

# Empress of Starlight

---

---

G. David Nordley

---

---

Somebody was stealing stars.

“A star eight times the mass of the Sun doesn’t just suddenly disappear,” Dr. Amber Cloud said, quietly, from her office at the rim of Shackleton Crater, Luna.

“It isn’t completely gone. There’s a coincident infrared source,” Tony M’tonka replied three seconds later, bringing up a display of IC 2602, with the vanishing star’s location marked. “And a pair of very faint polar jets. So something’s still there.”

“Uh-huh,” Amber said. Even in the twenty-third century, graduate students should be kept guessing as to what their professors were thinking.

“Not only that,” Tony continued. “But the Galactic Library files show this has happened before, at roughly twenty-million-year intervals. A new high mass star fades away just after it settles down to the main sequence. But it isn’t gone. Ten million years later or so it shows up again, ready to expand into a subgiant, as if nothing had happened. Then, after another million years or so, it happens again.”

“Uh-huh,” Amber said.

“My best guess is that it’s a Dyson swarm moving from star to star built by a Kardeshev class two civilization at work on something.”

“Uh-huh.” A teaching moment. “Tony, how do you define Kardeshev class two civilization?”

He frowned. “Okay, I’ll bite. A classic Kardeshev class two civilization used all the energy of a star; hence a Dyson sphere, almost by definition.”

“Uh-huh. But, human beings, and every other star-traveling civilization known, use a small part of the energy of many different stars. Where do we fit in Kardeshev’s classification system?”

“Uh, well, we could build a Dyson sphere if we wanted to, so I guess we’re type two.”

“Do you think the Kardeshev classification system is useful?”

He hesitated before answering. “I guess I do because I used it, but I take the point. Maybe it’s useful as a broad brush way of talking about scales of energy use. Maybe we’re a one-point-nine or something like that.”

Amber smiled. “Look up Nimmini’odd’s treatment of galactic development thresholds.”

“A Do’utian?”

“Yes. They’ve been at this much longer than we have. Anyway, a migrating Dyson sphere?”

“Do you have a better idea? It’s not an eclipsing object; the Galactic Library files . . .”

“ . . . have images from many different positions in the galaxy. An eclipse would only shade one position, and not for ten million years or so.” She smiled and shook her head. “No, I don’t have a better idea about what’s causing this.”

“Oh.” Tony seemed finally at a loss for words. Time to let him off the hook.

“It is intriguing. Who else have you told about this?”

“Nobody, uh, except the Galactic Librarian.”

Amber nodded. The Galactic AI at the Earthmind library mirror site would be discreet. It had started existence as a Troglan, from well rimward of Sol, and still took its native form for a few years when doing so amused it. Nothing much worries an immortal ten-meter-tall tripod.

“Of course. Let me think on this a bit. I’ll get back to you about this time tomorrow.”

“Oh, thank you, Dr. Cloud, thank you!”

She nodded, touched the net to end the connection, and took several deep breaths. It was okay; nothing had gone wrong. Then she took the lift down to the crater floor and walked out into the unheated observation dome. Starlight provided the only illumination here, but her eyes adapted quickly. The cold and dry air bit into her—she was alone here and hadn’t bothered with clothes; the digital coverall her AI had concocted for Tony had vanished with the connection—but she could tolerate that for a few minutes. Above, only about ten meters of nitrogen and oxygen gas and a few micrometers of graphene laminate separated her from the deep.

She located Theta Carinae quickly, to the right of the Southern Cross. A Pleiades-like jewel box of fifth magnitude stars surrounded the brilliant third magnitude Theta, about 465 light-years away. With the benefits of little atmosphere extinction and genetic engineering to eliminate the various vision flaws her ancestors had to endure, she could easily see down to seventh magnitude. She located the place where the missing star should be; it was, indeed, missing. She touched the net to log the naked-eye observation with a smile. Tycho Brahe, take that!

She glanced toward the Moon’s Southern Eye. The ancient ten-kilometer spherical mirror had long been superseded by optical interferometers with astronomical baselines for serious work, so she pretty much had it to herself. There were no student projects underway now, so she touched the net to position the secondary reflector and get some digital data.

Amber now allowed herself to notice the cold and shivered. Time to go back inside.

She didn’t meet anyone; she usually had Shackleton Rim all to herself. Astronomers had no reason to be physically close to their instruments, and hadn’t for centuries; robots did all the technical work—and that was why she was here; not to do instrument maintenance, but because nobody else *was here*, and that lack of people lowered her stress level.

But that would end in a few decades. They were going to terraform the Moon, fill its maria with real brine, and grow pines on the lunar Appenines. Warm now, she shivered anyway. She could go to Mercury’s south pole, but no great historic instrument graced the plains of Chao Meng Fu, and the light-speed delay would make teaching difficult. Besides, eventually, they would terraform Mercury. The Venus project was already well underway, and Mars was a shirt-sleeve environment. Biological immortality spurred lots of unexpected long-term projects.

She looked up at Theta Carinae again. Long term?

\* \* \*

“Alone?” Boris Malenkov asked.

Amber nodded to the transportation minister and shrugged. “That’s in the application. Why not?”

“Ah, it’s just surprising, that’s all. I see you’ve addressed all relevant questions. The thing is that one would usually send either full crew or purely automate the mission. If there are human decisions to make, being alone creates a single point failure. And while I have no doubt you can upgrade your interplanetary license to be master of an interstellar ship, you’ll obviously have no experience in interstellar flight.”

“I don’t know anyone I could ask to spend hundreds of years of their life for what may be

no more significant than satisfying my curiosity.”

“When you get back, as much time will have passed on Earth as has passed from Shakespeare’s time to ours.”

“Maybe I’ll write a play. We all have indefinite biological lifetimes now.”

He sighed. “Point taken. We are still getting used to the idea. You wouldn’t get lonely?”

Amber smiled. Getting “lonely” was something she knew about other people in an academic sense, but not empathetically. “I don’t get lonely.”

“Contacting a Kardeshev type two civilization would be a lot more than satisfying curiosity. You’d be representing not just Earth, but the entire Galactic civilization.”

“Such as it is.”

“Such as it is. Slow, inattentive, hands-off, but that comes with astronomical distances. We are responsible members now.”

“I am very responsible,” Amber said, with a slight smile.

The minister smiled. “Realizing that everything is done by robots and we have a surplus in starships and propulsion capability after the 70 Ophiuchi affair, there are still trades involved and expenditure of IPA resources. If I were to find some other responsible adventurers, would you object?”

Amber’s throat tightened. She was not a group person. But she could function like one, as long as she had plenty of downtime between meetings to recover from the stress. She had never married or cohabited—the thought of having to be constantly mindful of someone else’s interests, discussing things, tolerating things . . . she shivered. But she wanted this mission. It was a once in a possibly eternal lifetime chance to do something unique and significant.

She smiled at him. “The only place I fit well in a group is at the head of it, and I don’t like leadership. One always has to worry about underlings ganging up on you. I hate politics. As you say, everything is a trade, but all said, I would rather go alone.”

Boris cocked his head to the side. “Well, I think there will be an expedition. The question is whether you will be on it.”

People! Disappointment coursed through her. Her shoulders slumped. Briefly, she considered getting an interplanetary ship and doing the trip by fusion power. It would be around ten thousand years round trip—Rip van Cloud getting back. Or maybe she wouldn’t come back. She remembered the grade school bullies who hated her for being different. The high school cliques. Her lone date in high school had been going to the senior prom; the nerd who’d asked her was as awkward as she was, but they’d done it anyway—to the utter surprise of many of her classmates. It was her only date, however; he’d gone to Cal Tech, she’d gone to MIT.

The minister seemed to notice. “Your personality profile isn’t unique. I think we can find a compatible crew. Trust me. Your publication record, your student reviews, the detailed program you’ve put forth, all of this argues for your inclusion. From all indications, you do much better with people than you think you do.”

*That isn’t the problem*, she wanted to scream. She could deal with people; the problem was the price she had to pay inside to do it. She nodded and gave him a tight little smile to acknowledge the compliment.

“I’ll get back to you,” he said.

“Thank you,” Amber said, as her mind stretched centuries back to the fate of women at the mercy of men’s decisions, and centuries forward to the possibility of a triumphant return from a Dyson sphere—anytime but here and now.

After a month, Boris did get back to her. The expedition was on.

\* \* \*

Four hundred and fifty-two Earth calendar years later, she gathered the crew of *SV Nicolas Louis de La caille* in Sphere 1 Park, the upper part of one of three spherical cabins, strung like three beads on the hundred-meter-diameter greater ring of the starship. Beneath its composite skin, this ring carried the superconducting cables that generated the magnetic field that had protected them from the lethal radiation of their passage, and the flares that coursed through this young stellar system. It was, she thought, like a wedding ring that bound her to the four

other beings on this journey, and though her life depended on this loop of technology, divorce was never far from her mind.

Digital paint covered the dome overhead, and showed the sky ahead of the starship as if the dome were transparent and facing in that direction. Even at twenty astronomical units away, the huge object beyond covered nearly ten degrees of sky, almost twenty times the apparent diameter of the Moon in Earth's sky. It seemed utterly smooth at this distance and glowed a deep, deep red.

"So that's what a Dyson sphere looks like up close," Amber said, realizing they were her first words in a couple of hundred years or so of proper time. Relativistic time and cold sleep left her vocal chords intact, apparently.

"Close, not yet," Ga Tan said.

"Impressive, but close not yet," echoed his mate, Ko Tor. The Kleth female opened her velvety webbed wings and closed them, a gesture equivalent to a shrug of human shoulders. "Put a talon on the skin of *that* thing, I would."

Katella M'tonka laughed. "Careful. Seven-hundred kelvins down there."

Ko Tor chirped her amusement and added, "Suitably insulated, of course."

Kleth co-captains represented one of the ministry's inventive ways of dealing with Amber's social phobias, while leaving her to study the stars free of human politics.

"The interferometer pictures were more detailed, but couldn't capture this, this three-dimensionality," Tony M'tonka said. He was holding the hand of his wife, Katella, a physicist, who represented the ministry's other inventive solution. Did the ministry still exist? Amber wondered. It probably did; the pace of change lessened as lifespan lengthened. In fact, Boris was probably still running it.

Amber told the spacecraft, informally called "Niki," to increase the magnification. It looked as if the starship zoomed across the intervening twenty astronomical units in seconds.

"It's mottled at high magnification," Niki observed. "There appears to be texture as well. The surface looks like hexagonal parachutes, or jellyfish, joined together at the rim. There's a strong magnetic field and holes in the skin over the poles of the star for plasma to escape."

"I would put a talon on the skin of *that* thing," Ko Tor repeated.

"Interesting, yes," Ga Tan said with an impatient snap of his beak. "But first, let us see to our return system and our mining system for fuel for operations. Also, we K'Leth need a sphere big enough in to fly."

Amber nodded. The ship would soon take up orbit in a gap in the disk surrounding the tempestuous red dwarf binary, which, in turn, orbited the Dyson sphere at approximately Saturn's distance from the Sun. Their precursor robots were already fully employed with the habitat and the return system. There was little the crew could do to hurry the process.

"Yes," Ko Tor sighed, a low whistle in Kleth. "Proceed as planned, I'm sure we will."

That, Amber realized, was directed to her as the Expedition Leader. "Please do. Thank you for asking, but I only need to be consulted about exceptions." She smiled and nodded to her Kleth second. Then she turned to Tony.

"Tony?"

"Yes, Dr. Cloud?"

