

LOKI'S REALM
by C. SANFORD LOWE & G. DAVID NORDLEY

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Illustrated by William Warren

Engineers must work with what they have....

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Chapter 1

Broadford, Isle of Skye, Scotland,

12 March 2260

I suppose it's more interesting when, in the words of Robert Burns, "the best laid schemes o' mice an' men gang aft agley" than otherwise. I'll have no quarrel with that, though I do have to say that, had everything gone according to plan, it still would have been quite an adventure. I'm Bruce Macready, historian of the Epsilon Eridani mission to build and launch one of the four impactors of the Black Hole Project.

The idea of the BHP was to accelerate four billion-ton iron-rod impactors from four different stars up to relativistic velocities, then crash them together to generate a pressure at their meeting point that far exceeds what even quantum mechanics can resist, the result being a miniature black hole. Though smaller than an atomic nucleus, it would mass a billion tons or so—enough to stay around long enough for the physicists to play with it and someday, perhaps, use its progeny to construct vast Faustian machines that would manipulate the very fabric of space itself to humanity's purposes.

Aye, that was the hope.

How, you might ask, did a Scottish professor, who had not left the Isle of Skye more than a half dozen times in his 147 years—let alone go into *space*—become involved in this? Well, I had taught the history of science and technology

at Broadford College for over half *its* existence, and held every position including chancellor at one time or another. I thought the human race was in a flat place of late, not making history like it had done before. Earth was pacified. Mars was nearly terraformed, and it would be centuries before Venus followed suit. So I sensed that, short of the possibility of alien contact, the BHP would be the signal event of this era.

I found that among the BHP principal investigators was one Bradford Adams, an Australian physicist who had attended Broadford for a year on exchange and had taken one of my classes. Year after year, in explaining our expansion into space, I unleashed the words of Tsiolkovsky to thunder down on Brad and my other students, telling them that one could not live in a cradle forever. Now he spoke to me.

I took it on myself to contact Brad and offer my services as an historian on the fifty-year expedition to Epsilon Eridani—a star about a third of the Sun’s luminosity, which, due to its extreme youth, was not suitable for a colony and thus had no indigenous historians. To my great surprise, the project leader, Dr. Zhau Tse Wen, showed up at Broadford to interview me. We hit it off well, and over a glass of fourteen-year-old Talisker, my proposal was accepted. So, with a little more fuss than I need relate here, I made my goodbyes to my older brother, to Macready Manor, to Broadford College, and to my past life.

I sent a few personal things ahead and began this journey of some thirteen light-years on foot, hiking the ten kilometers to Kyle of Lochalsh. One travels light among the stars, and I wanted to savor what little time I had left on Skye. It was October—clear, bright, and nippy—and the view of Skye from the height of the bridge almost made me turn in my tracks and head back.

But no, I have an inertia in me that is legendary, and my path I’d chosen. I sighed and marched down the mainland side of the span and into the transit station. There I caught a fan bus to Glasgow and took an orbital shuttle four hundred kilometers up to Sheffield Spaceport, the rotating toroidal space station near which the starship *Admiral Byrd* was then keeping station.

As I left the shuttle, a smiling attendant met me. “Dr. Macready?” he said. “You’re wanted on the starship.”

I was surprised; the *Admiral Byrd* wasn’t due out for two more days, and I’d anticipated some time to explore Sheffield Spaceport.

The attendant handed me a pair of somewhat old-fashioned looking spectacles. Smart glasses, I realized. They’d been around for a couple of centuries, but with an old-fashioned wrist comp for all my needs, I’d never used them before.

“They’re for those who haven’t had bioradios installed,” he said.

Of course. I’d been born a wee bit early to have the genetic modification that

allows people's brains to send and receive radio waves. The spectacles were a prosthesis for those of us so handicapped, and they'd known I was coming. I put them on with a frown. Nothing appeared.

"Speak the name of what you want to know as quietly as you like, or stare at something for more than a second, down the hall to the shuttle dock, for instance."

I looked at the attendant. The glasses identified him as "Lane Woo, flight attendant, Cislunar Transportation Service."

"Thank you, Mr. Woo. This will take some getting used to."

He nodded with a smile and went about his business as I went about mine. The glasses led me to an elevator down to the 0.1 gee level, through a long park-like transit lounge to the shuttle gate. In a few minutes, a runabout whisked me off to the starship.

Up close, the *Admiral Byrd* was impressively weird. It had a hundred-meter-wide crown of six 120-meter-long icicles that were evenly spaced. At the wide end of each icicle was a ten-meter-radius sphere, which housed the habitable parts of the starship. This entire arrangement rotated majestically. From my point of view, the icicles occasionally eclipsed each other, separated, and eclipsed each other again, making me think of the blades on wool shears.

As I got closer, I could see that the band of the crown that joined them all was thick enough for people to pass through. Closer still, I saw the forward ring sitting about a quarter of the way between the bases and the tips of the icicles. Thin "legs" slanted in and forward to attach this smaller ring to the rest of the ship. That forward ring was a magnetic choke that would increase the ship's ability to reflect the ions that would push it along—the design actually dated back to the twentieth century, though not realized until the twenty-second. It also helped deflect charged debris in front of the ship. It is one thing to study the history of such things, or see them on some video display, and entirely a different thing to see them with one's own eyes. I was awestruck. This was a real starship and I was going to ride on it.

The runabout set down on the inside of the small ring in a complicated maneuver, which its AI handled flawlessly, leaving me with about a tenth of a gee of spin gravity. I wondered if that maneuver could even be attempted manually.

Dock and seal were quickly announced, and the smart glasses guided me down a long, sloping corridor that ran inside one of the choke ring supports to the passageway in the main ring and something approaching lunar gravity. From there they conducted me into the middle of Sphere One, a living roomlike common area surrounded by doors to private quarters and a fireman's pole in the center leading to decks above and below. I had barely begun to wonder which door was mine when one to my left opened unbidden. An AI somewhere was responsible, of course.

The cabin was tiny; a fold-down bunk two meters long took up the entire

outboard side. A well-disguised lavatory sat to the right of the door at the foot of the bed, and a small desk and chair sat to the left of the door at its head. I checked to see if my personal stores had been stowed, and they had—as part of the shield mass. Included was a precious case of my native island whisky, Talisker. I pursed my lips and set aside my thirst for the nonce.

“Hello, Dr. Macready. Rumor is I’m in charge of this zoo.”

I turned. Outside my door was our expedition commander, George P. Weaver, a tall man with close-cropped steel gray hair. By his biography, he was a horseman, a Texan, with Ph.D.s in animal husbandry and systems management. He still had vestiges of a Texas accent, but this was well smoothed toward an aerospace standard English that sounded not too unlike the Canadian of the Toronto region. He offered me the callused hand of a sincere physical hobbyist, with a correspondingly firm grip.

“Glad to meet you, sir,” I replied, wondering what he’d think of my rather unsmoothed Scots accent, “and there’ll be no need for the ‘doctor’ so far from the classroom. It’s Bruce.”

He gave me a long look as if judging whether he was ready to be on a first-name basis.

“Right, Macready ... uh, Bruce ... Brad Adams arranged for you to have this stateroom.”

“Aye.”

“Will you be riding out the acceleration with us?”

Others had described *that* experience well enough for me. “No, I’ll be in cold sleep unless something noteworthy happens. Project management’s arranged for me to be woken up in that event.”

Weaver raised an eyebrow. “Project management will soon be a long, long way away. We’ll have ninety-six scientists with us who want to study the Epsilon Eridani system in detail. They’re in cold storage and will stay there until we’re ready for them.”

“I hope my arrangement meets with your approval, then,” I added.

His face remained impassive.

“Ah, once I’ve sorted myself, I hoped to ask Dr. Davra about the finer points of what the robotic minions at Epsilon Eridani can do on their own and what might require our direction.” Davra, a comely lass, was the chief roboticist.

He looked at me a bit, then nodded as if making a judgment. “I see you’ve homed in on the central issue already. The short answer is, their programming *can’t*

anticipate everything. That's why Doc Zhou sent us."

Dr. Zhou and Weaver had a history that went back several decades, and when Zhou had wanted someone he could completely rely on to ensure the Epsilon Eridani impactor went on time, he'd picked Weaver, as he'd told me over a whisky at our interview.

"Bad luck on Davra, though. She's on ice already." Weaver smiled and gave me a wink. "So you do your research, heed that data, and plan for contingencies. Those are survival traits out here."

I took that as high praise. "Thank you, sir."

"We'll have you on ice tomorrow and you'll wake up in the space colony being built to house us at Epsilon Eridani. So settle in and make your calls today."

I did so, but before turning in, I poked around the ship a bit. If things went according to plan, this would likely be the last I'd see of it.

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Chapter 2

Aboard the Admiral Byrd,

in route to the Epsilon Eridani System,

9 November, 2272

I woke to a low-pitched thrum and a slight metallic taste in my mouth, presumably a legacy of my cold sleep experience. Otherwise, I might have had an afternoon nap. Our trip to Epsilon Eridani should be over, and I should be in some kind of house or apartment in the great rugby-ball-shaped habitat that the robots had been building for us, along with about a hundred other freshly thawed people. Every second or so, I heard a distant hollow thump—a construction device of some sort, perhaps. I was not entirely motionless, but the accelerations were slight; had I not been on a mattress, I doubt I'd have felt anything.

I lifted my head and opened my eyes. The light level was quite low, but enough for me to see that I was still in my stateroom aboard the *Admiral Byrd*.

"*Admiral?* Why am I not in the habitat? Haven't we made it to Epsilon Eridani?"

Do you hear me satisfactorily?

"Aye, but not in my ears! What have ye done to me?"

You've been given an implant. It's a necessary safety item aboard a starship. In a few days, you'll be able to communicate subvocally on the local net, but for now, continue to talk; this lets your chip learn the impulse patterns of the

nerves to your vocal cords.

I had just been getting used to the glasses! I blinked hard, shook my head, and stretched to wake myself. Something had happened! I could complain about the surgery later.

You have a message from Dr. Weaver.

“Aye?”

Weaver’s voice sounded in my head. *A very violent and entirely unpredicted collision in the Epsilon Eridani system has increased the amount of meteoric debris in the system by three or four orders of magnitude, two orders of magnitude more than the array-building system had been designed to withstand. We will be meeting in the Sphere Three Park at 1400 to discuss the situation and make plans.*

“Well!” They must have known this for some time, I thought. So much for my arrangement. “Let’s see what’s out there. Forward view.”

I saw a glowing Medusa—a black disk surrounded by curling wavy streams of light. It took me a few seconds to register what I saw with what I knew.

“We’re in the shadow of this habitat?”

Yes, the Admiral answered. The outward end of the shell has been covered—that is the black disk. I can amplify it if you like, but it is smooth and featureless at this magnification.

“Never mind. All those streams?”

Those are comets. There are 973 of them in your field of view.

“They’re all heading right into the star?”

That is mostly perspective, the AI answered. Only 311 have perihelia within the photosphere. All but fifteen of those are actually ammonia-saturated slag balls from our mining and solar power station construction operations.

The *Admiral*’s comments notwithstanding, I was in awe of this picture, of all this cosmic debris falling toward the star, and feeling not a little uneasy. How did the artificial intelligences building the array cope with this? What plans should we make? Was the project itself in jeopardy? I got myself up to speed as much as I could.

Then it was time to go to the Sphere Three Park. Getting there was no problem: the hollow main ring led through the center of each sphere. A woman by the name of Jill Davenport, head of biology, soon followed me on the pole and assured me this was the way.

As I came up the pole I was greeted by a shapely lass wearing a glossy purple shipsuit that looked as if it had been painted on her body. It had a white

shoulder-to-hip band, broken by a triangle of well-tanned skin nearly down to her navel.

“Hello, Dr. Macready.”

