to extra-physical content, the CIF must incorporate all possible consistent mathematical objects and relationships, or it would implicitly deny their consistent status. Such content may be identified with the physical (pan)universe. This view of physical reality is a cousin to Pythagoreanism and Platonism, in that it supposes the independent existence of mathematical entities. Yet unlike Platonism, these entities do not exist in a mysterious hidden realm, but are manifest through nature. The ideobasic view is also similar to the *mathematical universe hypothesis* recently proposed by the cosmologist Max Tegmart, in which the physical universe consists of a set of (consistent) mathematical structures.[13]

Fleegello thus proposed an argument for the a priori existence of the CIF, based on an analysis of a consistent judgment of truth, in place of Berkeley's causal proof for the existence of God. Fleegello's proof is also distinct from common ontological arguments for God's existence, such as that proposed in 1078 by Saint Anselm.[14] It can be extended to require the a priori existence of endogenous fields associated with any self-supporting rightness logic.

In contrast, an exogenous ideo field is ostensibly created, unified and perpetuated by the dynamic physical patterns of a foundational endogenous field (in particular, the CIF). To Fleegello, exogenous emotions are the conscious manifestation of the physical mental coding that makes different states or behaviors more or less desirable in a given situation. As the conscious expression of a creature's feelings and attitudes, emotions reflect underlying rightness logic(s). Conscious will and desire are similarly mirrors of associated rightness patterns.

Fleegello felt that exogenous rightness logics are not limited to rational assertions of goodness (e.g., "it is right to be consistent"), but include non-rational desires and the most basic, primitive instincts (e.g., "it is right to seek sex"). This position resembles that of ethical *emotivism*,[15] which holds that the statements "this is good" or "this is right" are equivalent to (or follow from) "I desire this." But emotivists typically view all such statements as equally valid, and mere expressions of emotional attitudes, devoid of any truth value. Instead, Fleegello argued that in attempting to reason in a consistent manner, a person implicitly embraces the consistency general rightness logic, and to assert that statements upholding other rightness patterns (whether general or restricted) are equally valid (as opposed to merely possible) is a contradiction. Thus, statements of a person's desires and attitudes toward rightness may still be good or bad, right or wrong, from the perspective of consistency logic.

Unlike an endogenous field, an exogenous creature may simultaneously incorporate multiple contradictory rightness patterns. A person may strive to follow a lofty moral code, even while assaulted by the most primal, oppositional instincts. Instinctive drives may even fluctuate in intensity, outside conscious control, depending on a person's physical state. Fleegello felt that this leads to confusion about emotion, and its association primarily with non-rational impulses. Yet how can a person claim to embrace even a rational logic, without feeling an emotional conviction to it? Lack of emotion implies an absence of motivation; an emotionless pursuit of logic is an oxymoron.

The mental coding of an exogenous creature must not only define an internal model of the external world; it must also define the emotional significance of the various entities in that model. What is to be avoided, or feared? What is to be cherished, or sought out? Without emotional context, the individual model components have no consequence, and so no meaning. Indeed, how then could an exogenous creature have consciousness at all? Just as a rightness logic is required for an endogenous being to persist, so rightness patterns are needed for exogenous content and consciousness to meaningfully exist.

When an exogenous creature dies, Fleegello reasoned that the former content should beget a corresponding endogenous being, no longer controlled by and confined to a material body and time line. Because an endogenous ideo field is unified and perpetuated only by its inherent will, this liberated being may split into multiple selves, if its will is divided. It may merge with another field, if the mutual wills are compatible. It may even be stillborn, if it lacks sufficient will to continue.

The ideobasic view of the world is *panentheistic*,[16] in that it interprets our physical universe as an immanent manifestation of the mind of a panuniversal Being, which in turn timelessly transcends the physical realm. This Being does not "intervene" in the world, in that It *is* the world (and more). What we see as physical laws are descriptions of the physical patterns embraced by the universal mind. Any supposed deviation from these laws represents a pattern we do not yet understand. Indeed, the laws of physics (as currently formulated) are not ultimately explanations of anything, but rather descriptions (albeit quite accurate ones). Physics will remain a description, until it can elucidate why physical patterns are what they are, and not something else.

Spinoza's view of God is similarly panentheistic, in that the associated substance has an infinite number of attributes in addition to mind and matter. Various non-western philosophies also embrace panentheistic conceptions of the Divine. Consider Hinduism, for example. The six orthodox Hindu philosophic schools encompass pantheistic, panentheistic, monotheistic, and even atheistic beliefs.[17] The Vedanta school (the name originally referred to the Upanishads, the "last part" of the Vedas scriptures) is dominant in modern times. All strands of Vedanta include a belief in the existence of Brahman, the Supreme Godhead.

The subschools of Vedanta differ primarily in how they view the ultimate nature of Brahman, and the relationship between Brahman and the individual. Advaita Vedanta (established by Adi Shankara, circa 788–820 CE) maintains an absolute monistic viewpoint, in which everything in the universe except Brahman is considered an illusion. Even the individual self is unreal. Brahman exists as a constant, impersonal emptiness, with no attributes or form. Vishishtadvaita Vedanta (founded by Ramanuja, circa 1017–1137 CE) espouses a distinct attributive monistic (or *qualified non-dualistic*) concept of Brahman that is more similar to the CIF. In this view, Brahman has essential qualities or attributes, including (non-human) intelligence and knowledge. While the universe is perceived through a cloud of illusion, it does exist. An individual's sense of self is not an illusion, but a reflection of Brahman's eternal truth. The universe nonetheless cannot be divided into separate pieces. The Divine and the Physical exist in harmony as a non-dualistic whole.
In both Vishishtadvaita and Advaita, consciousness is the essence of phenomenal reality. Dvaita Vedanta (developed by Madhvacharya, circa 1238–1317 CE) holds a dualistic (arguably monotheistic) position, in which the supreme reality of Vishnu (equivalent to

Brahman) is distanced from the real but separate physical universe, which includes matter and individual souls, and is itself Vishnu's creation. God is now personal, and grants salvation (liberation and freedom) to the worthy.[18]

Idealism lost favor in academic circles of the United States and Great Britain in the early twentieth century, after various philosophers educated in the British idealist tradition – most notably, Bertrand Russell and G. E. Moore – turned against idealism (and later traditional philosophy in general), and developed *analytic philosophy*.[19] Propositions were re-expressed in the language of *symbolic logic*, developed previously by the German mathematician/logician Gottlob Frege, with the goal of avoiding the ambiguities of natural language. The analytic school also turned from constructing grand philosophical systems, to focusing on rigorous analysis of narrowly defined issues. In the fictional account of octan history found in *The I of the Storm*, analytic philosophers translated Fleegello's ideobasic arguments into a purely formal language following his death. While assorted logical ambiguities and errors were thereby resolved, Fleegello's broad conclusions remained intact. Whether ideobasism would actually survive such logical scrutiny is an open question.

Russell, an agnostic (nearly an atheist, from a practical point of view) throughout his adult life, subscribed to *epistemic structural realism* (a type of *indirect realism*) – the view that science can illuminate the causal relations of real things, but cannot reveal what those things are, in themselves.[20] While perception and science accurately describe various aspects of experience, neither can provide an understanding of the underlying world as it actually is. Only introspection can provide direct knowledge, but of nothing more than a person's own mental state. By 1919, Russell espoused an attributive version of *neutral monism* – the monistic view that the ultimate constituents of reality are *sense data*, which are neither physical nor mental, but which can be organized or interpreted as physical or mental in different situations.[21] These objects are considered neutral, insofar as mental and physical substrata are not presupposed. They can be understood through scientific study of causal relations. Sense data are called *qualia* – the non-functional and non-intentional qualities of subjective experience – when they are before the mind. This viewpoint rejects both the material substance of physicalism, and the mental substance of idealism. It is mind, not brain, that is known directly; physicalist attempts to reduce mind to brain are erroneous. Yet neutral monism also has an element of pan-psychism, in that there is a mental aspect to all meaningful things. There is thus some overlap between Russell's neutral monism and the attributive monism of ideobasism. Spinoza's metaphysics may itself be regarded to be a substantival form of neutral monism.

Analytic philosophy led to *logical positivism* in the 1920s.[22] In this philosophic system, every significant assertion is either *analytic* (a statement of formal logic) or *synthetic* (a verifiable statement of science). All other assertions are dismissed as nonsensical. Most of traditional theology and metaphysics (including ideobasism) is thereby denigrated as nonsense. Yet logical positivism is self-refuting, as its own tenets cannot be verified empirically. Its applicability is now widely seen as limited to the acquisition of scientific knowledge.

Idealism experienced a resurgence later in the twentieth century, with the development by physicists of relativity theory[23] and quantum mechanics.[24] These revolutionary paradigms challenged fundamental classical notions about the physical world, and recast the role of an *observer*. Special relativity, introduced by Albert Einstein in 1905, is based on two postulates: 1) the laws of physics are the same in all *inertial* (unaccelerated) frames of reference; and 2) the (measured) speed of light in a vacuum is also the same in all inertial frames, regardless of the motion of the light source. Einstein showed that events that are simultaneous to one observer may then be non-simultaneous to another observer in a state of relative motion (although causal relations remain the same). Newtonian absolute space and time (and the Kantian a priori notions of separate space and time) do not exist, but must be replaced by a unified *spacetime*.

The new quantum theory suggested that the mind of an observer is intimately connected to an object being examined. A physical system is now represented by a mathematical *wavefunction*, which provides only a probability that an (independent) observer will detect a particular value of some system parameter at any given time. In the standard *Copenhagen* interpretation, reality is viewed as a single unfolding history, and the very act of observing a system causes its wavefunction to randomly collapse to a state representative of a single value of an observed variable.[25] The wavefunction thus embodies an observer's knowledge about the world, rather than a description of an objective external reality. An observer occupies a special place, outside the quantum mechanical equations, and the world is deterministic in only a probabilistic sense. As Sir James Jeans wrote in 1930, "The stream of knowledge is heading towards a non-mechanical reality; the Universe begins to look more like a great thought than like a great machine."[26]

Though many other interpretations of quantum theory have been advanced, the Copenhagen version prevailed until 1957, when Hugh Everett III offered a viable alternative, now commonly known as the *many-worlds* approach, that is compatible with strict determinism.[27] In this picture, an observer and any measuring device are included in the wavefunction description of a physical system, and reality resides in the wavefunction itself. During a measurement, the physical system (and associated universe) branches into multiple, parallel worlds, with distinct values of the measured parameter. An observer likewise splits into multiple selves, each with a distinct future experience. There is no mysterious collapse of the wavefunction. The subjective appearance of collapse has been explained by *quantum decoherence*, which results from interactions between a system and its environment. An observer does not see physical evolution as completely deterministic, only insofar as the observer's mind does not encompass all branching worlds. Because ideobasism requires absolute determinism, it is compatible with the many-worlds view of quantum mechanics, but not the Copenhagen interpretation.

The absence of a single, absolute, universal time, as well as the possibility of parallel worlds, has important implications for the CIF. The only way the CIF can incorporate multiple temporal perspectives into a unified ideo field is by experiencing time the way humans experience space – the *block time* perspective.[28] Does this render the passage of time merely an illusion? In some respects it does, but in other important respects it does not. The underlying CIF reality must transcend physical time. Past, present and future of all consistent physical universes must span a single, constant, eternal moment in the mind of the CIF. Yet time-like dimensions certainly exist within this reality, defining sequences of causally related events. In contrast, events separated along a space-like dimension at a given moment cannot be causally connected. Time-like and space-like intervals are treated differently when computing overall spacetime separations, a distinction critical to defining the causal relationships among events. Time-like dimensions link the vast number of (spatial) physical configurations that a given observer identifies with distinct universal states.

An animal's immediate experience appears to be limited to content generated by the physical brain associated with a single universal state. There are many more direct links between this state and other universal states that involve an increase in thermodynamic *entropy*, as opposed to a decrease in that quantity. If a person's experience consists of a *random walk* along a succession of connected states, the most likely path will be toward states of progressively higher entropy, thus defining an *arrow of time* – a term introduced in 1928 by Sir Arthur Eddington.[29] Although a person may occasionally move backward, these will be rare events. Even if an individual continually splits into multiple selves, as in the many-worlds scenario, the individual paths will overwhelmingly conform to this arrow.

Yet without a memory of past events, a sense of the flow of time would not be possible. Experience would comprise a perpetual now, with no conscious impression of time's passage. The brains of many animals are in fact so constructed that they hold memories of a succession of links to "past" universal states, but not to "future" states. Although the equations of physics are symmetric with respect to time, this asymmetry by itself should produce a primary experience of an arrow of time. One might expect that natural selection would favor creatures in which the memory arrow conforms to the thermodynamic arrow. Otherwise, an individual's memories would get out of sync with changes in the surrounding world. As long as the creation of a memory involves an irreversible thermodynamic process (increasing the overall entropy of the universe), the memory arrow should conform to the thermodynamic arrow. Even if a person were to (occasionally) step backward in time, any memory of the later times would be lost. Encountered memories would still be consistent with the (earlier) external world, and imply moving through time in a conventional manner.

The strict determinism of ideobasism does not preclude certain types of *free will*. Indeterminism implies an element of randomness, not intentional choice. That a thing can be understood so well that its own future is evident does not imply that the thing is not responsible for its own actions. Fate and determinism are compatible with free will to the extent they are directed by that will. Because endogenous ideo fields are fully responsible for internally generating and accepting from external agents the forces that determine their own experience, they may be said to have absolute free will. In contrast, human and other exogenous beings must defer in all matters to their foundation worlds, so cannot have unqualified free will. Yet many ectobeings are so integrated with their underlying worlds that personal experience matches their will to a significant extent. Fleegello defined *effective* free will as an extrinsic ability of an ectobeing to live as if it had true free will. Accepting this as a legitimate type of free will is a form of *compatibilism*.[30]

Fleegello attempted to derive a consistent ethical philosophy, by applying consistency logic to an evaluation of personal behavior and interpersonal relationships.[31] For this purpose, the logic may be succinctly expressed: a person should strive to behave in a manner consistent with reality. Ideobasic ethics is *universalistic* (as opposed to *relativistic* or *nihilistic*),[32] as it applies universally, across species and cultures. It is not based on a *divine command theory*,[33] insofar as ethical principles are not true simply because the CIF supports them; rather, the CIF upholds ethical principles because they are consistent. Ideobasic ethics is *objectivistic*, in that simple, unambiguous (within a given context), internally consistent moral statements – e.g., "Stealing the money from Aunt Sally was wrong" – are considered true or false, independent of any person, when viewed through the lens of consistency logic. Although Fleegello felt that the judgement "this is good" is equivalent to "I desire this," he further argued that there is only one *consistent* good, independent of individual desires. Thus ideobasic ethics, which explicitly espouses consistent good, is not *subjectivistic*.[34]

Yet determining the truth of a moral assertion is generally much more problematic than establishing the validity of a scientific theory about the physical world, since applicability of the scientific method is limited. A consistent morality even has relativistic elements – a given behavior may be right or wrong depending on the situational context, which partly defines reality. A behavior may further be moral in some respects, but immoral in others. Intentional acts are generally based on incomplete knowledge and understanding, and a person's ability to affect the world is bounded. When judging behavior, it then becomes important to distinguish between a person's inherent virtue and (effective) moral responsibility, and the goodness of a person's actions and any associated consequences.

Since the endogenous physical patterns of the CIF are presumably always consistent, the moral character and responsibility of an exogenous creature are meaningfully defined only by the associated exogenous mental intent, or motivation. Virtue is hence determined solely by the extent to which a person honestly strives to embrace consistency logic. Whether actions have consequences that are consistent (and hence, good) or inconsistent (bad) with ideobasic ethics is irrelevant. A person cannot be morally responsible for a bad consequence that inadvertently follows an act based on a serious pursuit of consistency logic, or for an unintentional good consequence that follows an act motivated by inconsistency. Insofar as such outcomes result from a legitimate lack of knowledge, they are accidental, and outside a person's (effective) control.

Natural physical law served Fleegello as a guide in developing a consistent ethical philosophy. Just as the same physical law applies to all points in spacetime, so a common ethical law must equally apply to all sapient beings (including one's own self). This ethical law should be a function of the analogue of physical conditions – those characteristics that meaningfully define conscious fields and their situational contexts. These include personal beliefs, desires and aspirations, skills and capabilities, but not nominal titles – an analogue to physical coordinate systems – or any other extrinsic or prejudicial label of individual identity.

Fleegello thus derived tentative concrete guidelines for behavior. In particular, his ethics espouses an equivalent of the *Golden Rule* of many world religions.[35] It also supports a form of individual rights: every (capable) person has a right to direct xyr own life (adopting the gender-neutral pronouns xe/xem/xyr/xyrs), to interact with others in mutually acceptable ways, but generally does *not* have the right to violate the same freedoms in others. It is thus wrong to forcibly attempt to convert others even to ideobasism. This viewpoint, and the epistemological doubt inherent to ideobasism, both support philosophical/religious tolerance, *except* when a person attempts to forcibly impose xyr own will on others. Acceptable methods of upholding individual freedom are limited. Force may be explicitly directed against offending actions, but not offenders per se, except when necessary to stop a more serious violation.

Ideobasic ethics can be extended to political philosophy. Certain forms of government are compatible with ideobasic ethics, in particular constitutional democracy that guarantees consistent personal rights. These rights are analogous to those promoted by John Locke[36] and John Stuart Mill[37] in the seventeenth and nineteenth centuries, respectively, only now they are derived from ideobasic ethical principles. The main purpose of an ideobasic government would be to uniformly support and protect consistent individual rights, while promoting activities that sustain and expand consistent consciousness. Support and participation in state functions should be wholly voluntary, though individuals who refuse support may be denied citizenship and appropriate privileges. Ideobasic government is much closer to Aristotle's ideal Polis, in which the individual is more important than the state, than Plato's authoritarian Republic, ruled by an aristocratic elite of philosopher kings.[38] Hypothetical octan versions of ideobasic government are depicted in the novel.

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Appendix F

Octan Physics

[Fleegello originally wrote his critique of octan physics as section 2.3 of the *Principia*. It is listed separately here, as it frankly stands apart, and interferes with the flow of that work. Scholars agree that Fleegello did not introduce novel physics in this section. Rather he took ideas advanced by contemporary physicists, and fit them to his own philosophical framework. Editorial comments are enclosed in brackets, to distinguish them from primary content.]

The physical panuniverse has been identified as the Physical Consistency Subfield (PCS) of the Consistency Ideo Field (CIF) – the complete set of mathematical objects that both define physical (temporospatial) relationships and are compatible with consistency logic. The PCS may itself be naturally divided into multiple, logically self-contained physical universes, characterized by distinct physical laws and conditions. Our own universe would be one of these worlds.

Mathematical objects in the PCS may manifest (in part) as *states* of a physical system, or as *operators* representing *observables* or other entities that act on those states. If modern physics is a guide, they incorporate a broad class of multidimensional objects known as *dimensors* [including common *scalars*, *vectors*, more general *tensors*, and *spinors*]. Many useful dimensor operators (e.g., those representing observables) define *linear* relations between other dimensors.

In standard *Shrodiik* [*quantum*] *theory* [named in honor of the pre-Dracian physicist Shrodo], a physical state (of any sufficiently isolated system) is denoted by a *ket* symbol $|\psi\rangle$, where ψ is an arbitrary label. This entity is supposed to encompass all physical aspects of a system. $|\psi\rangle$ was originally interpreted in terms of the motions of material *particles* at a time t in a pre-existing three-dimensional (3D) space $\vec{x}$ [here the arrow indicates a physical 3D vector]. Observables then include the positions, energies, and momenta of these particles.

Contemporary Shrodiik physics has a most peculiar feature. For any physical state $|\psi\rangle$, only the *probabilities* for measuring different values of a given observable can be computed. Even granted complete knowledge of a physical system at a particular moment, the future course as seen by any octan observer cannot in general be predicted with certainty. Detailed prescriptions for computing probabilities may be found in Shrodiik physics texts.

For any physical system, there is a range of possible states. Related to its probabilistic character, $|\psi\rangle$ can consist of a linear combination, or superposition, of these available states. The selection of a set of fundamental *basis* states is then arbitrary, to some extent; any given set of basis states can be mixed into new combinations, to form distinct sets.

In general, $|\psi\rangle$ can be viewed as a *vector* in an abstract *space* that spans all the possible states. If the components of a state vector are defined with respect to a specified set of basis vectors, the state may be represented by a single-column array. Linear operators may in turn be represented by square arrays that transform one state (by matrix multiplication) into another.

Let $\hat{A}$ represent a (linear) operator corresponding to an observable A. Here the symbol "hat" denotes operator, versus numeric parameter, status. When $\hat{A}$ is applied to a state vector, the result is typically a linear combination of other state vectors. Suppose, however, that $\hat{A}$ is applied to a vector $|\psi_a\rangle$ characterized by a well-defined value *a* of *A* – i.e., a state in which a measurement of *A* always yields the value *a*. Then $\hat{A}$ acts on $|\psi_a\rangle$ by extracting this value:

$$\hat{A}\,|\psi_a\rangle = a|\psi_a\rangle \ .$$

This is what it *means* for $\hat{A}$ to represent an observable. Mathematically, $|\psi_a\rangle$ is an *eigenstate* of $\hat{A}$, with a well-defined value *a* of that observable.

