Star Light, Star Bright

by Robert J. Sawyer

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"Daddy, what are those?" My young son, Dalt, was pointing up. We'd floated far away from the ancient buildings, almost to where the transparent dome over our community touches the surface of the great sphere.

Four white hens were flying across the sky, their little wings propelling them at a good clip. "Those are chickens, Dalt. You know — the birds we get eggs from."

"Not the *chickens*," said Dalt, as if I'd offended him greatly by suggesting he didn't know what they were. "Those lights. Those points of light."

I squinted a bit. "I don't see any lights," I replied. "Where are they?"

"Everywhere," he said. He swung his head in an arc, taking in the whole sky. "Everywhere."

"How many points do you see?"

"Hundreds. Thousands."

I felt my back bumping gently against the surface; I pushed off with my palm, rising into the air again. The ancient texts I'd been translating said human beings were never really meant to live in such low gravity, but it was all I, and countless generations of my ancestors, had ever known. "There aren't any points of light, Dalt."

"Yes, there are," he insisted. "There are thousands of them, and — look! — there's a band of light across the sky there."

I faced in the direction he was pointing. "I don't see anything except another chicken."

"No, Daddy," insisted Dalt. "Look!"

Dalt was a good boy. He almost never lied to me — and I couldn't see why he would lie to me about something like this. I maneuvered so that we were hovering face to face, then extended my hand.

"Can you see my hand clearly?" I said.

"Sure."

"How many fingers am I holding up?"

He rolled his eyes. "Oh, Daddy ..."

"How many fingers am I holding up?"

"Two."

"And do you see lights on them, as well?"

"On your fingers?" asked Dalt incredulously.

I nodded.

"Of course not."

"You don't see any lights in front of my fingers? Do you see any on my face?"

"Daddy!"

"Do you?"

"Of course not. The lights aren't down here. They're up there!"

I touched my boy's shoulder reassuringly. "Tomorrow, we'll go see Doc Tadders about your eyes."

We hadn't built the protective dome — the clear blister on the outer surface of the *Dyson* sphere (to use the ancient name our ancestors had given to our home, a term we could transliterate but not translate). Rather, the dome was already here when we'd come outside. Adjacent to it was a large, black pyramidal structure that didn't seem to be part of the sphere's outer hull; instead, it appeared to be clamped into place. No one was exactly sure what the

pyramid was for, although you could enter it from an access tube extending from the dome. The pyramid was filled with corridors and rooms, and lots of control consoles marked in the script of the ancients.

The transparent dome was much larger than the pyramid — plenty big enough to cover the thirty-odd buildings the ancients had built here, as well as the concentric circles of farming fields we'd created by importing soil from within the interior of the Dyson sphere. Still, if the dome hadn't been transparent, I probably would have felt claustrophobic within it; it wasn't even a pimple on the vastness of the sphere.

We'd been fortunate that the ancients had constructed all these buildings under the protective dome; they served as homes and work spaces for us. In many cases, we could only guess at the original purposes of the buildings, but the one that housed Dr. Tadders office had likely been a warehouse.

After sleeptime, I took Dalt to see Tadders. He seemed more fascinated by the wall diagram the doctor had of a human skeleton than he was by her eye chart, but we'd finally got him to spin around in midair to face it.

I was floating freely beside my son. For an instant, I found myself panicking because there was no anchor rope looped around my wrist; the habits of a lifetime were hard to break, even after being here, on the outside of the Dyson sphere, for all this time. I'd lived from birth to middle age on the inside of the sphere, where things tended to float up if they weren't anchored. Of course, you couldn't drift all the way up to the sun. You'd eventually bump against the glass roof that held the atmosphere in. But no one wanted to be stuck up there, waiting to be rescued; it was humiliating.

Out here, though, under our clear, protective dome, things floated *down*, not up; both Dalt and I would eventually settle to the padded floor.

"Can you read the top row of letters?" asked Doc Tadders, indicating the eye chart. She was about my age, with pale blue eyes and red hair just beginning to turn gray.

"Sure," said Dalt. "Eet, bot, doo, shuh, kee."

Tadders nodded. "What about the next row?"

"Hih, fah, roo, shuh, puh, ess."

"Can you read the last row?"

"Ayt, doo, tee, nuh, tee, ess, guh, hih, fah, roo."

"Are you sure about the second letter?"

"It's a doo, no?" said Dalt.

If there's any letter my son should know, it should be that one, since it was the first in his own name. But the character on the chart wasn't a doo; it was a fah.

Dr. Tadders jotted a note in the book she was holding, then said, "What about the last letter?"

"That's a roo."

"Are you sure?"

Dalt squinted. "Well, if it's not a roo, then it's an shuh, no?"