“Dr. Davra, I presume?”

She smiled and motioned to a spot on the grass. “We’re about ready to start.”

I nodded, sat down on the grass like everyone else and looked up at displays of comets and collisions spread all over the dome.

“Damn it, Emma,” Weaver said at length, “how’d this happen?”

Emma Lewis, our astrophysicist, stood up so she could see everyone. She reminded me of my kindergarten teacher so many years ago, save for a London accent. She was dressed, much as I was, in plain walking shorts and a loose pullover tunic that gave little hint of any figure.

“Bad luck, isn’t it? The big collision followed a bolometric luminosity spike of almost twelve percent—a huge flare by solar standards—that occurred the year we left. This flare increased cometary activity, causing more random nongravitational accelerations. That caused changes in previously settled orbits, increasing collision rates which increase debris, which increase the number of collisions, and so on. It’s a feedback process—exponential as long as a reservoir of material exists; and the giant planet Loki’s eccentric orbit continually stirs things up. But a collision that big might not have happened for tens of thousands of years. Instead, it happened now.”

“So, what do you think we should do about it?” Weaver asked.

“Study it for now,” Lewis answered, somewhat hesitantly. “Something is going on we don’t quite understand. We’ll come up with a better solution when we do.”

“Meanwhile, we’re losing ground,” Davra complained. “Simulations show the response of the AI systems is to divert power array production to beam drivers, up to the point where that’s all that’s being made. Without replacement array panels and any new arrays, we’ll be falling behind. We’ll need to do some creative thinking.”

She was answered by a tall, angular, light-skinned man with a shock of dark boyish hair falling on his forehead. After a moment’s cobweb-cleaning in the cold-sleep-dusty cells of my memory, I recognized Dr. Daggert Dickson, an engineer, expert in propulsion systems.

“The AIs won’t? I thought these systems were fairly creative,” he said.

“We constrained their creativity,” Davra responded. “We didn’t want them thinking up new purposes in a thirty-year management control loop....”

“Oh, of course not,” Dickson agreed. “If we don’t watch out they might

invent sex....”

“Humpf,” Weaver interjected. “Well, our starship isn’t under any such constraints ... on creativity that is. *Admiral*, do you have any ideas?”

“The current system is already at an optimum factory-array production balance. It would lose ground under any change in allocation of manufacturing effort. Therefore, to complete the project with the planned performance margins, the current system will need to be changed.

“There are three things being produced: factories, array panels, and beam drivers. One change would be to add something else to the system. That additional thing would need to attenuate the debris flux. One could build spacecraft to find and divert collision fragments before they come into range of the impact-protection systems of the arrays. This would enable the array system to grow again, but not fast enough. However, you asked for ideas, not solutions.”

Dickson chuckled. “Thanks, *Admiral*.” He turned to Lewis and frowned. “Look, the composition of the collision debris appears to be mainly S—and C-type asteroidal material, right?”

“Carbonaceous chondrites. True.”

“Okay. They’re rocks, like the raw material we’re using for manufacturing. *Admiral*, what if we collect that, instead of going after more inner-belt asteroids? That takes more propulsion, but we’d be able to put less effort into mining and get kind of a two-fer.”

“That was a good idea, Dr. Dickson,” the ship said.

I frowned. AIs are programmed to praise humans because it makes them seem more human themselves. However, in practice, I’ve always found the effect a bit cloying.

Lewis sighed. “Of course it was, *Admiral*. And so was yours. I liked that.”

“Why don’t you ask him what he’s doing tonight?” Dickson quipped.

Everyone laughed except Lewis, who simply pursed her lips and waited for it to stop.

Weaver held up a hand. “Okay, Davra and Dagger, can you get together and polish this off? Give us a look tomorrow morning?”

Lewis looked as if she wanted to say something, but held off when Weaver turned to her.

“And now,” Weaver said, “for those who haven’t met him yet, I’d like to introduce our captive historian, Dr. Bruce Macready, late of Broadford College, Isle of Skye, in Scotland.”

Davra sat up and looked right at me and smiled so come hither she might have been a sophomore in danger of flunking a course she needed very, very badly. I'm not sure what my facial response looked like to her, but, so help me, she giggled. I took it to be a friendly giggle.

Lewis also looked my way, expressionless except for a slightly raised eyebrow.

Dickson shrugged and said, "Hi, Bruce, call me Dagger."

"Greetings, everyone."

And that was that. We all stood up and chatted with each other for a while. Whether by chance, natural reticence, or intent, Emma Lewis was the last to greet me, and by the time we'd exchanged pleasantries, the others had left.

I suddenly realized I was ravenously hungry. "Cold sleep, apparently, gives one an appetite. I thought I'd head to the canteen. Would you like to join me, Dr. Lewis? You could explain again to me just what's happening in the Epsilon Eridani system."

She looked at me as if I'd said something exceedingly strange, but then said, "I don't know that I'll be able to take you much beyond the background material you've already studied, but..." She shrugged and gave me a slight smile. "I'm hungry, too."

Once our canteen sandwiches were devoured, she asked what had been bothering me.

"A great amount of planning has gone into this. So much so that a problem of this magnitude seems inconceivable."

Lewis nodded very seriously. "The system has been studied, modeled, and monitored for over two hundred years, with increasing accuracy over time. What happened was unprecedented. I suppose we have to remind ourselves that two hundred years is a near-infinitesimal part of the life of a star. But that doesn't make me feel much better."

"Oh, it would appear to be a serious matter, but I dinna think it one for which you should bear any particular blame just for being an astrophysicist."

She shook her head. "You don't understand. I led the modeling team. It was my call, my assurances..."

Och! So it did weigh heavy on her. I am not sure how to explain what I did next, other than that Davra's display had put me in the mood. Davra herself seemed clearly untouchable to me. Those subtle things that sort us males from alpha to zed had made clear to me from my wee years that women like Davra belong only to the alpha sort. To assume she was other than untouchable would only invite heartache.

But Lewis was more like another professor, of similar disposition to my own, I thought. And she seemed clearly unspoken for and in need of some friendship. So I had motive and opportunity. Alas, I had also the means.

“In that case, bonnie lass, you’ll be needing a wee bit of fortification. Now, have you ever tasted the whisky of my native isle? It is called Talisker, and I have brought a supply with me.”

“Whisky? I’ll have a bit of wine now and then, but...”

“It is only technically whisky. Really one consumes it as a liquor, or a cordial. There’s a touch of sherry to it, some say, and a thickness and a sweetness that will put you in mind of no whisky you have ever tasted before. You really must try some.”

She gave me a wan smile. “Dr. Macready...”

“Bruce,” I said.

“Bruce,” she echoed, “Call me Emma. I’m 123 years old. Been around the block, haven’t I?”

The way she said it, I didn’t believe a word of it. “Then come along, lass, will you?”

She laughed a bit. “Oh, why not?”

She followed me out of the canteen. “How did you happen to come on this expedition?”

“I knew someone on the project and I asked. To my surprise, I seem to have been the only one to have this idea.” We’d reached my stateroom and its door glided open at my approach. I gestured for her to precede me, then put a scene of Loch Ness on the wall across from the bed, a sunny day in late October full of autumn color.

Emma sighed. “So whatever errors I make, whatever consequences my mistakes have, you’ll be there to record it for all eternity.”

They dinna send idiots out to the stars. “Now, lass, I’m a fair man. Besides, for such inquisitions there would always be the official logs. My job as project historian is to make what all happens comprehensible to the general reader. I’ll not be passing negative judgments on people just because they’re people.”

She simply looked at my view of Loch Ness. “You mentioned some local libation?”

I smiled, glad for the change of subject. “I did indeed. Talisker, a single malt Scots whisky.” I explained about aging, sherry cask wood, local grains and all, as I poured us a finger each.

She took a sip. “Bruce, I can detect very faint echoes of some of the qualities you mentioned, but my overwhelming impression is more of ... of some kind of mouthwash. And my mouth burns.” She gave me a kind of wry little smile. “But it does make me warm.”

Her first reaction to Talisker, alas, was an all too frequent one for a novice to Scots whisky. I put my hand on hers and sighed.

She made no move to remove it, but only shook her head. “I’m not sure what’s gone wrong. Epsilon Eridani is a very young star system, and it’s suffered some recent pathology. The planetary orbits haven’t settled down; they’re still eccentric and migrating. So it’s very hard to tell what happened, or when. A passing star or rogue planet may have disturbed the system. Or the system may be disrupting itself chaotically.”

“Disrupting itself?”

She shrugged. “Orbits evolve. Planets perturb each other. Eccentricities vary in cycles. A system may clank along alone like that for millions or even billions of years, then someday all the cycles match up the wrong way and two planets come too close to each other and there is a brief gravitational embrace, one gets ejected and the other moves inward in an eccentric orbit. Then they settle down, like Uranus, Neptune, and Pluto in our system. But it takes billions of years. In this case it’s Loki swinging wildly in and out, flinging planetesimals out of the protoplanetary disk with its gravity at both ends.” She drained her glass. “This stuff does grow on you.”

I poured another round.

She raised an eyebrow at me. “Must remember I’m on the record...
“Somehow she had moved near to me, her arm lightly touching mine.

It burned where we touched, in a way I remembered from close dancing in the days of my youth. I mulled over whether she might welcome an invitation to become more intimate, or whether that would be too forward for now.

“You’re a professor of history?” she asked.

I nodded and brought up pictures of Skye, Broadford, Portree, and the family on the wall screen.

It was then that the terrible reality of what I’d done hit home. “It’s just been a couple of days to me, but they’ve not seen or heard a thing from me for over a dozen years now. Like that star system you describe, all of a sudden things come together, then, boom, I’m off into the cold dark. History can be like that, do you know? The lives of those who have done things of note oft get a bit messy in the process. But I left no other complications behind.”

“Me neither. If you think about it, that’s probably true of most of us on this mission.”

“Davra?” I asked.

Emma rolled her eyes. “I’d guess life is *very* simple and uncomplicated for people like her and Dagger. No need for anything deep or long term. No need to waste time. She can get what she wants out of any man. So we off and do something when we don’t really know what we’re dealing with.”

“Maybe you should have a talk with Weaver, privately.”

“We call him G. P., Bruce.” Emma looked into the bottom of her cup, then gave me one of those subtle but suave know-it-all looks that the English are so good at. “It’s too late. Davra’s already persuaded Dagger to go for her robotic solution and G. P. goes with a majority.”

“He has no view of his own?” I asked.

Emma nodded and took another sip. “He can be disengaged at times. He’s a widower—his wife was thrown from one of his horses. Awful thing and I imagine he blames himself.”

“Aye, that’s a hard thing to get over.”

“Isn’t it? This star will likely settle down and stay that way for twenty billion years. We don’t die of natural causes anymore. So he may still be blaming himself twenty billion years from now.”

I shook my head, raised my glass, and smiled. “If in that time he dinna fall off a horse himself.”

Emma laughed slightly “The universe, I think, needs some stable people in it. Those that don’t fall off horses.”

“Aye.”

We sat for what must have been minutes not saying anything, then she sighed and stood up. I missed the touch of her arm immediately, but couldn’t think of a thing to do.

“I enjoyed this, Bruce. We should talk again some time.”

“It’s been a good conversation, yes.” I stood up. There was no walking her to the door, as it was only a meter or so from us. So she simply walked out the door, it closed, and I sat back on my couch. Two minutes ago a real woman had been sitting next to me ready for anything as far as I could tell, and I had not as much as put my arm around her. Sadly, such was typical of my history to that time, if the truth be known.

I noted that we’d done in a quarter of a liter. With several years to go, I’d need to be a bit more parsimonious from here on.