From the perspective of a given observer, $|\psi\rangle$ evolves in a smooth manner until a measurement is made. Curiously, at this point $|\psi\rangle$ jumps discontinuously to an eigenstate corresponding to the measurement result. Performing a measurement (observation) abruptly reduces a system to an eigenstate of the observed quantity!

In *bra-ket* notation [physicists used this archaic script in Fleegello's era], the numeric *overlap* between two states $|\phi\rangle$ and $|\psi\rangle$ is represented by $\langle\phi|\psi\rangle$, where the states are *normalized* such that $\langle\psi|\psi\rangle = 1$ for all $|\psi\rangle$. The overlap value is a *probability amplitude* for starting with a system in state $|\psi\rangle$, but observing it in $|\phi\rangle$. The actual probability is the absolute square of this amplitude, or $|\langle\phi|\psi\rangle|^2$. For example, consider a one-particle system. If $|\vec{x}\rangle$ is the state with the particle at a 3D position $\vec{x}$, then $\langle\vec{x}|\psi\rangle$ is the *wavefunction* $\psi(t,\vec{x})$ of *Shrodiik mechanics*, and $|\psi(t,\vec{x})|^2$ is the probability per unit 3D volume at time *t* for finding the particle at $\vec{x}$. This is an absolute probability if $\psi(t,\vec{x})$ is normalized such that the *integral* [a continuous sum over a volume of a function multiplied by an infinitesimal volume element] of $|\psi|^2$ over $\vec{x}$ is unity.

The *expectation value* of an observable *A*, defined as the average value <*A*> over repeated measurements on identical states $|\psi\rangle$, is given by

$$<A> = \langle\psi|\hat{A}|\psi\rangle$$

The observable *A* has a definite value *a* only if $|\psi\rangle$ is already an eigenstate $|\psi_a\rangle$ of $\hat{A}$.

In classical physics, material particles were treated as localized entities, distinct from *waves* (such as light) that propogate through underlying fields or media. Only waves could undergo self-interference, or diffract around obstacles. At the dawn of the Shrodiik revolution, ostensible particles were found to have wave properties, and nominal waves to sometimes act like classical particles. Observables that classically had a continuous range of values – e.g., the energy of an electron in an atom – might now be *quantized*, or restricted to discrete values.

Energy is one of the central observables in quantum physics. It is associated with the *Hoobitean* operator $\hat{H}$ [named for the classical physicist Hoobitu]. For material particles, $\hat{H}$ is often written as the sum of a *kinetic energy* term $\hat{H}_0$ plus a *potential energy* (interaction) term $\hat{H}_{\text{int}}$. After wave-particle duality was discovered, the energy E of a (set of) particle(s) in an eigenstate of $\hat{H}$ became associated with a temporal *frequency f*, or *angular frequency* ω:

$$E = h\,f = h\,\omega/2\pi = \hbar\,\omega \ ,$$

where h is the minuscule *Planko constant* [named for the pioneering physicist Planko], and $\hbar$ is the *reduced* Planko constant. Conversely, experiments showed that the energy in a traditional wave of frequency f was not continuously distributed over the wave, but carried by discrete quanta with individual energies given by the same equation. $\hat{H}$ embodies the way a state changes in time. When $\hat{H}$ acts on a state vector $|\psi\rangle$, the result is the constant ($i\hbar$) multiplied by the time rate of change of $|\psi\rangle$, where i is the *imaginary unit* (square root of -1). It is remarkable how imaginary (or *complex*) quantities arise naturally in the equations of Shrodiik physics!

A 3D vector quantity closely related to energy is *linear momentum*, represented by the symbol $\vec{p}$. Much as energy is associated with temporal frequency, momentum p_x along a spatial axis x is associated with a spatial frequency equivalent to to an inverse *wavelength* λ_x or *wavenumber* k_x:

$$p_x = h/\lambda_x = \hbar k_x \ .$$

Shorter wavelength (and so either larger momentum, or a smaller value of h) generally begets more particle-like behavior. When the operator $\hat{p}_x$ acts on a state vector $|\psi\rangle$, the result is the constant ($-i\hbar$) multiplied by the spatial rate of change of $|\psi\rangle$ along x.

For a single material particle, the relationship between time and energy is thus analogous to that between spatial position and linear momentum. For a multiparticle system, however, the situation is more nuanced. Whereas every particle may be assigned its own dynamical position and momentum operators, all particles traditionally share a common time. Time is then treated as a numeric system parameter, and not associated with a true operator.

Using *calculus,* it can be shown that the (unnormalized) time- and space-dependent wavefunction $\psi(t, x)$ of a particle (or any quantum) with pure angular frequency ω and wavenumber k_x (energy E and momentum p_x) has the exponential, wave-like form

$$\psi(t, x) = e^{-i\omega t}\, e^{ik_x x} = \cos(k_x x - \omega t) + i \sin(k_x x - \omega t) \ ,$$

where e is the *Eulero number* of mathematics, and the "cos" and "sin" terms refer to standard trigonometric functions. More generally, for a 3D *wavevector* $\vec{k}$ (momentm $\vec{p}$) and position $\vec{x}$,

$$\psi(t, \vec{x}) = e^{-i\omega t}\, e^{i\,\vec{k}\cdot\vec{x}}$$

where the *scalar product* $\vec{k} \cdot \vec{x}$ is the length of $\vec{x}$ multiplied by the projection of $\vec{k}$ onto $\vec{x}$. Note that the relative probability at any moment for finding the particle at a given 3D position (the absolute-square of the wavefunction) is the same for *all* $\vec{x}$ values.

With quantum physics, the order in which observables are measured may be significant. Consider then two observables A and B, represented by operators $\hat{A}$ and $\hat{B}$. The observables/operators *commute* if the order of measurement is irrelevant, or equivalently if the order in which $\hat{A}$ and $\hat{B}$ act on a physical state is irrelevant – i.e., if $\hat{A}\hat{B} = \hat{B}\hat{A}$. They do not commute if $\hat{A}\hat{B} \neq \hat{B}\hat{A}$. In this case the very act of measuring A or B introduces uncertainty in the value of the other, *complementary* observable. A system cannot simultaneously be an eigenstate of two operators that do not commute – neither operator would alter such a state, so their order could not matter. It is then impossible to simultaneously measure the values of two non-commuting observables, since such a measurement must create an eigenstate of both.

In Shrodiik mechanics, the archetypal pair of observables with non-commuting operators are the distance x and linear momentum p_x of a material particle along a given direction. Classically, these quantities commute, and every particle simultaneously has well-defined position and linear momentum. Based on their operator interpretations, the quantum *commutation relation* between $\hat{x}$ and $\hat{p}_x$ is

$$\hat{x}\, \hat{p}_x - \hat{p}_x \hat{x} = i\hbar \ .$$

Because the operators do not commute, an eigenstate of $\hat{p}_x$ must span a range of x values. An eigenstate of $\hat{p}_x$ is indeed totally unlocalized in space. Conversely, it can be shown that an eigenstate of $\hat{x}$ must include all possible linear momenta p_x. More generally, if σ_x is the [standard deviation] uncertainty in x, and σ_{p_x} the uncertainty in p_x, it can be shown that

$$\sigma_x\, \sigma_{p_x} \geq \hbar/2 \ .$$

Consider then a system $|\psi\rangle = |x_o\rangle$, in which a particle initially has a definite position x_o. Suppose an observer measures first the position x of the particle, and then its momentum p_x. Because the system starts in a state of well-defined position, the particle will be found at x_o with 100% probability, and the wavefunction is unchanged. Because this wavefunction contains all possible momentum values, any value of momentum may be observed in the subsequent measurement, with equal probability. Now suppose the order of measurement is reversed – the observer measures momentum first, followed by position. The likelihood of initially observing any value of momentum p_x is the same as before. But the momentum measurement forces the particle into a state of well-defined momentum. The particle's position is thereby scrambled, and the observer may subsequently find the particle at *any* location!

Consider now a more general system in which one member of any pair of non-commuting observables is well defined. Mathematically, the system can be considered a *superposition* of pure eigenstates with different but well-defined values of the other non-commuting quantity. The existence of non-commuting observables is contrary to classical (pre-Shrodiik) physics. The natural law that describes physical evolution applies to superpositions of pure states, rather than to states in which all classical variables have precise values.

The state $|\psi\rangle$ of a physical system can in general be written as a coherent sum

$$|\psi\rangle = C_1|\phi_1\rangle + C_2|\phi_2\rangle + C_3|\phi_3\rangle + \cdots = \sum_j C_j\, |\phi_j\rangle$$

over a *complete* set of *orthonormal* states $|\phi_j\rangle$, where the C_j are (complex) constants.

The $|\phi_j\rangle$ are orthonormal if $\langle\phi_j|\phi_k\rangle = 0$ for all $j \neq k$, and $\langle\phi_j|\phi_j\rangle = 1$ for all j.

The choice of the $|\phi_j\rangle$ is arbitrary to some extent, but they must be eigenstates of a complete set of commuting observables that cover all physical aspects of the system.

The probability of starting with the system in state $|\psi\rangle$ but finding it in a state $|\phi_j\rangle$ is then $C_j^* C_j$, where C_j^* is the *complex conjugate* of C_j. The expectation value of an observable A is

$$\langle A\rangle = \langle\psi|\hat{A}|\psi\rangle = \sum_j \sum_k C_j^* C_k A_{jk} \text{ where } A_{jk} = \langle\phi_j|\hat{A}|\phi_k\rangle \; .$$

The off-diagonal terms $j \neq k$ in the sum represent nonclassical interference between the different states in the coherent superposition comprising $|\psi\rangle$. These terms in general vanish only if the $|\phi_j\rangle$ have well-defined values of A (i.e., are eigenstates of $\hat{A}$).

The physical interpretation of the state vector $|\psi\rangle$ has a long and tortuous history. Originally it was viewed merely as a device for computing the probability of observing a given outcome in an experiment. Reality was seen to reside in the observed positions and momenta of individual particles. The physical universe was assumed to evolve in a linear manner, with a single unfolding history, which was deterministic in only a limited, probabilistic sense. The act of observation was divorced from the natural evolution of a physical system, and treated as something special, even magical (the so-called *measurement problem*).

Yet consistency logic requires that the universe be totally deterministic. Recently, the contradictions inherent in the original interpretation of Shrodiik mechanics have led the Evette group to develop an alternative *multi-world* view, in which reality resides in $|\psi\rangle$ itself.

Observers, measuring devices and related processes are now included as integral parts of $|\psi\rangle$. The panuniversal $|\psi\rangle$ is viewed as a superposition of conventional quantum worlds, each represented by a restricted state vector, which have become "decohered" and mutually orthonormal [or minimally overlapping]. These worlds evolve [almost] independently of each other, and continually split [rarely merge] into new separate, decohered worlds through time. A given observer occupies one conventional world at a given instant. As this world subsequently splits, the observer likewise branches into multiple selves, each with a distinct future experience. An observer does not see physical evolution as completely deterministic simply because no individual mind encompasses all worlds of the unfolding panuniversal state.

[Unfortunately, only the barest references to the original Evette School survive in the historical record. The writings may have been systematically destroyed by conservative, fundamentalist religious sects that flourished at the time, and found the work heretical. These traditionalist factions believed that the universe progressed in a linear fashion along a single preordained path and time line, in accordance with a divine plan for the octan race. The random, branching character of the multi-world view demanded an even greater, and to many more threatening, decentering to the octan psyche than the recognition five octujopes earlier that Jopitar was not at the physical center of the universe, but was a nonsingular ball of ordinary matter orbiting a common star adrift on a vast ocean of space and time.]

Let $|\phi_0\rangle$ represent a conventional world in the Evette sense. Then the matrix elements A_{0j} between this world and any other coexisting conventional world $|\phi_j\rangle$ must be [essentially] zero for *all* observables A, including those with noncommuting operators. Such conventional worlds evolve independently, with no [minimal] mutual interference.

Suppose that $|\phi_0\rangle$ incorporates a subsystem consisting of a simple superposition $(|B_1\rangle + |B_2\rangle)$ of orthonormal eigenstates of an observable B. Then

$$|\phi_0\rangle = (|B_1\rangle + |B_2\rangle)\,|\mathcal{E}\rangle$$

where $|\mathcal{E}\rangle$ represents the environment of the subsystem. The environment may interact with the subsystem, so as to become correlated with its eigenstates. This happens in particular when $|\mathcal{E}\rangle$ includes an observer who measures the value of B. If $\hat{B}$ commutes with the interaction Hoobitean $\hat{H}_{\text{int}}$, the eigenstates of $\hat{B}$ are not changed by the interaction, and

$$|\phi_0\rangle \Longrightarrow |B_1\rangle|\mathcal{E}_1\rangle + |B_2\rangle|\mathcal{E}_2\rangle = |\phi_1\rangle + |\phi_2\rangle$$

where $|\mathcal{E}_1\rangle$ and $|\mathcal{E}_2\rangle$ are eigenstates of observables with operators that commute with $\hat{H}_{\text{int}}$.

Consider the matrix elements A_{12} and A_{21} with $|\phi_1\rangle$ and $|\phi_2\rangle$ for an arbitrary observable A. If $\hat{A}$ commutes with $\hat{B}$, then $A_{12} = A_{21} = 0$, since the eigenstates of $\hat{B}$ are orthonormal. If $\hat{A}$ does not commute with $\hat{B}$, then it acts only on the B subsystem (if $\hat{A}$ were a product of operators that separately act on the subsystem and its environment, then A would not be a valid observable). In this case $\hat{A}$ does not affect $|\mathcal{E}\rangle$, and $A_{12} = A_{21} = 0$ if $|\mathcal{E}_1\rangle$ and $|\mathcal{E}_2\rangle$ are orthonormal. The states $|\phi_1\rangle$ and $|\phi_2\rangle$ can thus be identified as two new conventional worlds, split off from the original $|\phi_0\rangle$, if only $|\mathcal{E}_1\rangle$ and $|\mathcal{E}_2\rangle$ are orthonormal.

[This line of reasoning, which did *not* originate with Fleegello, helped resolve a problem with the many-world interpretation, involving an apparent ambiguity in the identification of the individual worlds. Some researchers argued that the choice of states $|B_1\rangle$ and $|B_2\rangle$ in the given example was quite arbitrary. By choosing a rotated basis set, e.g.

$$|b_1\rangle = (|B_1\rangle + |B_2\rangle)\,/\sqrt{2} \quad \text{and} \quad |b_2\rangle = (|B_1\rangle - |B_2\rangle)\,/\sqrt{2}\,,$$

the state $|\phi_0\rangle$ appeared to split into a different set of conventional worlds. Eventually it was realized that the interaction between a system and its environment naturally selects a particular (compatible) basis set. If the operator $\hat{B}$ does not commute with $\hat{H}_{\text{int}}$, then $|B_1\rangle\,|\mathcal{E}\rangle$ does not evolve into $|B_1\rangle\,|\mathcal{E}_1\rangle$, since $|B_1\rangle$ is itself transformed by the interaction.]

Conventional worlds can thus be distinguished by non-interfering "memories" of prior branchings. The storage sites of these data may include, but are by no means limited to, animal brains (and recently, scientific apparatus acting as extensions of those brains). The physical structure of a brain determines its interactions with the environment, and thus the types of conventional worlds (i.e., which observables are relevant and well-defined) generated by the observation process. If a brain is so constructed that only one value of a particular observable can communicate with (affect) other elements in a conscious field, then a state including a coherent superposition of different values of that observable at the same moment must correspond to distinct unified ideo fields, or selves, in separate (conventional) worlds. The information stored in a brain does not *define* the external reality of the associated world – a person may make faulty observations – but it may still be a point of reference by which that world is distinguished from others. Two distinct conventional worlds can even merge, if their distinguishing memories are lost or corrupted so as to become identical. Observers inhabiting the worlds would experience no sense of merger, as all valid memories of a former distinct past would be absent.

What determines useful observables, other than position? The mathematician Noethra has linked many such quantities to *symmetries* in the equations of motion that describe the temporal evolution of $|\psi\rangle$. Noethra's first theorem states that for every continuous, *differentiable* coordinate *transformation* that does not alter these equations, there is a corresponding observable whose expectation value is *conserved*, or constant over time. For sufficiently isolated (closed) systems, the equations are in fact generally unaffected by several such transformations, including time displacement, spatial displacement, and spatial rotation. Each of these symmetries is associated with an observable and a conserved quantity.

Why are the dynamical equations unaffected by the given transformations? Although physical conditions clearly vary at different locations in time-space, there is nothing else to distinguish points or directions. From an ideobasic perspective, physical law for a sufficiently closed system (which incorporates all relevant causal agents) should then depend only on extant physical conditions. Although distinct physical laws may apply in different physical universes, the same law and dependencies should apply at all times, positions and orientations within a given universe. This leads to the observed symmetries.

When the equations of motion are not affected by displacements in time (i.e., they remain the same over time), then what is commonly called *energy* is conserved. This is primarily what makes energy a useful observable. When the equations are not affected by displacements in spatial position (i.e., they are the same at different spatial points), then *linear momentum* is conserved, and is a useful observable. When the equations are not affected by spatial rotations (orientation in space), then *angular momentum* is conserved, and useful. More generally, the expectation value of any operator that both commutes with the Hoobitean operator $\hat{H}$, and is not an explicit function of time, is also a constant of motion. Every symmetry in $\hat{H}$ is thus associated with a conserved quantity, and a corresponding observable.

Classical observables may have nonclassical analogs that result from a reinterpretation (typically involving commutation relations) of associated operators. In particular, the commutation relations among the three orthogonal angular momentum operators imply the existence of a nonclassical type of angular momentum, called *spin*. Elementary particles are found to inherently possess this type of angular momentum. Particle spin is naturally quantized to discrete values, characterized by a *spin number s*, which must be an integral multiple of 1/2. Overall spin angular momentum is $\hbar\sqrt{s(s+1)}$, while the maximum possible component in any 3D direction is $\hbar s$.

Spin angular momentum operators can be represented by *irreducible* $(2s+1) \times (2s+1)$ arrays. The spin aspect of a spin-s particle can then be represented by a $(2s+1)$-dimensional single-column dimensor known as a *pointor*, designated by $\check{S}$. An overall single-particle state may in turn be represented by a pointor wavefunction $\check{S}\,(t, \vec{x})$ of time t and 3D position $\vec{x}$.

Spinless ($s = 0$) particles are represented by simple *scalar* (*zero-rank* dimensor) functions, with no inherent directionality. [No elementary spin-0 particles were known in Fleegello's era, although composite spin-0 particles (for example, *pions*) were certainly recognized.] Spin-1/2 particles are represented by special two-dimensional pointors known as *spinors*. Spinors do *not* transform like geometric vectors under coordinate transformations. Spin-1 particles with mass are represented by three-dimensional pointors, which do transform like geometric vectors. [Because massless spin-1 particles (e.g., *photons*) have no rest frame but are constrained to move at light speed, they must be represented by two-component pointors.] Particles with even larger spin values are represented by distinct pointor classes.

Yet particles do not normally exist in isolation. How then can the state of a multiparticle system be represented? Suppose first that the particles are distinguishable, and motions are much slower than light speed. Such systems have traditionally been represented by a direct product of the pointor functions for the individual particles, in which time t is a common system parameter, but the coordinates $\vec{x}_j$ of the various particles j are distinguished. For example, the state of a two-particle system might be represented by $\check{S}_a(t, \vec{x}_1)\ \check{S}_b(t, \vec{x}_2)$, where subscripts a and b label two different single-particle states.

Suppose now that two particles in a system are *identical*. The probability of finding either cannot be affected when their labels are exchanged – they would otherwise be distinguishable. Because the probability is equal to the absolute square of the wavefunction, and the associated exchange operator must (as an observable) be linear, the state can at most acquire a complex *phase factor* (absolute value one) under particle exchange. Since two successive exchanges must leave the state unchanged, the phase factor is limited to values ±1. A state must then be either *symmetric* (unchanged) or *antisymmetric* (phase factor -1) under identical particle exchange.

The wavefunctions of identical *bosons* (particles with integral spin) are found to be symmetric, while those of identical *fermions* (particles with half-integral spin) are antisymmetric. The appropriate symmetry can be achieved if a system is represented by a sum over the direct pointor products, in which the functional dependencies of the particles are suitably interchanged. For example, the state of two identical fermions might be represented by

$$\check{S}_a(t,\vec{x}_1)\ \check{S}_b(t,\vec{x}_2) - \check{S}_a(t,\vec{x}_2)\ \check{S}_b(t,\vec{x}_1)\ .$$

Symmetries in the equations of motion are not limited to continuous time-space transformations, but may also include discrete operations, such as *time reversal* and *parity inversion* (mirror reversal). Internal symmetries, that do not transform time-space points, can give rise to additional conserved quantities and observables (e.g., *electric charge*).

[Fleegello stubbornly maintained that various discrete spacetime symmetries should generally hold, despite contrary evidence. For example, experiments seemed to demonstrate that parity is *not* conserved during certain types of radioactive decay. Parity is conserved if the equations of motion are unchanged when a system is replaced by its mirror image. Fleegello believed that physics could not be affected by such a simple transformation, and felt that crucial elements had been omitted from experimental analyses. Yet physicists soon realized that, since time and space are intimately linked, and *antiparticles* are equivalent to ordinary particles moving backward in time, the true symmetry involves the *CPT transformation*– a combination of particle-antiparticle charge exchange, parity inversion, and time reversal – and not any one of these operations in isolation.]