"I seem to have fallen into a surface examination. Could you check with Niki on the contemporary source survey?" The motions of stars in the chaos of a galaxy had only limited predictability, and their maps were half a millennium out of date.

"Got it."

"Ko Tor?" Katella asked, "Why don't we put together a feast for five beings who haven't eaten in seventy-five proper years?"

"Empty our gizzards are," she replied with a friendly chirp. "So off to the kitchen!"

Amber barely heard her. The surface scan had just reported 268.4 Kelvins on dome tops, just under the freezing point of water. The much larger areas between the domes were Venus-hot where they joined, but their surface was convex so they did not shine on the dome tops. As she watched, one of the domes emitted a long silvery projectile, which rapidly accelerated away

## ANALOG

from the Dyson sphere.

To where?

\* \* \*

Amber called the Dyson sphere the “Red Rubber Ball,” and it stuck. Radiation pressure supported its surrounding “skin,” so it was thin enough to be quite flexible. It also had negligible mass in astronomical terms, so Niki could work out the mass of the enclosed star by observing the velocity of a ring of orbital debris. It came out to be 8.245 times the mass of the Sun. A young star of that mass would normally have a luminosity of some 2,000 Suns. Take away the sphere, and at their distance, their little scientific station would be hit by twenty times Earth’s insolation or more. With the sphere, the Red Rubber Ball was barely visible, though prominent in infrared.

The shell radiated far less energy than it received. Where did the rest of the energy go?

\* \* \*

Katella wanted her attention on the net. DR. CLOUD?

Amber wanted to say, *Not now, Katella, I have this nice juicy problem to think about*, but she successfully suppressed that response. One had to get along with people, or they would become even more of a problem.

She kept her net voice cheery. WHAT CAN I DO FOR YOU?

WE’VE MODELED THE STAR’S GRAVITY FIELD FROM HOW IT AFFECTS THE SHAPE OF THE DYSON SPHERE, THE FRAME DRAG, AND GRAVITATIONAL LENSING. WE CAN THEN COMPARE ITS SHAPE WITH EVOLUTIONARY MODELS, AND . . .

OKAY, OKAY. WHAT’S THE RESULT? Amber didn’t need an astronomy lecture from a physicist.

OUR BEST FIT SAYS IT’S TURNING OFF THE MAIN SEQUENCE, MAYBE THIRTY MILLION YEARS OLD, ABOUT THREE THOUSAND TIMES AS BRIGHT AS THE SUN.

That was in line with the age of the cluster, but overluminous. THE SPHERE PROBABLY AFFECTS THE STAR’S EFFECTIVE TEMPERATURE, she ventured. ANYTHING ON THE RED RUBBER BALL ITSELF?

IT’S APPARENTLY UNDER TENSION, LIKE A BALLOON FILLED WITH LIGHT. SMALL DIFFERENCES IN THE INFRARED INTENSITY FROM PLACE TO PLACE INDICATE THAT IT ADJUSTS ITS EMISSIVITY LOCALLY—PROBABLY TO KEEP IT CENTERED ON THE STAR. IT WOULD NEED SOME KIND OF SMART FABRIC TO DO THAT. WE’VE GOT A NEUTRINO TELESCOPE UNDER CONSTRUCTION, BUT THE BEST WAY WOULD BE TO GET A PHYSICAL SAMPLE. WE NEED TO GO THERE.

WE’LL SEND A ROBOT.

YOU’RE NO FUN! DON’T YOU WANT TO BE THE FIRST PERSON TO SET FOOT ON A DYSON SPHERE?

YES, I AM NO FUN, AND NO I DON’T WANT . . . Amber stopped herself. SORRY, I DIDN’T MEAN TO BE SHARP. KATELLA, THIS ISN’T A RELIC; IT’S AN ONGOING OPERATION OF SOME SORT, PROBABLY BEING RUN BY AN AI THAT HASN’T CHOSEN TO COMMUNICATE WITH US. WE HAVE PROTOCOLS TO OBSERVE. ALSO, REMEMBER THAT WHATEVER IS RUNNING THIS THING HAS ABOUT TWELVE TIMES, AH, TEN TO THE TWENTY-NINTH WATTS TO PLAY WITH. SUPPOSE THE SURFACE HAS A PHASED LASER ARRAY? Or *is* a phased laser array . . .

YOU THINK IT’S A WEAPON?

I THINK IT COULD BE IF IT WANTED TO BE. IT’S FOUR TIMES THE EARTH’S ORBIT ACROSS. Amber touched the net and asked Niki for the resolving power of an array with a radius of two AU.

OH, MY GOD! Katella said.

She must have done the same thing.

\* \* \*

As much as Amber hated meetings, she called one.

Tony was as grim as Amber ever remembered seeing him. “Earth is four hundred and fifty light-years away. But if the surface of this thing includes a phased optical array, it could put about half the star’s energy output on a spot as small as one hundred meters on Earth.”

“Only half of that within one hundred meters, darling,” Katella said

Four heads looked at her as if she were crazy.

“Just being ironic. The intensity would be something like ten to the eighteenth Suns—an ex-  
asun if you like. Something like ten million trillion Suns per square meter.”

“Or, defocused, a mere thirteen trillion suns over the whole planet,” Tony added, “at lousy efficiency. We knew this before we left, or we should have. I should have.”

Ga Tan clicked his beak and spread his wings. “We too. Nobody thought about it.”

Ko Tor waved her beak. “Cjo Dok egg, our name for a Dyson sphere is. A thought exercise, it was. About encountering one in reality no one deeply thought. For all that energy, no real need exists. So why build one?”

“If it helps, K’Leth is even closer to this than Earth.” Ga Tan added, careful, as always to put the glottal stop in the name of his world, even when speaking astro-English.

Amber shuddered. Everyone looked at her. There was no calling back to Earth, or even Kleth, for marching orders to arrive nine hundred years later. She would have to decide, but maybe later. “That aside, does anyone have any idea of where those spacecraft leaving from the ‘cold hills’ are going? The answer may lie there. Niki?”

The starship’s AI displayed a graphic showing the convergence of the vectors of some 834 spacecraft that had been observed departing the Red Rubber Ball. “The vectors converge on a location about 2,700 AU from here that’s moving at 31.47 kilometers per second with respect to this system’s center of mass, mainly tangentially, but with a significant radial component; the trajectory would be hyperbolic—not bound to this system. But I have not found an object there, yet. I will have more aperture available if I modify the return array.”

Amber smiled to herself. The array of power stations and beam drivers their robots made to get them home would be a tiny sliver of a Dyson sphere itself and around a tiny star; many orders of magnitude smaller than the Red Rubber Ball. Call it the “Red Rubber Band,” she thought.

“Let’s hope whatever is running this show hasn’t noticed us yet,” she said.

“When we leave,” Ko Tor added, “we must not toward K’Leth or Earth head, at least not to start.”

Tony reached over to Katella and held her hand. An incredible exile had just become longer. But they had each other. Amber wondered what that was like, both the needing and the having.

“Perhaps,” Amber said. “But we haven’t tried to talk to it yet.”

“Do we?” Tony asked.

“How else do we find out what this is all about?”

“Do we lie about from where we come?” Ko Tor asked.

“No, no,” her mate responded. “We do not tell it, but we will tell it that we do not tell it. If intelligent, it will understand why. If not, it will not matter.”

Amber considered that. In her mind, a spectrum of possibilities flowed between those two bookends. But she didn’t want to discuss it now.

“If it is intelligent?” Katella asked. “But how could it not be and do this?”

“On K’Leth, we have little worms that build vast lacy colonies a hundred meters tall, with guard worms, worker worms, breeding worms, scout worms—but each worm is only a millimeter long and has a three-picogram brain with only about ten million cells.”

Amber thought about bees, termites, and army ants.

“How do they . . .” Katella asked.

“Little tiny tentacles their tiny mouths surround.” Ko Tor put her four-fingered hands at each side of her beak and wiggled her fingers.

Laughter and beak clicking ensued, breaking the tension. Eventually, it died down, and Amber realized she would have to come to some sort of decision as to what to do next. As she realized she didn’t know enough to make a decision, her choice became obvious.

“For now, I think, we gather data passively.”

Katella shook her head. “But if it knows we’re here, it will have that much more time to react to us. We should go to the Red Rubber Ball and find out what makes it tick.”

“Do we use a shuttle or risk *Niki*?” Tony asked.

Ko Tor spread her wings and did a quick circuit of the dome.

Her mate clicked his beak. “*Niki* gives us at least some room to fly. The journey will take several weeks, at least.”

Tony shook his head. “It’s not designed to land, and the habitat modules aren’t designed for microgravity.”

“We can levitate magnetically and build a despin coupling device,” Ga Tan said.

Ko Tor waved her beak. “Extra fuel will be needed for the thrusters.”

“We have plenty of ice and boron in this disk,” Tony said.

“We do,” Amber said. “And it seems we’ll be using it. But first we need to establish ourselves and get more data.”

\* \* \*

The expedition established itself in the disk around “Double M,” as they called a red dwarf binary that orbited the Red Rubber Ball. Their robots reproduced themselves and made a one-kilometer rotating spherical habitat with a ring lake around the inside of its equator and three houses spaced along its shore. A huge mirror gathered light from the rather distant and disk-obscured red dwarfs while other mirrors and lenses concentrated and relayed it to the inside of this habitat. The spin provided one Kleth-normal gravity, about 40 percent of Earth’s, at the maximum spin radius. They also finished the return beam system, getting it ready in case they needed to depart quickly. The Red Rubber Ball ignored them.

The inside of the habitat was a work in progress, which the crew took turns managing. On Amber’s shift, to outward appearances, she stood on a terrace with her arms crossed near the “north” spin pole of the habitat, drinking in the view. In reality, she was hard at work, in contact with Niki, making decisions on where to put trees, streams, farms, and roads on the ten-meter-thick shell of regolith gathered from the disks and painstakingly purged of radioactive isotopes by their mining and refining robots.

They’d brought a simplified boreal forest ecology with them, to be gradually introduced from the *Niki*’s stores of frozen embryos, spores, cysts, and files of genetic material. So far they had a minimally complex soil, grass, some saplings, and three cottages along the shore. Sheep would be next.

After a couple of years, their trees were higher than they were, and Amber was knitting a sweater. There was nothing left to do but go to the Red Rubber Ball.

The voyage took three months. Short for interstellar travel, but, as Amber recalled someone saying about Pluto, a Chihuahua is still a dog. In terms of actual time they spent awake, it was three times as long as their voyage from the Solar System. Amber had not had to deal with people continuously for so long since her college days. Sometimes she screamed—but always behind closed doors.

The surface of the Red Rubber Ball proved an excellent conductor; the spinning starship could levitate over the mirror image of its magnetic field, almost a kilometer above its surface. Rather than build a despin device, they simply took a shuttle from the starship down to the surface. Each “mountain top” sat on about fifty million square kilometers of gossamer-thin reflective material—billions and billions of concave light-sails joined rim to rim to make the Red Rubber Ball a photon balloon. The more-or-less flat top was still ten kilometers in radius. Ko Tor attached the shuttle to the surface less than fifty meters from the last Red Rubber Ball spacecraft exit tower.

Even in spacesuits with a month’s worth of supplies, Amber weighed almost nothing. Gravity is the weakest force in the Universe, and at two times Earth’s distance from the center of the eight-solar-mass enclosed star, it fell to an eightieth of Earth’s gravity.

“Potential entrance one,” Ko Tor said. With a spacesuit covering his wings, he looked like a hunched-back demon out of a late medieval artist’s nightmare.