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The next day, Dickson and Davra's plan was adopted with a few technical modifications. I had several more conversations with Emma, all in public places. I felt awkward and the contacts grew less and less. Meanwhile, I learned how to "touch the net," to ask for information and send messages to people. I'd been perhaps too aware of the fears of how such communication would change us utterly, and was relieved to find them so very unfounded. It was no group mind or anything like that—much more like using a wrist comp without having to raise your arm to look at it or speak to it.

I ran into Weaver at the canteen.

"Morning, Macready. I hear this is becoming your work area."

He said that with a grin on his face the likes of which put you in mind of a brilliant morning sun chasing the mists away from the bay at Portree, that or twenty-year-old Talisker. He affected some rustic crudeness, but he could cut to the chase faster than Broadford's chancellor did, which was saying something, indeed.

"Aye, I suppose it is. It's a good place to meet people when they're not too busy and pump their brains. Now, since you're here ... I've scanned Davra's notes on the system feedback loops, and I wanted to fit it into the big picture, from your perspective."

Weaver waved me to a seat and ordered coffee from his replicator. He turned back at me. "Coffee?"

"Tea. Earl Grey with a bit of cream and sugar, if it wouldn't be a bother."

He stepped over to the dispenser. "We're about three months behind where we should be, even with the habitat construction delayed. I reckon it's manageable, but it's worrisome." He had the face of one who didn't need such worries.

"The research crew stays frozen then?" I asked.

"Until that habitat is ready, we've got nowhere to bunk 'em."

"Is there nobody in there with expertise that we might use, say in a brainstorming session?"

Weaver looked me in the eye. "I've got what I think are the best experts on this already. The group is about the right size—I don't want too many cooks. And I definitely don't want any more politics. I also do not want there to be anything to encourage the politics I've already got. Savvy?"

"I think I've been very careful not to take sides, Dr. Weaver."

He looked at me and nodded. "We have a break in the solar weather coming up and Dagger's going to take a look-see at the habitat tomorrow, hoping to get some ideas to speed up construction. You up for the trip?"

I'd not a thought about going off the ship, but the idea did arouse a bit of curiosity in me.

"Huh? I dinna see why not."

"You two might find a thing or two to chat about on the way." Weaver grinned and clapped me on the back. "Let's mosey."

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I met Dagger at the lift leading up to the runabout dock.

"You've been spending a lot of time with Emma." He looked at me as if testing to see my reaction.

I was duly taken aback and decided to avoid anything personal, at least for now. "I've learned a lot from her. We watched a big slagheap from the prograde feed path hit Epsilon Eridani yesterday. She's trying to detect any lasting spectroscopic evidence of the impact."

"Like a star spot? The only star spots I know of come from huge magnetic fields, so I don't..." Dagger stopped speaking and held up a hand; the lift had arrived. We got on it and announced our destination.

Dagger turned to me again. "Now, Bruce, you gotta keep in mind that this is a relationship with a woman, and there are some things that, well, naturally go along with that. Can't run away from that. Body won't let you."

I shivered at his crudeness but resolved to not play the tyro. "Aye and then not aye. She's a wonderful person, but matches my reserve all too well, if you understand."

To my surprise, he nodded quietly and sat for a moment, thinking. At last he looked at me dead in the eye and said, "So you both wait 'till hell freezes over before either of you makes a first move. I figured something like that. So throw a line in another pond."

"Aye ... Well, mine has never been all that needy, if ye ken."

Dagger slapped his leg and guffawed out loud.

"We're here. Let's check this bugger out, and I'll tell you all about it."

I found that a bit rude at the time, but he was an American, after all.

The runabouts were stored in the long hollow cones. When needed, they dropped out, i.e., away from the spin axis, flew up, and attached themselves to the docking port at their bellies. To me, the runabouts looked like half a transparent sausage lying atop a small version of Clarke's rectangular monoliths.

A person came in through a lock in the bottom center of the rectangular part

and entered the transparent half sausage. There were ten pairs of seats in this cabin, with an aisle down the middle. The ends were quarter-sphere domes. We floated in that way and strapped ourselves in at the front. Despite complete automation, Dagger looked over the boards very carefully.

“Okay, let’s go,” he said at length. The runabout detached itself, rotated, and jetted out toward the habitat with the slightest of acceleration.

As the runabout approached the mammoth incomplete habitat, I felt like the fledgling leaving the nest for its first trial flight. Yes, I’d ridden in another runabout out to the starship from the station—it seemed like a million years ago now—and that had been exciting enough. But that was really a glorified taxi ride above Earth. Now here was an alien star system!

“Bruce?” I turned to see Dagger staring at me with a big grin on his face.

“Uh ... Wee bit new to this, is all. You were saying.”

“Just if it’s not gonna work with Emma, it’s not gonna work. Hedge your bets. Spend time with someone else.”

“Och! That would seem disloyal at this point.”

“Women, they understand that kind of thing. Sometimes I think that’s about all they do understand. Look at this mess we’re in. Emma did the astronomy and Davra did the robotics.”

“I’ll not be traveling that road with ye, Dagger,” I said, shocked. “There were many, many other eyes on those plans and most of them men, I’d think.”

“But not since we started having problems. Things haven’t gotten better, they’ve gotten worse. I don’t think either of them has the big picture. They try to deal with it by intuition, and whatever it is, it’s outside their intuition’s box.”

“Aye, there may something to that. Not that anyone else seems to know either, mind you. I thought of suggesting to our chief that he might be getting a wee bit more help on this, and he nearly bit my bloody head off, so to speak.”

“Probably because I suggested the same thing. G. P. is a bit touchy when it comes to critiquing his leadership.”

A huge comet tail came into view just before we came around the edge of the half-finished habitat. I couldn’t see the coma—indeed, it might have already hit the star. A pebble splashing in the sea, I thought, contemplating the relative nature of violence in the Universe.

The edge of Epsilon Eridani came into view. In a blink, stars and comets vanished as my eyes adapted. The smooth gray surface of the half-finished habitat gave way to a latticework of aluminum beams extending out to where its equator

would be. Our shuttle glided around this and finally gave us a clear view of the inside.

“Take us across the diameter, for a first look,” Dagger told the runabout. “Then we’ll fly back along the surface that’s been built so far. Align our roll axis to the habitat sun line.”

The runabout performed the last of these maneuvers first, then canceled what remained of our sunward velocity, leaving us nose first to see a “full” habitat. A topography of sorts had begun to emerge. You could tell where a large lake was going to be. I could see the sculpting of the far end—what would become tree—and grass-covered highlands sloping down to the higher-gravity lowlands of its equator.

“Tell me, Bruce, did you bring one of those kilts with you?”

“No, but it would be easy enough to replicate; there are many patterns on file. Getting a bit warm?” The star on one side and the reflection from several square kilometers of unfinished habitat on the other were warming the insides of our transparent bubble rather rapidly.

“Yes, a little. The fans will kick on in a bit. About the kilts, I always wanted to ask a Scot...”

I laughed. “In my case, generally a well-used pair of walking shorts, as I’m not so fond of embarrassing accidents.”

Dagger laughed. “Well, you could make an exception for Davra....”

Now *that* was the nature of the man.

“I’d need to know her a wee bit better,” I replied.

“She hasn’t made a move on you yet?” Dagger seemed astounded.

“No. I’m not very tall, my voice is a bit high, and I tend to lecture, so it’s no surprise.”

“Hmm. She has a purpose in life and she knows what it is.”

“She’s an excellent roboticist.”

Dagger shrugged. “That too.”

“Emma seems more my type.”

Dagger laughed. “Coward! Emma makes love like she writes a scientific paper. Everything precise and in its place and a soft little squeal if she gets something out of it. I asked her once what would happen if she let go. She said, and I think she meant it, that she *was* letting go.”

“You’ve been intimate with Emma? I dinna...”

As so often happens, when you discuss someone, they pop up. The ship's attention tone sounded again and there she was on the console screen. She could not have heard our discussion, I had to remind myself, but guilt must have been written all over my face!

"You look as if you've swallowed a canary, Bruce."

"Good day, Emma," I said.

Dagger waved at the video pickup.

"The habitat looks an awesome sight from where you are," Emma said. "Pity we haven't finished the other half."

When finished, the habitat would provide a decent living space once the rest of the passengers were defrosted. While our crew's work would be done in a few years, the people who'd come to study the star system might remain here for decades, perhaps permanently. The full kilometer from the center to the empty half-finished bed of the equatorial pond was a very impressive sight.

"Real estate," Dagger said. "I'm looking forward to making some wings. Maybe have the robots make me a little split level on a riverbank. You should see the slobber marks all over the canopy. Getting hard to see."

"You'll find serviettes in the mess module. Now, there's a new prediction of particle flux hitting in about two hours. It might be more than the runabout can handle, so Captain Lee wants you both back at the ship before then."

"Uh, right." Dagger said. "Tell her I plan to be back aboard and on my back in bed by then. Unless, of course, she prefers it some other way...."

"Message received, Emma," I said. "Thank you."

"Cheerio."

"Let's hang out here a while," Dagger said. "I want to pick out a place for my geraniums."

"Deceleration in three seconds," the AI announced. "Two, one..."

A soft *thunk* and a lean to the side announced the maneuver.

The inside of the habitat reminded me of a cleaned-out eggshell—almost that white—with the ragged latticework of the equator serving as the rough edge of such a shell.

"Impressive bunch of real estate," Dagger said.

A sudden *snap* got my attention. With no more warning than that, miniature lightning bolts began to jump from place to place across the control panel, between

seat frames, and even off my fingers toward anything remotely conducting.

“What the hell?” Dagger exclaimed.

“Emma?” I called.

No sound.

Dagger gave me a quick look that said trouble. “Shuttle, what’s our status?”

The AI said nothing. I looked over the instrumentation console. The screens were as gray as a November morning fog on Skye.

“I think we’re looking at a real power loss here,” Dagger said in measured, professional tones that did nothing to disguise the tension in his voice. “Ouch!”

I felt a surge up my spine. Electricity or fear, I knew not.

Gradually, the fireworks subsided to be replaced by dead silence.

“Have we been hit?” I asked

Dagger shook his head. “Didn’t feel anything like that.”

“They’ll miss us, right?”

I could see Dagger’s face reflected off the canopy. He was scanning the boards, looking for anything.

“Yeah, they should. If they’re okay themselves. Looks like a complete electrical failure here.”

“What does that give us?” I asked quietly.

“Well,” Dagger scratched his head. “The good news is we’re alive with enough breathable cabin oxygen for thirty minutes or so. The bad news is, we can’t hang here. Notice it getting hotter? Reflection, I’d say. Getting insolation from both sides.”

Our shuttle had begun to tumble. “Can we get away?”

“Maybe. Let’s get our emergency suits on. They’ve got a cooling system that’s body-movement-driven, a marvel of fluidics.”

I found the cabinet—marked EMERGENCY in big red letters—pulled the panel away, and grabbed the suits. “Helmets?” I asked.

“Not yet, but let’s keep them handy. Gotta move this thing somehow.”

“Fluidics ... Dagger, if I remember properly, there are valves...”

“Yeah, of course.” Dagger dove for a panel in the floor. “Can you pass me

the tool kit?"

I found it and gave it to him. He squeezed himself under the floor. In a few minutes, punctuated by groans and expletives, he bellowed, "Hold on to something!"

I grabbed a seat. "Holding."

There was a kind of boom and we jerked up. I almost fell.

"I think I've found the plus-Z peroxide feed. Now, what you'll need to do is look straight up and tell me when the edge of the habitat is overhead."

"What part?" I asked.

"Any part!" he yelled back.

"Aye, I hear you." I looked up. It seemed to take forever, but eventually our slow rotation precessed to the point where the unfinished edge of the habitat was overhead.

"I've got an edge overhead now," I said.

"Hang on."

I did so, and this time there was a sustained push for maybe two seconds.

"What's happening?" he asked.