The fundamental interactions between elementary particles are thought to derive from a variety of internal *local gauge symmetries*. For example, consider the electromagnetic interaction. Under a *local phase transformation*, the single-particle wavefunction $\psi(t,\vec{x})$ is multiplied by a *phase factor* $e^{i\lambda(t,\vec{x})}$, where $\lambda(t,\vec{x})$ is an arbitrary function of time-space. The absolute square (probability density) of ψ is unchanged by this transformation. If local gauge symmetry holds, then the new wavefunction must also satisfy the standard equation of motion. The kinetic energy part of that equation generally contains terms involving both the time- and space-rate of change of ψ, so the phase factor in the transformed wavefunction generates new quantities. The equation is invariant under the transformation only if it also contains terms that transform so as to cancel the effect of $\lambda(t, \vec{x})$, while maintaining the original form of the equation. These terms can be identified with the electromagnetic *scalar* and *vector potentials*.

The physicist Vigno has argued that symmetries do not merely restrict the laws of physics, but further *define* much of physical reality. While fundamental forces have been related to symmetries in the equations of motion, elementary particles have themselves been associated with (irreducible) mathematical representations of abstract *symmetry groups*. Every consistent object and process must coexist with every other consistent object and process somewhere within the PCS. This may involve a natural segregation into distinct, self-contained universes.

Coordinate systems do not exist a priori in nature. The choice of a coordinate framework should thus be arbitrary, from a strictly mathematical viewpoint (though one frame may be more convenient than another for a given purpose). It should then be possible to describe the laws of physics in a coordinate-free manner, in which observables appear only as abstract quantities, with no explicit reference to coordinate components. Expressing physical laws in such a *covariant* manner simplifies identification of symmetries and conserved quantities.

If the PCS is to respect the inherent arbitrariness in the choice of coordinate system, then fundamental *physical constants* that appear in the laws of physics should also be the same for all observers within a given physical universe, independent of the choice of reference frame. This applies in particular to *dimensionless* constants (e.g., the *fine structure constant*), which carry no physical units, but can be expressed as the ratios or products of *dimensional* constants that do possess units. Changes in the values of dimensional constants are generally meaningful only with respect to changes in their dimensionless combinations. So long as the values of physical constants are individually changed in a way that maintains the values of all fundamental dimensionless constants, the physical world is unaffected. Dimensionless constants stand independent of any arbitrary choice of measurement units. Indeed, no variations over time or space have thus far been detected.

[Some quantities thought to be fundamental constants in Fleegello's era have since been found to be variable. These have been reinterpreted as functions of truly fundamental constants and local physical conditions.]

Dimensionless fundamental constants need only be the same at all points within a particular physical universe. The values in distinct, non-interacting universes may be different. If there is no fundamental reason a constant should have a particular value, then the PCS *must* encompass a host of universes covering the range of acceptable values. Yet these values should be countable (either discrete/quantized, or at least represented by rational numbers). All the worlds otherwise could not have meaningful existence within the PCS.

Even fundamental dimensional constants (whose numeric values depend on the choice of physical units) should be the same for all observers in a given universe, when measured with respect to reproducible units characteristic of fundamental physical processes. In particular, the speed of light in a vacuum, commonly denoted by the symbol c, appears to constitute a universal limit to the rate at which information can propagate through space. [Note that distinct limiting speeds for different types of information would lead to inconsistencies.]

As first proposed by the physicist Niestu in his *theory of inertial invariance*, the speed c has the same value for all observers, irrespective of their state of motion. This is contrary to classical expectations, whereby an observer moving toward (away from) a light source detects a higher (lower) relative light speed than an observer at rest with respect to the source. That c is finite may be expected from an ideobasic viewpoint. An infinite speed is a special, limiting case of a general value, and the PCS should opt for the least encumbered conception.

Niestu introduced a major paradigm shift in physics when he showed that a common value for c implies that time (space) intervals measured by one observer may be partially seen as space (time) intervals by an observer in a relative state of motion; time and space do not exist separately, but must be combined into a unified *timespace* [scientists of Fleegello's era apparently preferred this expression to today's more common *spacetime*]. The effect is tiny at low velocities, but becomes significant as speeds approach c (so-called *Niestiik* speeds). The associated coordinate transformation between reference frames in a relative state of motion is distinct from that of classical physics. If the equations of motion are to remain invariant under a velocity transformation, then those equations must be modified as well. A remarkable consequence of inertial invariance is that any mass m is associated with an energy mc^2. For a free particle, the relationship between total energy E, momentm p, and rest mass m_o is

$$E^2 = p^2c^2 + m_o^2c^4 \ .$$

Niestu ultimately expanded his ideas into the *theory of general invariance*, which describes gravity in terms of distortions in the geometry of timespace.

[Fleegello overlooked a related serious inconsistency in his view of the CIF. The CIF must encompass all possible reference frames. If It experiences the same time as observers in those frames, as Fleegello envisioned, It must integrate the various time lines to maintain a single unified state of being. Yet if speed *c* is the same for all observers, events that are simultaneous in one frame may be *non*simultaneous in another. Events could then be seen by the CIF as both simultaneous and not simultaneous, a contradiction. This inconsistency is resolved only if the CIF transcends physical time, and experiences it the way corporeal creatures experience space – as *block time*. All events in the physical panuniverse then span a single, eternal moment in the mind of the CIF. Yet the CIF must still distinguish the time-like and space-like separations among physical events that define causal chains. Primacy resides in these chains, and not in the reference frames that observers use to describe them.]

While inertial invariance was readily incorporated into Shrodiik mechanics for single particles, problems arose for multiparticle systems. In particular, time and space coordinates were not treated coequally in the traditional equations of motion. Inertial invariance requires that time and position *both* be treated either as system parameters, or as formal operators. Currently the most widely adopted solution, based on the first approach, is to reformulate Shrodiik mechanics into a Niestiik *quantum field theory* (QFT), in which elementary particles of a given type are treated as quantum excitations of an underlying *field*. QFT covers both traditional particles with mass, like the electron, and zero-mass particles once considered pure waves, like the photon. Different particle types are represented by distinct fields. For each field type, a position *field operator* and a conjugate momentum field operator, now functions of common timespace parameters $(t, \vec{x})$, replace the single-particle 3D position and momentum operators $\hat{\vec{x}}_j$ and $\hat{\vec{p}}_j$ for the discrete particles *j* of Shrodiik mechanics. Because all fields share one time parameter, QFT (like Shrodiik mechanics) is a *single-time theory* (STT).

A simple field state in QFT is characterized by the number of (identical) *quanta* occupying each of a set of allowed levels. The number of quanta is just the number of "particles" of the given type. Field quanta contain no explicit particle labels; QFT respects the exchange symmetry of identical particles in a natural way. Indeed, QFT fields with half-integral spin *must* be antisymmetric, and those with integral spin symmetric [dictated by the distinct Niestiik equations of motion]. Many physicists prefer not to speak of particles at all in QFT, but only quanta. A general field state can be represented by a superposition of simple states. Unlike in Shrodiik mechanics, this is not limited to states with a fixed number of particles; interactions cause the routine creation/destruction of quanta. The overall state of a system is described by the direct products of its constituent fields, or a superposition of such products.

Shortly after QFT was introduced, the mathematician Draci proposed a *multi-time theory* (MTT) alternative, in which both the (observer-based) times and positions $(t_j, \vec{x}_j)$ of various particles j are now distinguished, and associated with coequal system operators $(\hat{t}_j, \hat{\vec{x}}_j)$. The earliest version was a simple extension of Shrodiik STT. For a system of fixed N particles, and an observer in an inertial reference frame $(t, \vec{x})$, the associated multi-time (MT) wavefunction has the form $\psi_{\text{mta}}(t_1, \vec{x}_1; t_2, \vec{x}_2; \ \ldots; \ t_N, \vec{x}_N)$. This reduces to the single-time (ST) wavefunction of Shrodiik mechanics if all t_j are are set to a common time t. Just as the ST wavefunction was defined over a constant-time surface, ψ_{mta} is only defined over appropriate *space-like hypersurfaces*. As in Shrodiik STT, $|\psi_{\text{mta}}|^2$ is a probability per unit 3N-dimensional (3ND) spatial volume. Normalization requires that the integral of $|\psi_{\text{mta}}|^2$ over all 3N spatial coordinates on a specified hypersurface equals unity.

A later version of MTT was a more radical departure from single-time theory, but more attuned to inertial invariance and the vagaries of measurement, and is adopted here. Every particle j in MTT has an innate *proper time* dimension, measured along the particle's *world line*. Different time lines are *not* inherently synchronized, but correlated only through interactions. To locate at time t_o the position $\vec{x}_j$ of particle j, an observer must interact with the particle at some particle proper time τ_j. Due to a synchronization ambiguity [Fleegello elucidates this point later], τ_j is not in general well defined for any given t_o and $\vec{x}_j$. There must then be a probability distribution over a range of τ_j. If there is at least a probabilistic Niestiik-like transformation relating timespace coordinates $(\tau_j, 0)$ in the particle rest frame to $(t_j, \vec{x}_j)$ in the observer frame, there is a corresponding distribution for t_j, centered on but not limited to t_o.

The wavefunction ψ_{mt} must then separately incorporate the observer time t_o at which the $(t_j, \vec{x}_j)$ are measured, and feature a probability distribution over each t_j for any given $(t_o, \vec{x}_j)$. Inertial invariance requires an extra spatial coordinate $\vec{x}_o$, paired with the time coordinate t_o. The functional dependence of the wavefunction is thus $\psi_{\text{mt}}(t_o, \vec{x}_o; t_1, \vec{x}_1; t_2, \vec{x}_2; \ \ldots; t_N, \vec{x}_N)$. This function is a joint probability amplitude that, when the observer finds itself at time t_o, it somehow sees itself at $\vec{x}_o$, and each particle j at t_j (corresponding to τ_j) and $\vec{x}_j$. As in STT, ψ_{mt} is defined over spacelike surfaces of constant t_o. But now ψ_{mt} can be normalized in a Niestiik-invariant manner if only $|\psi_{\text{mt}}|^2$ is a probability per invariant 4ND particle timespace $(t_j, \vec{x}_j)$ volume *and* 4D observer timespace $(t_o, \vec{x}_o)$ volume. The integral over all t_j, $\vec{x}_j$, $\vec{x}_o$, and an invariant range of t_o should then be unity. Because ψ_{mt} is defined for single values of t_o, the integral over t_o makes physical sense only if there is minimum *proper* time interval Δ_o along the observer time line, and the integral over t_o is confined to Δ_o at t_o.

Note that the new MT wavefunction ψ_{mt} does *not* simply reduce to the ST wavefunction when all t_j are set to a common t_{o}. Times t_{o} and τ_j are *not* assumed to be well-correlated, though for non-Niestiik speeds it may be possible to set the average of each t_j equal to t_{o}. Yet MTT does not posit that any material particle evolves along multiple time dimensions. Each particle *j* evolves along a single proper time line τ_j. The corresponding t_j are observer-based, and measured with respect to a single observer time line. From the adopted MT perspective, a multiparticle system can be accurately described using one time coordinate *only* if t_{o} and the τ_j are well correlated.

Unlike traditional Shrodiik physics, ψ_{mt} incorporates an observer state, and so applies not only to observed objects, but also to the *observer itself*. If the observer is a massive composite entity, $\vec{x}_{\mathrm{o}}$ may be chosen to be the 3D position of the *center of mass* (COM) of its observing apparatus, within the observer's frame of reference. It is natural for the observer to select an inertial reference frame centered on this COM. However, an inertial observer may select any frame moving at constant velocity relative to its COM rest frame. The overall wavefunction may then include not only a t_{o}-dependent energy term, but also an $\vec{x}_{\mathrm{o}}$-dependent self-momentum term. By summing over a range of states, it should be possible to localize $\vec{x}_{\mathrm{o}}$ in ψ_{mt} to values close to the COM.

A typical measuring device is designed to select a single eigenstate of a specified observable, even if an observed system starts in a superposition of states. Interactions between the device and system should smoothly generate a superposition of decohered composite eigenstates, each with its own observer and measured value, as per Evette. However, measuring equipment is typically not explicitly represented in ψ_{mt}, or is treated as a composite object characterized by position $\vec{x}_{\mathrm{o}}$ alone. ψ_{mt} then cannot possibly capture the complex evolution of the composite system into a sum of decohered states, but must appear to collapse discontinuously during a measurement to an eigenstate of the measured quantity. Only if an observing apparatus is sufficiently represented and integrated with the observed system in ψ_{mt} can the wavefunction evolve smoothly during an observation. An observer's experience is the same, whether ψ_{mt} appears to collapse or not.

It may seem exceptional that observer self-coordinates $(t_{\mathrm{o}}, \vec{x}_{\mathrm{o}})$ refer to a composite macroscopic object, rather than a simple particle. Yet even the observed objects in ψ_{mt} are not limited to elementary particles. Any object may be represented in ψ_{mt}, so long as it can be treated like a single, unified entity within the given context and level of approximation. Define a *porticle* as any physical entity (elementary *or* composite) in MTT that can be represented in ψ_{mt} as a mathematical object that evolves along its own proper time line. In contrast, *particles* are traditionally viewed in physics as miniature bogleballs, embedded in an external 4D timespace. To distinguish MT from other theories, it is helpful to now replace "particle" with "porticle" throughout MTT [early versions of *Principia* omit this substitution].

From the perspective of a porticle *j*, the energy associated with *j* itself should be proportional to the time rate of change of ψ_{mt} with respect to τ_j (with t_{o} and all other τ_k held constant). From the observer perspective, the energy of porticle *j* is then proportional to the time rate of change of ψ_{mt} with respect to t_j (with t_{o} and all other t_k constant). Because t_{o} derives from the observer's own proper (rest-frame) time, then from the same perspective, the time rate of change of ψ_{mt} with respect to t_{o} (with all t_j constant) should be proportional to the observer self-energy, and NOT the total energy of the system. The total system energy is instead the sum of the individual porticle energies, plus observer self-energy.

If there are no porticle interactions, ψ_{mt} should separately satisfy the free-porticle equations of motion for each porticle *j*, as well as for the observer. If there are also no observer-porticle interactions, observer-porticle distances cannot be defined, or the relation between t_{o} and the t_j established. Then ψ_{mt} can only be a function of t_{o} and proper times τ_j. In this case, ψ_{mt} can be constructed from products of free energy eigenstates $e^{-i\omega_{\mathrm{o}}t_{\mathrm{o}}}$ and $e^{-i\omega_j\tau_j}$, where ω_o and ω_j are the angular frequencies associated with rest masses m_o and m_j of the observer and porticle *j*, respectively.

If there are minimal observer-porticle interactions but still no interporticle forces, ψ_{mt} can be constructed from products of energy-momentum eigenstates $e^{-i\omega_{\mathrm{o}}t_{\mathrm{o}}+i\vec{k}_{\mathrm{o}}\cdot\vec{x}_{\mathrm{o}}}$ and $e^{-i\omega_j t_j+i\vec{k}_j\cdot\vec{x}_j}$, where $\vec{k}_{\mathrm{o}}$ and $\vec{k}_j$ are wavevectors corresponding to the (observer-based) momenta of the observer and porticle *j*. Now ω_o and ω_j are frequencies associated with the overall energies of the observer and porticle *j*. The observer has the same chance of seeing *any* t_j at a given t_{o}.

With interporticle forces, interaction terms must be introduced into the equations of motion, resulting in *N*+1 coupled equations of motion for an *N*-porticle plus observer system. Draci has shown that, for any MTT, the respective interaction terms must satisfy a consistency condition, or the evolution of ψ_{mt} along the various t_j is not well-defined. Finding consistent MT equations with interactions is a challenge. Most notably, conventional interaction potentials *always* lead to inconsistency. Interactions must then be implemented by other means, in particular through the use of *creation* and *destruction operators* (defined to maintain appropriate symmetry under identical porticle exchange), as in QFT. While the simplest forms of MTT have fixed *N*, use of these operators allows *N* to change.

It is often useful to adopt composite MT timespace coordinates to replace the $(t_j, \vec{x}_j)$. For an observer plus N=2 porticles (j = 1 or 2), define

$$\vec{X} = a_1\vec{x}_1 + a_2\vec{x}_2 \text{ and } \vec{r}_{12} = (\vec{x}_2 - \vec{x}_1)\,,$$

where a_1 and a_2 are constants with $(a_1 + a_2) = 1$. Center-of-mass (COM) coordinates with $a_j = m_j/(m_1 + m_2)$ are routinely used in non-Niestiik analyses of two-body systems. Analogous time coordinates may be defined, by

$$T = a_1 t_1 + a_2 t_2 \text{ and } \rho_{12} = (t_2 - t_1).$$

At Niestiik speeds, *center of momentum* (also COM) coordinates are appropriate, with $a_j = \omega_j/(\omega_1 + \omega_2)$ for free porticles. If the porticles interact, individual energies $E_j = \hbar\omega_j$ are no longer constant, but a constant-velocity COM can still be defined.

The $(t_o, \vec{x}_o; t_1, \vec{x}_1; t_2, \vec{x}_2)$ are thus replaced by composite COM coordinates $\left(t_o, \vec{x}_o; T, \vec{X}; \rho_{12}, \vec{r}_{12}\right)$. Recall that $(t_o, \vec{x}_o)$ is already composite, if the observer (including all measuring devices) is a macroscopic entity composed of myriad porticles. While this $(t_o, \vec{x}_o)$ could in principle be included in the definition of $\left(T, \vec{X}\right)$, and $(t_o, \vec{x}_o)$ replaced by coordinates with respect to a grand observer-plus-observed COM, such blurring of the observer with the observed is not generally useful in MTT.

The observer is nonetheless integrally connected to the observed two-porticle system. Interactions between the observer and the porticles *define* the COM motion of that system. If the porticles are otherwise isolated, then ideally porticle interactions determine the primary dependence of ψ_{mt} on both ρ_{12} and $\vec{r}_{12}$, but interactions with the observer must inevitably have some residual effect.

The $\left(T, \vec{X}\right)$ and $(\rho_{12}, \vec{r}_{12})$ each transform in the same way as any conventional $(t, \vec{x})$. As long as $(a_1 + a_2) = 1$, the rate of change of ψ_{mt} with respect to T (with ρ_{12} fixed) equals the sum of the rates of change of ψ_{mt} with respect to t_1 and t_2 (with t_2 or t_1 fixed, respectively). The rate of change with respect to $\vec{X}$ (with $\vec{r}_{12}$ fixed) similarly equals the sum of the rates of change with respect to $\vec{x}_1$ and $\vec{x}_2$ (with $\vec{x}_2$ or $\vec{x}_1$ fixed, respectively). These results can be extended to N>2 porticles. Total porticle energy E and momentum $\vec{P}$, equal to the sums of the individual porticle energies E_j and momenta $\vec{p}_j$, are then proportional to the rates of change of ψ_{mt} with respect to T and $\vec{X}$, respectively. If every $(\hat{\vec{x}}_j, \hat{\vec{p}}_j)$ and $(\hat{t}_j, \hat{E}_j)$ form a pair of complementary, non-commuting operators, so do $(\hat{\vec{X}}, \hat{\vec{P}})$ and $(\hat{T}, \hat{E})$.

Energy / linear momentum eigenfunctions for two free porticles can now be written

$$\psi_{\mathrm{mt}}^{\mathrm{free}} \sim e^{-i\omega_{\mathrm{o}}t_{\mathrm{o}}+i\vec{k}_{\mathrm{o}}\cdot\vec{x}_{\mathrm{o}}}\ e^{-i\Omega T+i\vec{K}\cdot\vec{X}}\ e^{-i\omega_\rho\,\rho_{12}+i\vec{k}_r\cdot\vec{r}_{12}}$$

where $(\Omega,\ \vec{K}) = (\omega_1+\omega_2,\ \vec{k}_1+\vec{k}_2)$ and $(\omega_\rho,\ \vec{k}_{\mathrm{r}}) = (a_1\omega_2 - a_2\omega_1,\ a_1\vec{k}_2 - a_2\vec{k}_1)$. Note that ω_ρ (and so all dependence on ρ_{12}) vanishes if $a_j \sim \omega_j$ (Niestiik COM). The free eigenstate shows no preferred value of T, $\vec{X}$, ρ_{12} or $\vec{r}_{12}$ at any t_{o}. More generally, interactions between the observer and porticles determine the correlation between t_{o} and T.

Interactions between porticles 1 and 2 determine both the primary dependence of ψ_{mt} on $\vec{r}_{12}$, and the correlation between t_1 and t_2, and so the dependence of ψ_{mt} on ρ_{12}. For strong repulsive interactions, ψ_{mt} should be significant only for large values of the Niestiik-invariant timespace separation $S_{12} \equiv \sqrt{r_{12}^2 - c^2\,\rho_{12}^2}$. For strong attractive interactions, there should be solutions of ψ_{mt} localized to small values of S_{12}. If t_1 and t_2 are tightly correlated, ρ_{12} is confined to values near zero, and the porticle time dependence of ψ_{mt} is mainly through T.