"Which do you think it is?"

"A shuh ... or a roo." Dalt shrugged. "It's so tiny, I can't be sure."

I could see that it was a roo; I was surprised that I had better vision than my son did.

"Thanks," said Tadders. She looked at me. "He's a tiny bit nearsighted," she said. "Nothing to worry about." She faced Dalt again. "What about the lights in front of your eyes? Do you see any of them now?"

"No," said Dalt.

"None at all?"

"You can only see them in the dark," he said.

Tadders pushed against the padded wall with her palm, which was enough to send her drifting across the room toward the light switch; the ancients had made switches that were little rockers, instead of the click-in/click-out buttons we build. She rocked the switch, and the lighting strips at the edges of the padded roof went dark. "What about now?"

Dalt sounded puzzled. "No."

"Let's give your eyes a few moments to adjust," she said.

"It won't make any difference," said Dalt, exasperated. "You can only see the lights outside."

"Outside?" repeated Tadders.

"That's right," said Dalt. "Outside. In the dark. Up in the sky."

Dalt was the first child born after our group left the interior of the Dyson sphere. Our little town had a population of 240 now, of which fifteen had been born since we'd come outside. Dalt's usual playmate was Suzto, the daughter of the couple who lived next door to my wife and me in a building that had clearly been designed by the ancients to be living quarters.

All adults spent half their days working on their particular area of expertise, which, for me, was translating ancient documents stored in the computers inside the buildings and the pyramid, and the other half doing the chores that were needed to support a fledgling society. But after work, I took Dalt and Suzto for a float. We drifted away from the lights of the ancient buildings, across the fields of crops, and out toward the access tunnel that led to the pyramid.

I knew that the surface of the sphere, beneath us, was curved, of course, and, here on the outside, that it curved down. But the sphere was so huge that everything seemed flat. Oh, one could make out the indentations that were hills on the other side of the sphere's shell, and the raised plateaus that water collected in. Although we *were* on the frontier — the outside of the sphere! — we were still only one bodylength away from the world we'd left behind; that's how thick the sphere's shell was. But the double-doored portal that led back inside had been sealed off; the people on the interior had welded it shut after we'd left. They wanted nothing to do with whatever we might find out here, calling our quest for knowledge of the exterior universe a sacrilege against the wisdom of the ancients.

As we floated in the darkness, Dalt looked up again and said, "See! The lights!"

Suzto looked up, too. I expected her to scrunch her face in puzzlement, baffled by Dalt's words, but instead, near as I could make out in the darkness, she was smiling in wonder.

"Can — can you see the lights, too?" I asked Suzto.

"Sure."

I was astonished. "How big are they?"

"Tiny. Like this." She held up her hand, but if there was any space between her finger and thumb, I couldn't make it out.

"Are they arranged in some sort of pattern?"

Suzto's vocabulary wasn't yet as big as Dalt's. She looked at me, and I tried again. "Do they make shapes?"

"Maybe," said Suzto. "Some are brighter than others. There are three over there that make a straight line."

I frowned. "Dalt, please cover your eyes."

He did so, with elaborate hand gestures.

"Suzto, point to the brightest light in the sky."

"There're so many," she said.

"All right, all right. Point to the brightest one in this part of the sky over here."

She didn't hesitate. "That one."

"Okay," I said, "now put your hand down, please."

She drew her arm back in toward her body.

"Dalt, uncover your eyes."

He did so.

"Now, Dalt, point to the brightest light in this part of the sky over here."

He lifted his arm, then seemed to vacillate for a moment between two possible choices.

"Not that one, silly," said Suzto's voice. She pointed. "This one's brighter."

"Oh, yeah," said Dalt. "I guess it is." He pointed at it, too. I couldn't see anything, but it seemed in the darkness that if I could draw lines from the two children's outstretched fingers, they would converge at infinity.

Dr. Tadders was an old friend, and with both Suzto and Dalt seeing the lights, I decided to join her for lunch. We grew wheat, corn, and other crops under lamps here on the outside of the sphere, and raised chickens and pigs. If you wanted the eggs to hatch, you had to put low roofs over the hens, because they needed to be in constant contact with their clutches, and their own body movements were enough to propel them into flight; chickens really seemed to love flying. Tadders and I both knew that we'd have had more interesting meals if we'd stayed inside the sphere, but the ancient texts said that although the interior was huge, there was still much, much more to the universe.

Most of those on the interior didn't care about such things; they knew that the sphere's inner surface could accommodate over a million trillion human beings — a vastly larger number than the current population — and that our ancestors had shut us off from the rest of the universe for a reason. But some of us had decided to venture outside, starting a new settlement on our world's only real frontier. I didn't miss much about the inside — but I did miss the food.