It was hard to tell how much movement we got from it by eye; but I did notice something. "We're spinning faster, and it's getting a bit cooler," I said. "I'd say we're off dead center, so to speak."

Dagger groaned.

"Well, I dinna think it was that bad."

"No, damn it, not you. I've lost the wrench."

"Och! Well, at least we are moving."

"How close are we to the habitat wall?"

We had moved noticeably. It was hard to judge by eye, but it seemed as though we were twice as close to the side toward which we were moving as to the other side. "Maybe seven hundred meters and closing," I responded.

Dagger emerged from the hole in the floor. "Can't find it. How are we doing?"

"Maybe six hundred meters, now—that done in about a minute," I said. "About twenty meters a second or so. We should be there in about six minutes."

Dagger and I watched the habitat get closer and drift slightly off to the right. “I don’t think we’re going to hit it, Doc,” he said.

“Well, a bit of good news!”

“That’s not good news. Without power, this runabout is a death trap. If someone doesn’t rescue us, we’ve gotta get some mass between us and that particle storm before it gets here.” He pointed at the habitat. “That mass.”

Epsilon Eridani rotated into view. It was covered with ominous spots. The runabout’s air was beginning to smell sweaty and stale—the canopy was large, but would contain only so much oxygen. I thought about all the years I’d spent at Broadford and the inexplicable humor of a cosmos that might end me so far from the Isle of Skye.

“How are we bloody going to get there?”

Dagger looked at me like a man possessed. “We’ll have to jump for it. Grab your helmet.”

It looked a bit chancy, but it was clearly the only choice, and one that was fast approaching. We got our helmets on and began to check each other, as the manual called for.

“Bet this is as fast as you’ve ever had to do this,” Dagger said as I inspected the neck seal behind his head.

“Easily, but that would be unfair.”

“How so?”

“Well, laddie, this would have to be the fastest time for reason of it being the only time.”

Dagger sounded for a moment like he was choking, so much so that my eyes went to his air hoses with concern.

“Doc, there’s no orange showing on the seal, is there?”

“None at all. I did read the manual.”

“That’s a good thing ... a good thing. Well, Doc, do you happen to remember where the manual canopy bleed is?”

I thought for a moment, calling forth a fuzzy image of the schematics in my mind; but I could not see it so clearly. My memory of text has always been far superior to my memory of images.

“Sorry, I cannot. Why don’t we just go out the lock?”

“It needs power, Bruce.”

“Oh.” Of course it did. “Uh, how *are* we going to get out?”

“There’s a canopy door for use inside the habitat. It opens in, so we’ve gotta let the air out first, otherwise we’ll never be able to pull it open against the pressure.”

“Oh.”

Our rotation brought us around to a close-up view of the habitat’s edge.

“Jeez, we’re almost there.” Dagger flipped upside down and started working on the base of one of the runabout’s chairs.

“Dagger...” I had no idea of what he was doing, and we had to get out of here in a couple of minutes or be fried by the particle storm. Some anxiety must have slipped into my voice.

“Stifle it, Bruce, and grab this chair so it doesn’t float away.”

Having no idea what he intended, I did so. Then the chair came free and he flipped back, feet to the floor.

“Now hold on to me. Use my backpack harness.”

I grabbed it with one hand and a still-attached chair with the other.

Holding the backrest of the chair with both hands, with a mighty heave, Dagger swung its titanium legs into the canopy. There was a satisfying crack. He did this again, and a small crater appeared in the transparent cover. Two more swings and there was a slight pop and a noise like a balloon deflating. Necessity is indeed the mother of invention.

We were almost even with the girders of the habitat.

“Come on, give me a hand with the door,” Dagger said, his voice noticeably fainter.

We both pulled the hatch in as hard as we could. Finally it moved. Air rushed out past me. We pulled harder and it swung open. The remaining air blew out with a ghastly whoosh as I hung on for dear life.

Our emergency suits had kits with dispensers of what looked like brilliant orange cloth measuring tape. Dagger pulled a tape from his suit and attached it to mine.

“If one of us catches on, we both do. Get ready.”

Our rotation brought the habitat’s bare frame in front of the hatch.

Dagger pointed to a girder. He mouthed, “Jump!” I braced my feet on the doorjamb and leaped at the girder. Dagger jumped a bit later, before the tether between us went taut.

Terrified, all I could do was reach out and hope to find a grab-hold. It took forever—we were farther away and the structure was bigger than it had first seemed. I closed in on the girder, finally saw a crosspiece come within reach. I grabbed it like a monkey and held as my feet swung to the frame. I gasped with relief, then looked back.

Dagger floated toward me, arms stretched out waiting for a girder, but none came within reach. Then the tether between us pulled taut, and he swung onto the girder feet first like he'd been born to it.

He tethered us both to the girder, then pointed at our runabout tumbling away into space. The escaping air and our jumps had propelled it away from the habitat at right angles to its original motion, slanting away off to our right. There, save for some very good luck, went I! We allowed ourselves a minute to catch a breath.

Dagger touched his helmet to mine. "Radios don't work. Life support's on a body-powered fluidic backup—it's limited, so take it easy. First time EVA?"

"Aye."

"Well, better us rather than the girls. Kinda hard to imagine them coping, isn't it?"

"Oh, I dinna know, Dagger. Wreck the boat and get themselves stranded on a bunch of bare girders waiting to be fried by a particle storm? Och, that they might have done."

Dagger guffawed so hard his helmet came away from mine, and I was treated to what looked like a silent movie of a man in convulsions. Finally he calmed down and looked around.

I did as well. Our only immediate protection was the junction of two girders—maybe a square meter of shadow space. The silence was deafening, and through it came a fast beating of my heart. At least I'm alive, I thought.

But for how long? We'd had two hours until the particle storm was due to hit, but no telling how much of that was gone with the chron on my wrist inside the suit and the suit's electronics out.

We were probably going to die anyway. I was going to miss out on half of the biggest adventure of my life. And then where would I be? The chronicle would never be finished. It was the one thing I'd wanted—a book of my own about something really important. With a bit of time to think, I'd quickly gone from relief to profound regret.

Dagger touched helmets again.

"Gotta get in the shadow ... should be able to see the starship ... only a couple of kilometers."

“How?”

“Leap-frog. I’ll skim on ahead and out on the tether. You stop me and I should swing down to the surface. I’ll tie down there, then you release and jump out. The line will swing you back in an arc and you’ll land ahead of me—be sure to land feet first. Then you tie down and I’ll do the same thing.”

“Aye, I understand. Any idea of the time?”

“Thirty minutes to the particle storm arrival, maybe. Didn’t think to take my watch off before I put the gloves on. Well, I’m off. I’ll pull on the line a couple of times when I’m ready for you.”

I watched carefully as he jumped over the unfinished habitat latticework toward the portion that was solid and might provide more protection. After some time, the line went taut and he swung down to the surface.

Then the line jerked twice. My turn. I found I could grab an edge of the beam with each hand and assume a kind of squatting position. Then I just let go and stood up; that got me going as fast as I wanted. The tether pulled taut in a second or two, and I swung forward over Dagger and down toward the habitat. With some doing, I was able to get my feet “under” me again.

As I descended, I realized I would miss anything solid and “land” in a gap between the beams. Judging the matter as best as I could, I pulled on the tether tape to bring me down a little closer to Dagger, where there was a solid girder. I missed with my feet, but was able to grab it with my hand as it went by. Whew!

I tied down, pulled the line twice. Dagger made his jump, with much the same results as the first, except that he vanished near the end of his swing—we’d reached the shadow of the habitat.

I took another jump, swung down, and went blind as I entered the shadow before my eyes had adapted. I bounced in the dark and floated out, helpless. Dagger reeled me in.

We touched helmets. “Gotta absorb the impact with your legs. Shit, pull the protective covers off the geckro patches on your boots!” Dagger said, showing me the gray circles on the bottom of his space boots. Normally the geckro patches—areas of artificial nanofibers that cling to things in space like the microscopic hairs on gecko feet—are protected by special plastic covers so the boots don’t stick to everything.

“Och. I dinna think of it.” I quickly reached down and pulled them off. Memory is a tricky thing. There’s a fine difference between knowing something, and thinking of it under pressure in unusual circumstances.

“Yeah. We’re on the completed part of the habitat shell now. There should be a line of handholds every ten meters,” Dagger said. “Latitude and longitude—it’s a

standard safety feature on the outsides of these things.”

Latitude and longitude, I realized, referred to the habitat’s outer surface. The “north pole” would be the completed end of the half-egg shape, with longitude lines running from it, and latitude circles at right angles to those. I looked around but was unable to spot anything.

“Bloody hard to spot. They should have lights.”

“They do.” Dagger said. “But there’s no power yet. Where the devil...” he complained. “Bruce, move your foot.”

I did so, and there, right under it, was a hand-sized depression with a small bar running across its diameter.

Using the handholds as tether attach points, we were able to continue our journey. Soon we saw the starship rise over our tiny horizon. As the rising was due to *our* motion and not its, this event was not that much of a comfort.

“I’m exhausted,” Dagger said. “Need to rest.”

“Right.” When exercising, the CO₂ built up faster than our body-powered back-up life support systems could handle.

After a couple of minutes, Dagger said, “Look, I got an idea. We take a Mylar blanket from the emergency kit, jump out into the sunlight, and use the shiny side to reflect a bright spot down on the habitat. The *Admiral* should see it moving around and tell someone.”

“If it’s still functioning.” I was in a gloomy mood. “And if the someone doing the reflecting doesn’t get fried when the particle storm gets here.”

“Hell, Bruce. Sometimes you gotta take a chance.”

“Aye.” I fumbled the kit open, pulled out the blanket, and flattened it. I could see stars in the reflection of the shiny side. We touched helmets again.

“It should work,” Dagger said.

We gave it a try. It seemed to go well enough; we didn’t feel like we got fried and a bright spot of light danced around on the shadow side of the habitat. Then we pulled ourselves back down to wait.

The conversation, as such things are wont to do, worked its way around to the women. “Let me see if I understand,” Dagger said after I tried to explain my unconsummated friendship with Emma. “It’s never got that far with Emma, or with anyone?”

“Look, it’s not as if I’m gay or anything like that. I’d be quite willing under the proper circumstances, I assure you. It’s just that every woman I met was a

student or a married professor or a colleague with whom I would not want to embarrass myself, or too dull to interest me, or ... och, I don't know. Look, Emma may need a little more effort than I'm ready for. Anyway, there is no hurry, these days."

"She's a bit of a cold fish at times—just needs some leadership. But Davra now. She takes charge, more than even I can handle sometimes. Of course, maybe that's her real purpose."

I winced at his rough assessment. "Aye, with the robots and AIs taking care of themselves, she wouldn't really have that much else to do."

"You should give her a try."

I winced again, this time for Davra. "I'd not be her type, I assure you—sophisticated things are beyond my imaginings." I could adore her from afar, but actually having to contend with her experience might be an exercise in humiliation.

"I have some video files," Dagger offered. "Training material. I dated this girl once who starred in..."

"I'll pass, thank you. Look at these stars, now. I've never quite seen a sky like this." My eyes had fully adapted to the dark, and the Milky Way was right across my field of view, but much brighter than I'd ever seen on Earth. And it was repeatedly crossed by comet tails every bit as bright as it was. Some were long and thin, some double, some fans of gold light.

"Yeah, you're right. Even wall screens don't do it justice. Not enough field of view. God, look at all the comets. And all the space junk; half the stars in the sky look like they're moving, like we're near some kind of airport."

I shuddered and broke contact. Those weren't airplanes moving at a few hundred meters per second; each slowly moving point of light was the size of a mountain or larger and moving hundreds of times as fast. And one of the stars seemed to be getting bigger, or brighter. I bumped Dagger's elbow and pointed at it. We touched helmets again.

"I see. It's not moving. Just getting closer," he said.