Both QFT and standard MTT assume a pre-existing, observer-based, four-dimensional (4D) timespace framework $(t,\vec{x})$. Even if this timespace is affected (warped) by matter and energy, it is not created by them. Yet what is the origin of timespace itself, and how are its coordinates meaningfully defined at all for a multiporticle system? Neither time nor space can be measured in absolute terms. Temporal and spatial intervals are gauged only with respect to physical processes and structures, which are traditionally interpreted in terms of elementary porticles and their interactions. Stripped of these vestments, timespace loses all meaning. Physical objects and dimensions of relation are inextricably linked.

Every elementary porticle with mass does have an innate proper time dimension. For every external observer time t_j in standard MTT, there is a corresponding internal proper time τ_j. Indeed, MTT can be formulated using the more fundamental τ_j. Yet because distinct proper time lines are not inherently synchronized, and correlated only by interactions, further temporospatial relationships can be defined *only* if porticles interact.

Interactions corresponding to the fundamental forces are associated with gauge symmetries. In QFT, their description can be interpreted in terms of the exchange of *phantom* gauge bosons by elementary fermions. The *electromagnetic*, *weak*, and *strong* interactions involve the exchange of phantom photons, *W* and *Z bosons*, and *gluons*, respectively (all spin-1). Phantom porticles have all the attributes of their real counterparts, except mass; the usual relation between energy, momentum and rest mass is not followed, making these porticles ephemeral. Many physicists consider the porticles not real in any sense, but merely a bookkeeping device.

Elementary fermions include *electrons*, *neutrinos*, and *quarks* (all spin-1/2). [Fleegello's archaic list omits forms of *shadow matter*, that interact with ordinary matter solely through gravity.] Only the gravitational force, which is ostensibly associated with the exchange of phantom *gravitons* (spin-2, and normally massless), has eluded incorporation into the QFT framework.

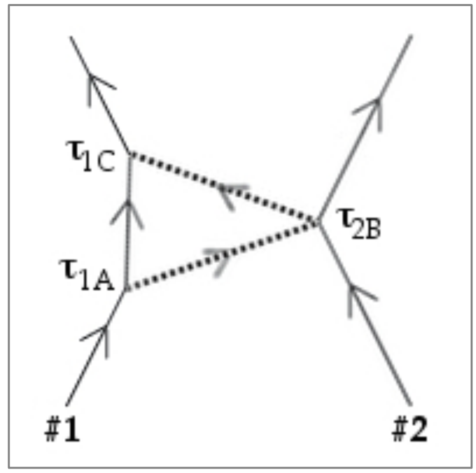
While phantom particles were introduced in QFT, gauge symmetries in MTT should lead to expressions for interactions with an analogous interpretation in terms of phantom porticles. Because phantom bosons in either approach are superpositions spanning energies and momenta that do not respect standard mass relationships, their exchange should not be literally interpreted in terms of porticle trajectories. Yet they do link real porticles in MTT, and transfer information at light speed. Physical objects may also be linked and transfer information via real porticles, though energy-momentum conservation may require either composite porticles or paired links. The exchange of either phantom or real porticles can thus establish *causal links* (CLs) – *phantom causal links* (PCLs) or *real causal links* (RCLs), respectively.

Because individual porticles can be identified in MTT, but not QFT, fully exploiting CLs requires an MT approach. Consider then a CL from porticle j at proper time τ_j to porticle k at τ_k. CLs are universal; all observers identify the same connections, at the same proper times. CLs are directional; time (and information) flows forward or backward from one porticle to the other. This interporticle direction may be indicated by a binary parameter $\theta_{jk} = \pm 1$, where value +1 signifies forward flow from j to k, and -1 signifies reverse flow. Every [electromagnetic] CL can also be associated with a 3-component (equivalent to a 3D) unit vector $\vec{u}_{jk}$, that defines a 3D *spatial* direction of the flow at τ_k.

[While the parameter θ_{jk} is useful, it is not strictly necessary, as the information is already encoded in the temporal frequencies associated with the link. In quantum physics, a temporal phase factor $e^{-i\omega t}$ indicates flow of positive energy along increasing time t when frequency $\omega > 0$. The factor $e^{-i\omega_{jk}(\tau_k - \tau_j)}$ thus indicates flow of positive energy from j to k only when frequency $\omega_{jk} > 0$. If $\omega_{jk} < 0$, the factor can be rewritten as $e^{-i\omega_{kj}(\tau_j - \tau_{kj})}$, with frequency $\omega_{kj} = -\omega_{jk} > 0$, indicating flow of positive energy from k to j. Thus only positive frequencies ω_{jk} and ω_{kj} are allowed for $\theta_{jk} = +1$ and $\theta_{jk} = -1$, respectively.]

Let an elementary *event* be any point on the world line of a porticle at which a CL is established with another porticle. Physicists Machi and [later] Niestu have promoted the radical idea that the network of CLs does not merely occur *within* timespace, but even *defines* timespace. The number of spatial dimensions is just the number of components in $\vec{u}_{jk}$.

For example, consider the pair of electromagnetic links between two charged porticles #1 and #2 in the diagram at right. Suppose a CL (dotted line) connects #1 (solid line) at proper time τ_{1A}, defining event A, to #2 at τ_{2B}, marking event B; and a second CL connects #2 at τ_{2B} to #1 at τ_{1C}, or event C. Arrows point in the direction of time.



The location of porticle 2 from the perspective of #1 (a non-inertial "observer" in this case) is

$$\vec{r}_{12B} = r_{12B}\,\vec{u}_{1AB}$$

at time $\tau_{1o} = (\tau_{1A} + \tau_{1C})/2$, where $\vec{u}_{1AB}$ is a 3D unit vector pointing in the spatial direction of flow from A to B at τ_{2B}, and r_{12B} is the scalar interporticle distance

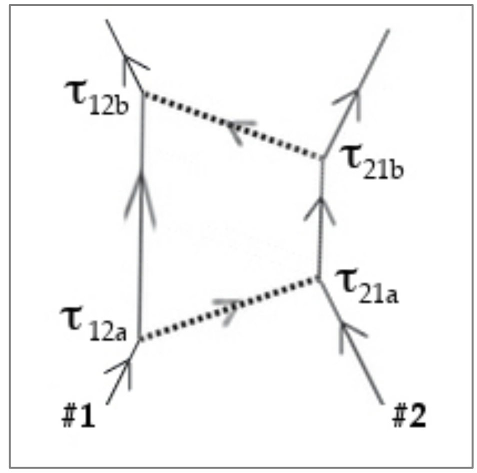
$$r_{12B} = (\tau_{1C} - \tau_{1A})c/2\ .$$

From the same perspective, $\vec{u}_{1BC} = -\vec{u}_{1AB}$. Note that neither τ_{2B} nor the relative interporticle speed v appear in these equations. If τ_1 and τ_2 are not perfectly correlated (by the probability distributions for all possible interactions), a range of τ_{2B} values could give the same result. Time τ_{1B} (which is *not* necessarily equal to τ_{1o}) should be related to τ_{2B} by at least a probabilistic, Niestiik-like (due to v-dependence) transformation. For non-Niesiik motion, one can set $\tau_{1B} \sim \tau_{2B}$ based on the single interaction. However, τ_{1B} must equal τ_{1o} *only* if τ_1 and τ_2 are perfectly correlated. More generally, τ_{1B} has a range of possible values, corresponding to the range of τ_{2B}, but (with even minimal synchronization) centered on τ_{1o}.

From the perspective of #2, the situation is more nuanced. Timespace coordinates of event B are $(\tau_{2B}, 0)$. It is *not* generally true that the link paths are equal, or that $\vec{u}_{2BC} = -\vec{u}_{2AB}$. Interporticle distance r_{21B} at τ_{2B} now depends on v, with Niestiik corrections expected. While r_{21B} and v can be related to times $(\tau_{2A}, \tau_{2B}, \tau_{2C})$, deriving τ_{2A} from τ_{1A}, and τ_{2C} from τ_{1C}, depends on the $\tau_1 - \tau_2$ correlation. The interaction defines $\tau_{1o} = \tau_{1B} = \tau_{2B}$, with $r_{21B} = r_{12B}$, *only* if time is absolute, *and* the time lines are synchronized.

Serial links are required to correlate time lines and define interporticle distance over time. Yet the properties of successive links must be compatible, and accord with physical principles. Adjacent CLs should reflect a consistent sense in the flow of time, or distance is ill-defined. Relative speeds must not exceed c. Accelerations should reflect linear momentum transfers.

Consider now the more general set of link pairs depicted at right, again between porticles 1 and 2. Introduce a new labeling scheme, whereby τ_{jk} is the proper time on the world line of porticle *j*, for a link connecting *j* to *k*. Let $\cap_{12}$ represent the joint probability amplitude for the 1-2 link pairs, from the perspective of #1 (the first index), with dependence $\cap_{12}\,(\tau_{12\mathrm{a}}, \tau_{21\mathrm{a}}, \theta_{12\mathrm{a}}, \vec{u}_{12\mathrm{a}};\ \tau_{12\mathrm{b}}, \tau_{21\mathrm{b}}, \theta_{12\mathrm{b}}, \vec{u}_{12\mathrm{b}})$. Assume that $\cap_{12}$ is a complex quantity, and that the connection probability per $\tau_{12\mathrm{a}}$, $\tau_{21\mathrm{a}}$, $\tau_{12\mathrm{b}}$, $\tau_{21\mathrm{b}}$, solid angle in $\vec{u}_{12\mathrm{a}}$, and solid angle in $\vec{u}_{12\mathrm{b}}$ is $|\cap_{12}|^2$.



With respect to 1 at $\tau_{1\mathrm{o}}$, distance r_{12} is defined by the special link pair AB and BC considered earlier, with $\tau_{1\mathrm{A}} = \tau_{1\mathrm{o}} - r_{12}/c$ and $\tau_{1\mathrm{C}} = \tau_{1\mathrm{o}} + r_{12}/c$. These link pairs correspond to setting $\tau_{12\mathrm{a}} = \tau_{1\mathrm{A}}$, $\tau_{21\mathrm{a}} = \tau_{21\mathrm{b}} = \tau_{2\mathrm{B}}$, $\tau_{12\mathrm{b}} = \tau_{1\mathrm{C}}$, $\theta_{12\mathrm{a}} = +1 = -\theta_{12\mathrm{b}}$, and $\vec{u}_{12\mathrm{a}} = \vec{u}_{1\mathrm{AB}} = -\vec{u}_{12\mathrm{b}}$ in $\cap_{12}$. The joint ABC link-pair amplitude is then $\cap_{12}\,(\tau_{1\mathrm{A}}, \tau_{2\mathrm{B}}, +1, \vec{u}_{1\mathrm{AB}};\ \tau_{1\mathrm{C}}, \tau_{2\mathrm{B}}, -1, -\vec{u}_{1\mathrm{AB}})$. In terms of $\tau_{1\mathrm{o}}$ and r_{12}, this is $\cap_{12}\,(\tau_{1\mathrm{o}} - r_{12}/c\,, \tau_{2\mathrm{B}}, +1, \vec{u}_{1\mathrm{AB}};\ \tau_{1\mathrm{o}} + r_{12}/c\,, \tau_{2\mathrm{B}}, -1, -\vec{u}_{1\mathrm{AB}})$.

The average of $|\cap_{12})|^2$ over $(r_{12}, \vec{u}_{1\mathrm{AB}})$ for links ABC defines a probability distribution from the perspective of 1 at $\tau_{1\mathrm{o}}$ that 2 is at time $\tau_{2\mathrm{B}}$, as well as the most probable value $\tau_{2\mathrm{B}}^{\mathrm{p}}$, for any given $\tau_{1\mathrm{o}}$. The distribution width along $\tau_{2\mathrm{B}}$ is a measure of the correlation between the time lines τ_1 and τ_2 at $\tau_{1\mathrm{o}}$, which is in general *not* one-to-one. Single-time theory then cannot most accurately describe the system.

Similarly, the average of $|\cap_{12}|^2$ over $(\tau_{2\mathrm{B}}, \vec{u}_{1\mathrm{AB}})$ defines a probability distribution with respect to 1 that 2 is at distance r_{12}. As in standard Shrodiik physics, the width of this distribution may be nonzero even when τ_1 and τ_2 are well-correlated.

Remarkably, $|\cap_{12}|^2$ for the link pair ABC has units equivalent [within a conversion factor c^{-3}] to a probability per 4D $(\tau_{2\mathrm{B}}, \vec{r}_{12})$ timespace volume, just like the probability of an MT observer seeing porticle 2 at $\tau_{2\mathrm{B}}$ and $\vec{r}_{12}$. Apart from an expected $\vec{x}_1$ dependence, a CL-related partial wavefunction ϕ_{mt} can then be identified, with

$$\phi_{\mathrm{mt}}(\tau_1; \tau_2, \vec{r}_{12}) \sim \cap_{12}\,(\tau_1 - r_{12}/\mathrm{c}\,, \tau_2, +1, \vec{r}_{12}/r_{12};\ \tau_1 + r_{12}/\mathrm{c}\,, \tau_2, -1, -\vec{r}_{12}/r_{12})\,.$$

For any given τ_1, the quantity $|\phi_{\mathrm{mt}}|^2$ defines a joint probability distribution over $(\tau_2, \vec{r}_{12})$. Amplitudes should be normalized such that the integral of $|\phi_{\mathrm{mt}}|^2$ over all $(\tau_2, \vec{r}_{12})$ is unity.

In order to incorporate and interpret a variable $\vec{x}_o$ in the MT wavefunction $\psi_{mt}(t_o, \vec{x}_o; \cdots)$, a student of Draci has proposed that a physical object may even have PCLs to itself. Consider the world line of porticle 1, still from the perspective of 1. A self-link connecting τ_{11a} to τ_{11b} effectively extends out a distance $r_{11} \sim (\tau_{11b} - \tau_{11a})\, c/2$ in direction $\vec{u}_{1a1b} = \vec{r}_{11}/r_{11}$ at $\tau_{1o} = (\tau_{11a} + \tau_{11b})/2$. The link-pair amplitude for a pair of self-links 1a-1b and 1c-1d may be written $\cap_{11}\,(\tau_{11a}, \tau_{11b}, +1, \vec{u}_{1a1b};\ \tau_{11c}, \tau_{11d}, +1, \vec{u}_{1c1d})$, defining a partial wavefunction

$$\phi_{mt}(\tau_1, \vec{r}_{11}) \sim \cap_{11}\,(\tau_1\text{-}r_{11}/c\,, \tau_1\text{+}r_{11}/c\,, +1, \vec{r}_{11}/r_{11}\,;\ \tau_1\text{-}r_{11}/c\,, \tau_1\text{+}r_{11}/c\,, +1, \vec{r}_{11}/r_{11})\ .$$

Although porticle 1 is not a classic observer, this ϕ_{mt} is defined from the perspective of 1, so $(\tau_1, \vec{r}_{11})$ is equivalent to $(t_o, \vec{x}_o)$ in ψ_{mt}. The two links associated with $\phi_{mt}(\tau_1, \vec{r}_{11})$ are indistinguishable, so $\vec{r}_{11}$ is in effect defined by a single link rather than a pair of links. $|\phi_{mt}|^2$ now has units equivalent to a probability per invariant 4D timespace $(\tau_1, \vec{r}_{11})$ volume, like any other link pair. The integral of $|\phi_{mt}|^2$ over both $\vec{r}_{11}$ *and* some invariant range of τ_1 should then equal unity for any τ_1. This makes sense only if there is a minimum proper time interval Δ_1 (which may differ from Δ_o along the *composite* observer proper time line t_o in ψ_{mt}), and the integral over τ_1 is confined to Δ_1 at τ_1.

Self-links may occur along the world lines of classic observers, as well as ordinary porticles. They thus offer a way to physically define observer self-distance $\vec{x}_o$, just as link pairs define interporticle distances. Indeed, it may be that $\vec{x}_o$ is meaningfully defined *only* by self-links. Self-links may mark elementary porticles as extended objects, and even embody classic force fields (e.g., the electric field of an isolated charged porticle). As such, they would contribute to the rest-mass energies that dominate ψ_{mt} in the low-interaction limit.

In a two-porticle system, a self-link pair may become correlated with link pairs between the porticles, such that the corresponding joint link-pair amplitude is *not* a product of two simple amplitudes. Let Λ_{jk} represent the full joint link-pair amplitude, including all self-links, for CLs involving two porticles *j* and *k*, where *j* and *k* are either 1 or 2 in the current example. Amplitude Λ_{12} is functionally dependent on $(\tau_{11a}, \tau_{11b}, \theta_{1a1b}, \vec{u}_{1a1b})$, $(\tau_{11c}, \tau_{11d}, \theta_{1c1d}, \vec{u}_{1c1d})$, $(\tau_{12a}, \tau_{21a}, \theta_{12a}, \vec{u}_{12a})$, $(\tau_{12b}, \tau_{21b}, \theta_{12b}, \vec{u}_{12b})$, $(\tau_{22a}, \tau_{22b}, \theta_{2a2b}, \vec{u}_{2a2b})$, and $(\tau_{22c}, \tau_{22d}, \theta_{2c2d}, \vec{u}_{2c2d})$.

Based on its relationship with the standard wavefunction, it is convenient to now redefine $\cap_{jk}$ as a *truncated* link-pair amplitude only including CLs with at least one end anchored to the world line of porticle *j* (the first amplitude index). For example, $\cap_{12}$ includes link pairs 1-1 and 1-2, but not 2-2. While the full amplitude Λ_{jk} is a more complete representation of a system, $\cap_{jk}$ can be derived from Λ_{jk} by appropriately averaging over extraneous link-pairs.

This scheme can be extended to *N*>2 porticles. Links between different porticle pairs may be correlated, such that joint link-pair amplitudes cannot be written as products of one- or two-porticle amplitudes. The *N*=3 joint link-pair amplitude may be written Λ_{123}, and includes links 1-1, 1-2, 1-3, 2-2, 2-3, and 3-3. The truncated $\cap_{123}$ includes links 1-1, 1-2, and 1-3.

Amplitudes $\cap$, Λ and ϕ_{mt} should evolve in a smooth manner until a measurement is made. If they do not directly incorporate the measuring device, they must then discontinuously jump to eigenstates of the measured quantity. However, the role of observer is ambiguous here. Who performs a measurement – the reference porticle, or a distinct external observer? The reference porticle is not equipped to perform a classic measurement, and is a non-inertial platform. The $\cap$ and Λ further utilize a mixed perspective, relying on proper times with respect to distinct porticles. While proper times are independent of perspective, 3D directions and the values of quantities transferred by CLs are not. It is thus customary to express functional dependence in terms of quantities defined from a common perspective.

In the traditional external-perspective MT (MTe) approach, a wavefunction is defined from the perspective of an inertial observer *external* to the system being examined. As described earlier, this observer is typically an organization of objects that establishes a common timespace framework, and provides a consistent perspective from which to survey a system. The observer should minimally perturb that system, except during a measurement. The position of a porticle #1 is defined by CL pairs connecting the observer at $t_{\mathrm{o}1}$ with the porticle at $t_{1\mathrm{o}}$, where $t_{1\mathrm{o}}$ is the most likely t_{o} (measured in the observer frame) corresponding to $\tau_{1\mathrm{o}}$. The full observer-based link-pair amplitude may be represented by $\Gamma_{\mathrm{o}1}$ (including o-o, o-1, and 1-1 link pairs), and the truncated amplitude by $\gamma_{\mathrm{o}1}$ (with only o-o and o-1 pairs).

Truncated MTe amplitudes generally embody all information directly accessible to an external observer by measurement. The $\gamma_{\mathrm{o}1}$ defines a partial wavefunction

$$\phi_{\mathrm{o}1}(t_{\mathrm{o}},\vec{x}_{\mathrm{o}};t_1,\vec{x}_1) \sim \gamma_{\mathrm{o}1}(t_{\mathrm{o}}-\tfrac{x_{\mathrm{o}}}{c},\ t_{\mathrm{o}}+\tfrac{x_{\mathrm{o}}}{c},+1,\tfrac{\vec{x}_{\mathrm{o}}}{x_{\mathrm{o}}};\ t_{\mathrm{o}}-\tfrac{x_{\mathrm{o}}}{c},\ t_{\mathrm{o}}+\tfrac{x_{\mathrm{o}}}{c},+1,\tfrac{\vec{x}_{\mathrm{o}}}{x_{\mathrm{o}}};$$
$$t_{\mathrm{o}}-\tfrac{x_1}{c},\ t_1,+1,\tfrac{\vec{x}_1}{x_1};\ t_{\mathrm{o}}+\tfrac{x_1}{c},\ t_1,\ -1,\tfrac{-\vec{x}_1}{x_1})\ .$$

The MTe formalism is readily extended to *N*>1 porticles. For a pair of porticles 1 and 2, link-pair amplitudes are $\Gamma_{\mathrm{o}12}$ and $\gamma_{\mathrm{o}12}$, with $\phi_{\mathrm{o}12}(t_{\mathrm{o}},\vec{x}_{\mathrm{o}};t_1,\vec{x}_1;t_2,\vec{x}_2)$. Links involving only 1 and 2 are defined in $\Gamma_{\mathrm{o}12}$, but not $\gamma_{\mathrm{o}12}$. Now $\phi_{\mathrm{o}12}$ defines a joint probability that the observer at t_{o} sees itself at $\vec{x}_{\mathrm{o}}$, porticle 1 at $(t_1,\vec{x}_1)$, and porticle 2 at $(t_2,\vec{x}_2)$. Units of $|\phi_{\mathrm{mt}}|^2$ are probability per 4D $(t_{\mathrm{o}},\vec{x}_{\mathrm{o}})$ timespace volume for the observer (defined over interval Δ_{o} at t_{o}), and per 4D $(t_j,\vec{x}_j)$ timespace volume for every porticle *j* (defined over all t_j).