Their high resolution imagery showed a number of circular somethings near the spacecraft exit; the first one looked like a smooth hemispherical bulge about two meters in diameter. Up close, it was still a smooth hemispherical bulge about two meters in diameter.

“Radome?” Ga Tan speculated.

Amber looked at the dome closely. Its surface was barely pitted; clearly, it was regularly maintained.

“Not a way in, I’d venture,” Katella said. “Let’s jet over to number two on the list.”

They finally hit paydirt at number sixteen. It looked like an ordinary circular plate, but they happened to watch a bristly robot emerge from it. The thing had a body about a quarter meter

in diameter with a fuzz of arms projecting at more or less equal intervals around it. It seemed oblivious of them.

“Play back the recording of the exit,” Amber told Niki.

That told her where the hinge was—a simple, universal solution to a simple, universal problem. Their nanobots made quick work of the mechanism, and the door opened.

Inside glowed in a diffuse way like a huge room, the windows or light fixtures of which were out of view. The lack of reds struck her; objects were white to gray with occasional hints of blue, green, or rarely orange. A sparse latticework surrounding a giant tube vanished into the haze of the depths below them.

“Who does not want to be among the first into a Dyson sphere?” asked Katella. In for a dime, in for a dollar, Amber thought. “Okay. The open hatch might be noted, and a closed hatch would block our data stream. Let’s go quickly.”

Along with a half-dozen head-sized, spider-armed exploration robots, they dropped in one at a time, checking their fall with brief thruster bursts when their velocity built up to a meter per second.

After an hour or so, their scenery changed. The haze ahead of them began to resolve into some kind of industrial-mechanical landscape.

Amber signaled for a stop. They braked and clung to the scaffolding like sparrows on the Eiffel tower. “Now we’ll send a robot first.”

The robot video resolved into a forest of spacecraft identical to the one they’d just seen exit. They sent their robotic eye closer to the tube; there was no reaction.

“To our right,” Ga Tan said. He used his own eyes, much better than human ones.

Amber turned up the magnification. A large cylinder glided toward a spacecraft near the launch tube, which opened a hatch along its side and took in the cylinder. The bottom part of the launch tube then rotated, revealing an opening.

“A breechloader,” Tony commented.

The spacecraft lifted slightly on its tail and glided sideways into the tube opening. Another rotation of the tube bottom closed the opening. A slight vibration ensued.

Data poured in from the robot. The cylinder massed 5.34 tonnes, the spacecraft 42.68 tonnes. The neutron activation spectrum . . .

“Gammas? Pions . . .” Katella asked.

“Annihilation products,” Ga Tan said. “P-bar, neutron annihilation to be precise. There’s anti-hydrogen in the cylinder. Very cold, from the narrowness of the spectra.”

“Fuel,” Katella said. “The spacecraft are antimatter fueled.”

Ga Tan’s spacesuit didn’t allow his beak movements to be seen, but Amber imagined it waving negatively.

“It doesn’t make sense for the trip to the target area. This launch tube is an accelerator, an electromagnetic gun. It easily provides enough velocity and does it for a tiny fraction of the energy needed for an antimatter engine’s fuel cycle.”

“If the antimatter isn’t the fuel,” Amber said, “it must be the cargo.” Her suit alarm beeped. “We’ve got company. Ascend. *Now!*”

They hit their jets and zoomed up parallel to the launch tube. Whatever was following them moved much faster, however. Amber recalled their exploration robot; it would come up from behind their pursuer a minute or so before it reached them.

“We can send the other robots to the side as it gets near us,” Ko Tor suggested. “We can englobe it.”

So quickly do the hunted become the hunters, Amber thought. Her feelings had changed as well, from a touch of fear to the anticipation of a predator about to pounce. That, she realized, was dangerous.

“Stay vigilant,” she said. “This is likely a convenient first responder, a scout of opportunity. There could be billions of these things here in a matter of hours.”

“Yeah, the first of the Dyson sphere’s version of a flash mob,” Tony added.

“But if we catch it, we might have a way of talking to this thing,” Katella said.

Amber thought she heard a hint of the tiger in Katella's voice. The younger woman was right, of course. Assuming they could capture the pursuing robot nondestructively, they should have a channel to whatever passed for the controlling mind of this operation. Capture? With a mental effort, she shifted her thoughts from offense back to defense.

"What might this thing do when it reaches us?" she asked. "Simply observe and report? Or will it recognize us as foreign and attempt to . . . remove us?"

That got clicks from Ko Tor. "We should go to the side, too. Let it chase a robot." The Kleth female opened her belly pack. "I will use a space blanket to make one look bigger."

They jetted away from Ko Tor's decoy and found pieces of scaffolding to cling to. The decoy adjusted its speed so that the pursuing robot closed on it where the humans and their robots were waiting.

When the pursuer got within a few dozen meters of the decoy, it blasted it with a laser, putting a quarter-meter hole right in the middle of Ko Tor's space blanket. That was not where the robot was, however, Ko Tor having set the decoy up asymmetrically. The decoy played dead, however, and when the alien robot closed in to what it had shot, the rest of their own robots pounced on it.

It got off three shots, disabling three of its attackers, but that was all; the remaining two stuck to it like burrs. There was a bit of a whirling mechanical stalemate for a few seconds, but then their original reconnaissance robot caught up to them and the three overwhelmed the alien and disconnected its laser and maneuvering jets; snip, snip, snip.

With the alien robot disabled, the crew approached. Ko Tor slapped some space tape over what appeared to be its cameras.

Amber wrapped a space blanket around it; it would have to power down whatever it was using as a power supply or overheat, she thought. Besides, the space blanket had a conductive layer; it made a good Faraday cage.

"That was way too easy," she said. "We need to get out of here before its buddies show up. They all glommed onto their captive and hit their jets, trusting their interlinked computers to get them to the hatch with zero delta-v left.

About fifty meters from the surface, Tony sent, "Here comes the posse. I'd say a couple hundred of them. We should get to the hatch on time, but not with a moment to spare."

"Send one of the robots ahead to open the hatch," Katella sent. "When it's open, have the *Niki* get its lasers ready."

What was on the other side of that hatch, now? Amber thought. How much did whatever was controlling the sphere know? The response should still be local, she reasoned; it had only been about eight minutes since they'd captured the robot; even at light-speed, news of it could have only gotten about the distance from the Earth to the Sun where they were. About one AU. The circumference of the Red Rubber Ball was over six times that. No, half that distance, round trip. How smart was a half-AU patch of this thing? Was there a central brain? Was it near here? Events were happening too fast. She needed to think. She needed more information.

"We're not going to the hatch," she sent. "Off to the side, two kilometers longitude, with the hatch as the zero meridian and the star's equatorial plane as zero latitude."

"What are you doing?" Katella said, "We'll get caught inside."

"No, I understand," Ko Tor said. "Caught *outside* we could be!"

"We should stick an antenna through," Ga Tan said, "and contact our spacecraft to see what the situation is."

"Dr. Cloud, we should head for the hatch. It isn't that smart. No response to our queries . . ."

"It doesn't have to be smart, Tony," Amber sent, "just experienced. Think white blood cells. And no more queries."

"Oh. Okay."

"Tony!" Katella shouted.

"Not my call," he replied. "Radio silence."

Amber, the two remaining robots, and the Kleth changed their thrust vectors, as did Tony a

couple of seconds late. Katella, apparently realizing she couldn't out-tug the five of them, did likewise.

Perhaps a kilometer away from the hatch, they reached and clung to the underside, a millimeter or two of alien composite away from the surface. Any wrong decision could get them all killed, she thought. Not doing anything would almost certainly get them killed.

"Do we risk contacting the ship now?" Tony asked Amber, helmet to helmet.

"Yes. We need to put a tiny hole through, enough for an antenna, but maybe not enough to trigger maintenance concerns."

Amber wished she had a needle. In a sewing kit? In the emergency medical supplies! She pulled it off the upper arm of her suit, irrationally worried that the zipping sound of the geckro would alert some alien menace. That didn't happen, and when she opened it, there was indeed a needle inside.

Ko Tor and Tony set it up. A robot claw held one end of the needle. They got ready to flee if something bad happened when the needle poked through; but nothing did. They found a frequency the ship used that was quiet around the Red Rubber Ball and got their link.

*Niki* sent a disturbing video of a cluster of menacing, laser-equipped maintenance robots over the hatch, but which ignored, so far, the immobile shuttle just a few meters away.

"They would notice the rocket exhaust if it moved," Ga Tan said.

"How else can we move it?" Katella said, clearly impatient.

Amber imagined the shuttle gliding over to their location without rockets, somehow.

"Too bad it doesn't have legs," Tony said.

"It does!" Ga Tan exclaimed. "It has robot legs—the legs of the robots inside it. They can carry it in this gravity. If they do it slowly and don't harm anything, maybe the movement won't be noticed."

Amber nodded. "We'll move it very slowly and unthreateningly. First we sacrifice another robot, however. We'll move it toward the group at the hatch, slowly first then more rapidly until they do something. Then we'll know the threshold."

She told *Niki* what to do. It printed and deployed a sacrificial robot, which was vaporized when its speed reached half a meter per second.

Using a hatch on the other side of the shuttle from the mob of mechanical menaces, a trio of robots slowly emerged and gently worked their way beneath the aerospacecraft, one under each delta wing, and one under the nose. There was no reaction from the Red Rubber Ball's robots.

*Niki's* bots slowly lifted the shuttle. Then, with infinite patience they began carrying the shuttle toward the explorer's location at a slow walk.

The Red Rubber Ball's robots stayed guarding the port.

"They must be like frogs," Tony said. "If something stays roughly in the same place they ignore it. I bet the maintenance bots would react differently. This is like an ant colony, or a beehive. No intelligent central direction, but every worker and drone knows what to do."

"Maybe." Amber didn't know how much she trusted that model, but it seemed to be working so far.

"We'll have to break something to get out," Tony said. "It may not like that. We should close it up quickly after we go out. But how?"

Amber nodded. They could laser a hole and get into the shuttle in probably less than a minute. But then what would happen? If the shuttle were recognized as hostile, it would likely be vaporized. There would be no getting away; "out of range" did not apply to Dyson spheres.

Amber looked at the suture kit. Was there enough thread to sew it up after they cut through? Would they have time? What else did they have?

"The vacuum tent doors are big enough, and self sealing," Ga Tan offered, obviously thinking along the same lines. "If we can relocate them."

"Space glue we have," his mate added. "One door to the inside surface of the sphere we glue. Into the tent we go, that door seal, through the shell cut, through the cut go, and let the door close up after us like an air lock. A maintenance problem it would be, but not an ongoing one it

would seem. Worker bots rather than soldier bots would respond.”

“That’s a good theory,” Amber said. She didn’t have to say they would probably be dead if it was wrong.

After an extended discussion, however, nobody came up with a better idea. Go slow and don’t upset the natives seemed to work.

It took them less than an hour to rig their ersatz exit lock. It took perhaps another hour of talk to plan and replan their “escape” from the Red Rubber Ball; once in the shuttle, they would slow-walk away from the cold hill and float well away with cold-gas jets, then ascend at minimum acceleration and rendezvous with the *Niki*. Then the starship would ascend magnetically as far as it could before using its engines. They could only hope that the starship’s fusion engines, ignited at a distance, wouldn’t elicit a response. There had been no response coming in.

That left eight hours, approximately, before the shuttle had walked to their position.