"That means it's going to hit us, doesn't it?"

"Yeah. It's coming right for us. Too bad about the habitat. Too bad about everything."

"We could jump."

He shook his head. "Hang onto something big and solid. Half the chance of getting hit by shrapnel after the break-up."

I grabbed a handhold and watched in silence as the oncoming object suddenly vanished into the shadow of the habitat. My eyes adjusted and I thought I could make out its black shadow against a comet's tail. Is this how it would end? I thought bitterly. Would our hopes be dashed by a futile spot in the sky?

A brilliant light suddenly exploded around us. I braced for the shock.

Dagger's helmet bumped mine. "Hang on, Doc, it's another runabout with a searchlight!"

"They've come for us then?" My eyes adjusted and I could see the dark shape of the space vehicle with Davra's lovely face lit by light from the controls. In that moment, life seemed wonderful and Davra particularly so.

Positioning jets spit from the side of the little craft as it slowed, swung around, and gently drifted down to us.

Dagger bumped my helmet, laughing. "Our limo has arrived."

We stood up just as the airlock in the bottom of the little runabout opened up. Emma, bless her, motioned us to jump in and we did. Never had a wee bit of ship's noise sounded so good.

Topside, we pulled our helmets off. Emma's face could have been the model for the *Mona Lisa*. She motioned us toward the seats.

"You have the most beautiful face I seen in the last three hours!" Dagger said, grabbing her for a big kiss. "I can't believe we're alive!"

"Emma, Davra, what the bloody hell happened?" I asked.

Davra turned around and shook her head. "We got a major electromagnetic pulse when the coronal filament loops collapsed just before the flare. The half-finished habitat acted like a parabolic mirror. Every wavelength over a centimeter came right back at you, several million times stronger."

"But we weren't in the exact center!"

"Neither was the pulse in the center of Epsilon Eridani's disk! Probably ten thousand kilometers above the left limb. We'll go over it all later, but first we've got to hurry back to the ship before the particle radiation storm hits."

"Buckle up," Davra said. "*Admiral*, get us out of here!"

The shuttle reacted as if an unseen hand grabbed us and threw us at the starship. The *Admiral* began to grow larger ahead of us.

"Uh, Davra, Emma, thanks," I said.

Davra turned and gave me a smile that would take the mist off a moor, but

there was a bit of cat-that-caught-the-canary to it. “Sure, Bruce. A piece of cake! You guys gave us a bit of excitement out there!”

“The particle flux has arrived and is increasing,” the *Admiral* told us. “Ten millisieverts a second now, lethal levels predicted in approximately seven minutes.”

“Is this as fast as she can go?” Dagger muttered. “Where’s a fast woman when I need one?”

No one laughed or said anything. We kept looking at our wrist comps as the *Admiral* grew from a toy to a full-sized spaceship.

A hundred millisieverts a second. Somewhere I remembered that a prompt dose of fifty millisieverts was fatal—I could take about a hundred seconds of this. But the ship filled the sky. About six hundred meters from the ship’s center, the *Admiral* announced, “Two millisieverts a second.”

“Home free, pretty much,” Davra said. “We’re within the ship’s magnetic field. But it would be better to get down to the spheres where we’re behind some water.”

The runabout glided neatly onto the docking attachment with a satisfying clank. Air whooshed into the airlock.

We were greeted by Jill, who hurried us out of the lock toward G. P. Weaver, and a very tall East Asian woman with dramatically long hair, wearing a simple black jumpsuit. Her face seemed familiar, but my European-trained eyes couldn’t place her for certain. She asked how we were, seemed satisfied, and then told us very gently that we would not get many second chances out here. She looked at Weaver the way a disapproving parent would look at a child, shook her head, and left. I’d thought she was the ship’s physician until I’d gotten a clear look at the nametape on her jumpsuit. Despite over a decade of being no farther from her than the length of a football field, that was the first and only time I met Captain Lee Hyun Sil face to face.

“Let’s get downstairs,” Weaver said.

Tension drained from me as we entered the Sphere Three Park area. I turned to Emma. “You saw our light spot, then?”

She looked at Davra. They giggled.

“We had a better homing beacon,” Emma said. “Uh, ‘cold fish,’ I recall.”

“...wouldn’t really have that much else to do ... “ Davra added.

“...just needs some leadership’?” Emma raised an eyebrow.

“...likely into sophisticated things’?” Davra stuck out her tongue at me and wiggled it.

“Your suit transceivers were fried,” she added, “but the microphone preamps worked just fine.”

* * * *

Chapter 3

Aboard the Admiral Byrd,

In the Epsilon Eridani System,

November 2272

Meeting in the Sphere Three Park the next day, we put the banter all behind us.

“We aren’t achieving exponential growth,” Weaver said. “Between an increasing impact rate and particle storm damage, we’re barely achieving any growth at all.”

Emma sighed. “Star weather, like all weather, is chaotic. In all likelihood, our best strategy may be simply to slog on and wait for it to get better.”

Dagger shook his head. “And when will that be? The impactor should start on its way in less than two years, and we’ll need to have the array up to full power within a month of that.”

Davra, for once entirely serious, nodded. “We try to optimize for one set of conditions, and the conditions change, with no rhyme or reason to it.”

Weaver’s face looked grim. “We’ve got to come up with something, folks. I’m counting on you, along with people on three other planets, not to mention the impact station.”

I looked at him. This was leadership, aye. But where were the ideas going to come from? Everyone sat silently.

Well, this was not so different from uncounted faculty meetings. I could at least get a ball rolling. “I’m no technical genius, but if you don’t mind some input from a historian, there’s an old engineering problem-solving technique called brainstorming. You sit around and throw out ideas, no matter how crazy they seem. No criticism, just throw out ideas; one then suggests another and you record all of it. Then you display what you got, note the problems and maybe solutions to the problems. Those that have no solutions, you winnow out.”

“I reckon that sounds like a way to start, anyway,” Weaver said. “Let’s try it. Dr. Macready?”

He wanted me to set an example, so I thought of the craziest thing I could. “We seem to be fighting a hostile intelligence. Maybe we can communicate with it?”

Emma groaned.

Dagger laughed. “Can’t critique yet, if I got the gist of the rules. Okay. Maybe Davra here is in cahoots with all the anti-Black Hole Project people back on Earth and is secretly sabotaging the robots. We fire her and it gets better. We’re going round robin on this? You’re next, Davra.”

She clenched her hands together in front of her and stared down, then took a deep breath. “We don’t need the power right now. Maybe we can store everything in one protected place, then unfold it when we really need it. G. P.?”

Weaver seemed surprised at the notion that he would participate in the brainstorming session, but he smiled. “Haven’t had to saddle that stallion for a while. Well, now. If we think there may be an optimum strategy outside our search area ... something extreme ... Maybe we don’t make any more arrays at all, just grow array makers exponentially. Less area to worry about. Then we turn ‘em loose all at once.” He smiled again and shrugged his shoulders. “Emma?”

She gave a short laugh. “It’s an engineering problem, really. I don’t recall reading of any similar situation.”

Everyone looked at her.

“Oh, very well. Impact damage goes as the square of velocity. So we could start over farther out where the relative velocities are lower and the particle cloud is less dense. We’d use thin film reflectors to concentrate light and make up for the loss of insolation.”

We went round and round in this way for an hour. Everyone leaned forward as they threw out their ideas. Good, I thought, as the words flew across the grassy floor of the dome.

I had trouble visualizing the problem, so I asked the *Admiral* for a view of the Epsilon Eridani system and the cloud of debris.

The *Admiral* portrayed the system on the dome ceiling. The debris cloud looked like a fat translucent doughnut, with Epsilon Eridani a spark in the center of the hole. The plane of the orbits of the planets sliced through the doughnut the way one would slice a bagel. The debris cloud got less and less dense the farther one got from that plane.

“Pity we can’t orbit the arrays over the poles,” I offered.

Emma groaned. “Basic astrodynamics. Sorry, Bruce. Critiquing, aren’t I. The project plan is for an equatorial ring. But even in a polar orbit, the arrays would still pass through the debris torus, and then there will be precession....”

“Okay, okay,” Dagger said. “But they only have to pass through the debris cloud twice an orbit, right? Most of the time the array is out in the clear. That’s

better than being in the mess all the time, isn't it?"

We all looked at him.

"*Admiral?*" Weaver said with renewed interest.

"The problem is one of rates," the *Admiral* responded. "Lowering the exposure lowers the rates, giving the robots a chance to catch up. We should be back into exponential growth in a few weeks. As far as visibility toward the impact station, we can tilt the array ring up to thirty-seven degrees inclination and still give the beam drivers a clear shot at the impactor."

"Well, this works for me," Weaver said.

"Don't we want to critique the rest of the ideas?" Emma said. "If it's a good process, the process should be served."

I thought about enduring a critique of my hostile intelligence idea. "'Tis not always necessary, if ye hit on something that looks good right away," I offered.

Davra grinned at me. She'd caught the excitement of a potential solution. I winked back, happy to be noticed by her and relieved that the team seemed to be reinvigorated and pulling together.

Emma didn't react; she had that faraway look of one communing with the computer over her neural net. "Very well. In these conditions, we should need at least 28.75 degrees inclination to cut the impact rate down enough for exponential growth. The reaction mass needed to push the array elements into the new orbit would be about as much as the mass of the array itself."

"Yeah, well, I've got an idea about that," Dagger said. "We can have array elements north and south of the orbital plane push on each other by tossing mass back and forth with rotating tethers. It's like a couple of sailboats with fans, each blowing the same wind back and forth at each other."

Emma frowned. "But half of the array segments would go into an orbit tilted one way and the other half would go in an orbit tilted in the opposite direction."

"So?" Dagger replied. "All we care about is that the orbits are out of the debris most of the time."

"Hmm," Weaver said. "This begins to sound like it might work. *Admiral?*"

The group dynamic was still working, I thought, but with some unvoiced concern. Weaver looked relieved. I was partly worried, and partly impressed, by how hands-off he was. There were lots of smiles and nods, but very little involvement in the discussion or even managing the discussion. There are techniques for leading problem-solving efforts, but he seemed to rely mainly on his personality and aura of command. Would that take us far enough? I wondered.

“Dr. Dickson’s idea would significantly reduce the time to achieve exponential array growth,” the AI said.

“Davra?” Weaver nodded her way.

“Coaxial electromagnetic launchers would make more sense than tethers,” Davra said. “Simpler.”

Dagger laughed. “Only if you’re fixated on things going in and out...”

“I fail to get your point,” Emma said. “What does that ... Oh, my!”

Davra gave her a lopsided ironical grin. “I don’t think anyone’s been getting Dagger’s point lately.”

Groans all around signified the end of the meeting. But they were groans with smiles.

* * * *

Chapter 4

Asgard, Epsilon Eridani System,

25 March 2274

Two months passed. Schemes may unfold in one’s mind in an instant and be communicated in a few minutes. But when such schemes involve the rearrangement of the heavens, some time is required. Meanwhile, we got ahead of the game enough to allocate some resources to finishing the habitat.

About two hundred fifty days after our arrival in the system, the habitat shell was finally completed, and we all piled into a runabout to watch the flipover and spinup. It lay before us like a huge silver egg, with one long end toward the star. Brilliant violet plumes erupted around the shell’s shadow line/fusion rocket exhaust. The rockets began the spinup with their initial thrust vectors just enough canted that the shell slowly swung up as the applied forces and moments of inertia performed their complex, carefully calculated dance. After three hours of ponderous, majestic twisting, the fusion flames vanished and the habitat was left with its long axis at right angles to its orbital plane and spinning fast enough to provide one third of an Earth gravity. We were all suitably impressed.

Over the next few days, a thin film mirror, angled to reflect sunlight down into the habitat, was erected over its north pole on a “despin platform” that rotated in the opposite sense of the habitat, to keep it pointed at the star and to provide a landing place for the various runabouts and shuttles. Magnetic fields sprang up to protect the area from particle storms.