When averaging over link pairs to derive γ from Γ, information is lost. Truncated link-pair amplitudes are nonetheless indirectly affected by processes explicitly represented only in the full link-pair amplitude. For example, even though the truncated amplitude γ_{o12} does not directly include any 1-2 links, the o-1 and o-2 link pairs defining the joint probability amplitude for observer-porticle vectors $\vec{x}_1$ and $\vec{x}_2$ effectively defines the amplitude for the interporticle vector $(\vec{x}_2 - \vec{x}_1)$.

When deriving γ from Γ, it may sometimes be useful to either retain or discard extra information. An *alternate* truncated link amplitude $\tilde{\gamma}$ may then be defined, that contains more or less information than the standard amplitude γ, and is associated with an alternate partial wavefunction $\tilde{\phi}$. For example, suppose a wavefunction for porticles 1 and 2 is desired that retains direct information concerning *all* self-links. Then an amplitude $\tilde{\gamma}_{o12}$ excluding only 1-2 link pairs can be derived from Γ_{o12}, defining the alternate partial wavefunction $\tilde{\phi}_{o12}(t_o, \vec{x}_o;\ t_1, \vec{x}_1, \vec{x}_{11};\ t_2, \vec{x}_2, \vec{x}_{22})$. Here $\tilde{\phi}_{o12}$ is a joint probability amplitude that the observer at t_o sees itself at $\vec{x}_o$, porticle 1 at $(t_1, \vec{x}_1)$ with a self-displacement $\vec{x}_{11}$ (at $t_{11} = t_1$ in Γ_{o12}), and porticle 2 at $(t_2, \vec{x}_2)$ with a self-displacement $\vec{x}_{22}$ (at $t_{22} = t_2$ in Γ_{o12}). Units of $|\tilde{\phi}_{o12}|^2$ are probability per 4D $(t_o, \vec{x}_o)$ observer timespace volume (defined over interval Δ_o at t_o), per 4D $(t_j, \vec{x}_j)$ timespace volume for $j = 1$ and 2 (defined over all t_j), and per 4D $(t_{jj}, \vec{x}_{jj})$ timespace volume for $j = 1$ and 2 (defined over interval Δ_j at $t_{jj} = t_j$).

The probability configuration of a multiporticle system evolves in time, whether or not it is watched by an external observer. Ideally, the configuration in MTe evolves independently of the observer, except when a measurement is made. As discussed previously, even then it is unnatural that the wavefunction collapses non-deterministically. To avoid wavefunction collapse, and pursue a more complete, self-contained theory in which CLs independently generate timespace, an alternate *internal-perspective* MT (MTi) approach may be adopted. Such an approach neither presumes a classic external observer, nor relies on a pre-existing 4D timspace, but assumes only that every porticle has an innate proper time, and that CL (gauge) bosons are associated with mathematical objects that define common multi-D properties.

One version of MTi is an extension of MTe, in which the measuring device is explicitly included and modeled in Γ, such that the associated wavefunction does *not* appear to collapse when a measurement is performed, but instead separates into a sum of decohered states. The external inertial observer thus becomes an *internal* inertial observer. It is not necessary to model the measuring device in detail, but only to the extent that the wavefunction properly evolves into a sum of decohered eigenstates of the measured quantity during a measurement.

A second version of MTi is an extension of the original ∩ scheme. Because ∩ relies on proper times with respect to distinct porticles, it is inherently covariant in time, but utilizes a mixed perspective. Other quantities must still be defined with respect to some reference frame. In the new MTi approach, times and other quantities are now all defined from the consistent but non-inertial perspective of a given porticle, indicated by the first index in the link-pair amplitudes. For two porticles 1 and 2, the full MTi link-pair amplitude Γ_{12} with respect to porticle 1 covers links 1-1, 1-2 and 2-2, while the truncated γ_{12} covers only links 1-1 and 1-2. All times are measured with respect to the *proper* time of porticle 1, so $t_{1j} = \tau_{1j}$, and t_{2j} is the most probable time along the world line of porticle 1 corresponding to τ_{2j}, for j =1 or 2. Note that for any (τ_{12}, τ_{21}) there is a probability distribution over t_{21}, and for any (τ_{12}, t_{21}) a distribution over τ_{21}, defined by Γ_{12}. Amplitude γ_{12} defines a partial wavefunction $\phi_{12}(t_1, \vec{r}_1; t_2, \vec{r}_2)$ in the usual way, except that now porticle 1 replaces an external observer. ϕ_{12} is a joint amplitude, from the perspective of porticle 1 at t_1, that 1 is at $\vec{r}_1$ and 2 is at $(t_2, \vec{r}_2)$. The system may equally be represented by $\phi_{21}(t_2, \vec{r}_2; t_1, \vec{r}_1)$ from the vantage of porticle 2, with amplitudes Γ_{21} and γ_{21}. While the perspective in this approach is inherently non-inertial, an inertial perspective may be achieved by transforming quantities to a COM reference frame. Classic measurements remain problematic in this MTi version, as there is no capable observer.

For systems with N>2 porticles, link pairs may be correlated, such that CL amplitudes cannot be encoded using two-porticle Γ_{ojk} and γ_{ojk}, or Γ_{jk} and γ_{jk}. For N=3 porticles 1, 2 and 3, it is necessary to introduce correlated link-pair amplitudes Γ_{o123} and γ_{o123}, or Γ_{123} and γ_{123}. Information regarding links not involving the observer is found in Γ_{o123}, but not in γ_{o123}. Similarly, information regarding links not involving porticle 1 is in Γ_{123}, but not γ_{123}. The corresponding partial MTi wavefunction is represented by $\phi_{123}(t_1, \vec{r}_1; t_2, \vec{r}_2; t_3, \vec{r}_3)$. The system may equivalently be represented by ϕ_{213} or ϕ_{312}, from the perspectives of 2 or 3.

What are the functional forms of the link-pair amplitudes and wavefunctions in MTT? The explicit functional dependence ultimately derives from the MT equations of motion, which have not yet been identified. However, it is still possible to explore features expected of actual solutions, and to tentatively consider quasiphysical functions which embody these features. Consider then an MTe system consisting of an observer plus a single porticle #1. Let $\gamma_{o1}(t_{ooa}, t_{oob}, \theta_{oaob}, \vec{u}_{oaob};\ t_{ooc}, t_{ood}, \theta_{ocod}, \vec{u}_{ocod};\ t_{o1a}, t_{1oa}, \theta_{o1a}, \vec{u}_{o1a};\ t_{o1b}, t_{1ob}, \theta_{o1b}, \vec{u}_{o1b})$ be the truncated link-pair amplitude covering both o-o and o-1 links, and $\phi_{o1}(t_o, \vec{x}_o; t_1, \vec{x}_1)$ the associated partial wavefunction. All quantities are defined from the observer perspective.

It is useful to express both γ_{o1} and ϕ_{o1} as products $\gamma_{o1} = \gamma_{\text{free}}\, \gamma_{\text{int}}$ and $\phi_{o1} = \phi_{\text{free}}\, \phi_{\text{int}}$ of free-porticle and interaction terms. In the weak (free-porticle) interaction limit, we expect

$$\phi_{\text{free}} \sim \psi_{\text{free}} \sim e^{-i\omega_{\text{o}} t_{\text{o}} + i\vec{k}_{\text{o}}\cdot\vec{x}_{\text{o}}}\, e^{-i\omega_1 t_1 + i\vec{k}_1\cdot\vec{x}_1}\,,$$

where $(\omega_{\text{o}}, \vec{k}_{\text{o}})$ and $(\omega_1, \vec{k}_1)$ correspond to (energy, momentum) of the observer and porticle, respectively. Here $\hbar^2\omega^2 = \hbar^2 k^2 c^2 + m^2 c^4$ separately for the observer and porticle, if m is invariant rest mass.

This free-porticle behavior in ϕ_{free} can be reproduced by setting γ_{free} to a product of factors, one for each link (four total), where each factor is in turn the product of an exponential temporal and an exponential spatial frequency term. For observer self-links oa-ob and oc-od, the temporal terms have a common frequency $\omega_{\text{o}}/2$ and time variables $(t_{\text{ooa}} + t_{\text{oob}})/2$ or $(t_{\text{ooc}} + t_{\text{ood}})/2$, while the spatial terms have a common wavevector $\vec{k}_{\text{o}}/2$ and space variables $\vec{x}_{\text{oaob}} = c\,(t_{\text{oob}} - t_{\text{ooa}})\,\vec{u}_{\text{oaob}}/2$ or $\vec{x}_{\text{ocod}} = c\,(t_{\text{ood}} - t_{\text{ooc}})\,\vec{u}_{\text{ocod}}/2$, respectively. For observer-porticle links o1a and o1b, the temporal terms have a common frequency $\omega_1/2$ and time variables t_{1oa} or t_{1ob}, while the spatial terms have a common wavevector $\vec{k}_1/2$ and space variables $\vec{x}_{\text{o1a}} = c\,(t_{\text{1oa}} - t_{\text{o1a}})\,\vec{u}_{\text{o1a}}$ or $\vec{x}_{\text{o1b}} = c\,(t_{\text{1ob}} - t_{\text{o1b}})\,\vec{u}_{\text{o1b}}$, respectively. Here $\vec{x}_{\text{o1}}$ is a 3D distance vector from the observer to porticle 1, defined separately for each link at t_{1o}.

The link frequencies corresponding to $(\omega_{\text{o}}, \vec{k}_{\text{o}})$ and $(\omega_1, \vec{k}_1)$ can be interpreted as properties of the observer and porticle 1, respectively, and *not* quantities transferred by CLs. This is consistent with minimal interactions. Yet interactions between the observer and itself, or the observer and porticle 1, may cause information transfer over links, and determine γ_{int}.

Consider such a link pair between the observer and porticle 1. Define $\delta_{\text{o1}} = \theta_{\text{o1}}(t_{\text{1o}} - t_{\text{o1}})$, the forward time displacement between the observer and porticle 1 along link o1a or o1b. Let $\omega_{\text{o1}} > 0$ be the temporal frequency associated with energy transfered along δ_{o1}, and $\vec{k}_{\text{o1}}$ the wavevector associated with linear momentum transfered in the same direction. Mathematically, a summation $\sum_\omega e^{-i\omega t}$ over a range of ω peaks at $t{\sim}0$. If interactions correlate t_{o} and t_1, then $|\gamma_{\text{int}}|$ should peak at some $\delta_{\text{o1}} \sim d_1/c$, where $\vec{d}_1$ is a 3D distance vector that is in general a function of t_1. If $\vec{x}_{\text{o1}}$ is bounded, $|\gamma_{\text{int}}|$ should also peak at $\vec{x}_{\text{o1}} \sim \vec{d}_1$. The functional dependence of γ_{int} can then be approximated by a product of two 4D sums

$$\gamma_{\text{int}} \sim \sum_{\omega_{\text{o1a}}} e^{-i\omega_{\text{o1a}}(\delta_{\text{o1a}} - d_1/c)} \sum_{\vec{k}_{\text{o1a}}} e^{+i\vec{k}_{\text{o1a}}\cdot(\vec{x}_{\text{o1a}} - \vec{d}_1)} \sum_{\omega_{\text{o1b}}} e^{-i\omega_{\text{o1b}}(\delta_{\text{o1b}} - d_1/c)} \sum_{\vec{k}_{\text{o1b}}} e^{+i\vec{k}_{\text{o1b}}\cdot(\vec{x}_{\text{o1b}} - \vec{d}_1)}$$

over a range of $(\omega_{\text{o1a}}, \vec{k}_{\text{o1a}})$ and $(\omega_{\text{o1b}}, \vec{k}_{\text{o1b}})$ for links o1a and o1b, respectively.

What is the functional behavior of the corresponding $\phi_{\text{int}}(t_o, \vec{x}_o; t_1, \vec{x}_1)$? Define a time correlation parameter $\varepsilon_{o1} = (t_1 - t_o)$ and an associated vector $\vec{\varepsilon}_{o1} = \varepsilon_{o1}\, \vec{x}_1/x_1$, where $\vec{x}_{o1} = \vec{x}_1 + \theta_{o1} c \vec{\varepsilon}_{o1}$ when $t_{o1a} = t_o - x_1/c$, $t_{o1b} = t_o + x_1/c$, and $t_{1oa} = t_{1ob} = t_1$. Then

$$\phi_{\text{int}} \sim \sum_{\omega_{o1a}} e^{-i\omega_{o1a}(c\varepsilon_{o1}+x_1-d_1)/c} \sum_{\vec{k}_{o1a}} e^{+i\vec{k}_{o1a}\cdot(c\vec{\varepsilon}_{o1}+\vec{x}_1-\vec{d}_1)}$$

$$\times \sum_{\omega_{o1b}} e^{-i\omega_{o1b}(-c\varepsilon_{o1}+x_1-d_1)/c} \sum_{\vec{k}_{o1b}} e^{+i\vec{k}_{o1b}\cdot(-c\vec{\varepsilon}_{o1}+\vec{x}_1-\vec{d}_1)}\,.$$

This function peaks at $\varepsilon_{o1} \sim (d_1 - x_1)/c$ and $\vec{\varepsilon}_{o1} \sim \left(\vec{d}_1 - \vec{x}_1\right)/c$ for link o1a, but $\varepsilon_{o1} \sim (x_1 - d_1)/c$ and $\vec{\varepsilon}_{o1} \sim \left(\vec{x}_1 - \vec{d}_1\right)/c$ for link o1b, or overall at $t_1 \sim t_o$ and $\vec{x}_1 \sim \vec{d}_1$, as expected with interactions.

Consider now an observer interactive self-link pair. Define $\delta_{oaob} = \theta_{oaob}(t_{oob} - t_{ooa})$ and $\delta_{ocod} = \theta_{ocod}(t_{ood} - t_{ooc})$, the forward time displacement along observer self-links oa-ob and oc-od, respectively. Let ω_{oo} be the temporal frequency associated with energy transferred along δ_{oo}, and $\vec{k}_{oo}$ the wavevector associated with linear momentum transfered in the same direction, for each link. Suppose that the functional dependence of γ_{int} with respect to observer self-links can be approximated by a product of two 4D sums

$$\gamma_{\text{int}} \sim \sum_{\omega_{oaob}} e^{-i\omega_{oaob}\delta_{oaob}} \sum_{\vec{k}_{oaob}} e^{+i\vec{k}_{oaob}\cdot\vec{x}_{oaob}} \sum_{\omega_{ocod}} e^{-i\omega_{ocod}\delta_{ocod}} \sum_{\vec{k}_{ocod}} e^{+i\vec{k}_{ocod}\cdot\vec{x}_{ocod}}$$

over a range of $(\omega_{oaob}, \vec{k}_{oaob})$ and $(\omega_{ocod}, \vec{k}_{ocod})$ defined separately for each self-link oa-ob and oc-od. The corresponding ϕ_{int} peaks at $\vec{x}_o \sim 0$, corresponding to the observer seeing itself localized at the origin of the observer coordinate system.

By using generalized link amplitudes that include both free-porticle and interaction terms, partial wavefunctions ϕ_{mt} can be made equivalent to the complete wavefunction ψ_{mt}. To the extent they define this wavefunction, links essentially define timespace itself. When interactions are considered, γ_{o1} includes dependence on $(\omega_{oaob}, \vec{k}_{oaob})$, $(\omega_{ocod}, \vec{k}_{ocod})$, $(\omega_{o1a}, \vec{k}_{o1a})$, and $\left(\omega_{o1b}, \vec{k}_{o1b}\right)$, in addition to $(\omega_o, \vec{k}_o; \omega_1, \vec{k}_1)$. The link-pair probability per dependent quantity is again $|\gamma_{o1}|^2$.

[Fleegello unnecessarily restricted each CL to the transfer of a single quantum of information. A link may actually transfer any number of information packets, each a superposition of frequency (or other) states. A link amplitude must specify the number of packets, as well the link type (PCL or RCL) and the state superposition distribution associated with each. Amplitudes may alternatively be reformulated in a way resembling QFT, to specify the number of quanta occupying each of a set of link states.]

Return to link pairs o1a and o1b between the observer and porticle 1. What are the restrictions on transferred quantities, if energy and momentum are conserved at every link vertex? In the case of RCLs (e.g., an observer may scatter a real photon from porticle 1 to see where and when it is), then only $t_{1oa} = t_{1ob}$ (link pairs defining the wavefunction ϕ_{int}) is allowed if porticle 1 is elementary. Quantities ω_{o1} and $\vec{k}_{o1}$ must further satisfy the standard relation between temporal frequency, wavenumber, and rest mass of the link porticle along each link.

For PCLs, energy-momentum conservation requires that the effective link mass for a solitary link be imaginary, if porticle 1 is elementary. This is allowed, as PCLs are transient, and represent only the effect of a force field, not actual porticles. Although information moves at light speed, the relation between ω_{o1} and $\vec{k}_{o1}$ is not constrained. Because a negative frequency ω_{o1} moving in the positive time direction is equivalent to a positive frequency moving in the opposite θ_{o1} direction, physically meaningful ω_{o1} can be restricted to positive values.

Momentum wavevectors $\vec{k}_{o1}$ may in general contribute to ϕ_{int} even when they point in directions other than $\vec{u}_{o1} = \theta_{o1}\vec{x}_1/x_1$. Whereas the *average* value of $\vec{k}_{o1}$ should be collinear with $\vec{u}_{o1}$ for RCLs, this restriction does not apply to PCLs. The quantity $\vec{k}_{o1}$ presumably contributes to changes in the velocity of porticle 1 seen by the observer. Define $\vec{k}_{o1}^{+}$ to be the component of $\vec{k}_{o1}$ along $\vec{u}_{o1}$, with $\vec{k}_{o1}^{+} = k_{o1}^{+}\vec{u}_{o1}$. The philosopher Puuliin has suggested that forward wavenumbers k_{o1}^{+} must be positive if an interaction is repulsive, and negative if it is attractive. $\vec{k}_{o1}^{+}$ respectively points in the same direction as $\vec{u}_{o1}$, or in the opposite direction.

How closely can the proposed product of two 4D sums of frequency eigenfunctions in γ_{int} correlate t_o with t_1, and $\vec{x}_1$with $\vec{d}_1$? In addition to the time correlation parameter ε_{o1}, define a 3D distance correlation vector $\vec{\eta}_{o1} = \vec{x}_1 - \vec{d}_1$ at (t_o, t_1). In the classical limit, t_o and t_1 can be synchronized, and a unique 3D distance $\vec{d}_1(t_1)$ exists at t_1. The quantities ε_{o1} and η_{o1} are then both zero with 100% probability. The corresponding γ_{int} can be approximated by a maximal summation over $(\omega_{o1a}, \vec{k}_{o1a})$ and $(\omega_{o1b}, \vec{k}_{o1b})$ eigenfunctions. In the classical extreme, the sum is over discrete values of ω_{o1} from 0 to $+\infty$, and each component of $\vec{k}_{o1}$ from $-\infty$ to $+\infty$ (including zero), at increments $\Delta\omega_{o1}$ and $\Delta\vec{k}_{o1}$, in the limit $\Delta\omega_{o1} \to 0$ and $\Delta\vec{k}_{o1} \to 0$. Each phase factor in the sum is multiplied by the four-dimensional product of the increments.

[This sum is comparable to the product $\delta(\epsilon)\,\delta^3(\vec{\eta})$ of four Draci *delta functions*, where $\delta(x)$ is defined by $\delta(x) = 0$ for $x \neq 0$, and $\delta(0) = \infty$ such that the area under $\delta(x)$ is unity. δ^3 is the product of three ordinary delta functions, one for each spatial component of $\vec{\eta}$.]

Can such a link-pair amplitude be realized in our physical world? RCLs and PCLs actually have distinct minimum and maximum allowed absolute values $(\omega_{\min}, \omega_{\max})$ of angular frequency and $(k_{\min}, k_{\max})$ of wavenumber in any superposition of simple states.

For real massless bosons, an RCL travel distance d_1 defines a limiting maximum wavelength $\lambda_{\max} = 2d_1$, entailing a *minimum* frequency $\omega_{\min} = \pi c/d_1$ and wavenumber $k_{\min} = \pi/d_1$. Limiting maximum values of frequency and wavenumber are defined only by the (inverse) smallest meaningful size of a timespace interval, and so are presumably huge but finite.

The situation is reversed for PCLs. Because a PCL represents collective phantom processes and does not comprise an independent time line, phase cannot gradually change along its length; only the net shift is meaningful. This shift must then be limited to the range $-\pi$ to $+\pi$. Any outside value would be indistinguishable from a number inside the range. A PCL travel distance d_1 thus defines a limiting *maximum* absolute frequency $\omega_{\max} = \pi c/d_1$ and wavenumber $k_{\max} = \pi/d_1$. The minimum frequency and wavenumber are both zero.