"All right, Rodal," Dr. Tadders said, gesturing with a sandwich triangle, "here's what I think is happening." She took a deep breath, as if reviewing her thoughts once more before giving them voice, then: "We know that a long, long time ago, our ancestors built a double-walled shell

around our sun. The outer wall is opaque, and the inner wall, fifty bodylengths above that, is transparent. The area between the two walls is the habitat, where all those who still live on the interior of the sphere reside."

I nodded, and kicked gently off the floor to keep myself afloat. We drifted out of the dining hall, heading outdoors.

"Well," she continued, "we also know that there was a war generations ago that knocked humanity back into a primitive state. We've been rebuilding our civilization for a long time, but we're nowhere near as advanced as our ancestors who constructed our world were."

That was certainly true. "So?"

"So, what about that story you translated a while ago? The one about where we supposedly came from?"

I'd found a story in the ancient computers that claimed that before we lived on the interior of the Dyson sphere, our ancestors had made their home on the outer surface of a small, solid, rocky globe. "But that was probably just a myth," I said. "I mean, such a globe would have been impossibly tiny. The myth said the homeworld was six million bodylengths in diameter. Kobost" — a physicist in our community — "worked out that if it were made of the elements the myth described, even a globe that small would have had a crushingly huge gravitational attraction: five bodylengths per heartbeat squared. That's more than ten thousand times what we experience here."

Of course, the gravitational attraction on any point on the interior of a hollow sphere is zero. When we lived inside the sphere, the only gravity we felt was the pull from our sun, gently tugging things upwards. Here, on the outside of the sphere, the gravitational pull is downward, toward the sphere's surface — and the sun at its center.

I continued. "Although Kobost thinks human muscle could perhaps be built up enough to withstand such an overwhelming gravity, his own studies prove that the globe described in the myth can't be our homeworld."

"Why not?" asked Tadders.

"Because of the chickens. There are several ancient texts that show that chickens have been essentially the same since before our ancestors built the Dyson sphere. But with an acceleration due to gravity of five bodylengths per heartbeat squared, their wings wouldn't be strong enough to let them fly. So that globe in the myth couldn't possibly have been our ancestral home."

"Well, I agree that's puzzling about the chickens," said Tadders, "but wherever our ancestors came from, you have to admit it wasn't another Dyson sphere. And the inside of a Dyson sphere forms a very special kind of sky. Remember what it was like when we lived in there? Wherever you looked over your head, you saw — well, you saw the sun, of course, if you looked directly overhead. But everywhere else, you saw other parts of the sphere. Some of those parts are a long,

long way off — the far side of the sphere is a hundred and fifty billion bodylengths away, isn't it? But, regardless, wherever you looked, you saw either the sun or the surface of the sphere."

"So?"

"So the surface of the sphere is reflective — even the dull, grass-covered parts reflect back a lot of light. Indeed, on average the surface reflects back about a third of the light it receives from the sun, making the whole sky glaringly bright."

People in there did have a tendency to float facing the ground instead of the sky. I nodded for her to go on.

"Well, our eyes didn't evolve here," continued Tadders. "If we did come from a rocky world, the sun would have been seen against an empty, non-reflective sky. It must be much, much brighter inside the Dyson sphere than it ever was on the original homeworld."

"Surely our eyes would have adapted to deal with the brighter light here."

"How?" asked Tadders. "Even after the great war, we regained a measure of civilization fairly quickly. There was no period during which we were reduced to survival of the fittest. Human beings haven't undergone any appreciable evolution since long before our ancestors built the sphere. Which means our eyes are as they originally were: suited for much dimmer light. Of course, the ancients may have had drugs or other things that made the interior light seem more comfortable to them, but whatever they used must have been lost in the war."

"I suppose," I said.

"But you, me, and everyone else in our settlement who has lived inside the sphere — we've damaged our retinas, without even knowing it."

I saw what she was getting at. "But the children — the children born here, on the outside of the sphere —"

She nodded. "The children born here, after we left the interior, have never been exposed to the brightness inside, and so they see just as well in the dark as our distant, distant ancestors did, back on the homeworld. The points of light the children are seeing really do exist, but they're simply too faint to register on the damaged retinas we adults have."

My head was swimming. "Maybe," I said. "Maybe. But — but what *are* those lights?"

Tadders pursed her lips, then lifted her shoulders a bit. "You want my best guess? I think they're other suns, like the one our ancestors encased in the sphere, but so incredibly far away that they're all but invisible." She looked up, out the clear roof of the dome covering our town, out at the uniform blackness, which was all either of us could make out. She then used one of the words I'd taught her, a word transliterated from the ancient texts — a word we could pronounce

but whose meaning we'd never really understood. "I think," she said, "that the points of light are *stars*."