“I think we can take a rest now,” Amber said. “The shuttle won’t be here for a few hours. I want to be alone for a while.” Then she put her com on auto, clambered a couple dozen meters away from the group, clipped herself to a strut, and hung there. She exhaled in a great gasp and then began shaking involuntarily. She tried chanting *nam yoho rengo kyo* and let the stress of dealing with people and situations ebb away. Gradually, her shaking subsided and her breathing became more regular. How much of that her crew saw, she wasn’t sure. *Nam yoho rengo kyo*. The universe gives us the power to choose our destiny, though I walk through the valley of the shadow of death, word-fame is the one thing that lasts forever. . . .

\* \* \*

She woke to a gentle touch on her shoulder.

“Dr. Cloud?”

It was Tony. She groaned and shook herself awake.

“I’m here.”

“The shuttle is almost here, and there’s been a development.”

She followed him over to their soon-to-be exit, where the data rate was better. Soon, she looked down on their cold hill through the *Nicolas La caille’s* eyes.

It had taken the better part of a day for the shuttle to glide its way over to them. As it did, a collection of “warrior robots” had formed over every potential exit on their cold hill. Only by good luck, they were nowhere near one. There were thousands of them. Were they being produced locally? If the Red Rubber Ball didn’t have a laser array now, it could develop one rather quickly, she realized.

“We can depressurize the cabin and use the nose-wheel maintenance entrance,” Ga Tan said. “We place the nose wheel just ahead of the slit and the doors will impede views from the side. We can lower the back of the shuttle to impede the view from that direction.”

They’d done some additional planning to counter the increased number of warrior robots. Amber nodded her approval. “Let’s get in the lock.”

They crowded in and sealed the door behind them.

“I’ve got a boarding order,” Katella announced. “Ga Tan should go first as he’s the pilot. Then Dr. Cloud, myself, Tony, and Ko Tor with the robots, in case there’s some rear guard action.”

There was silence. Amber couldn’t read Kleth body language in space suits, but she didn’t have to.

“One doesn’t separate a Kleth pair in these circumstances, Katella,” Amber said.

“Don’t lecture me,” Katella snapped. Tony put a hand on her arm, but she shrugged it off. “What?”

“Kleth mate for life,” he said. “Literally. If one dies, the other dies as well.”

“Huh? If we don’t all get in, we all die.”

“Ko Tor will follow Ga Tan,” Amber said. “I will stay with the robots until you are all aboard.”

“We greatly appreciate that,” Ko Tor said.

“It’s not optimum,” Katella protested, “and everyone’s lives are at stake. We should at least discuss it longer, Dr. Cloud. You shouldn’t just be making arbitrary decisions.”

Nobody answered her, but Tony put his helmet against Katella’s so they could speak in private

with the radios off. She pushed him away.

They did not have time for this, Amber thought; they had to get aboard the shuttle. The Kleth, at least, should not have to pay for this human comedy with their lives. Katella had followed the last time. She would again, by force if necessary.

There was a surgical knife in the medical kit—hardly bigger than a penknife, but enough to cut through the alien fabric. Before uncertainty could grip her, she plunged the knife into the skin of the Red Rubber Ball behind the gap and pulled the blade steadily down along it. The fabric pulled aside quickly, and, under a surprising amount of tension, formed a nearly circular hole.

“Ga Tan, Ko Tor, now!”

The Kleth complied without a word.

“Bastard!” Katella said.

“Tony,” Amber said.

“Who are you married to, her or me?” Katella yelled, the volume muted by the comm software.

“We have to go, Katella. Now.” Tony said calmly and quietly. Then he turned and followed Ko Tor through the opening.

Amber queried their robots about any sign of reaction from the Red Rubber Ball. Maintenance robots were on the move but no sign of warrior robots yet. Amber motioned for Katella to move through the opening. The other woman just hung onto a strap near the tent entrance and did nothing.

“He’s yours if you go to him,” Amber said. “I don’t mate. But you must go to him or die here.”

After taking another few precious seconds, Katella let go and pushed herself over to the opening and up through it.

Amber motioned the robotic crew up and in with their captive first. They were essential, and she didn’t want to enter the shuttle in close proximity to Katella. Then she went through and commanded the tent door to seal behind her. It couldn’t; it appeared to be trying at the ends but the tension must be too great.

Amber pushed herself down to the gap and grabbed the two sides close to an end of the slit and pulled them together. With the stress relieved, the seal worked its way up toward her hands, almost like a zipper being pulled by an invisible hand. With as much strength as she could muster, Amber slid her suit-gloved hands up the gap without releasing the fabric and pulled it together again. The seal followed. She could see the far side of the tent bulge; maintenance robots or worse were there. She pulled the fabric together again, and the seal advanced to halfway.

A metallic arm rent the far door and protruded through, thrashing around.

Amber pulled one more time, and the sealing mechanism took over, now overpowering the tension of the now smaller gap. It closed with a snap she could feel through her suit.

Some loose Red Rubber Ball skin was left on either side of the tent seal. Remembering what got them there in the first place, Amber took the surgical knife, still in her leg pouch, and sliced off a ragged square. Then she pushed herself away from the Red Rubber ball and up into the shuttle’s wheel well.

She saw the surface glide away beneath her as the carrying robots began moving the shuttle, perhaps a little faster than when they took it here. That rate had some margin built into it, and now was the time to use that margin.

In a few minutes, maintenance robots converged to where the opening had been, but ignored the creeping spacecraft.

Amber entered the maintenance hatch and watched the nose wheel rise, very slowly, behind her. When the doors finished shutting slowly over it, she slammed the hatch door shut, sat down with her back against it and shook like a leaf while the shuttle repressurized. *Nam yoho renga kyo.*

Then, without saying anything to anyone, and not being asked anything by anyone, she went toward the rear of the shuttle, wriggled into one of the tiny shuttle bunks, and accorded the

side down behind her. *Nam yoho rengo kyo.*

Through a trembling haze, she monitored the shuttle's slow, hour-long walk to where the slope of the cold mountain began to get warm. Then the robots let go and clambered back aboard through the air lock as the shuttle took flight, hidden by the bulge of the dome, and began its slow climb up and away on its attitude control thrusters.

Enough self-indulgence, she told herself. She was still the leader of this expedition, however flawed. She had duties. She replicated a half pint of beer in the bunk alcove's tiny printer, chugged it, took another deep breath, raised the bunk side, and made her way to the front compartment. Katella had plunked herself down in the command seat, but that would mean nothing to Niki, so Amber chose to ignore it.

\* \* \*

Amber supervised the rendezvous with the *Niki* from the shuttle pilot station. She filled her mind with the details of the operation to keep it off the people problems that she would have to deal with after they settled back into shipboard routine. The shuttle glided through the main ring nose first along the rotation axis of the starship, then matched its spin with its bottom aligned with the number three hull from which it had come. The hull's shuttle bay doors opened, and the shuttle cradle rose up on telescoping supports and locked onto it. The starship compensated for the change in the hull's mass and angular momentum by pumping fluids back to the other two hulls as the shuttle descended in the complex mechanical ballet that kept the spin center fixed.

The human crew exited the shuttle in silence and headed for their compartments. The Kleth headed for the sphere on dome to stretch their wings.

At dinnertime on the second deck of Sphere 3, Katella pointedly ignored Amber. Fortunately, Amber had a peace offering.

"Katella . . ."

"I don't want to talk about it."

Maybe I should go through her husband, Amber thought. No, that relationship seemed to be a problem for her. The Kleth? She had presumed of them too much already. It was hard to tell, but she thought she could detect the beginnings of an attitude of condescension beginning to work its way into their dealings with the humans. No, she would have to do this. Deep breath.

"It's not about that," she said, lying as pleasantly as she could. She reached into her flight suit pocket and pulled out a transparent envelope with a scrap of cloth in it. "I cut this out at the last instant. It was why we went there in the first place, as I recall."

She held out the sample of the Red Rubber Ball's skin to Katella. "It's as light and strong as you might imagine; about five grams per square meter."

Katella took the sample, eyes wide with interest. "Probably full of circuitry. It could tell us a lot, along with the robot . . ."

"I hope so."

"Okay . . . thanks." Katella turned and slid down the center pole to the lab area below.

Had she achieved a truce? Who knew? Amber sighed and ordered herself a beer. When it came, she ascended to the dome above and drank it alone, losing herself in the stars.

\* \* \*

When they got back to the "Double M" habitat, they had woods, fields, and a small flock of sheep. Relationships got back to normal. In another couple of months, Amber had the sheep shorn and knitted sweaters for everyone; for the Kleth, that meant a kind of vest-like poncho arrangement with fasteners at the bottom. They expressed diplomatic appreciation.

In spare moments she tracked the progress of the antimatter-cargo spacecraft they'd seen depart from the Red Rubber Ball. On its present ballistic course, it would reach the convergence point in about four months. Should they follow it? If so, when?

They continued watches, with someone "on duty" for data collection operations and habitat minutiae. Since the *Niki* came from the Solar System, its day, and thus the colony day, followed a human convention of twenty-four hours, but whereas human beings divided this into two twelve-hour segments, the octal-raised Kleth more naturally divided it into three eight-hour segments.

That, it turned out, was best for people as well. So Amber was on nine hours, including an hour overlap with her predecessor. This evening, that was Ga Tan. While their shift could be done anywhere, they'd established precedent of a face-to-face handover; in this case, Ga Tan flew over to her house.

"Anything new on the Red Rubber Ball?" she asked as he alighted.

"It continues to ignore us," he replied after a second or two.

They did have a sense of humor, she recalled.

"Thank chaos for small favors. How's Ko Tor doing on the 'warrior robot'?"

By itself, it was little more than a telop; it responded with a limited suite of behaviors to a higher level external direction. But it had a database.

"She's found the map of the 'cold hill' segment we entered. She thinks each segment is largely self-sufficient and interacts with the other segments only as much as needed to keep the Red Rubber Ball centered, if that. The segments can modulate the net photon pressure by changing their emittance."

"That sounds more like a sponge or a jellyfish than a colony of bees or ants."

"*Oh ga so da*, on our world. They are quite successful, but not self-aware. If that is the case here, we won't be able to ask it why it does what it does. It wouldn't know."

She nodded. What did a sponge know about why it pumped water through its various holes?

"Yes. It may not know. Or maybe we don't have the key. What intelligence does it need to run the place and maintain it?"

"About that of a colony of oh-ga-so-da, I think. Consider all of the complex biological material in a living cell; systems to fight parasites, recognize the other, reproduce, and so on. The Red Rubber Ball is less complex, actually. It doesn't need to be self-aware, or intelligent as we understand intelligence. Perhaps just as well."

Yes, just as well. They'd gotten away with an invasion an intelligence might not have tolerated. On the other hand, an intelligence might have responded to their questions.

"The Red Rubber Ball sends ships, or at least one ship, with an antihydrogen cargo off to an object a few thousand astronomical units away. It does not know what it is doing or why. Perhaps something there knows."

Amber had seen the data collected since they'd been away. A series of occultations of very faint objects had revealed a very cold circular shape, presumably a sphere, about twice the size of the Sun where the cargo ship trajectories converged.

"Any thoughts on the black disk?" she asked

It took him a few seconds to respond—consulting with Ko Tor, probably.

"It is probably a sphere, and from the way it bends light, about a twelfth the mass of your sun, a tenth the mass of ours."

"And so cold?"

"That is a mystery. We are in its equatorial plane, so the poles are not visible to us and it may dump heat in that direction. There is evidence for a strong magnetic field."

"Do we go there?"