For RCLs, the $\omega_{\text{o}1}$ and $k_{\text{o}1}$ must further satisfy the standard Niestiik energy–momentum relationship with rest mass (zero for a massless boson link), and both $\omega_{\text{o}1}$ and k_{o1}^{+} are restricted to positive values. For PCLs, $\omega_{\text{o}1}$ must also be positive, and k_{o1}^{+} may be restricted to positive (negative) values if an interaction is repulsive (attractive).

A PCL sum may not favor all frequencies and momenta equally within the allowed ranges. Analogous sums in QFT electromagnetic calculations include factors like $1/(\omega^2 - c^2K^2)$, favoring photon-like states with effective mass near zero. Applying appropriate limits, but neglecting any weighting factors, a sum can be converted to an integral, and evaluated using calculus. Probability distributions may be derived from the absolute squares of the results.

Absolute squares of the sums over ω_{o1a}, $\vec{k}_{\text{o1a}}$, ω_{o1b} and $\vec{k}_{\text{o1b}}$ for links o1a and o1b yield partial distributions $P_{\text{o1a}\omega}(\varepsilon_{\text{o}1} + x_1 - d_1)$, $P_{\text{o1a}k}(\vec{\varepsilon}_{\text{o}1} + \vec{\eta}_{\text{o}1})$, $P_{\text{o1b}\omega}(\varepsilon_{\text{o}1} - x_1 + d_1)$, and $P_{\text{o1b}k}(\vec{\varepsilon}_{\text{o}1} - \vec{\eta}_{\text{o}1})$, respectively. The overall joint probability distribution $P(t_{\text{o}}, t_1, \vec{x}_1, \vec{d}_1)$ is the product of these partial distributions. For simplicity, write $\varepsilon \equiv \varepsilon_{\text{o}1}$ and $\eta \equiv \eta_{\text{o}1}$, and evaluate the restricted probability distribution $P(\varepsilon)$ at $\eta = 0$, the peak of $P(\eta)$. Note that all four sums over both temporal and spatial frequencies contribute to the distribution, and $|\vec{\varepsilon}_{\text{o}1}| = |\varepsilon_{\text{o}1}|$ exactly. Distribution $P(\eta)$ may similarly be evaluated at $\varepsilon = 0$, the peak of $P(\varepsilon)$. Although in general $|\vec{x}_1 - \vec{d}_1| \neq |x_1 - d_1|$, we can approximate $|\vec{x}_1 - \vec{d}_1| = \eta \sim |x_1 - d_1|$ when evaluating $P(\eta)$, underestimating the width of the distribution somewhat.

For PCLs, if wavevectors are *not* limited to $k_{o1}^{+} \geq 0$ or $k_{o1}^{+} \leq 0$, the distribution $P_{\mathrm{PCL}}(\varepsilon)$ is

$$P_{\mathrm{PCL}}(\varepsilon) \;=\; \frac{\sin^4(\omega_{\max}\varepsilon/2)}{(\omega_{\max}\varepsilon)^4}\;\frac{[k_{\max}c\varepsilon\cos(k_{\max}c\varepsilon)-\sin(k_{\max}c\varepsilon)]^4}{(k_{\max}c\varepsilon)^{12}}\;\omega_{\max}\,N_\varepsilon$$

where N_ε is a dimensionless normalization constant, and both $\omega_{\min}$ and $k_{\min}$ are set to zero. If $\omega_{\max} = k_{\max}c$, then $N_\varepsilon \cong 560$. This distribution is symmetric in $\pm\varepsilon$, and peaks at $\varepsilon = 0$ with a value 0.4 $\omega_{\max}$. The uncertainty in ε (~ 0.5 the distribution full width at half maximum) is $\sigma_\varepsilon \sim 1.1/\omega_{\max}$. For PCL limiting frequencies, the peak value is 1.3 $c/\,d_1$, and $\sigma_\varepsilon \sim\; 0.35\,d_1/c$.

If the k_{o1}^{+} *are* restricted (as per Puuliin) to either positive or negative values, the integrals over $\vec{k}_{\mathrm{o1a}}$ and $\vec{k}_{\mathrm{o1b}}$ become more complicated. The distribution is still symmetric in $\pm\varepsilon$, but with a broader width, and uncertainty $\sigma_\varepsilon \sim 1.5/\omega_{\max}$. For PCL limiting values, $\sigma_\varepsilon \sim 0.5\,d_1/c$.

The distribution $P_{\mathrm{PCL}}(\eta)$ has the same form as $P_{\mathrm{PCL}}(\varepsilon)$ to the extent that $|\vec{x}_1 - \vec{d}_1| \sim |x_1 - d|$, except now $\eta \geq 0$ and so $N_\eta \cong 2\,N_\varepsilon$. The uncertainty in η is $\sigma_\eta \geq\; c\,\sigma_\varepsilon$.

For RCLs, there is no explicit integration over ω_{o1}, as it is folded into the integration over k_{o1}. For massless boson links, $\omega_{\mathrm{o1}} = c\,k_{\mathrm{o1}}$. The distribution $P_{\mathrm{RCL}}(\varepsilon)$ is comparatively complicated, but again peaks at $\varepsilon = 0$, with an uncertainty $\sigma_\varepsilon \sim 2.4/\omega_{\max}$. However, the $\omega_{\max} = ck_{\max}$ limit is *much* larger than for PCLs. The distribution $P_{\mathrm{RCL}}(\eta)$ is related to $P_{\mathrm{RCL}}(\varepsilon)$ as with PCLs.

The correlation between t_{o} and t_1 is thus in general *not* one-to-one, especially for PCLs. As long as elementary physical objects have separate world lines (this conclusion then applies to MTT, but *not* QFT), STT is an approximation; a multi-time scheme must be more accurate. The classical limit is approached only through a sum of lower-energy PCLs and higher-energy real boson links. The minimum uncertainty in the correlation between t_{o} and t_1 from phantom processes alone is ~ d_1/c (the time light travels d_1). An uncertainty ~ d_1 is likewise inherent in any PCL specification of interporticle distance. Values for a macroscopic observer viewing a single fermion could be much smaller, if real porticles are used as probes.

The precise form and time evolution of MT causal link amplitudes and wavefunctions are ultimately defined by dynamic equations of motion. What are these equations, and …

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[At this point there is a gap in the historic record, in which Fleegello purportedly tried to formulate a regorous mathematical framework for MTT, and demonstrate that CLs provide a complete, novel MT framework for representing multi-porticle systems. Failure to complete this project apparently led Fleegello to doubt his own competence as a natural philosopher / physicist, and to destroy all related material in a fit of despair shortly before his death.

Physicists eventually did develop a complete MTT that supplanted standard single-time QFT. Here the connections among elementary non-gauge porticles (mainly fermions) inherently define spacetime, and PCLs are dictated by MT gauge symmetries. For every non-gauge porticle type, there is a pair of operators that create or destroy, respectively, one such porticle, including its own proper time line (typically beginning and ending on the world line of another non-gauge porticle, e.g. during a collision). For every gauge boson, there is a pair of operators that create or destroy, respectively, a CL between specified points on porticle world lines. Operator commutation relations ensure the appropriate symmetries of quantum states.]

Insofar as CLs specify 3D directions, they also define (probability amplitudes for) the relative 3D positions of all causally connected porticles in a system, regardless of number. Yet CLs should be capable of establishing a 3D spatial frame even *without* these inherent 3D directions.

Consider in this regard an isolated system of N distinguishable porticles. If relative speeds are non-Niestiik, then interporticle distances $d_{jk} \cong d_{kj}$, and CLs define amplitudes for $N(N-1)/2$ such distances. These are sufficient to construct amplitudes for the $(3N-6)$ coordinates of 3D interporticle relative position vectors (up to a rigid rotation and displacement of the entire system), as long as $N > 3$. Indeed, they should be sufficient to determine all relative coordinates for up to (N-1) dimensions. Relative speeds and accelerations are implicit in changes in the d_{jk} along world lines. Comparable conclusions apply even to quantum systems of identical porticles, and for Niestiik speeds.

The web of CLs and associated proper times among the world lines of elementary porticles could thus determine the geometry of timespace, in particular the large-scale geometry, whether or not CLs specify spatial direction. In either case, space can unfold from the relationships among myriad connected events. To the extent this occurs, space does not have independent existence, but is defined by the connections between the mathematical objects we perceive as porticles. A world without causal links would be a world without space; any porticles would be independent of each other, with no meaningful positional relationships.

Yet why do inter-porticle connections defined by interactions specifically generate an overall *three*-dimensional, nearly *flat* (under normal conditions) space?

The mathematical physicist Wittuu has proposed a mechanism that both restricts and defines the number of spatial dimensions. Large-scale timespace is defined mainly by the electromagnetic interaction, since it is associated with phantom photons of unlimited range. While real photons are massless, and restricted to two spin states, phantom photons have *three* spin states, like any spin-1 porticle with mass. These correspond to three inherent, independent "directions." Because all photons are identical, exchanging their identities cannot alter a physical system, so they must share the same three directions. Every interporticle distance defined by photon CLs is thus limited to vectors in a common 3D space.

The strong and weak interactions should establish additional spatial dimensions. While there are eight gluon types, these are not independent, and generate only three new dimensions. The three bosons of the weak force generate the same, making a total of nine spatial, or ten timespace dimensions. Yet the strong and weak ranges are so tiny (~10^{-13} and 10^{-16} centurets), they mainly affect the small-scale geometry of timespace. Wittu suggests the associated dimensions are "curled up," and only obvious at very small scales or high energies.

[While Wittuu's argument was sketchy, later generations of physicists demonstrated that his intuition was sound (though he missed a few small-scale dimensions). A rigorous explanation of the origin of macroscopic spatial dimensions was eventually developed. Spacetime essentially arises as an emergent property from the interconnections among primitive, abstract, timeless mathematical forms.]

What about gravity? The carrier of this interaction is ostensibly the massless graviton. Because the graviton is a spin-2 porticle with unlimited range, gravity might be expected to generate its own large-scale 5-dimensional space. Yet gravity has an unusual character, related to its incompatibility with standard QFT. All other fundamental forces are carried by spin-1 bosons, and associated with unique and conserved "charges" (e.g., electric charge). But gravity couples to a system's *stress-energy tensor,* to which *every* interaction contributes. Gravity reduces all "bare" mass energies, and even couples to itself, leading to nonlinearities in the *gravitational field equations*. PCLs established by gravity are thus dependent on and flow from the other interactions, so that gravity does not add new dimensions. It may nonetheless distort the large-scale structure of timespace, as in Niestu's theory of general invariance.

It is clear that neither standard graviton exchange nor general invariance represents the complete fundamental description of gravity, even if both are good approximations in the low-energy limit. A missing element in these theories may involve the small-scale structure of time. Physicists have traditionally considered time to be continuous. In an attempt to avoid divergent (infinite) quantities in QFT calculations [previously removed for forces other than gravity by a dubious procedure known as *renormalization*], Planko has proposed that proper time is quantized along the world line of every elementary porticle with mass. The fundamental proper time interval, or *chronon*, for elementary particles is represented by the symbol Δ. The distance between elementary particles is then naturally quantized in multiples of $\Delta c/2$. [Spacetime volume is more generally quantized, and not space or time separately. By inertial invariance, this quantity is unaffected by a velocity transformation.] Note that the intervals Δ_0 and Δ_j introduced earlier may differ from Δ, if they refer to *composite* time lines.

Quantized proper time may be *required* by ideobasic principles. Consistency logic compels the PCS to recognize the most general conception of time. Yet continuous time is only a limiting case of quantized time. The infinity of numbers on a continuous line segment is furthermore countable only for rational values; there is no one-to-one correspondence between irrational numbers and the set of positive integers. If it is impossible to locate irrational values within the PCS field, they cannot meaningfully exist there. Note that time is inherent only along porticle world lines; it does not meaningfully reside anywhere else.

If timespace is quantized, the smooth differential equations of Shrodiik physics, QFT and MTT must be replaced by discrete difference equations. Observables defined in terms of derivatives must be redefined. Symmetry principles and conservation laws are all affected.

[Other physicists had previously hypothesized that spacetime was quantized, but only with respect to the overall coordinate framework of a given observer, not with respect to individual porticles. These *lattice approaches* were doomed to failure, as they were divorced from the very processes that define space and time.]

A minimum proper time interval Δ along an elementary proper time line implies an associated maximum absolute angular frequency

$$\omega_{\max} = \pi/\Delta\,,$$

and a range of meaningful frequencies

$$0 \le \omega \le +\omega_{\max}\,.$$

This limit also applies to RCLs, though a smaller cutoff should apply to PCLs.

In MTT, every elementary porticle is characterized by a single, separate proper time line. Based on a symmetric version of the modified single-porticle equation of motion, Planko has proposed replacing the linear equation relating the energy E of an elementary porticle in its own rest frame to its proper time angular frequency ω by the trigonometric formula

$$E = \frac{\hbar\omega_{\max}}{\pi} \sin(\pi\omega/\omega_{\max}) .$$

This reduces to the standard equation when $\omega/\omega_{\max} \ll 1$, and can alternatively be written

$$E = E_{\max} \sin(E_{\mathrm{o}}/E_{\max})$$

where E_{o} is a porticle's uncorrected energy $E_{\mathrm{o}} = \hbar\omega$, and

$$E_{\max} = \hbar\, \omega_{\max}/\pi = \hbar/\Delta \text{ at the angular frequency } \omega_{\max}/2 .$$

Note that $E_{\mathrm{o}} = m_{\mathrm{o}}c^2$ for an elementary porticle with an uncorrected (bare) rest mass m_{o}.

[Massless porticles have no rest frame, and there is no passage of time along their world lines; frequency and energy must be specified with respect to associated porticles with mass.]

Proper time quantization reduces and limits a porticle's effective rest mass energy, in a manner curiously similar to gravity. For every known elementary porticle, $E_{\mathrm{o}}/E_{\max} \ll 1$. The sine function in the modified equation for energy can then be approximated by a truncated power series. Including only the first correction term in this expansion,

$$E \cong E_{\mathrm{o}} - E_{\max}(E_{\mathrm{o}}/E_{\max})^3/6 .$$

According to standard Shrodiik theory, the uncertainty in the position of a mass m cannot be smaller than $\hbar/2mc$. The bare rest mass m_{o} of an elementary porticle thus cannot be meaningfully confined to a volume with a radius smaller than

$$r_{\min} \cong \hbar/4m_o c = \hbar c/4E_o .$$

Using this relation to remove one power of m_o from the previous equation,

$$E \cong m_{\mathrm{o}}c^2 - (c^5\Delta^2/24\,\hbar)(m_{\mathrm{o}}^2/r_{\min}) .$$

The correction term is equivalent to the classical gravitational binding energy of a mass m_o distributed over a surface of radius $r_{\min}$, if one identifies the *gravitational constant* G as

$$G \cong c^5\Delta^2/12\hbar .$$

Conversely, the chronon Δ can now be related to the gravitational constant by

$$\Delta \cong \sqrt{12\hbar G/c^5} .$$

Indeed, Planko has identified the minimum distance $\Delta c/2$ with the *Planko length*

$$L_{\mathrm{P}} = \sqrt{\hbar G/c^3} \cong 10^{-33} \text{ centurets,}$$

and the chronon Δ with the *Planko time*

$$T_{\mathrm{P}} = \sqrt{4\hbar G/c^5} \cong 10^{-43} \text{ nocs,}$$

which differs from the value derived above by less than a factor of two.

[These estimates are remarkably close (within a factor of eight) to the chronon value obtained from subsequent experiments. The Planko quantities were inferred theoretically from the time/distance scale at which the quantum effects of gravity should become significant.]

Planko has further proposed a *natural* system of units, in which the equations of motion are simplified. The unit of time is the chronon, and the unit of distance Δc. Elementary porticle separations are then half-integral multiples of Δc, and c is numerically equal to one. Units of mass and electric charge are chosen so that the Planko and gravitational constants numerically equal one, and an elementary electric charge is the square root of the fine structure constant.

How does time quantization affect the energy of a multiporticle system? Consider a pair of elementary porticles 1 and 2, interacting solely by virtue of their mass, that are at rest with respect to an observer, and separated by radial distance r. When the porticles are far apart, interactions are negligible, so proper times τ_1 and τ_2 should be independent and uncorrelated. The two-body wavefunction ψ_{mt} is the product of free-porticle wavefunctions, with bare rest masses m_{10} and m_{20}. Because an increment Δ along one time line does not imply an increment along the other, total system energy E_{far} is the sum of individual porticle energies:

$$E_{\mathrm{far}} = \hbar\omega_1 + \hbar\omega_2 \cong m_1c^2 + m_2c^2$$

where m_1 and m_2 are the effective porticle rest masses, related to the bare rest masses by

$$m_jc^2 = E_{\max} \sin\left(m_{j0}c^2/E_{\max}\right) \ .$$

The energy limit $E_{\max}$ applies only to the rest mass energies of the individual porticles, along their respective world lines, and not to the overall system, so the maximum possible system energy is $2E_{\max}$. In terms of Niestiik COM time coordinates (T, ρ) defined earlier, the *discrete* rate of change of ψ_{mt} along T no longer equals the sum of the *discret*e rates of change of ψ_{mt} along τ_1 and τ_2. The latter instead equals the sum of the discrete rates of change along T for increments $a_1\Delta$ and $a_2\Delta$, respectively. This is equivalent to the discrete rate of change along T for an increment Δ_T, where $\Delta/2$ (for $\omega_1 = \omega_2$) $\leq \Delta_T \leq \Delta$ (for $\omega_1 \ll \omega_2$ or $\omega_2 \ll \omega_1$) . Note here that T is *not* a proper time measure, so the minimum increment Δ does not apply.

At smaller separations, τ_1 and τ_2 may be correlated by mass-related interactions (also required to define interporticle distance), and increments along τ_1 and τ_2 are no longer independent. The maximum correlation, at a minimum meaningful distance r_{min}, is equivalent to the porticles merging into a single world line and proper time – increasing τ_1 by Δ also increases τ_2 by Δ, and vice versa. The time correlation parameter ρ is restricted to values near zero, and the individual porticle wavefunctions merge into a single function characterized by a bare mass $(m_{10} + m_{20})$ and proper time T, now with a standard minimum increment Δ. Considering only bare mass and time quantization effects, the combined energy is then

$$E_{\text{near}} \cong E_{\text{max}} \sin[(m_{1\text{o}} + m_{2\text{o}})\, c^2 / E_{\text{max}}] \ .$$

Whereas a total energy limit corresponding to a minimum system time interval ~$\Delta/2$ applies when the porticles are far apart, a lower limit corresponding to Δ applies when they are near.

At intermediate separations r, one can write

$$E_r = (1 - \varepsilon) E_{\text{far}} + \varepsilon E_{\text{near}} \ ,$$

where ε is a function of r, such that $\varepsilon \to 0$ as $r \to \infty$, and $\varepsilon \to 1$ as $r \to r_{\text{min}}$. This equation can in turn be rewritten

$$E_r = E_{\text{far}} + E_{\text{int}} \ ,$$

where E_{int} is an effective interaction energy

$$E_{\text{int}} = -\varepsilon\, (E_{\text{far}} - E_{\text{near}}) \ .$$

If bare mass energies are much smaller than E_{max}, then to good approximation, correction terms of order higher than $(E_{\text{o}}/E_{\text{max}})^2$ may be ignored, and

$$E_{\text{int}} \cong -\varepsilon\, c^6 m_1 m_2 (m_{1\text{o}} + m_{2\text{o}}) \,/\, 2E_{\text{max}}^2 \ .$$

The minimum separation r_{min} can be estimated from the smallest volume that can confine the total uncorrected rest mass energy,

$$r_{\text{min}} \cong \hbar / 4 (m_{1\text{o}} + m_{2\text{o}}) c \ .$$

If Δ is approximated by $\sqrt{8\hbar G / c^5}$ (within a factor of two of the earlier estimates), then

$$E_{\text{int}} \cong -\, m_1 m_2 G\, (\varepsilon / r_{\text{min}}) \ .$$

This is identical to the classical expression for gravitational binding energy, if only

$$\varepsilon = r_{\text{min}} / r \ .$$

This low-energy radial dependence is appropriate for a long-range interaction carried by massless gravitons. It also suggests that the degree of correlation between times τ_1 and τ_2 is $\sim 1/r$, consistent with a cutoff frequency $\omega_{\max} \sim c/r$ for PCLs.

[While Fleegello used semiclassical reasoning in the above argument, the conclusions have some qualitative validity.]

Thus, in the low-energy limit, time quantization appears to effect system energy in a way similar to the low-energy limit of standard graviton exchange, assuming only that τ_1 and τ_2 can be correlated by purely mass-dependent interactions. Gravity would then be similar to other forces, in that it can be associated with the exchange of a gauge boson at low energies, but distinct in its more fundamental association with time quantization.