Finally, near the first anniversary of our arrival, Weaver gave the welcome command to defrost the rest of the crew and move everyone to the newly completed

habitat. I moved my things into my new quarters, a cottage on a tributary to the equatorial lake surrounded by saplings.

But grass still grows more quickly than trees, and Dagger soon had a place for his second-favorite recreational activity: the game of golf. The course was laid out in a great circle a couple of kilometers north of the central river so that one almost always struck the ball in the direction of the habitat's rotation; this brought a drive down about as quickly as it would have come down on Earth, despite the lower centrifugal gravity of the habitat. Dagger was a fanatic, and I soon found that, embarrassing as it was for a Scot, I could not play at his level.

The habitat needed a name. In line with the Norse mythology theme of the rest of the system, it became Asgard. We all settled in. Trees, aided by modified genes and soil additives, grew rapidly. So did the culture, for which we had plenty of time. That culture, as one might suspect, had much in common with other remote outposts throughout the history of exploration.

With the habitat up and running, our original group had blended into the general populace. While I still took careful note of what was going on, a certain routine had set in. I'd taken up my previous profession, and begun a class on the history and philosophy of astronautics. This, of course, meant the joy of imparting knowledge was balanced by the drudgery of grading. So I welcomed Emma's call.

On screen.

There was a rather un-Emma-like twinkle in the astrophysicist's eye. "We're having a little reunion of the early birds at Dagger's place tonight. Can you come?"

"Aye, it would be good to see everyone."

"1000 hours, tomorrow. You'll not mention this to Dagger now?"

"You mean a surprise party?"

"Indeed. Cheers!"

If Dagger reacted true to form, I thought, it could be fun. Dagger enjoyed pulling practical jokes, so getting one back on him would be quite the ticket.

"We'll meet where his path turns off the West River."

"Aye, see you then."

* * * *

Dagger's cottage of cast stone looked something like one might find in the middle of his native Maine. It even had a replicated stone wall along the front of the house with wild roses lovingly tended by microbots. We were kept outside for a couple of minutes—long enough to wonder who else might be there.

The front door, a large piece of solid replicated wood, opened and Dagger,

looking half asleep, looked out at us. I saw that his right arm was covered in a cast.

“Surprise!” We all shouted.

He suddenly awoke, shook his head, and blinked his eyes.

“That’ll teach me to run simulations past midnight. Well, come on in!”

We filed in and took seats around Dagger’s grand stone fireplace, complete with simulated fire. It was cool enough in here that the warmth was welcome. We ordered drinks and his domestic robot brought them.

Dagger thrust the appliance on his arm toward me. “Will you look at this, Bruce?” Dagger’s face was a mixture of mock disbelief and outrage. “I went to bed in perfect health and woke up with this! You’re a historian of technology. Do you know what this is?”

I dutifully looked the appliance over. “It’s a cast.” They were made to immobilize the arm to allow it to heal from a break. But nowadays, of course, we’d simply have a robosurgeon glue the bones back together. But I gained my comm implant in a similar way, so I’m sure there must be some other medical explanation. Jill?”

The biologist shrugged, but the twinkle in her eye told me she was in on it.

“Oh, come on,” Dagger implored. “Something’s up, someone knows!”

“Ladies,” Emma said, “I think we’re being asked for a diagnosis.”

“Better tell our Don Juan what this appliance is for,” Jill said, “or he’s likely to go crazy.”

Davra grinned. “*Admiral?*”

“It had come to my attention that Dagger’s hand was in danger of repetitive stress syndrome caused from his efforts to modify his golf swing to compensate for Coriolis force.”

We could hold our laughter no more. Seeing which way this was going, I touched the net to ask the *Admiral* to send us some of my replicated Talisker.

Dagger looked at us with disgust. “So that’s it now. I’m warning you, I’ll be getting even.”

“Dagger dear,” Davra cooed, “you could just let it ride and call it even.”

“Oh, no. Letting things ride, that’s not me. The chase is on.”

I looked at him in apprehension, then he broke out in a laugh. “Just kidding. Maybe. I think she wants you next, Bruce. If I were you, I’d look out.”

The whisky arrived. "I'll be trying a bit of bribery instead," I said. "Shall we toast to the balancing of the books?" The robotic servant produced glasses of the amber liquid, and I passed them out.

G. P. Weaver arrived as I did so. He seemed unhappy, but not, perhaps, about our escapade.

"Sorry I'm late, folks. What's this about retribution?"

We told him and he shook his head. "Folks, this is a fifty-year mission." Then he raised his glass of whisky and joined the party.

* * * *

Within our diverse community of scientists and engineers, there was a great sharing of cultural conditions. About six months after Dagger got his cast, I let him, Emma, and Davra talk me into a rendition or two on the bagpipes. I remembered that Emma had not done badly on the lute herself the previous month, while wearing an Elizabethan dress, even.

I had invited the gang over for libations, but my real purpose was to fill in some details on our debris problem. They were having fun sidetracking me, of course.

"So, having done my duty," Emma continued, "why don't you consider upholding your end of the British Isles? Play the pipes for us."

I smiled. If you would know the truth, I am a wee bit more of a science historian than Scots culture historian, but I had played the pipes a time or two and could do serviceable renditions of "Auld Lang Syne" and "Scotland the Brave" along with a few lesser known tunes requiring a more cultivated ear. "Some," I replied.

"And you could come up with suitable national dress?" Dagger wanted to know. "You'd look nice in a dress."

I gave him a withering look. So, I thought, if I was going to do the bagpipes, I'd have to come up with a kilt. "I dinna bring one with me, but with the help of our replicator, I should be able to manage that as well. And, it is not a dress!"

"Okay, okay," Davra said. "Pipes and kilt at 1900 Thursday?"

"It shall be done." I was eager to get back to my job as an historian. "How are things going?" I asked her.

"Our doubling period is down to about forty-five days and pretty much holding there. The more robots we make, the higher the debris flux gets." She looked at Emma. "Tell him about your sims."

"My simulations show that the system had been moving toward resonance

before the latest increase in magnetic activity. Things were settling into rings, Lagrange points, and so on. But the increase in flare activity, starting about six years ago, caused a lot of outgassing and nongravitational accelerations.”

“Heat up an asteroid with a lot of ice in it, and it turns into a steam rocket,” Davra commented.

“Thank you, I’ve read my Whipple,” I told her with a smile. “They move into different orbits and run into things.”

Emma nodded. “The debris population goes up by orders of magnitude. A lot of the stuff farther out gets perturbed into Loki’s sphere of influence, and not a small amount of that stuff has been flung into the inner system in retrograde orbits. It’s just now arriving at relative velocities of forty to sixty kilometers per second.”

“Kersplat,” Dagger said.

Emma smiled. “Also, we only use about ten percent of the mass we mine; the rest goes into orbiting slag piles, and they get hit, too, creating even more debris.”

“Yeah,” Dagger said. “We’re doing something about that now. We’ve got all the mass from the next load in one slag pile, so the amount of exposed surface is way down. And we’re gonna dump that right into Epsilon Eridani so we don’t have to keep defending the array from impacts.”

Davra nodded. “I’ve got enough robots on the job that some can be spared to seek out and consolidate potential impactors, even if we’re not mining them. We’ll dump them in the star, too.”

Emma cleared her throat. “I can see the increase in metallicity in the star’s atmosphere from what we’ve done already.”

Something in the back of my mind started wondering if that was entirely a good thing. I put it out of my mind. A star is not conscious, I thought, and so could not resent garbage being dumped on it, could it? Well, I was still uneasy, so, without telling a soul, I resolved to do a little checking of the history of the system since we started interfering with it.

* * * *

The *Admiral* and I fashioned a plaid and pleated skirt with a bit of mantle for my costume. I chose a traditional plaid from the Isle of Skye. In this I had the assistance of Kiri-Jean Stewart, a recently defrosted science anthropologist whose business was to study scientists as they studied the Universe. A big, cheerful, redheaded lass, she was actually from Christchurch, New Zealand, but she took her heritage seriously.

The bagpipe took a bit more work to assemble. Kiri-Jean said I fussed over the reeds for the pipe and drones a bit too much. Now I may have thought, Och, but does the lassie know! But I was very polite about everything as there was a bit of

chemistry between us for our common interest.

Finally the day arrived.

The pseudo-lamb dinner had been served. Davra and Weaver passed around a selection of synthesized single malt whisky, and everyone settled back for my performance. I had Dagger sit just behind me for the last bit.

As luck would have it, Asgard had developed some of its own weather and greeted the evening with a dark cloud between us and the axis, from which a sprinkle of cold rain fell. Well, the plants had to drink, too, so we crowded into our small theater.

I played a rendition of “Scotland the Brave,” the one everyone thinks of when you hear a bagpipe band in a parade. Everyone clapped. Aye, I thought, and they’ll clap for “Highland Laddie” as well. The test would come later.

Still, after three of the lesser airs, the audience applauded and asked for more. So I played two more energetic tunes, then threw off my pipes in the general direction of Dagger to symbolize the music was of my soul and not from the pipes themselves.

I bowed to a wonderful round of applause and invited them all to “drink up!” I was feeling entirely too good and pleased with myself and had completely forgotten that the second shoe had not dropped, so to speak, from the escapade Dagger and I had in the unfinished habitat. Ironically, I was probably not ten meters from where that ill-fated conversation had been held, on the other side of Asgard’s shell.

As I sat down, Weaver stopped by.

“A good rendition, Bruce. Thank you.”

“My pleasure, sir!”

I could tell, though, that he had something more on his mind than the bagpipes.

No more had I reached down to pick up my drink when I discovered it gone. Looking up, I saw serving robots disappearing with all the glasses, many like mine still with a wee bit of whisky in them. I was about to register a protest when more bagpipe music wafted into the theater. It was a slow piece, “The Lament of Children,” and it was played in the style of the old MacCrimmon family from Skye. I gripped the table to hold myself steady, remembering the legend, suddenly being transported back to Skye, to the pubs, to the college that was a dozen light-years from here. Tears welled up, I kept them back. Get a grip, man, I told myself.

Emma stepped through the companionway with a tray of small port glasses filled with a dark fluid. Something strange was going on here. The tunic she wore was the genuine mustard-colored linen with the bellowing sleeves and had no belt.

Of course. They'd wanted a Scot in a kilt and I'd not thought any further about it, nor had Kiri-Jean. So I'd ordered up what they were used to seeing.

But I had a sinking feeling this was much more authentic. Over the tunic, she had draped what was labeled a 'leine,' a mantle such as might have been worn by a twelfth-century warrior, held over her shoulder with a brooch that was no doubt an accurate relic of the time. Her beautiful legs were covered in the traditional garter socks; that much I recognized.

I felt chagrined. The Isle of Skye's honor had been duly served, but not by me. Emma set the tray down, picked up a glass, and gave it to me while taking one for herself.

"To Skye," she said, and the toast echoed through the hall.

The liquid poured down my throat and a smile spread across my lips. It was no whisky, but Bonnie Prince Charlie's Drambuie, and it melted its way down my gullet and into my stomach.

I turned to Kiri-Jean. "Well, it appears I've been upped."

Her eyes twinkled and she couldn't keep her face straight.

"Oh, no, lass, you're in on it?"

She laughed.

Well, it appeared that I indeed had been had, and I'd best be a good sport about it.

I thrashed the glass to the table, stood and swept up Emma in my arms, carried her to the stage, and set her down beside me. She took this all with characteristic aplomb, I should add.

"Well, now," I told the audience. "I stand here upstaged in my own culture by this charming young English woman. What you are drinking is a recipe of Drambuie given to my fellow Isle of Skye islanders by the Bonnie Prince Charlie as we rescued him from the redcoats. And, ladies and gentlemen, before you, on Emma, is a kilt from the twelfth century, Scotland, far older than the one that I wear."