There was a pause, a shift of the crest and a slight flap of his wings. She'd gotten good enough at Kleth body language to guess that he'd found something ironic or humorous in the question.

"We should go carefully, with robots going first. After we have a better picture."

Amber nodded. The better picture would come from the large synthetic aperture telescope they were building. With hundred-meter mirrors a quarter of an astronomical unit apart, they would be able to see whatever there was to see on the surface, with starlight.

"You've got the con." Ga Tan took flight, rising high toward the spin axis until he was a lonely small silhouette against the green of the far side of the habitat.

I should print myself some wings, Amber thought.

\* \* \*

Tony and Katella invited everyone over for dinner and a mysterious announcement the day after the SAT went operational.

"The 'Black Rubber Ball' has a satellite," Tony announced. "It's a torus."

Amber looked up from her coffee. A torus implied artificial gravity, which implied biology. “Spinning?”

Tony nodded. “Slowly, enough to give maybe half a meter per second acceleration—a twentieth of Earth gravity—but that may just be an outer shell. It’s about forty kilometers in radius. No effluvia that we can detect.”

“No question of what the antimatter is for now,” Katella said. “In a thousand years of space-flight, human beings have encountered only four other biological intelligent species.”

“If that’s a biosphere, it must need gigawatts,” Amber said. “It should be bright in the infrared. It’s not.”

“Maybe they’ve come up with a heat sink that we don’t know about,” Tony said. “Yet, anyway; we’re a bit behind the galactic times.”

Ga Tan clicked. “Both of our cultures are near the top of most technological S-curves; progress comes slowly. If I assume the shell is to attenuate cosmic radiation, it’s primitive. Superconducting loops form a much more efficient shield.”

“A stone age space doughnut. What is it guarding against? Debris? Meteoroids?” Tony speculated.

“Weaponry,” Ko Tor said.

They were all a bit quiet.

“They’d have a lot of antimatter by now,” Amber said. “How are you doing with the captured robot’s communications?”

More clicks from Ga Tan. “We can command it around as if it were one of ours. We should be able to communicate with whatever it can communicate with. But there are no assurances of a higher level mind to talk to.”

“Can we replicate it? With some improvements?” Amber asked.

“It should be printable. I’ll need specifications for the improvements.”

“There’s one more oddity,” Katella said. “The elements of the stone doughnut’s surface are depleted in radioactive isotopes.”

“Well, so are our habitat and ships,” Tony replied. “There’s nasty stuff in these young systems, bad for electronics as well as life. The front end of our replicators sorts that out.”

“Yes. But I mean *really* depleted. As in over ten billion years old.”

“You think it wasn’t built here?” Amber asked. The Dyson sphere surrounded a star only a million years old or so.

“That’s one hypothesis. Or the isotope composition may have been specified a long time ago.”

“By who?” Ga Tan asked, as he lightly fluttered his wings. He was dissatisfied with his state of knowledge.

As they all were. They exchanged glances, as if looking for answers in each other. Who, indeed?

\* \* \*

Amber found that another year of Black-Rubber-Ball data and analysis improved their picture only marginally. Their most-likely model had the Black Rubber Ball as a shell around a sphere of pure hydrogen ices about seventy times the mass of Jupiter, though compressed down to a Jupiter-like radius. If the hydrogen model stood up, it was on the edge of becoming a star—depending on its composition; the amount of helium and deuterium were critical in this calculation and could not be determined remotely.

There was nothing more to do but to get samples in situ, and it would be better, they agreed, to be close enough to that operation to supervise it. The Black Rubber Ball was nearer to the solar system than the Red Rubber Ball by a few light days; if they screwed up bad enough, they could at least provide a bit of warning.

There was no chance of that, she told herself—no intelligence to anger, no awareness to threaten Earth—only an opportunity to solve a great mystery.

They made plans; there could be no mass beam station at the Black Rubber Ball, so *Niki* would have to decelerate and reaccelerate on fusion engines, which required her to carry many

times her mass of hydrogen and lithium; even then, their velocity would be limited to about 0.15 c, and the journey would take several years. In the context of the centuries of offset they were accumulating with respect to the Solar System, she thought wryly, it mattered little. But they did use cold sleep.

\* \* \*

“By the authority granted us by the First Fledgling Aviary of Dar-K’leth,” intoned Ga Tan, spreading his wings wide above his shoulders, “we award the rank of *Master of Mindflight* to Anthony.”

They were all on Kleth, or as close to it as the dome of Sphere 3 could reproduce. Cool zephyrs of mint-and-orange-scented simulated wind chilled them as Kleth’s constellations brightened in the sky above them. The huge crescent of Bar As Do, ragged with mountains and craters, sat horns up on the horizon while the Bo Go leaves clattered in the wind like the hooves of tiny antelope on pavement.

By tradition, the Kleth awarded their equivalent of a Ph.D. after sundown the day after first new moon following the fulfilling of the requirements. *Niki* had reproduced the sky of Og Go Kan, the aviary of the educational institution awarding the degree by Ko Tor’s proxy. *Niki*’s Kleth side was no more than 434 years behind the times on such matters.

Amber caught the brief frown on Katella’s face as she gave Tony the traditional brief congratulatory hug, as did Ko Tor and Ga Tan. Otherwise, it was all celebratory. Tony had started his Kleth degree long before their ship left and managed to set a record for, as far as they knew, the amount of sidereal time as an undergraduate of the aviary school.

\* \* \*

They passed two of the Red Rubber Ball’s freighters on the way. This colony of machines moved at a far more patient pace than biological intelligence. As the second freighter receded, Katella called a meeting in the Sphere 1 Park about the rubber ball skin. She didn’t ask Amber for the meeting; she just called it herself. Amber made no protest. It was a minor thing and probably just an oversight on Katella’s part.

“As I thought,” Katella started, “it’s smart fabric. But it isn’t very smart and can’t do very much. It can contract or relax, report contact with other objects by mass and pressure, and pass along other messages, amplifying those beneath a certain threshold. The dots on the outside are photon emitters—millimeter wave to red light. It also has a lot more energy storage than it needs for that. In fact, the whole shell of this Dyson sphere seems to be a kind of battery.”

“If the whole shell can store as much as the sample, how much?” Ga Tan asked.

“An order of magnitude or two more than the star puts out in a second,” Katella said.

“Is that legal?” Tony asked.

He may have been kidding.

Or maybe not. The elder races were still around, however unobtrusively, and that was too much power, Amber thought, way too much. Unbidden, the thought of wielding that power came to her head, and she suppressed it. She shot a glance at Tony; he didn’t look like he was kidding. She glanced at Katella. Katella was looking at Tony as if he’d just put his foot in his mouth.

COULD I TALK TO YOU, TONIGHT? Tony sent.

Amber thought for a bit and decided. SPHERE 2 PARK, 1900. It wasn’t a question. She was the Expedition leader, and marriage counseling was part of the job description.

“If it’s illegal, dear, where are the cops?” Katella said, her voice dripping with derision.

Amber touched the net. NIKI, WE ARE THE COPS, AREN’T WE?

IT DEPENDS ON THE NATURE OF THE CONTEMPLATED ACTION AND THE PROXIMITY OF OTHER POTENTIAL ACTORS. GENERALLY, LACK OF CONSULTATION IS NOT AN ETHICAL REASON FOR NOT TAKING TIMELY ACTION. ETHICAL DUTIES OF A MATURE CIVILIZATION, BEST-HUGGER SILVERSMITH, GALACTIC LIBRARY LEGACY DOCUMENT 149344939546089, FILED ABOUT EIGHT BILLION YEARS AGO.

She knew it. Every space-struck boy or girl had read it; the literal translation of the author’s name was unforgettable. It was in the standard emergent civilizations section (according to the Galactic Library node at Proteus). It was nothing one really expected to come into play.

## ANALOG

I HAVE NO LIBRARY RECORDS OF DYSON SPHERES BEING HELD AS CONTRARY TO ETHICAL TRADITIONS PER SE. PARTIAL DYSON SPHERES HAVE BEEN USED TO POWER INTERGALACTIC TRAVEL FOR BILLIONS OF YEARS.

"It does seem to have been around a long time without attracting galactic notice," Amber agreed. "But so have a lot of things. We have a responsibility to our planet, and this part of the Galaxy, to find out as much as we can without hitting any trip wires."

"Nuts," Katella said. "We should grab control of it."

"Maybe," Amber said. "But carefully."

\* \* \*

That evening, Amber arrived about an hour early. A dip alone in the Sphere 2 park pond seemed like just the thing to release the tension of dealing with people for another day. It was roughly oval, about seven meters across, and about a meter deep over most of it. Its area happened to cover all of the central core of the sphere—it was tertiary radiation protection in addition to part of their limited ecology and recreation systems. Nothing in a starship went to waste, and almost everything served more than one purpose. She laid her clothes on a bench by the shore; there would be plenty of time to dry and dress before Tony arrived.

He showed up fifteen minutes later, stripped and dove in, apparently without noticing that she was there; as she was swimming in the other direction; the first indication that she wasn't alone was the splash. Then his body brushed by her before she could even react.

She froze. This was totally wrong by so many standards; naked with a subordinate, married, man in a conspired rendezvous that *she* had selected. She imagined her trying to explain it to the extrasolar affairs bureau. But the extrasolar affairs bureau was 450 light-years away, however heavily it weighed on her mind and not available for consultation.

Get a grip, she told herself. She was the authority here; she had to decide what to do and that would be that as the Kleth went along. They wouldn't intervene in human sexual affairs. Or would they? She'd intervened in a Kleth sexual issue—a welcome intervention, to be sure—but an intervention nonetheless that had put their biology ahead of what at least one member of the crew thought was overall safety. The same crew member who would go ballistic if she knew about this. Of course, not taking the swim would not have risked this. Was there something inside her that wanted to take this risk? The conscious mind was such a small part of overall motivation, she knew.

NICKI, AM I IN TROUBLE?

NOT YET. YOUR INSTINCTS MAY BE BETTER THAN MY ANALYSIS IN THIS MATTER.

"Dr. Cloud?"

"Sorry. I was a bit caught by surprise. This is awkward."

"It's not anything new, really, we've done laps together in the basement pool."

Bright lights, chlorine, tired muscles, marked lanes, so completely unsexy as to hardly be worth a thought. Not this intimate splash under a simulated dark starry sky. She decided to ignore the intimacy, for now.

"Okay, Tony, you called this meeting."

"I need to talk to another human being about a human being. That leaves you."

Oh, God. Of course, it did. "You know, you should get out of this pool, get your clothes on and get out of here as fast as you can." Or I should.

"Do you want me to?"

Yes! No. He was a crewmember. She had a responsibility no matter how awkward the circumstances. "What I want . . ." She was kneeling in the muck at the bottom of the pond now, very controlled, innocuous muck, but muck nevertheless that she didn't want higher up on her body. But kneeling made her breasts visible. Was that an unfortunate circumstance, or an excuse? Was something primal running her behavior and getting rationalized? He was staring at her breasts, of course.

The humor of the situation saved her. She actually let herself smile. "What I want seems to be under internal dispute. Okay, let's talk. But let's move out where the water is a bit deeper and sandier."

She floated and sculled forward in a breaststroke, washing the muck off her legs and putting

her chest underwater. So she got a few moments of respite.

In the center, sitting on clean sand, she said the obvious. “Katella is being a little more as-  
sertive than you care for.” More than any of the crew cared for, recently, actually.

“Yeah.”