Suppose now that the interacting elementary porticles have electric charges Q_1 and Q_2. The bare electrostatic interaction energy is then

$$E^o_{\text{elec}} = Q_1 Q_2 / r \ .$$

Again ignoring corrections of order greater than $(E_{\text{o}}/E_{\max})^2$, and adopting the original $\varepsilon(r)$, the residual interaction energy associated with time quantization is now

$$E_{\text{int}} \cong -\left[m_1 m_2 + (m_1 + m_2) E^o_{\text{elec}}/c^2 + E^o_{\text{elec}} E^o_{\text{elec}}/c^4\right] G/r \ .$$

The three terms in brackets can be interpreted as the gravitational interaction energies between the two masses, between the masses and the electrostatic field, and between the electrostatic field and itself. As in more traditional theories, gravity couples to all relevant sources of energy.

The PCLs generated by the electric (or any non-gravitational) force appear to only indirectly affect the correlation of the proper times of the two porticles; the derived mass-to-mass interaction energy with and without an electric interaction would otherwise have a different value for a given separation. The energies associated with non-gravitational PCLs apparently engender coincident graviton PCLs, which embody the actual process by which time correlations are established. This may reflect gravity's pivotal role in defining the geometry of timespace, and the fact that gravity does not appear to add any new spatial dimensions.

The origami-like unfolding of timespace from a milieu of interwoven, correlated events may generally result in a non-Euclidean macroscopic geometry. The effective curvature of conventional timespace would then be a natural consequence of the quantization of proper time intervals and the correlation of time lines by graviton exchange.

An elementary porticle's rest mass may derive from a variety of sources. Every porticle is effectively surrounded by a cloud of phantom exchange bosons, corresponding to all applicable interactions. But this is unlikely the sole source of mass for common porticles. For example, if the electron's effective size is the minimum volume that can contain its mass, then the electron electric field contributes less than 1% to the observed mass value (the magnitude of the negative gravitational self-energy contribution is 43 orders of magnitude smaller).

Rest mass may also originate in a porticle's underlying geometric character. Wittuu has suggested that elementary porticles may not be pointlike, but associated with vibrations of extended (but tiny) geometric forms. The size of such entities should be comparable to the radial parameter r_{min} computed earlier for a given rest mass.

Can quantized timespace be incorporated into a quantum field theory? Time and 3D space have traditionally been treated as continuous system parameters in QFT. Yet past attempts to include gravity in QFT have failed; the theory is not renormalizable for point porticles if system timespace is continuous. Even excluding gravity, the standard renormalized version of QFT predicts an enormous *vacuum energy density*. By adopting a multi-time framework, and restricting the *proper* time intervals between elementary events to integral multiples of a chronon, maximum energies are naturally limited, and the divergent quantities in QFT calculations may be tamed.

As discussed previously, maximum frequencies associated with phantom processes in a multi-time setting should be further restricted, and inversely proportional to the distance between interacting porticles. If space is defined by and only exists with respect to real material porticles, then phantom processes that are completely disconnected from real porticles might also be forbidden. Any new formulation should reflect that timespace is meaningfully defined only with respect to porticle world lines and interactions. It may even prove necessary to treat elementary porticles as finite-sized objects.

[The approach to quantized timespace outlined by Fleegello was naive, and flawed in many respects. It does not effectively address relative porticle motion, or modifications to symmetry principles and conservation laws, or how an observer can fully integrate the proper times and spatial separations of individual porticles with a global timespace coordinate system, and define a total system energy and wavefunction. Fleegello did acknowledge in private correspondence that his approach to quantized timespace was simplistic and incomplete, and certainly did not comprise a testable theory. Yet by replacing QFT with a multi-time theory, quantizing proper time intervals, and identifying elementary porticles with extended (though minuscule) vibrating geometric forms, physicists were at last able to integrate gravity into quantum theory, and accurately compute the rest masses of elementary porticles from first principles, avoiding the infinities that had plagued previous attempts.]

Although the fundamental (microscopic) equations of motion are symmetric in time, physical processes on a macroscopic level superficially do not appear to be time-symmetric. For example, if all the air molecules in a room were clustered in a corner, they would rapidly spread out to fill the entire room; yet the reverse process is not observed to happen.

Niestu has proposed that this so-called *arrow of time* is a purely statistical phenomenon. The universal state witnessed by an observer at a given moment is connected by a single time increment (chronon) to a host of other states. In Niestu's view, the number of less ordered (higher *entropy*) states corresponding to a "forward" time process is simply much larger than that for a "backward" process. If conscious experience is a random walk from one state to another, a person is much more likely to experience events along the traditional arrow of time. Reverse time steps occur, but are swamped by the sheer number of forward steps. This distinction acquires significance mainly in macroscopic systems, due to the sensitive dependence of the number of states of a given type on the number of porticles in a system.

Yet this statistical feature does not in itself guarantee our experience of time. A conscious being that lacked a memory would live in an eternal present, with no sense of time's arrow. Most animal memories in a given universal state are found to be of events in connected states with lower overall entropy. This implies that the creation of memory generally involves a statistically *irreversible process*. Memories laid down in this direction are normally adaptive, and facilitate survival into an expanding realm of universal states. Memories laid down in the opposite direction could in principle also be adaptive, but only if they overtly present as precognitions, consistent with a person's walk through time.

[Shortly after Fleegello died, the natural philosopher Loh demonstrated that even the observed expansion of the universe could be linked to such statistical considerations, providing a critical link between cosmology, gravitation theory and Shrodiik physics.]

As discussed in section 1.18, any physical universe must have [at least] one basic (self-caused) initial state. This state can imply no previous history; the system would otherwise logically extend to an earlier time. Every physical universe must therefore evolve from an initial state characterized by infinitesimal spatial volume. Our own universe appears to have originally experienced runaway, exponential growth – the primeval *hyperburst* of modern cosmology – from a minuscule primitive state. Every newborn universe must further incorporate porticles or analogous localized objects relative to which distance can be meaningfully defined. It could otherwise not expand (or contract) in any meaningful way.

[Fleegello failed to recognize that, if the experience of the CIF is timeless, a self-contained physical universe may also be cyclic, along a time-like dimension that loops back into itself. Such a system must in its entirety be the cause of itself. His basic argument has nonetheless since been extended to the *multiverse* of all possible physical worlds, whereby our own universe and its generative hyperburst may have been spawned by a pre-existing, self-caused system.]

Physics continues to evolve. Our understanding may yet be profoundly superficial. Will the physical objects and patterns identified so far prove to be unified by a single underlying entity? The multitudinous facets of one magnificent (mathematical) jewel? Or are they disparate, random elements, fragments tied loosely together only by the principle of consistency? Our descendants will hopefully discover the answer to this compelling question.

[During Fleegello's era, physics was rocked by conceptual revolutions every several jopes. Prominent scientists would periodically announce that a "theory of everything" was at hand, or that all that remained in physics was to clean up a few loose ends. These claims were invariably contradicted by new discoveries. Only after many octujopes of struggle was a viable unified theory in fact attained. Even then, physics was hardly dead. The new vision was so rich in possibilities, that its many veins continue to be mined even to this yad. Indeed, quantum physics is no longer considered the most fundamental of the physical sciences, but is viewed instead as the study of emergent phenomena arising from a still deeper level of mathematical reality. Other higher-level sciences (chemistry, biology, psychology, etc.) likewise continue to flourish, as an effective understanding of complex emergent reality inevitably transcends knowledge of underlying physical processes.]

Appendix F – Commentary and References

Clarifying non-fictional commentary and references concerning octan physics, as presented in section 2.3 of Fleegello's *Principia*

Fleegello's fictitious critique of octan physics represents an attempt to examine human physics from a speculative *ideobasic* perspective (developed in Parts I and II of Appendix E). According to ideobasism, our physical universe is one self-contained subset of a larger, complete set of abstract mathematical objects that both define spatial-temporal relationships and are compatible with consistency logic. This idea is similar to the *mathematical universe hypothesis* proposed by the cosmologist Max Tegmart.[1]

The discussion addresses in particular two paradigm shifts that revolutionized twentieth century science here on Earth – *quantum physics*[2] and *relativity theory*.[3,4] Much of the standard quantum mechanics content can be found in modern textbooks.[5,6] Further discussion and references concerning both quantum and relativity theory, including interpretations of the probabilistic character of quantum physics, and how human ideas connect with octan thought, are provided in the commentary section on octan philosophy.

In Jopian culture, non-relativistic quantum theory is also known as *Shrodiik physics*, in honor of the fictional physicist *Shrodo*. This name was inspired by Erwin Schrödinger, an important contributor to the development of human quantum mechanics.[7] Relativity theory on Jopitar was pioneered by the fictitious *Niestu*. This name evokes Albert Einstein, who introduced both the *special theory* and the *general theory of relativity* on our own planet.[8] Einstein did not actually coin the term *relativity theory*, and was supposedly not entirely happy with it, as the label was often misinterpreted to suggest "everything is relative." Yet even though it overturned the absolute space and time of Newtonian physics, the new theory was itself based on absolutes – in particular, the invariance of the laws of physics and the speed of light for all *inertial observers*. Einstein is thought to have originally preferred the term *invariance theory*.[9] While this did not catch on in human society, on Jopitar Niestu's theories are known as the theories of *inertial invariance* and *general invariance*. Einstein's thinking was strongly influenced by the physicist Ernst Mach, in particular by his conjecture that inertial frames are not absolute in a Newtonian sense, but ultimately tied to and determined by the large-scale distribution of matter in the universe.[10] Mach is the namesake of the Jopian physicist Machi, who argued that spacetime itself is ultimately defined by matter.

The *multi-time* (MT) *formulation* of quantum mechanics (attributed in the text to the octan physicist Draci) dates back at least to a paper published in 1932 by Paul Dirac,[11] in an attempt to incorporate special relativity into quantum physics. He and others soon argued (within certain assumptions) that relativistic *quantum field theory* (QFT) was a mathematically equivalent but simpler solution to this problem.[12]

There has recently been renewed interest in overtly MT theories.[13] Inclusion of multiple time coordinates is still, however, generally considered merely a way to deal with the effect of relativistic velocity transformations on individual particle spatial coordinates (space and time coordinates become mixed). The MT wavefunction thus includes a separate space and time variable for each particle (measured with respect to a 4D observer frame), and is defined only on spacelike configurations of a multiparticle system. The traditional single-time wavefunction is recovered by setting all time coordinates to a common observer time.

A more radical notion is presented in the text – that MT coordinates are also required to account for limits on the synchronization of distinct proper time lines. The MT wavefunction now explicitly includes a separate time variable for the observer, in addition to individual particle (or *porticle* in the manner of Fleegello) space and time variables. This function is interpreted as a joint probability amplitude that, at a given observer time, the observer sees each particle not only at a specified location, but also synchronized with the observer at a specified particle time (corresponding to a particle proper time). The wavefunction is defined over the *entire* range of particle spacetime coordinates, and a distinct normalization condition (involving invariant 4D integrals) applies. Because relativistic invariance demands that the observer time variable be paired with a spatial variable, the wavefunction must even incorporate a quantum state for the observer!

QFT is currently the most widely accepted fundamental quantum theory on Earth.[14] In addition to special relativity and QFT, the *Standard Model* of physics incorporates all known interactions except gravity. Attempts to include gravity, which is still separately described by general relativity, have not yet succeeded. This failure is one of the outstanding challenges to physics today. An MT version of QFT may ultimately be required to address this problem.[13]

The traditional method for computing interaction probabilities for elementary particles in QFT involves drawing *Feynman diagrams* of all the ways an interaction can occur (including the creation and destruction of intermediary *virtual particles*), then summing the likelihoods of the drawings. Because QFT at present does not properly handle events at very short distances and high energies, infinities are encountered. For most forces (but not gravity), these can be removed by a *renormalization* procedure, resulting in an *effective* field theory.[15]

The proposed origin of our world's three extended spatial dimensions (ascribed to the octan Wittuu) is speculative, and not grounded in any substantiated theory. Over the years, physicists have proposed various explanations for the dimensionality of nature. Much modern theoretical work involves some variant of (super)string theory, or more recently M-theory, that seeks to unify all consistent versions of superstring theory.[16] Elementary particles are no longer regarded as points, but are instead treated as extended objects – originally tiny vibrating strings (either open-ended or closed loops), or more recently minuscule higher-dimensional surfaces. Particle world lines are replaced by world sheets. These formulations naturally require either six (superstrings) or seven (M-theory) extra spatial dimensions, in addition to the standard four (3+1) spacetime dimensions, for mathematical consistency. The extra dimensions are either *compactified* to very small scales, or our world inhabits a 3+1 dimensional subspace, known as a *brane*, of a larger macroscopic system. In the latter case, all particle interactions (except gravity) and motions would be restricted to the brane. It is also possible that separate physical universes exist with branes of dimensionality smaller or larger than 3+1, but inhospitable laws of physics do not permit intelligent life to evolve there. In this case, by a *weak anthropic* argument, we can only find ourselves in a universe with three large spatial dimensions and one time dimension.[17]

Though string theory is still in its infancy, it can in principle be formulated as a QFT, but without the need for renormalization. Quantum gravity is itself a natural feature of string theory, without the intractable infinities generated by standard quantum field theoretic approaches. While other avenues are also being actively pursued to develop a viable quantum theory of gravity (most notably, *loop quantum gravity*), string theory offers a grand unification of all known interactions.[18] Yet novel predictions may be untestable for the foreseeable future, as the relevant distance scales are so small (~10^{-33} cm).

There have been various other attempts to reformulate QFT, both to simplify and to extend the range of computations. Traditional QFT calculations using Feynman diagrams can be extremely arduous, involving a huge number of terms even for simple processes. One attempt to facilitate the mathematics suggests that a *scattering amplitude* – a basic quantity defining the probability that a given set of particles will transform into another set upon colliding – may be equivalent to the volume of a new type of geometric object in higher dimensions. One version of this polyhedron analogue, that does not incorporate gravity, has been called an *amplituhedron*.[19] Important features of the physical universe, such as *unitarity* (the sum of the probabilities of competing processes must equal one) and *locality* (a particle is directly affected only by its immediate environs), appear to be emergent properties of the amplituhedron, rather than innate. The traditional view of particles moving through spacetime may even be illusory. Alternatively, the amplituhedron may simply be a convenient calculation tool, and reflect the underlying mathematical structure of our world in part *because* it is compatible with unitarity and other fundamental principles.

Fleegello's account of quantum time is highly speculative, and not based on conventional human physics. Spacetime is assumed to be continuous both in conventional QFT and in current versions of string theory. While many theorists feel that spacetime must be quantized in any ultimate theory, it is not yet clear how this may be accomplished, and still preserve sacrosanct symmetry principles. It should be noted that no serious attempt to date suggests that gravity is a natural consequence of time quantization (though in loop quantum gravity, quantization of general relativity gives spacetime a discrete structure). Of course, a fictional character like Fleegello is free to playfully speculate on such matters to his heart's content!

A technical review of discrete time mechanics has been published by G. Jaroszkiewicz.[20] Farias and Recami have also published a paper on various attempts to quantize time.[21] They note that time discretization can be achieved either by attributing a discrete structure to time (the approach followed by Fleegello, for proper time scales along particle world lines), *or* by considering time as a continuum in which events occur only at discrete instants. The authors discuss an extension of a proposed theory by P. Caldirola that follows the second approach. Here the *chronon*, or quantum of time, has a value much larger than the Planck time. This value is further not universal, but dependent on the system under examination.

Quantization of spacetime should reduce the *information content* of the physical world. Whether or not spacetime is quantized is thus related to the question of whether the physical (pan)universe contains a finite or an infinite amount of information. An ideobasic argument has been advanced that, if the physical universe is a subset of a unified conscious field (the Consistency Idea Field), then it must be possible to locate every bit of information within it. Any elusive content would not meaningfully exist. This in turn may require that the information content be finite (though outrageously vast). Alternatively, infinite content may be permissible, so long as the infinity is countable (the elements can be put in one-to-one correspondence with the set of natural numbers). The author personally finds the thought of a truly infinite consciousness particularly alien, and even frightening. While humans can conceptualize continuous dimensions and infinity, human consciousness appears to be finite in extent. Yet this in itself does not preclude the existence of an infinite awareness.

The names of the fictional Jopian researchers found in Fleegello's critique are derived from humans who investigated related topics, as listed below.

Planko – German physicist Max Planck (1858–1947)
Planck (reluctantly) helped begin the human quantum revolution in 1900, when he postulated that electromagnetic energy could only be emitted in quantized form. He further proposed that the energy of each quantum is proportional to both the frequency of the radiation, and the so-called Planck constant *h*. Planck won the 1918 Noble Prize in physics for this daring conjecture. Planck also introduced the system of natural units mentioned in the text.[22,23]

Niestu – German-born theoretical physicist Albert Einstein (1879–1955)
Einstein introduced both the special and the general theories of relativity that revolutionized physics. He also helped develop the new quantum theory (though he had an uneasy relation with it), and won the 1921 Noble Prize in physics for related work on the *photoelectric effect*.[8]

Machi – Austrian-Czech physicist and philosopher Ernst Mach (1838–1916)
Mach made important contributions to 19th century physics, in particular concerning the study of shock waves. Philosophically, Mach was a logical positivist who espoused a phenomenalistic approach to science – while we can order our obervations using mathematics, all we can ultimately know is sensory experience. His criticisms of Newtonian notions of space and time helped inspire Einstein's work in relativity theory.[10]

Noethra – German mathematician Emmy Noether (1882–1935)
Noether helped explain the connection between physical symmetries and conservation laws. Her work showed, for example, that if the equations of physics are unaffected by displacements in time and space, then it is possible to define quantities *energy* and *momentum* that are constants of motion.[24]

Shrodo – Austrian physicist Erwin Schrödinger (1887–1961)
In addition to other significant contributions to the new quantum physics and to physics in general, Schrödinger formulated the differential wave equation describing the time development of a quantum system. He shared the 1933 Nobel Prize in physics for this work, and is sometimes referred to as the "father of quantum mechanics."[7]

Draci – English theoretical physicist Paul Dirac (1902–1984)
Among many important contributions that furthered the development of quantum theory, Dirac proposed the *Dirac equation*, which describes the time development of fermions (elementary particles with half-integral spin), and predicted the existence of antimatter. He shared the 1933 Nobel Prize in Physics.[25]

Vigno – Hungarian-American physicist and mathematician Eugene Wigner (1902–1995)
Wigner made many cross-disciplinary contributions to physics. He shared the 1962 Noble Prize in physics, in recognition of his work on nuclear structure, and the application of symmetry principles to quantum mechanics.[26]

Evette – American physicist Hugh Everett III (1930–1982)
Everett proposed the first version of what is now commonly known as the *many-worlds* interpretation of quantum physics in 1957 (see the commentary section on octan philosophy). This viewpoint challenged the orthodox *Copenhagen* interpretation, which maintains that our universe has a single history, and that a measurement of some observable causes the system wavefunction to collapse in a discontinuous manner into a single eigenstate of that observable. The many-world interpretation was originally dismissed by most physicists, and did not begin to receive significant attention until the 1970's.[27]

Wittuu – American theoretical physicist Edward Witten (born 1951)
Witten has made important contributions to research in string theory, quantum gravity, supersymmetric quantum field theories, and other areas of mathematical physics. He is the only physicist to have been awarded a Fields Medal by the International Mathematical Union.[28]

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Appendix G

Octan Units of Measure

The following table defines common octan units of measure, and lists conversion factors to units widely used by both humans and simions (on Earth and Aerth, respectively).
In deference to human (and potential simion) readers,
all numbers here and throughout the text are expressed in the decimal system, base ten.
Octos customarily express numbers in the octal system, base eight.

Physical Quantity	Octan Unit	Definition	Human/Simion Equivalent
Time	noc	1/64 nim	1.09 seconds
	nim	1/64 roh	1.16 minutes
	roh	1/8 yad	1.24 hours
	yad	local Jopitar day (deep interior)	9.92 hours
	kew	8 yads	3.31 days
	thom	8 kews	26.5 days
	jope	local Jopitar year	11.86 years
	kilujope	8^3 jopes	6072 years
	megujope	8^6 jopes	3.109 million years
	bevujope	8^9 jopes	1.592 billion years
Distance	centuret	1/64 ret	1.460 centimeters
	ret	8^{-6} depth of floating thickets	0.935 meters
	kiluret	8^3 rets	0.479 kilometers
	meguret	8^6 rets	245.0 kilometers
	bevuret	8^9 rets	1.254×10^5 kilometers
	light jope	distance light travels in one jope	1.122×10^{14} kilometers
Mass	mag	mass of a 1 centuret cube of alpha-quartz	8.246 grams
	kilumag	8^3 mags	4.222 kilograms
Pressure	rab	8^{-3} atmospheric pressure at floating thickets	0.1187 bars
Temperature	nevlu	8^{-3} absolute temperature at floating thickets	1.119 degrees kelvin

Time, distance, mass, and temperature are fundamental quantities in the modern octan system. The corresponding fundamental units *yad*, *ret*, *mag*, and *nevlu* were originally defined in terms of mean values at the heart of the South Equatorial Belt in the jope zero of the (archaic) calendar of Zuul. The commonly used *jope* and *rab* were then redefined in terms of the fundamental units, to match accepted values during that epoch. All fundamental units were eventually redefined in a more precise, reproducible manner that still closely matched the original values, using dimensional universal physical constants.

Jopitar's rotation and the length of the yad were first inferred from observations of the coriolis force in the floating thickets. The standard deep-interior value was later refined through spacecraft measurements of radio emissions from Jopitar's magnetic field.