She laughed and spun around so they could see the whole thing.

"What Dr. Macready is wearing," she said, "was a version created in the seventeenth century so Scots workmen would safely work in a forge. It was, in fact, designed by an Englishman."

I looked down, mouth open. "Ye dinna say," I said weakly.

The *Admiral* confirmed it, as laughter cascaded through the audience.

Someone who sounded a lot like Dagger yelled from the back, “Time to kiss and make up.” So I took Emma’s hand and did so.

“Even?” I asked.

“Perhaps,” she said with a smile, turned, and headed off the stage.

Well, the rest of the party went on very well. Kiri-Jean, another couple who were actually from Glasgow, and I helped get everyone dancing some simple jigs—inhibitions and muscles being well lubricated with the ersatz whisky and Drambuie. Weaver, of all people, actually managed it quite well.

After cleanup, we early birds plus Kiri-Jean went off to Weaver’s ranch. He had a half dozen colts and fillies on some clear land about four kilometers from the central lake.

“I know how it was done,” I said, “but I’m still amazed at how big a horse can get only six months from an artificial womb and bottle feeding.”

Weaver smiled with the pride of a parent. “I started saddle training a couple weeks ago. No riding yet, but just to get them used to something on their backs.”

“They are beautiful,” Kiri-Jean said. “My family has horses back in New Zealand.”

Everyone went to the corral fence to be near the horses except Emma, who held back, apparently lost in thought. But even she was soon petting the colt with a white star on its forehead, who seemed to want all the attention for himself, snorting at any of his siblings that dared come close to us three humans.

It was too good a moment to end, but it did. I heard rapid footsteps come up behind us. It was Emma.

“Everyone, we have a problem. A major planetesimal headed for the array.”

* * * *

Emma had the *Admiral* circle one of a thousand comets displayed in the dome. Its statistics appeared beside it. “That one,” she said, “is the threat.”

It didn’t look any more threatening to me than all the others. Hardly any tail at all.

“Oh, crap!” Davra said.

Emma raised an eyebrow. “Indeed. Here’s the projection.” A graphic of the system appeared on the dome, replacing a big square of star field. The array was visible as a tiny train of thin blue squares gliding slowly around the star about a thumb’s width away from it, from my perspective. The comet was shown as a blinking white dot, an arm’s length away, trailing fainter dots as it rushed along its path.

“It’s on an orbit tangent to the array orbit, same inclination, same periapsis. In eight months, it will plow into the trailing half of the array right here.”

A broken red line appeared in front of the comet and joined the array before heading back out to our Kuiper belt. My eyes flipped back to first image, and looked at the numbers again. It looked like all the rest because it was farther away.

Weaver looked concerned. “How are we going to divert that? It’s as big as Pluto.”

“We have a Norse naming convention in this system,” Emma said. “I’ve called it Skrymir. He was an ice giant.”

“What I want to know is where did it come from?” Dagger asked. “Why is it a surprise?” He frowned and ran his hand through his hair.

Emma looked uncomfortable. “It was not on that orbit a week ago. It got hit by another smaller comet, one of thousands whose orbit had changed due to increased outgassing, due to the current anomalously high stellar activity. It passes near the giant planet Loki in three weeks, and Loki’s gravity greatly magnifies the small change produced by the comet impact. The odds against this happening precisely this way were, well, astronomically high.”

“If it’s too big to move, maybe we can move the array,” Davra said. “*Admiral?*”

“This would put us behind schedule again, but not impossibly so.”

“Hey,” Dagger said. “If a comet strike put it in this orbit, could another take it out?”

“Yes,” the *Admiral* answered, “assuming Skrymir stays on its present course.” The Admiral circled a tiny dot on the dome. “This new comet will pass within about a billion kilometers of Skrymir, in three months. A velocity change of about 1.2 meters per second on this newer comet would cause it to strike Skrymir essentially head on. The comet should hit with enough energy to cause Skrymir to miss the trailing end of the array. Probably enough to make it hit the star itself so it won’t be a problem on the other side of its orbit. Like this.” Dotted lines on the diagram changed to show Skrymir being hit and falling into Epsilon Eridani.

“That appears to take care of the problem for now,” Weaver said, nodding. “Make it so.”

* * * *

It so happened that Skrymir would strike Epsilon Eridani near the upper left of the star’s disk as seen from Asgard; a potentially spectacular sight. But a problem with living on the inside of a rotating habitat is that the lights in the sky at night are not stars, but the lights in the other houses above you. To see what’s going on with one’s own eyes, one must go outside.

Thus, the entire population of our tiny colony gathered in spacesuits on the sunward edge of the north pole despun platform. Our robots had temporarily repositioned the colony's main light-collecting mirror between us and Epsilon Eridani, creating the effect of a total eclipse.

The corona of the star was awesome, streamers going out several times the diameter of the disk. The array, a line of collectors nearly forty million kilometers long at this point, was foreshortened to a brilliant dot from our point of view. It looked somewhat like an elongated version of the planet Venus as seen from Earth. One could still see the gas from Skrymir streaming away from the star and toward the array.

"They've collided," Emma announced. "We should see the effects as the light reaches us—in about six minutes. Watch the tail of Skrymir."

It seemed like a long wait. Then, an incredible brilliant white wave began to race up the comet's tail away from the star. A collective "Oh!" came from our helmet speakers.

"It isn't often one gets the chance to actually see the speed of light," Emma commented, her voice filled with awe.

Meanwhile, a brilliant dome began to peek above the edge of our artificial moon, casting sharp shadows surrounded initially by light that was nearly blue white. Its growth was like watching the Sun rise over a distant hill on a clear day back on Skye.

"Did that do anything to the star?" someone asked.

"Not that we know of," Emma replied. "What you see is an extremely thin plasma of star and planetesimal material that fluoresces and glows in the starlight. The amount of mass and energy involved are insignificant by stellar standards."

I was watching the band around my shadow change colors when I saw a second, fainter shadow appear. I looked back to the sky.

The array, bathed in the light of the impact, had become noticeably more brilliant, maybe two or three magnitudes brighter than Venus from Earth, I estimated.

Gradually, things began to fade and people, with other things to do, began getting back to the locks and vanished into the habitat. I lingered a while, with Davra, as the impact dome dissipated and its light faded to deep orange.

"We'll be moving the mirror back in a few minutes. Wouldn't do to get the habitat cold."

"Aye. Davra, I have a sense of *déjà-vu* about this." I would remember it in detail, of course, as soon as I recognized what it was that I was trying to remember.

* * * *

Chapter 5

Asgard, Epsilon Eridani System,

5 April 2274

Next month, epsilon Eridani's magnetic weather went crazy again, and gave birth to a super flare. We called it "the Inconstant Moon flare," after the Larry Niven story about the moon suddenly getting bright enough to make people think the Sun had somehow become a nova. We didn't have a moon, but the flare lit up the system's giant planet, Loki, so much that one could see by the reflected flare light. Indeed, we actually turned Asgard's mirror away from Epsilon Eridani and used Loki's light for a couple of days. It wasn't enough to provide heat or normal levels of photosynthesis, but it was easily enough to read by, and our star was putting out a wee bit too much light.

Wonders aside, the array was in ruins and we were all in a black mood. The damage was so extensive, and so many robots had been damaged to so many varying degrees that it would be a week or two before we had a good handle on just how bad it was.

When we did, Weaver called a meeting. The project management meeting center on Asgard was a large circle under a video dome. A round table sat in the middle, causing local wags to call the building "Camelot." Depending on whom you asked, the table either had no head, or the head was wherever Weaver decided to sit. He waited until everyone else sat down before he entered. There were ten of us now, with two additional experts sharing in planetary astrophysics, robotics, and project engineering, working with Emma, Davra, and Dagger.

There was a long silence. Finally, Dagger spoke up. "We have twenty months or so before we have to launch the impactor. There's no shortage of raw material anywhere in this system. If we didn't have to deal with debris attrition, how fast could we rebuild it, *Admiral?*"

"Assuming enough material, without degradation, 728 days," the AI said.

"We are supposed to launch the impactor in 640 days," one of the new experts said.

"We all know that," Weaver said, sounding very dejected. Normally of erect posture, he sat slouched in his chair, frowning.

There was a great silence then; the cacophony of a room full of furious thinking. Could it be that it was all over? I knew the political situation on Earth; it would be a long time indeed before another attempt could be made. Perhaps with four different stars? Or would it be made at all? Would humanity turn inside, as China had a thousand years earlier, content with limits that did not risk upsetting the basis of rule?

Finally, Weaver turned to me, of all people. “Bruce, you’re good at teasing ideas out of people. Think you can pull a miracle out of your brainstorming hat?”

I frowned; an observer such as myself shouldn’t be taking a main role in events—it raises issues of objectivity in the end. Nonetheless, my help was being asked. It was just another departmental meeting, I told myself, though with higher stakes.

“I canna guarantee any results, but I’d be happy to give it a try. But first I think we might review some of the roads not taken in the last session.”

Dagger suggested building the array farther out, using reflectors.

“Could we not do that, then angle the reflectors away if a big flare comes?”

Emma shook her head. “There’s not enough time to move the array to an orbit far enough out. The modules would need to coast for a year. Then we’d need to figure out a way to push them in to circularize...”

“Why?” Dagger asked. “Why bother to circularize?”

Weaver looked at him sharply, then his features relaxed. “Doesn’t make much difference, I suppose. No good to anyone after we’re gone.”

Emma frowned. “Even if we just let them go ... But maybe, if we really don’t care...”

We all looked at her.

“There is a high inclination planetesimal inbound that we could use for raw materials,” she said, “or maybe an escaped moon. Loki throws one up there occasionally. Call it Skrymir II. It will eventually get within a couple hundredths of an astronomical unit of Epsilon Eridani and likely be vaporized. But not until about four years from now.”

“We have lots of robots now,” Davra said. “We can get them out there quickly with the surviving array modules. Without any interference, our doubling period could get down to maybe twenty days.” She held up a hand while she consulted the net. “Still not enough.”

“Yeah, well, it would be enough to *start* the impactor,” Dagger said. “Maybe we’ll think of something else in the meantime.”

“Yes, and maybe pigs will fly,” Weaver said.

We went around this way for another three hours without coming up with anything better. With the *Admiral*’s help and another brainstorming session, we somehow managed to convince ourselves that if we could get started, maybe something would come up.

Soon everything was again in the hands of the automated systems. At best, it would be the better part of a quarter century before an attempt was made again. And at some point, we would have to admit failure and warn the project that our impactor would be late. But everyone was still trying to come up with a scheme to save the situation.

Three weeks after the “Inconstant Moon” flare, Weaver left a message for me. “New colt’s a beaut. Come over Tuesday evening after my exercise, and we’ll trade horse stories.”

Weaver’s third colt—a young filly—had lately put a little sparkle in his eye again. Meanwhile, Star had grown big enough to ride, and Weaver liked to go out among the sculpted crags and streams of the south end of Asgard, where the artificial land curved up toward its spin axis.

Trading horse stories was Weaver-speak for getting us updated on the colts and getting him updated on what we were all doing. Tuesday, I took myself off the net to enjoy a walk and arrived shortly before our “sun” set behind the north end hills.

“Hi, Bruce.” It was Dagger, leaning up against the rail and petting the jet-black new arrival.

“Weaver still out?”

He nodded. I had a flask of ersatz Talisker with me, which I passed to him.

“Asked Davra out yet?” he asked, after a swig.

I laughed and shook my head. “I don’t know. I don’t think she’s my type....”

Laughter as clear as a bell rang out. “Don’t you guys ever learn anything?”