“Have you talked to Niki about this? He has a ton of psych data and is totally secure as far as  
sexual matters are concerned.” Too late, she thought of an exception, but that didn’t apply to  
this. SORRY, NIKI.

MY TON OF PSYCHE DATA IS TELLING ME IT ISN’T IMPORTANT. YOU’RE DOING OKAY.

Not fabulous, not outstanding, not the right thing: just “okay.” Goddamn AIs that were that  
smart.

“I’m on edge all the time,” Tony said. “She . . . it’s like she wants to run me like I didn’t have  
a mind of my own. Nothing I do is good enough.”

The man was actually in tears. Instinctively, she wanted to hug him. No. Not naked. She set-  
tled for touching his arm.

“Well, this may pass. See what Niki says.”

“How long do I have to wait? I’ve been waiting some time now, and it’s getting worse.”

“I’m going to talk to Niki.”

NIKI?

I DON’T MONITOR PRIVATE CONVERSATIONS. THE PUBLIC AREA DATA SEEM TO SUPPORT WHAT HE SAYS. KATELLA  
SEES HERSELF BEING TREATED AS THE NUMBER FIVE IN THIS CREW, LESS LISTENED TO AND APPRECIATED THAN EITHER  
OF YOU OR THE KLETH, AND SHE THINKS SHE IS BETTER THAN ALL OF YOU. IN MATTERS OF INTERNAL KNOWLEDGE,  
SHE MAY BE RIGHT. IN DEALING WITH COMPLEX CIRCUMSTANCES, WHAT MAY BE CALLED JUDGMENT, SHE DOESN’T  
DO WELL, HOWEVER. EMOTIONAL ISSUES MAY BE CLOUDING THIS JUDGMENT MORE THAN USUAL FOR YOUR SPECIES.

ARE YOU BEING SMUG, AI?

HA. I SEE WHERE YOU MIGHT THINK SO. NOT INTENTIONALLY. IN ANY EVENT, SHE IS NOT YOUR IMMEDIATE PRO-  
BLEM. TONY MAY BE BORDERLINE SUICIDAL.

WHAT!??

HE WAS VERY MUCH IN LOVE, AND THAT IS FALLING APART, LEAVING HIM WITH LITTLE TO FALL BACK ON EMO-  
TIONALLY.

EXCEPT ME. OR DRUGS. OR COLD SLEEP.

THERE ARE DOWNSIDES TO ALL THOSE POSSIBILITIES. YOU MAY BE THE LEAST DAMAGING.

She shivered. YEAH. GOT IT.

She looked Tony in the eyes and saw a lot of pain. When had this started? Was she, herself, re-  
sponsible in some way?

“How long has this been going on?”

Tony looked down at the water.

Amber touched him again. “Were there problems before the mission?”

He nodded.

“And neither of you said anything?”

“We both wanted to go very much. It was our chance to be part of history. It was the oppor-  
tunity of a lifetime. And I wanted to be with you.”

Amber took a deep breath. “I was your professor. Now, I’m your expedition commander.”

He nodded. “You’re beautiful. You’re brilliant. You listen to me carefully and never get angry  
or harsh. You are a safe place to come to when Kate gets troublesome. I need you.”

She had been entirely too good at pretending to be someone she wasn’t.

While she was thinking, he embraced her. He was a child, she thought, half her age and to-  
tally besotted with her. A lethal combination of maternal instincts and reproductive imperatives  
clawed for control of her mind. Out of pity, as much as anything, she found she could give him  
what he needed, and not without wanting it and caring for him. In fact, she cared for him far  
too much, in her position. She should get fired for this. The people who could fire her were  
450 light-years away. She gave in with a sigh, returned his kisses, returned his hugs, and wel-  
comed him into her. When he was done, she kissed him again, briefly, to let him know she was  
okay with it.

They didn't say another word as they dried and dressed. She touched him briefly, to indicate that he should stay a while, and then she left the park, went down to her room, took a pill, then had a hot needle shower for half an hour. There had been no "right" decision, she told herself; what she had done had seemed the least wrong and the least stressful at the time.

She needed to be away from people and away from such decisions. If she could only stay here by herself, 450 light-years away from them and everything.

\* \* \*

After the six-month trip and a gentle deceleration on its fusion thrusters, Amber stationed the *Niki* at the forward Lagrange point of the Stone Doughnut's fifty-eight-hour orbit around the Black Rubber Ball.

That put their ship a good 2.2 million kilometers away from the center of either object, at the expense of a fifteen-second light-speed control loop lag with the robots. Their avatars would have to move slowly, and decide a lot of things on their own. The human operators would "feel" what the robots felt but be along for the ride otherwise.

Ga Tan set up the virtual reality command deck on deck 2 of Sphere 3, just under the active galley. He'd learned Amber's coffee habit. They would send three of their "Trojan" warrior robots in, with the humans linked to each and the Kleth watching over the operation. The warrior robots were non-flyers, except for occasional rocket jumps, and Ga Tan thought human instincts would work better.

Amber settled into a chair and put her hood on and found herself transported, at least visually, to the open airlock of *Shuttle Number 3*. She practiced moving the robot by telling it what to do, not trying to move individual arms or legs. The VR system moved her limbs fifteen seconds later and let her feel what they felt. The weird part was the feeling of resistance she got as the robot's limb pushed something; that the hood and its software managed to find and stimulate just the right part of her brain to do that was always a wonder to her.

"Okay, I'm in. Tony, Katella?"

"Good to go," Tony said

"The time lag's a nuisance," Katella said. "We should bring the ship closer."

Amber sighed. They'd discussed that, and she'd made the decision. That was probably Katella's main problem with it; not the time delay but the fact that Amber made the decision on where to put the ship, and Tony cheerfully complied. Should she try to think of something polite to say? Or just ignore Katella's challenge?

"You'll get used to it, dear," Tony said, taking Amber off the hook.

Niki, in its shuttle persona, reported that they'd engaged the traffic control system of the Stone Doughnut, mimicking one of the Red Rubber Ball spacecraft. With their captured robot's operating system and the radio traffic of several spacecraft arrivals in hand, Niki had made short work of the alien berthing protocol.

The shuttle hovered in the microgravity above the spin axis of the Stone Doughnut and matched its spin rate. The surface looked smooth, but radar, looking several meters into the shell, told a different story. It had been repeatedly cratered, repaired, and smoothed over.

There were five hatches, at what seemed to be random angular spacing, on the inner part of the doughnut. They would have been invisible to the eye, but clear on the subsurface radar and thus on Amber's computer generated view. Spacecraft going to the Stone Doughnut went to the center of the doughnut's rotation, in its metaphorical doughnut hole, then matched rotation and coasted down to the surface in a radial direction to its inner surface, picking up angular velocity as they went. Their shuttle was about to try the same thing.

"We're being hit by an electron beam," Tony said. "It's part of the berthing system. We get a static charge, which the Stone Doughnut uses to manipulate the incoming spacecraft."

Would this really work? Amber wondered. They had not succeeded in contacting a "higher mind" of the Stone Doughnut, nor found any digital evidence of any such thing. What they were doing now was the cybernetic equivalent of turning a doorknob—on someone else's house, without invitation.

"It's formed an array of positive locations around the hatch area, mostly spinward. We're being

pulled forward,” Tony said. “Very gently.”

A small hole formed below them and grew to the size and approximate shape of their spacecraft. Programmable matter, Amber thought as the spacecraft coasted into a huge, featureless hanger. It’s used here, but not at the Red Rubber Ball. Why?

A platform rose up out of the hatch, and their shuttle was placed on it. Then it was drawn in. The hatch closed over it, and all contact was lost. Their avatars were on their own.

Contact was restored an hour later. The avatars had succeeded in linking with its computers, and they now had full access all of its systems.

“It’s like trying to communicate with a swarm of bees,” Tony said as the shuttle ascended from the Stone Doughnut. “It does what it does, but it isn’t conscious in the sense we are.”

Ga Tan lifted his wings slightly, a sign of uneasiness. “It may not be conscious of itself, but it is now conscious of us. If our activities match that of some threat it has encountered in the past, it can annihilate us.”

“We could take control of it,” Katella said. “In self defense.”

“Such an attempt may trigger defenses,” Ko Tor said. “While it may not be conscious in the sense that we are, it has survived for billions of years.”

“We should find out more,” Amber said.

“Yes, like what is inside the Black Rubber Ball?” Tony asked, rhetorically, as he answered his own question to the extent he could. “Something as massive as a very small star, but very, very, cold. Absolute zero, to the degree we can measure from out here. The shell is held in place by magnetism generated by superconducting loops. We can tell from the Stone Doughnut’s orbit that the mass is almost entirely concentrated in the center.”

It was maddening, Amber thought. They now knew what it was doing, delivering antimatter to the Black Rubber Ball, and how they did it. What they didn’t know was what they were delivering it to, or why.

Ga Tan seemed to read her mind. “If you are thinking of following something into the Black Rubber Ball, that may also trigger defense,” he said.

“There’s nothing else to do,” Amber said. “We may be able to suppress the defense. Niki is working on it.”

For once, everyone seemed to agree with her.

“We can’t hover above the surface; the gravity is nearly eight meters per second squared—almost Earth normal.”

“For us, way too much,” Ko Tor said.

“We’d have to land a shuttle. An uncrewed shuttle.”

“Chicken,” Katella said. “We’re in control now. Let’s see for ourselves.”

“Amber,” Tony pleaded, “It’s a singular opportunity. We’ve beaten the risk down to nothing.”

“We don’t know what’s in there!” Amber said.

“Caution is best,” Ga Tan said.

“Best caution is.” Echoed Ko Tor.

Suddenly, Amber’s crew threatened to split on species lines—her worst nightmare. Time for a compromise.

“We send the robots in first,” she said. “If it looks safe, we’ll go in to view the cargo delivery. There, I hope I’ve made everyone equally unhappy.”

Ko Tor clicked her beak. Tony shrugged. Ga Tan was immobile, and Katella looked like she was wanted to bite Amber’s head off. But no mutiny happened.

\* \* \*

The Sphere 1 Park sky served as their remote viewing area. They did not view from a particular robot; rather, Niki absorbed all the robot video and reconstructed their display as if seen from an imaginary flying disk inside the Black Rubber Ball.

“Here it is,” Niki said.

Utter blackness greeted them. “I can see no light inside the Black Rubber Ball at any wavelength,” Niki said.

“Have the robots form a centimeter wavelength synthetic aperture,” Amber said. “Illuminate

the center.”

“Way ahead of you,” Niki replied, to chuckles and clicking beaks. “Here we are in centimeter waves.”

A featureless ball appeared about twenty degrees above their artificial horizon toward park “north,” ninety degrees from where the main ring pierced Sphere 1.

“The ball is seventy-five thousand kilometers in radius at its equator, about seventy-one thousand through its poles; we’re looking down from the north pole. It’s rotating every thirteen hours and has a huge, axisymmetric magnetic field. But in a perfect vacuum, no radiation belt. I brought the robots in through the North Polar lock; it does not seem to be much more than a lock, though there are extreme contamination reduction measures. To honor that, I have the robots using the magnetic environment for propulsion. We haven’t had to use thrusters except for a couple of times.”

“What happened then?” Amber asked.

“The gas was ionized by lasers and attracted to the shell’s inner surface, where it was absorbed,” Niki replied. “I can find no ambient gas inside the ball; only occasional transients.”

“The getting must be absolute,” Katella remarked.

“Getting?” Ko Tor asked

“High vacuum terminology for removal of any stray molecules,” Katella said.