The kiluret, nevlu and rab scales were originally calibrated such that the numerical values of depth (beneath the tropopause), temperature, and pressure were all approximately 512 (which is 1,000 in the octo base-8 number system) at the level of the floating thickets. The value of the ret was then similar to a popular ancient unit of distance, based on the average length of the dextrous tentacle of a mature octo.

Octos frequently add prefixes to basic units, to define convenient smaller or larger units. Several of the units defined in the previous table are examples of this practice. The following table lists and defines some of the most commonly used prefixes.

Prefix	Definition
nanu	x 8^{-9} = x 1/512 x 1/512 x 1/512
micru	x 8^{-6} = x 1/512 x 1/512
millu	x 8^{-3} = x 1/512
centu	x 8^{-2} = x 1/64
octi	x 8^{-1} = x 1/8
octu	x 8
hectu	x 8^{2} = x 64
kilu	x 8^{3} = x 512
megu	x 8^{6} = x 512 x 512
bevu	x 8^{9} = x 512 x 512 x 512
teru	x 8^{12} = x 512 x 512 x 512 x 512

Appendix H

Planetary Systems

System Suol

Object	Mean Distance from Suol (kilurets)	Equatorial Diameter (kilurets)	Mass (Kilumags)	Characteristics	Major Moons
Terra-1	1.21×10^8	1.02×10^4	7.82×10^{22}	Small terrestrial world No atmosphere	
Terra-2	2.26×10^8	2.53×10^4	1.15×10^{24}	Terrestrial world Thick CO_2 atmosphere Barren, hellish surface	
Terra-3 Aerth	3.13×10^8	2.67×10^4	1.41×10^{24}	Terrestrial world Similar to Earth	Lune
Terra-4	4.76×10^8	1.42×10^4	1.52×10^{23}	Small terrestrial world Thin CO_2 atmosphere Barren, frigid surface	
Planet-5 Jopitar	1.63×10^9	2.99×10^5	4.50×10^{26}	Gas giant Similar to Jupiter	Moon-1 Moon-2 Moon-3 Moon-4
Planet-6 Sattorn	2.99×10^9	2.52×10^5	1.35×10^{26}	Gas giant	Titun
Planet-7	6.01×10^9	1.07×10^5	2.06×10^{25}	Ice giant	
Planet-8	9.41×10^9	1.04×10^5	2.43×10^{25}	Ice giant	

System Los

Object	Mean Distance from Los (kilurets)	Equatorial Diameter (kilurets)	Mass (Kilumags	Characteristics	Major Moons
Planet-1	2.59x 10^{8}	2.62 x 10^{4}	1.24 x 10^{24}	Terrestrial world Thick CO_2 atmosphere Barren, hellish surface	Unnamed
Planet-2 Malzen≠≠gren	3.93 x 10^{8}	3.01 x 10^{4}	1.98 x 10^{24}	Carbon world $CO+N_2+CH_4$ atmosphere Graphite/diamond crust	
Planet-3 Omen	1.46 x 10^{9}	2.98 x 10^{5}	4.39 x 10^{26}	Gas giant Similar to Jopitar	Loslo
Sentry Shell #1	1.60 x 10^{9}	---	---	Sentry stations	
Planet-4	4.45 x 10^{9}	2.74 x 10^{5}	2.12 x 10^{26}	Gas giant	
Sentry Shell #2	6.96 x 10^{9}	---	---	Sentry stations	
Planet-5 Outpost	9.47 x 10^{9}	1.38 x 10^{5}	3.59x 10^{25}	Ice giant	Como
Sentry Shell #3	1.05 x 10^{10}	---	---	Sentry stations	

Appendix I

Megon Production

The following description applies to the production of a megon (crafton) from a solid rock/ice moon some 780 kilurets in diameter, as in Na's original simulation at Loslo.

Phase 1: Establishing a Creatoid Workforce

A convenient symmetry axis for the intended megon is first established, based mainly on the target moon's innate internal structure, defining "north" and "south" poles. Two identical, generic creatoid seeds are then planted on opposite sides of the body, in the equatorial plain. These hatch, and mature into cylindrical creatures some 8 rets in diameter by 8 rets long. Once mature, the creatoids immediately begin reproducing. Assuming a doubling time of 1.5 thoms, creatoids nearly cover the moon's surface within one-third jope.

A critical density is reached when the creatoids are spaced about 9 rets center-to-center, or one individual per 82 square rets. The creatoids then cease reproduction, and the undifferentiated organisms metamorphose, transforming into dedicated work units. Most become *worm* creatoids, while a 1.6% minority become *diggers*.

Phase 2: Hull Construction

The conscious machines organize into five-fold symmetric patterns over twelve pentagonal surface sectors, defined by the radial projections of the twelve regular faces of an imaginary dodecahedron that circumscribes the spherical moon. Two opposing sectors are centered close to the moon's designated poles.

Standing on end, the worms within each sector arrange themselves in concentric pentagons. These are spaced 9.3 rets center-to-center radially at the pentagon corners, and 10.9 to 10.4 rets azimuthally (the distance varying from the the inner to outermost rings).

The diggers climb atop the worms, and distribute themselves in a more sparse design. They shun the central zone of the south polar sector, a skull cap encompassing the central point plus the first 256 pentagonal rings, leaving it occupied exclusively by worms. Diggers congregate at the hubs of the remaining sectors, one digger mounted on each worm, filling the inner 3 (nonpolar) to 24 (north polar only) pentagonal rings. Elsewhere the diggers uniformly spread themselves over the sea of worms in a similar, overlaid pentagonal array with eight times the spacing. The precise scale of the basic pentagonal pattern is adjusted so that sector boundaries are defined by worms alone, with standard spacing between diggers on either side.

When the creatoids are all in position, the worms attack the crust in unison. They burrow downward at about 3 centurets/nim, ingesting rock. Neighbors share the material between them; every square centuret is devoured. The raw stock is converted into a stringy siliceous mix, which the worms excrete behind them, transforming the crust into a stout, solid medium. An amorphous matrix of fibers slowly crystallizes within the new material, adding strength and resilience. The random filaments will spontaneously coordinate over time, forming a flexible, pervasive neural network. Worms midway between the solitary diggers lay down tracks of tougher, fibrous material, which will eventually become major nerve roots. The megon hull, which will be 48 kilurets thick when completed, grows from the outside inward.

The diggers are temporarily stranded on the surface. The isolated diggers and the peripheral members of the crowded sector hubs pass the time preparing clutches of 49 constructor creatoid eggs each.

When the worms pass the 256 ret depth mark (in about 11 yads time), the diggers shift into action. The isolated majority begin to individually excavate hollow, 9.3-ret diameter shafts, straight down. The round holes are gradually tapered, their sides converging toward the moon's central point. Assemblies of diggers at the sector hubs labor together to clear wider openings of pentagonal cross section into the moon: a primary access port at the north pole, some 367 rets wide (the diameter of the inscribed circle at the surface); and ten secondary access ports roughly 52 rets across, one at the heart of each nonpolar sector. A 7.5 kiluret-broad area at the south pole is left free of holes.

Each egg-bearing digger plants a single constructor seed in its passageway's wall near the surface, and then at 1 kiluret intervals in depth. The constructors in the isolated shafts grow and mature within one thom into comparatively small, flexible, multisegmented and multiarmed forms some 4 rets wide by 6 rets long. Each is programmed to build and tend a protective iris diaphragm, to limit access through its own shaft. The constructors lining the larger access ports together construct and maintain gateways for these routes. The surface creatoids will also rework the outer few rets of the moon's surface, transforming it into a tough, sensor-studded layer of skin.

The diggers line their passageways with reflexive electromagnetic induction coils (later elaborated and refined by the underground constructors), to help control the flow of excavated material. Steaming pellets of synthetic rock shoot out as the diggers advance. Selected material is captured at the surface, and stockpiled between shafts for later processing by the local workers. The rest is directed outward, deflected and focused at the surface into huge streams. The moon slowly spirals outward from its host planet.

The digger force bores through the crust in step with the worms far below. Each lone digger (except those in the inner and outermost rings) has six isolated nearest neighbors in the same sector, forming an irregular six-sided polygon. These neighbors are traditionally labeled 1 through 6, beginning with the digger in the same pentagonal ring in a clockwise (looking downward) direction, and proceeding clockwise around the string of nearest neighbors.

At a depth of eight kilurets – one-sixth the desired hull thickness – the diggers abruptly change direction. Each one begins tunneling down a 45° slope toward a projection of the vertical shaft of its second neighbor. Halfway there (some 51 rets distance) the digger stops, and slides back to the divergence point. It then repeats this process for neighbors 3 through 6, clearing a small chamber some 16.2 rets across at each junction with a tube already dug by a neighbor creatoid. Isolated diggers on the innermost pentagonal rings (except in the south polar sector) also connect with their broad central-sector corridors.

Each lone digger finally connects with the angled shaft cleared by its first neighbor. All the shafts in each sector are now linked, providing alternate travel routes, switch points, and rest stations. This structurally weakened layer also serves as a crumple zone, which will preferentially absorb shock and shatter during a collision with a small asteroid, comet, or other comparable object. Shafts are not joined across sector boundaries, to help localize damage during any impact or other mishap.

The diggers now resume course straight down, though each has been displaced azimuthally, midway between its original vertical shaft and that of its first neighbor. Primarily to reduce radiation hazards, there will be no direct line of sight access along the myriad narrow shafts into the megon interior.

At a depth of sixteen kilurets, the solitary diggers reverse their earlier choreographed shuffle, creating an upside-down scaled replica of the network of interconnecting tunnels established eight kilurets higher up. They then again tunnel downward along projections of their initial paths, in the primary pattern. These diggers alternate between primary and secondary shaft patterns through the remainder of the megon hull, switching every eight kilurets.

When they finally breach the 48 kiluret depth mark, after digging for nearly 1077 yads (about 0.1 jope), each digger pauses long enough to fabricate and plant a packet of 64 digger and constructor eggs. It's time to remake the moon's interior, and extra help will be needed for the excavation work.

Phase 3: Interior Construction

The worm creatoid bodies are just touching when they reach the intended inner surface of the hull, after 16 thoms of labor and about one thom ahead of the diggers. To minimize mutual interference and reduce physical stresses on individual units during interior construction work, the worms divide into six cohorts, which now advance in a shifting pattern of telescoping and twisting rings.

Traditionally, the first cohort consists of worms on the primary digger grid (extended into the sector hubs). The second through fifth cohorts comprise worms on the four sets of successive hexagonal rings surrounding members of the first. The fifth cohort can alternatively be viewed as triangles (12 worms each) midway between the primary digger grid points, which form an interlocking pattern of six-cusped stars centered on those points. The sixth cohort includes all remaining worms, which form tight, isolated triads within the extended triangles of the fifth.

The primary cohort and corner members of the fifth push ahead in unison, each worm plowing straight for the moon's heart. Next comes a synchronous wave of mid-segment units from the fifth cohort (three worms per triangle), then a staggered, curling succession of all remaining fifth and sixth cohort worms (one worm per triangle at a time). These are followed in turn by the expanding worm rings of the second, then the third, and finally the fourth cohorts. Worms from each of these groups initially move parallel to their respective first cohort leaders along non-divergent paths, processing nested hexagonal rock sheaths of constant size.

The worms of the fifth and sixth cohorts deposit an extremely strong medium, laced with a variety of fibers and primitive seeds that will mature into a maze of nerves, nerve trunks, sensors, and conduits. This synthetic connective tissue will provide the framework for an elaborate system of halls, passageways, rooms, and megon organs, which will ultimately extend from the hull to a solid, 172-kiluret-diameter core. The worms in these two cohorts also lay eggs for a hoard of microcreatoids – simple, flexible units barely one ret in diameter, which will inhabit open spaces in the walls, and perform a wide range of housekeeping functions.

The majority of the worms in the other four cohorts convert the rock to a bland but sturdy amalgam, much of which will be cleared away by the diggers to create open spaces. The remainder produce specialized parenchymal media, which will mature into an assortment of dedicated structures. For example, the worms in the digger-free south polar hub manufacture a mix laden with exotic tubules that will grow, multiply, and interconnect to form a throbbing network of plasma chambers and quantum interference circuits. These will eventually become the megon Drac bubble generator, Xam drive, and primary matter-energy converter, integrated directly into the megon brain in the outer core deep below.

As they progress inward, members of various worm cohorts become superfluous, as the overall area of their work zone shrinks. These creatoids instinctively retire, and sink into the synthetic stone, to await a future need.

When they penetrate the interior, diggers at the sector hubs continue to excavate the major access ports as before, tapering them gradually toward the moon's core. The isolated diggers change tasks. They lay their eggs, then begin to hollow out a labyrinth of open spaces. Once they mature, the digger offspring help their parents clear space along their assigned tracks.

The basic architectural elements in the overall interior design are the *blok* and the *collyph*. The blok is a long tapered volume with an oval cross section, associated with and centered on a primary hull shaft. Selected bloks are hollowed out by the diggers to form continuous halls some 256 kilurets in length, and ranging in lateral size from 68x57 rets near the base of the hull to 11x8 rets near the core. Other bloks are configured as a series of abutting halls, or honeycombed with rooms and chambers surrounding a central corridor. The remainder contain the various megon organs, many of them clustered in functional units, and laced with access tunnels.

The collyphs are the main structural components of the foundational framework – towering, interconnected columnar structures that separate the bloks and support the bulk weight of the overlying hull and interior elements. They are flared at both top and bottom to bear their heavy gravitational burdens. Each collyph has a blunted triangular cross section (three concave sides joined by three short, straight segments) near the hull, roughly 38x26 rets in size, and a more compact, squashed hexagonal shape (three straight 8.1 ret sides joined by three shorter concave sides) some 14x9 rets across near the core.

The walls of a typical blok are defined by six collyphs, which radiate outward and merge with each other and adjoining collyphs, forming in cross section an interlocking pattern of hourglass shapes. The hourglass necks, fully 8.1 rets thick at the thinnest point, are riddled with ports and passageways (more so in the upper sections) that interconnect the bloks. A sinuous tunnel, barely wide enough for a microcreatoid to pass, snakes down the center of each collyph, linking a string of side chambers.

Phase 4: Core Construction

The worms require about half a jope to advance the 256 kilurets from the inner hull to the planned outer core, some 171 kilurets wide. Only 6% actually penetrate this far; the rest have been crowded out. The remaining worms reorganize, and enter the core. Now they labor in the heavy darkness, both extending the weight-bearing collyphs toward the inner core, and filling the intervening space with a solid, complex neural mix. This medium will mature into the vast megon brain.

The brain gradually comes to life, performing basic functions, linking with the neural network distributed throughout the megon, and assuming responsibility for coordinating creatoid activities. Many creatoids surrender their limited individual identities, and merge with the overall megon awareness, forming a global, unified conscious field. When a threshold of sophistication is achieved, the memory and personality of a meton will be transferred to the megon brain. The Omenites still have strict rules forbidding the creation of a wholly synthetic individual.

Within 1,000 yads (another tenth of a jope) the brain extends 43 kilurets deep, halfway to the center of the moon. At this level the collyphs intersect and join together, squeezing out the final wedges of brain parenchyma. One-quarter of the worms persist deeper still, eventually replacing most of the inner core with a homogeneous alloy of great strength. One by one these worms stop, and convert themselves into conscious sensors, linked to the megon brain by slender nerve roots, at one with the megon consciousness.

Figure Captions and Credits

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Cover – The planet Jopitar, with three meton spacecraft in the foreground

The image is a modified photo (flipped east-west, and rotated) of Jupiter,
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Figure 1.1 – A tribe of reys in V-formation, gliding down from the cloud tops of Jopitar

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Figure 2.1 – The planet Jopitar, in crescent phase

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Figure 2.2 – A rey, searching for manna amidst the deep hot springs

Figure 3.1 – The towering thunderhead in Na's dream

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Figure 3.2 – A tangle of tornadoes confronted by Na and Ki on their journey

The image is a modified photo of a tornado and associated clouds,
credit National Oceanic and Atmospheric Administration (NOAA).

Figure 3.3 – An overhead view of the mighty storm that swept up Na and Ki

The image is based on a 3D reconstruction from NOAA of 1984 Hurricane Diana.

Figure 4.1 – Lightning that attended Ki as she searched for other reys

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Figure 5.1 – A mature octo

The image is based on a public-domain retouched drawing of Octopus Cyanea, dated to 1886, attributed to a report on the cephalopoda collected by H. M. S. Challenger during the years 1873–76, and displayed on Wikimedia Commons.

Figure 8.1 – The metons Na, Nemo and Ulixis, as they approach Aerth on their mission

The image of Aerth is from a photo of Earth in crescent phase (showing eastern Africa), taken by Apollo-11 astronauts in July, 1969, credit NASA.

Figure 8.2 – The northward face of the simion farmhouse visited by Na

The image is a retouched photograph taken in 1955 by my mother, Mrs. Marjorie Bond, shortly after my family moved into the house in Candia, New Hampshire.

Figure 9.1 – The starry sky that greeted Na and his companions in deep space

The image is a small portion of a high-resolution panoramic view of the Milky Way, credit European Southern Observatory (ESO) and Serge Brunier.

Figure 12.1 – The configuration of black holes encountered by Na, Nemo and Ulixis

The galactic core backdrop is a modified photo of the Omega Centauri globular star cluster, credit ESO / INAF-VST / OmegaCAM.

Foreground stars are from a Hubble Space Telescope photo of the core of the NGC-6397 globular star cluster, credit NASA.

Figure 13.1 – A glimpse of the voidling

Figure 14.1 – Omen's moon-1, as Na and Ulixis first encountered it

The image is a modified photo of Jupiter's moon Io, credit NASA/JPL/U. of Arizona.

The background star field is a tiny portion of a high-resolution panoramic view of the Milky Way, credit European Southern Observatory (ESO) and Serge Brunier.

Figure 15.1 – A nascent thicket, growing at 512 kilurets depth in Omen's atmosphere

Because the scene would be pitch black in "visible" light, it is depicted as it might appear to a creature with trichromatic infrared vision .

Figure 16.1 – An early voidling comet strike on a mid-sized moon of Outpost

The targeted moon is a modified photo of Jupiter's moon Callisto, credit NASA / JPL.

The incoming body is from an artist concept of a collision between objects that created the dust ring around the star Vega, credit NASA / JPL-Cal Tech.

The starry background is a modified infrared photo of the Bootes star field, credit NASA / JPL-Cal Tech / UC Irvine.

Figure 17.1 – A megon candidate moon surveyed by Na and Neris in a reality-2 simulation

The image is a modified photo of Saturn's moon Enceladus, credit NASA / JPL.

Figure 18.1 – *The Gift* being presented to Poy during a reality-two trance

The gift object is a composite of modified public-domain images of gemstones and viruses.

The hands are a modified photo of the hands of my wife, Susan M. Bond.

The starry background is a modified infrared photo of the Bootes star field, credit NASA / JPL-Cal Tech / UC Irvine.

The planet is a modified Cassini photo of Jupiter, credit NASA / JPL / Space Science Institute.

Figure 19.1 – A distant view of galaxy G-3, the destination of Na-3 and Nemo-3

The image is a modified photo of spiral galaxy NGC6744 (many foreground stars and some background galaxies have been removed), credit ESO.

Figure 20.1 – Metons streaming from their megon starship, in the outer halo of galaxy G-3

The backdrop is a modified photo of spiral galaxy NGC4603, credit NASA / STSci.

The distant star system in the upper portion of the image is a modified photo of dwarf galaxy NGC5477, credit ESA / Hubble & NASA.

The planet is a modified artist concept of super-Earth-size planet Kepler-62f, credit NASA Ames / JPL-Caltech / Tim Pyle.

Figure A.1 – The planet Jopitar, in gibbous phase

The image is a modified photo of Jupiter (rotated 180 degrees from the standard orientation, then flipped east-west), credit NASA / JPL / University of Arizona.

The background star field is a tiny portion of a high-resolution panoramic view of the Milky Way, credit European Southern Observatory (ESO) and Serge Brunier.

Figure A.2 – A cross section of Jopitar’s atmosphere and interior

For references on the internal structure of gas-giant planets, see pages 206–209.

Acknowledgements

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Please note that the use of references in the appendices does not indicate endorsement of the material in this novel by any of the cited authors.

Welcome to Jopitar, a mighty gas-giant planet
orbiting an ordinary star in a remote spiral arm of galaxy G-1.
Although it has no accessible surface, Jopitar is home to hybrid
silicone-based life forms adapted to the scorching heat and crushing pressure
more than 150 miles beneath the cloud tops.
These include the reys, tribal soaring creatures that ride aloft towering storms
from a torrid feed zone to the chill upper reaches of the atmosphere.
But the dominant species on Jopitar until now has been the octo,
founder of the ancient, space-faring octan civilization.
These multi-tentacled animals traditionally inhabit floating thickets
that cluster around deep, upwelling hot plumes of life-sustaining nutrients.
Octos share their domain with synons, an assortment of synthetic beings
introduced by the octos long ago, during their great philosophical awakening.
Reys and octos have generally led separate lives, but that is about to change.
Witness the clash between the octan and rey world views,
as these creatures confront one another through their life struggles.
Ponder the logic-driven octan perspective
on the origin of consciousness and the universe itself,
in contrast to the more spiritual, nature-centered rey orientation.
Attend the birth of a new, hybrid society.