Davra sauntered into view wearing a cowboy hat, jeans and a bright blue halter with two big red stars on the only place big enough for big red stars.

“I’ll decide who’s my type....” Davra held up a hand as if listening on her neural net. Her smile vanished and her face turned into one of shock.

I put myself back on the net and instantly got an urgent incoming. I could see Dagger had one too.

It was Jill. *Not good news, everyone. I’m at the clinic. G. P. is dead.*

Dead! I sent, *How can anyone be dead anymore?*

They think it was a riding accident. He was off the net. When he didn’t show up for our date, I sent an emergency message. He didn’t respond. I called public safety, and they found him with the survey cameras up in the rocks up by the north pole with his head bashed in and the colt nuzzling him. They had him in

the clinic in ten minutes, but it was too late.

“I’ve got a car coming,” Dagger said. “Five minutes.”

How are you doing? I asked Jill.

There was a pause. *I feel awful. The horses aren’t used to the low gravity up there. The trails aren’t maintained as much. It’s the sort of thing G. P. does to clear his mind when the burdens become overwhelming and he isn’t careful. I should have said something to him. If I’d only called earlier...*

Jill, don’t blame yourself, I sent.

“Damn!” Davra said. “He was awfully down. You don’t think he arranged...”

Dagger shook his head. “Not Weaver! He’d think that was a coward’s way out.”

“Aye,” I said. “But people with problems who would never think of killing themselves still might give death more of an opportunity to solve their problems than it would normally have. In the First World War, Churchill, fired from the Admiralty because of the Gallipoli disaster, went into the army and exposed himself to fire on the western front. He survived. Tchaikovsky, failing in personal relationships with women and men, drank tainted water. He died. An American President, Nixon, about to be forced from office, went on a strenuous foreign mission with blood clots in his leg. No such luck, mind you, he lived to be disgraced.”

People stared at me.

“On the other hand, maybe it was just an accident,” I said, but I wondered.

Then the fan car arrived and set down in a swirl of leaves. Everyone piled in.

* * * *

Whether by intention or premonition, Weaver had left final instructions only a few days old. He wished his remains to fertilize the soil of the uplands he loved, so we buried him on a rise of ground with a fine view of Asgard spread out below. Jill planted flowers from the same pot I’d seen in his quarters over the years. I played “Amazing Grace” on the pipes.

* * * *

“We need a leader,” Dagger announced as we stared at each other across the circular table.

One chair had been left empty, not by any design; it had just happened that way, and no one had come to fill it. Dagger had become acting director on Weaver’s death, but made it clear that was temporary.

“There seems to be a consensus among the project people that it be one of us early birds,” he continued. “In fairness, whoever it’s going to be will probably have

to tell the universe we failed.”

“Isn’t that a wee bit premature?” I asked. “We haven’t tackled this one yet. Every time we do, we come up with something.”

“Someone has to preside,” Davra said.

“It just isn’t my thing,” Dagger answered. “I do better kibitzing. Anyone here have any management experience? Emma, you led the astronomy team.”

She shook her head. “And my reputation hasn’t suffered enough, has it?”

I thought to object, but held my tongue. She had a point.

“Davra?” Dagger asked.

She looked around the table at a number of frowns, then shook her head, too. “I have enough to worry about with the robotics. And besides,” she lowered her voice, “it might interfere with my social life.”

Though the remark was clearly meant for the laughs it got, she had a point also.

Jill stood up. “What we need is a generalist, someone who has an overall view of everything. The department heads already have their hands full. Bruce Macready is such a person.”

My jaw dropped. I looked at Dagger, who raised an eyebrow; at Emma, who seemed to be looking somewhere else; then at Davra, who smiled as if she’d just swallowed the canary.

Jill continued. “He has personally chronicled every event from the time we left Earth. He has interviewed everyone here, and he has a good working knowledge of our overall mission. At Broadford College, he chaired his department twenty-three times and served as chancellor for a decade. He’s also been three times president of the International Science Historians Guild.”

“Now wait a minute,” I objected. “Yes, I’ve had a wee bit of what you might call management experience, but none of it at this level of responsibility.”

They looked at me again. How had this happened? I asked myself. I’d come along to report on this thing, not to run it. Bruce, I told myself, they do not want a leader as much as a scapegoat. But I met Davra’s eyes, and those eyes seemed to say yes, in several ways. Are you going to go for it, Macready? For once in your life, are you going to go for it?

Of course, maybe if I had fully appreciated the impossibility of completing the mission with success at that time, I would have shied away too. So I don’t know. But either for Davra’s eyes or out of ignorance and hope for something of significance to show for my time out at Epsilon Eridani, I decided to pick up this

caber and try to stick it upright.

“Very well, I’ll ride point for you—but not to be throwing in the towel just yet. We have almost a year, do we not, before we run out of power to push the impactor on its designated profile?”

The *Admiral* confirmed this.

“Then we shall meet again tomorrow with our thinking caps on, aye?”

They all nodded.

“Weel, I’m feeling a bit dry just now. Those who want, come over to my house and we’ll lift a glass to the late Dr. Weaver.”

* * * *

The wake was all that it should have been. Everyone brought a bottle of his or her favorite replicated liquor or drink and shared it around. One of Davra’s people wailed away on an Irish fiddle while his wife dragged all the men to the center and taught them how to do an Irish jig. By and by, we were all dancing and singing and having what Dagger called a whale of a wake.

Very late into the evening, Davra jiggled into my arms. We danced until I needed a wee breath, and so I took her hand and led her out to the edge of my garden. She looked me straight in the eye.

“Something on your mind, lass?”

She laughed softly. “I’ve got to come up with some entirely new strategy for getting the project back on target tomorrow and you ask if I’ve got something on my mind? Well, besides that what I’ve got on my mind right now is I’m horny as hell.”

Call it a death wish, but there is something about me that will not even walk through an open door to my dreams. “I dinna know if I have a cure for that, lass.”

She laughed again, took my hand and led me away from the house and the commotion of the party.

About halfway on the path, surrounded by trees and singing birds, she stopped. “Bruce, Bruce. Look at me. The real me.”

I stared into her eyes. “You’re a beautiful lass, a lot more than I could...”

“Oh, stop putting me on an unreachable pedestal. I’m a real woman who loves to love and I’ve always wanted to love you as much as anyone. Leave me on the ground where I belong.”

“The ground is it?” I looked around; there was a small grassy clearing just a few feet from the path.

“Yes, oh yes!”

Summoning up nerve from I dinna know where, I took her hand. Her eyes glowed as she followed me through the brush, laughing. In the clearing, she kicked her sandals off and with one smooth motion, she pulled her long black dress over her head and stood before me naked.

She was beautiful, no doubt about it. This was a Davra I’d never seen before. Quiet, but excited, watching me, as I was her. Was she as nervous on the inside as I was, I wondered. I stepped to her and she grabbed my tunic and pulled it over my head, pressing her firm breasts against me as she did. The tunic fell to the ground, as in a moment did we. There, in the cool grass and soft leaves, we made love.

* * * *

The next day was all business. I have a degree of stubbornness in me, and an analyst’s bent. Up until now I’d put all my work into historical studies of what people did and why. Now it was a star I was trying to figure out, a star that seemed to consciously fight our every effort.

Well, what was this star’s pattern, this opponent of mine? I looked up the history of the entire project from the first robotic presence to the present day, and made graphs of its activity and ours. A correlation was no great surprise, but indeed ... A chill went down my spine.

I called Emma. “If ye look at this, it seems that when we throw something big at the star, it throws something back a few days later.”

Her image on my wall screen shrugged. “It’s always throwing stuff out. So it’s always throwing stuff out when we throw stuff at it.”

“But it happens when other stuff hits it, too. Natural stuff. If ye look at the correlation.”

She frowned. “You’re saying it’s not random?”

“So does the *Admiral*, Emma.”

There was a long silence. Finally, she said. “Bruce, you might get a paper out of this when we get back. Astronomy is probably friendlier to contributions by amateurs than most sciences.”

She was trying to let me down gently, but I was not to be deterred. “But don’t you see it, Emma? It’s us that have been making the star flare. Us! By dumping our waste on it.”

She paused for a bit, then shook her head. “Possibly. But how? The material doesn’t penetrate, really; it just sort of splatters on the photosphere.”

“But it’s all kinds of metal, heavy ions, current paths...”

She gave me a wan smile. “Well, maybe. I’ll suggest to Davra that she direct the waste elsewhere. I don’t suppose it could hurt. Not that anything’s going to help now.”

Were there tears in her eyes?

“I dinna want to make you feel bad, Emma.”

The look she gave me was unreadable. “No, I don’t suppose you did.”

* * * *

There were long faces at Camelot. We all had a bit of a toast as our impactor, that billion-ton iron caber, started its journey to the implosion vertex. But we had to acknowledge a larger sobering thought. We would ultimately call it quits if we didn’t find more power in another hundred and thirty days.

“Almost twenty percent more,” Dagger said, “We could actually use one of those big flares now.”

“Huh?” we all said simultaneously.

“Sure,” he said. “Photovoltaics like light. It’s particle radiation that hurts them, but that’s all down in the magnetosphere. They’ll take as much as double the illumination.”

“So why don’t we just build bigger concentrating reflectors?” I asked.

“That’s how we’re keeping up,” Davra said. “Can’t build ‘em any faster. We’ve got the surface of Skrymir II covered with robots, and it’s getting noticeably smaller as we take stuff away. That’s a bottleneck. To get more light, you’ll need to make Epsilon Eridani brighter.”

My eyes met Emma’s. Come on, Lassie, I thought. You say it. Make it your idea and get back some of your self-respect.

“There may ... may be a way of doing that,” Emma said. “If we could dump a lot of mass in at the right time, it seems that flares should follow in a few days. Metallic ions affect currents beneath the photosphere, destabilizing it...”

“We’ve got plenty of slag to push,” Davra said.

Emma nodded, then shut her eyes. She’d be in a silent, furious conversation with the *Admiral*, I thought.

Finally, she said, “It will take about a hundred and thirty two billion tons, if my model is right. Spread over several days with impacts maybe three hours apart.”

“Well,” Dagger added, “there’s that much and more floating around this place. Let’s get going.” Then he looked at me with a curious expression on his face, as if he just remembered who was in charge.

I smiled and nodded. “Aye, let’s do it.”

As we left Camelot, Davra grabbed my hand. And Dagger took Emma’s.

* * * *

Weeks later, with the pellets all safely on their way to the accelerating impactor, I walked out with Davra to the rise where we buried G. P. Weaver. He and I had been confidants of sorts over the years, and it seemed right to give his headstone an update, if nothing else but to clarify some of those details every once in a while.

I also needed to prepare a message to the Vertex facility concerning what we’d done. They’d get it a few weeks before the impactors all arrived. I sat on a rock and brought up my notes. Davra sat beside me, looking out over this vast inside-out green, white, and blue Easter egg we lived in. In spite of everything, people were going to found an Epsilon Eridani colony. Davra and I had other plans, though. We were going with Captain Lee to Vertex to see how this all turned out, and then on to the Solar System and Skye—my whisky cache was about gone.

“You’ve sent the report?” Davra asked. “Emma’s calculations were a bit conservative; a thousand massive bodies impacting the photosphere will...”

“Aye, I know. We need to let the Vertex facility know that, in spite of what they see, our impactor will arrive on time and with the right velocity. As for the rest of the galaxy, well, we can have a few days of fun with them.” Galaxy was a wee exaggeration—only about a hundred settled star systems were involved.

Davra took my hand. “Oh, yes. I wonder what they’ll think on Earth when, all of a sudden, Epsilon Eridani becomes one of the brightest stars in the sky.”

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(EDITOR’S NOTE: Earlier stories of the Black Hole Project were “Kremer’s Limit” [July/August 2006], “Imperfect Gods” [December 2006], and “The Small Pond” [March 2007].)