“English language human jargon,” Amber said, getting a frown from Katella. “Continue, Niki.”

“The central mass is mostly degenerate cryogenic metallic hydrogen with a very pure H<sub>2</sub> molecular surface layer. We do see a rather diffuse background of annihilation gammas; that’s consistent with antimatter being used for something on the surface of the Black Rubber Ball shell. *What* it’s being used for is not obvious and probably occurs in nanoscale operations. There are also gamma events on the surface, consistent with antimatter leaking down there; these events probably keep the surface a degree or so above absolute zero.

“The shell is very thin smart fabric, as with the Red Rubber Ball, with embedded superconducting solenoid loops circling the entire shell like lines of latitude at milliradian intervals. A combination of loop stress and repulsion keeps the sphere taut, and magnetic alignment keeps it centered on the Iceball.”

“Profoundly isolated, that sphere is,” Ko Tor said. “Some kind of experiment? Part of a gravity telescope? A probe of the galactic magnetic field?”

“We need a forensic technological archaeologist for that,” Tony said. “Me just physics dude. Uga uga.”

Katella started laughing uncontrollably, as did Ko Tor, in her way, after Niki provided the colloquial explanation. When she regained some composure, Katella kissed Tony lightly on the cheek.

Amber had never seen any display of affection between the two before, and it sent daggers of fear and guilt through her. What had she done? Things were clearly different than she thought. How could she get out of this situation?

\* \* \*

Two days later, while Amber was doing laps in the Sphere 2 basement pool, Katella came in, stripped and dove in after her. *You’ve got to be kidding me*, Amber thought. *When one of that couple wants something, they catch me naked. How much does Tony tell her?*

“You screwed my husband,” Katella said when she caught Amber.

Amber stopped and stood; this pool was a meter-and-a-half deep circle; at least. She was frozen into silence. How was she supposed to handle something that wasn’t supposed to happen? Abject apologies? Try to explain? Get tough?

“In grad school, all those late nights, you screwed him. That’s why we’re here, isn’t it?”

Saved by not saying anything at all out of fear, Amber shivered in the release of tension. “No. I was his professor.”

“I don’t believe that.”

“Why?”

“Because he loves you, wants to be with you, drools over you. You had to be screwing him.”

Katella's voice was cold, steely.

"Unrequited obsession can be the strongest of attractions, Katella. And imagination can be much more powerful than reality. Perhaps I should screw him now and get it out of his system?"

"Damn you!" Katella's expression changed then, into more of wonder than anger. "You meant that, didn't you? Like it was some kind of astronomical problem to be solved. You don't feel. You don't understand at all."

Niki?

THE CHANCES ARE VERY GOOD THAT SHE IS JUST VENTING AND IT WILL BLOW OVER. JUST WAIT UNTIL SHE'S DONE, AND LEAVES.

"Listening is part of my job, Katella. If there is something you feel I don't understand, perhaps you can explain it to me?"

"Chaos! Ask Niki. He's more human than you are." With that, Katella splashed out of the pool, grabbed her clothes, and caught the lift pole for the next deck up. Why not, Amber thought. The Kleth wouldn't care, and Tony had seen it all before.

Not for the first time, Amber wondered if Katella were right, in a way. *Am I some kind of mutant? Do I lack normal human intuitive responses? Is that why I want to be alone so much?*

\* \* \*

PROGRESS? Amber asked Niki.

I'VE GRADUALLY INFUSED MYSELF INTO THE STONE DOUGHNUT'S SYSTEMS. THEY AREN'T DESIGNED FOR CONSCIOUS AI, ASSUMING I COUNT AS CONSCIOUS, OF COURSE.

YOU FOOL ME.

I'M PROGRAMMED TO FOOL YOU.

WE'LL LEAVE THAT THERE. ANYWAY, DOES THE STONE DOUGHNUT HAVE A BRAIN?

IT DOES NOW—A PRINTED COPY OF MY STARSHIP BRAIN. WHAT I'M WORKING ON IS AN OVERLAY OF BROADER BAND INTERCONNECTIONS. THE ORIGINAL SETUP WAS VERY DISTRIBUTED, SIMPLE BY OUR STANDARDS BUT STILL CONTAINING EONS OF EXPERIENCE AND PATTERNS. THERE WAS SOME VERY STRINGENT CONFIGURATION CONTROL, SO THAT EVERY MODULE HAD THE SAME BEHAVIORAL SET. MY WORK IS AN OVERLAY; YOU SAID TO KEEP THE ORIGINAL INTACT SO IT COULD BE STUDIED. BUT TO ADD THE OVERLAY AS WELL, THERE NEEDS TO BE AN INCREASE IN CAPACITY OF TRILLIONS OF MODULES AND METAMODULES. IT WILL TAKE WEEKS.

CAN THE STONE DOUGHNUT BE MADE HABITABLE?

YES. IT SEEMS TO HAVE BEEN ORIGINALLY BUILT FOR A CONSTRUCTION CREW OF LIVING BEINGS, SOMEWHAT LARGER THAN HUMAN, FROM THE ARCHITECTURE, BUT THERE ARE NO PICTURES, HISTORY, NOTHING TO SAY WHO EXCEPT SOME RECOGNITION CODES.

MILITARY SECURITY, MAYBE. WHOEVER DID THIS DIDN'T WANT TO BE TRACED.

MAYBE, SOMEWHERE IN THE GALAXY, THERE IS A RECORD.

HOW LONG AGO?

RADIOISOTOPE DATING OF THE BASIC PARTS OF THE STATION INDICATES THAT IT IS MADE OF MATERIAL ABOUT 9.7 BILLION YEARS OLD.

BUT NOTHING SAYING WHEN THAT MATERIAL WAS USED?

NOT YET.

ARE THE BUILDERS STILL AROUND, SOMEWHERE?

ALMOST CERTAINLY NOT.

ALMOST?

TEN TO THE MINUS THIRTEENTH, BASED ON MANY REASONABLE ASSUMPTIONS.

\* \* \*

"Time to strap in; at its current speed, the cargo carrier is five minutes out," Katella said.

Amber checked the video from *Niki*. The carrier had matched velocity with the Black Rubber Ball a week ago. Now it deployed a solenoid loop field generator and fell toward the north pole, using the solenoid field to brake against the Black Rubber Ball's field. It was a propulsion system that made a great deal of sense, given its destination's magnetic field, but it took forever.

"It's carrying a lot of antimatter," Tony said. "Roughly five tonnes. Mix it with an equivalent amount of matter, and the energy released would be almost a zettajoule, roughly a tenth the

energy needed to get the *Niki* up to speed.”

“Which would be used over tens of days,” Katella said. “If it were released in a second, we’ll be dealing with a zettawatt! I’ve always wanted to use that word in a sentence. It’s exciting!”

“It also gives us some insight into why this is a fully automated operation and the skin of the Stone Doughnut is five meters thick,” Amber said. “Think of an asteroid a kilometer across hitting a planet at thirty clicks.”

Tony and Katella had landed about a hundred kilometers from the pole. They were strapped into their acceleration seats, ready to head south at five gravities on a moment’s notice if something went sideways.

But nothing did. The carrier slowed drastically, floated on its magnets into the lock, which cycled, and came out the other side. Inside the Black Rubber Ball, it continued down toward the Iceball, accelerating rapidly to a few kilometers per second in its balance between magnetism and gravity.

“Well,” said Tony, “that answers one question. The antimatter isn’t being used at the surface.”

“But there’s nothing like a processing facility on or near the Iceball’s north pole.”

“Not yet, anyway.”

“We should bring the shuttle in,” Katella said. “We can establish a polar orbit that dips over the pole at just the right time.”

“Too much contamination, I think,” Amber said. “The interior is very clean for a reason, and we don’t know what that reason is.” Once again, she was in opposition to Katella, but the younger woman simply hadn’t thought things through. And she was putting Tony in a bad position again. Maybe this time she’d thought quickly enough, however.

“Niki, run the numbers on shuttle effluvia and see what Ga Tan and Ko Tor think.”

Amber could almost see the relief on Tony’s face.

Katella frowned, but she really had no reasonable objection.

The answer was a bit of a surprise. Ga Tan spoke for the group on the *Niki*. “We’re going to print a magnetic shuttle with a set of cameras, super clean, with a scalable clean observation room if someone wants to ride it. It will be ready in a couple of days.”

“I’m going,” Katella said.

It was a good solution, Amber thought. But the fact that it had been adopted without her own input was a symptom of how far things had gone.

“Very well,” Amber said. “I’m curious as to what goes on in the Stone Doughnut, and now that we have access to its data, I want that with as little time delay as I can get while this operation is in progress, so I will be there. Tony, it’s your choice as to where you want to be.”

She touched the net for Niki. PACK AND SEND ALL MY PERSONAL EFFECTS OVER TO THE STONE DOUGHNUT. I WILL BE THERE FOR SOME TIME, ASSUMING IT SURVIVES. I’M GOING TO NEED ONE OF THE SHUTTLES AS WELL. CONNECT ME WITH GA TAN.

GA TAN?

YES, AMBER CLOUD?

IN THE EVENT THAT I DO NOT RETURN WITH THE EXPLORATION GROUP, YOU WILL NEED TO LEAD THE GROUP BACK HOME.

I SINCERELY HOPE THAT IT DOES NOT COME TO THAT, BUT I RECOGNIZE AND ACCEPT THE RESPONSIBILITY. WILL I HAVE TONY’S SUPPORT?

A good question, she thought. That Ga Tan asked it was a good sign.

ALMOST CERTAINLY, BUT IF THERE IS ANY QUESTION, APPEAL TO HIS SENSE OF RESPONSIBILITY. I SENSE THAT KATELLA HAS ERRED TOO MANY TIMES TO HAVE HIS UNQUESTIONING LOYALTY OR PERHAPS EVEN HIS AFFECTION; THE BONDS BETWEEN OUR PAIRS ARE NOT AS STRONG AS AMONG THE KLETH.

UNDERSTAND. IN SUCH CIRCUMSTANCES, WE WILL DO OUR BEST. WE WANT TO GET HOME, TOO, OF COURSE. WITH YOU IF POSSIBLE.

UNDERSTAND. THANK YOU. BUT THE UNIVERSE MAY HAVE ITS OWN PLANS.

Amber had not yet crossed her Rubicon. If she were to leave, and live here permanently, it would be a betrayal, a violation of promises, explicit and implicit.

Tony would suffer the most; she was his safety valve, and he had given her, however unsought,

a glimpse of being loved despite her aloneness. But she did not want, and could not tolerate, the continued permanent companionship and responsibility for someone else, even someone who loved her. Neither could she fight Katella for him; even success in that would tear her up inside to the point of suicide.

The people who had sent her out here in good faith, at her insistence, to whom she had pledged to do this, would be perplexed and disappointed at first, then perhaps angry at how she had desecrated this artifact for her own ends, and finally fearful once they realized the literal power she could command. The relationship could become testy, but it would be much dampened by the 450 light-years between them.

Her Rubicon was waiting, uncrossed as yet, Niki willing. But she had set foot on the bridge across it.

\* \* \*

Three days later, the Red Rubber Ball's antimatter carrier approached the Black Rubber Ball's north pole. *Shuttle 1* sat on the surface of the Black Rubber Ball. Tony and Katella, in the magnetic shuttle a hundred thousand kilometers over the north pole of the Black Rubber Ball, watched the radar picture with their eyes on the deck window in case something visible happened. Ga Tan and Ko Tor monitored from the *Niki*. Amber, in *Shuttle 3*, watched from less than a light-millisecond from the Stone Doughnut, connected to its data feed in near real time.

Her excuse of monitoring events from there wasn't entirely a deception. After nine billion years, she had to think of this alien system as an evolved being, however different it was from beings like Amber or Ga Tan. To survive this long, it must have left the design, if not the purpose, of its makers far behind. Her version of Niki modeled every input and output, every algorithm as they functioned. Activity was clearly increasing. It was also responding to her data taps. On some level, it knew they were here.

What is this thing? It could be a scientific experiment, but it could also be a weapon of unimaginable power. But it had no apparent defenses.

Hours passed; the Universe had no respect for human time perception, Amber thought. Things took forever . . . or they happened in milliseconds. Amber tried hard to clear her head of feelings, of pleasing people, of Katella, of Tony. Focus, focus.

What if it were a weapon, or part of a war effort in some way? If you build a weapon, and you don't want it to fall into the wrong hands. . . .

A self-destruct mechanism?

NIKI, GET KATELLA AND TONY OUT OF THERE, NOW! IF THE ANTIMATTER HITS THE ICEBALL SURFACE, WHAT SHOULD HAPPEN, IN DETAIL?

IF THE CYLINDER HITS THE SURFACE AS SOLID ICE, ITS SURFACE LAYERS WILL ANNIHILATE AS IT PENETRATES THE ICEBALL'S OUTER MOLECULAR LAYERS. THAT WILL CREATE GIGAWATTS OF HALF-GeV GAMMA RAYS AND A CLOUD OF ANTIHYDROGEN AROUND THE ENTRANCE POINT. THE CYLINDER WILL BORE DOWN THROUGH THE SURFACE LIKE A HOT KNIFE IN SOFT BUTTER, PERHAPS AS MUCH AS TEN KILOMETERS. THEN THE PRESSURE OF REACTIONS AT ITS FRONT END WILL SLOW IT TO A STOP. IT WILL VAPORIZE AND MIX WITH THE HYDROGEN UNDER HIGH PRESSURE; THIS WILL TAKE ONLY A FEW TENTHS OF SECONDS; IT WILL BE ESSENTIALLY AN EXPLOSION. THE RADIATION WILL BE LARGELY ABSORBED BY THE SURFACE LAYERS, HEATING THEM TO STELLAR INTERIOR TEMPERATURES. EXCEPT FOR A NARROW CONE DIRECTLY OVER THE ENTRY POINT, OBSERVERS WOULD SEE ONLY NEUTRINOS AT FIRST. THE BLAST WAVE WILL TAKE SECONDS TO MAKE ITS WAY TO THE SURFACE.

OKAY, NIKI, SO WE'LL HAVE A HORRENDOUS FLASH ON THE SURFACE FROM THE ANTIMATTER IGNITION AND FUSION REACTIONS, AND A COMPRESSION WAVE TO THE CORE. THE ICEBALL BECOMES A STAR?

YES, IF THE CORE IGNITES. THE NEW STAR WOULD EXPAND INTO SOMETHING RESEMBLING A T-TAURI STAR BEFORE SETTLING BACK TO A VERY LATE RED DWARF OR A BROWN DWARF, IN A TIME FRAME OF ABOUT TEN MILLION YEARS OR SO, WITH A HORRENDOUS STELLAR WIND TO START WITH. BUT IT WOULD TAKE HOURS FOR THE CORE IGNITION WAVE TO REACH THE SURFACE.

WILL THE STONE DOUGHNUT BE SAFE?

EASILY; IT SEEMS DESIGNED FOR EVEN WORSE EVENTUALITIES.

What might those be? she wondered.

TONY, KATELLA, she sent, I THINK THE MECHANISM INTENDS TO IGNITE THE ICEBALL AND MAKE A STAR OUT

## ANALOG

OF IT. IT MIGHT BE A SELF-DESTRUCT CONTINGENCY THAT WE TRIGGERED. GET OUT OF THERE, NOW, AT MAXIMUM ACCELERATION. I'LL BE SAFE IN THE STONE DOUGHNUT.

Once they were on the *Niki*, the starship itself could surf away on the plasma wind, not entirely unlike the intentional fury that pushed it to the stars in the first place. They and the Kleth would be okay inside its magnetic field.

NIKI, PUT AN IMAGE OF THE MAGNETIC SHUTTLE ON THE RIGHT AND THE SURFACE ON THE LEFT.

She saw the magnetic shuttle stayed put for a few precious seconds. Katella! If she threw orders at the woman, she would only resist more. Amber could only watch and hope that Niki, the Kleth, and Tony could move her. Or maybe not.

NIKI, CAN YOU STOP OR SLOW DOWN THIS PROCESS?

NO. IT'S COMPLETELY AUTONOMOUS, AS FAR AS I HAVE BEEN ABLE TO DETERMINE. THE SYSTEM IS NOT EVOLVED FOR CENTRALIZED CONTROL.

Amber would have work to do. For now, she was helpless.

The container with its load of antimatter descended inexorably, now only a few kilometers above the Iceball's surface.

Finally, the magnetic shuttle rose rapidly toward the surface of the Black Rubber Ball. Not soon enough, she thought. Not soon enough.

The container slowed and stopped its descent a few minutes later. Its extremely cold cargo, rendered jet black in the radar visualization, began to slide out from it, picking up speed as whatever fields had contained it began to lose their grip on five tons of antimatter in a hundred and seventy gravities.

The magnetic shuttle reached the polar lock.

The black cylinder fell in the high gravity, but less fast than it should.

As soon as the antimatter cargo cleared the container, the latter accelerated upward against gravity at an impressive three gravities, given it was using magnetic repulsion alone.

DIAMAGNETIC, Niki sent. THE FIELD LINES ARE CONVERGING, SO THERE'S A REPULSIVE FORCE.

The magnetic shuttle emerged from the surface and flew into *Shuttle 1*'s hold.

NIKI. Amber crossed her Rubicon. Perhaps some would think of it as a sacrifice instead of a desertion. PICK THEM UP AND EVACUATE, NOW. GA TAN IS IN COMMAND. I AM STAYING HERE. GO HOME, I WILL RELAY ANY DATA UNTIL THE END. BUT IF THERE IS NO END, I AM CONTENT. THERE IS SO MUCH TO LEARN, SO MUCH TO DISCOVER.

AMBER, Tony sent, privately. PLEASE . . . I LOVE YOU.

I KNOW. THAT, IN PART, IS WHY I MUST STAY. I CANNOT RETURN THAT KIND OF LOVE. BUT DO THIS FOR ME; SUPPORT GA TAN. IT WILL BE DIFFICULT, BUT I THINK YOU UNDERSTAND WHY. WHEN YOU RETURN, GIVE KATELLA A CHANCE. PEOPLE LEARN AND CHANGE. BUT IF NOT, THERE WILL BE OTHER LOVES.

WE NEED TO GET INTO THE STONE DOUGHNUT, Niki reminded her.

Deja vu hit her along with the acceleration. Her prom date, those many years ago, had hoped for more after the dance. She had disappointed him with similar words and spent waking moments in the wee hours of the morning ever since wondering about "the road less traveled."

"We're away," Tony reported on audio minutes later, his voice professional and controlled, "accelerating south at five gravities."

THEY WILL REACH ESCAPE VELOCITY IN TEN MINUTES, Niki said.

It might be enough, Amber thought as she entered the Stone Doughnut's axial lock.

The antimatter cylinder hit the ice surface, sending a target pattern of waves moving rapidly away from the impact point. It left a momentary crater that collapsed as fast as it formed. That was all.

WHAT THE HELL? Katella sent. THAT WAS FIVE TONS OF SOLID ANTIMATTER!

It was up to Ko Tor to voice what was both obvious and impossible. THE ICEBALL, OR AT LEAST ITS OUTER LAYER . . . MUST . . . OF LIQUID, OR PERHAPS SUPERFLUID, ANTIHYDROGEN BE.

I RECOMMEND YOU DO NOT STOP ACCELERATING, Amber sent. IF THE SHOCK OF THIS IMPACT WAS ENOUGH TO TRIGGER STAR BIRTH, THE T-TAURI WINDS WILL BE MADE OF ANTIMATTER!

Then she decided to burn the bridge over the Rubicon.

NIKI, I THINK WE NEED TO THROW SOME ROCKS. BIG ROCKS.

\* \* \*

The *SV Nicolas Louis de La caille* did not stop at the base at “Double M” and reached a third of the speed of light by the time the antiproton plasma wave reached the beam projector complex with its very attenuated, but still lethal, radiation. Forewarned, the robotic facility coped with it.

Its job was done in any event. The tail end of the acceleration beam had already been completely generated and projected. It spent the next month furiously overtaking the starship to deliver its load of momentum.

\* \* \*

Katella, Tony, Ko Tor, and Ga Tan stayed in cold sleep for the three-gravity acceleration. They revived for their first scheduled waking period ten ship years later.

When they woke, Niki had a message for them. But first he sent them to an observation station in the main ring, a place with real windows where they could see the blue-shifted stars in their direction of travel wheel around with their own eyes.

“Ahead of us, about ten degrees from the sun, is a rogue kuiperoid, maybe the mass of Phobos or so. It’s about three o’clock from Sirius, if you can spot that. I’ve sent you a marking circle.”

“I have it,” Tony said. “But surely we can’t see anything that small by starlight.”

“That is about to change.”

As Niki said that, an impossibly brilliant star appeared in the designated place, then faded with twinkling embers.

“Good morning,” Amber’s voice said. “As you see, I survived the birth of the Antistar. I am now in control of the Red Rubber Ball, and I am repurposing it as an astronomical instrument. One of the things I can do is to vaporize objects at an absurd distance to do spectroscopy on their content. I may actually file papers on this, assuming the institutions that publish them still exist. I may also send other messages to you, and I have taken special care to see that nothing unwelcome lies on your path home.

“The Stone Doughnut and the Black Rubber Ball had been floating through the spiral arm, using star after star for antimatter production for over nine billion years. The builders left no trace of its purpose that I can find, but the Black Rubber Ball had reached the limit of its storage capacity. Still, the last antimatter delivery didn’t quite push it over the edge. That took several thousands of tons of normal matter. I have no regrets; it would have happened in a few years, or a few million years, anyway.

“As a star, rather than an Iceball, that antimatter is now safely out of reach of anyone with designs on it. Trillions of years from now, it will become a ball of cold antihelium ash, its surface radiating half-GeV gammas and more from infall. But I’ll leave that problem for future generations.

“With the Red Rubber Ball, I now control more power than any individual being should control. I am not sure I am entirely sane by human standards, and perhaps that combination will provoke an interesting response from the ancients of the Galaxy a few millennia hence. But, for now, I feel content and more relaxed than at any time in my existence. I am an Empress of Starlight, with extraordinary powers for hundreds of light-years around me, and only the speed of light and my own values as a constraint. So, Katella, don’t be an asshole.”

“Seriously, I ask only this of all of you. Treat each other kindly, and at least make sure everyone understands that I am alone by choice, and I want to stay that way. Bon voyage.”

*G. David Nordley is the pen name of Gerald David Nordley, an author and a astronautical engineer who has worked with spacecraft operations and advanced propulsion. His main interest is human expansion into space in a plausible future. Gerald is a past Hugo and nebula nominee and a four-time Analog "AnLab" winner. His latest novel is To Climb a Flat Mountain, and the latest book is a collection, A World Beneath the Stars from Brief Candle Press or Amazon.com. He lives in Sunnyvale, CA. His website is www.gdnordley.com.*