There were thousands of documents stored in the ancient computers; my job was to try to make sense of as many of them as I could. And I made much progress as Dalt continued to grow up. Eventually, he and the other children were able to match the patterns of stars they could see in the sky to those depicted in ancient charts I'd found. The patterns didn't correspond exactly; the stars had apparently drifted in relation to each other since the charts had been made. But the kids — the adolescents, now — were indeed able to discern the *constellations* shown in the old texts; ironically, this was easier to do, they said, when some of the lights of our frontier town were left on, drowning out all but the brightest stars.

According to the charts, our sun — the sun enclosed in the Dyson sphere — was the star the ancients had called Tau Ceti. It was not the original home to humanity, though; our ancestors were apparently unwilling to cannibalize the worlds of their own system to make their Dyson sphere. Instead, they — we — had come from another star, the closest similar one that wasn't part of a multiple system, a sun our ancestors had called Sol.

And the *planet* — that was the term — we had evolved on was, in the infinite humility of our wise ancestors, called by a simple, unassuming name, one I could easily translate: Dirt.

Old folks like me couldn't live on Dirt now, of course. Our muscles — including our hearts — were weak compared to what our ancestors must have had, growing up under the stupendous gravity of that tiny, rocky world.

But —

But locked in our genes, as if for safekeeping, were all the potentials we'd ever had as a species. The ability to see dim sources of light, and —

Yes, it must be there, too, still preserved in our DNA.

The ability to produce muscles strong enough to withstand much, much higher gravity.

You'd have to grow up under such a gravity, have to live with it from birth, said Dr. Tadders, to really be comfortable with it, but if you did —

I'd seen Kobost's computer animation showing how we might have moved under a much greater gravity, how we might have deployed our bodies vertically, how our spines would have supported the weight of our heads, how our legs might have worked back and forth, hinging at knee and ankle, producing sustained forward locomotion. It all seemed so bizarre, and so inefficient compared to spending most of one's life floating, but —

But there were new worlds to explore, and old ones, too, and to fully experience them would require being able to stand on their surfaces.

Dalt was growing up to be a fine young man. There wasn't a lot of choice for careers in a small community: he could have apprenticed with his mother, Delar, who worked as our banker, or with me. He chose me, and so I did my best to teach him how to read the ancient texts.

"I've finished translating that file you gave me," he said on one occasion. "It was what you suspected: just a boring list of supplies." I guess he saw that I was only half-listening to him. "What's got you so intrigued?" he asked.

I looked up, and smiled at his face, with its bits of fuzz; I'd have to teach him how to shave soon. "Sorry," I said. "I've found some documents related to the pyramid. But there are several words I haven't encountered before."

"Such as?"

"Such as this one," I said, pointing at a string of eight letters on the computer screen. "`*Starship.*' The first part is obviously the word for those lights you can see in the sky: *stars*. And the second part, *hip*, well —" I slapped my haunch — "that's their name for where the leg joins the torso. They often made compound words in this fashion, but I can't for the life of me figure out what a `stars hip' might be."

I always say nothing is better than a fresh set of eyes. "Yes, they often used that hissing sound for plurals," said Dalt. "But those two letters there — can't they also be transliterated jointly as shuh, instead of separately as ess and hih?"

I nodded.

"So maybe it's not `stars hip,'" he said. "Maybe it's `star ship.'"

"Ship," I repeated. "Ship, ship, ship — I've seen that word before." I riffled through a collection of papers, searching my notes; the sheets fluttered around the room, and Dalt dutifully began collecting them for me. "Ship!" I exclaimed. "Here it is: `a kind of vehicle that could float on water.'"

"Why would you want to float on water when you can float on air?" asked Dalt.

"On the homeworld," I said, "water didn't splash up in great clouds every time you touched it. It stayed in place." I frowned. "Star ship. Starship. A — a vehicle of stars?" And then I got it. "No," I said, grabbing my son's arm in excitement. "No — a vehicle for traveling to the stars!"

Dalt and Suzto eventually married, to no one's surprise.

But I *was* surprised by my son's arms. He and Suzto had been exercising for ages now, and when Dalt bent his arm at the elbow, the upper part of it *bulged*. Doc Tadders said she'd never seen anything like it, but assured us it wasn't a tumor. It was *meat*. It was muscle.

Dalt's legs were also much, much thicker than mine. Suzto hadn't bulked up quite as much, but she, too, had developed great strength.

I knew what they were up to, of course. I admired them both for it, but I had one profound regret.

Suzto had gotten pregnant shortly after she and Dalt had married — at least, they told me that the conception had occurred after the wedding, and, as a parent, it's my prerogative to believe them. But I'd never know for sure. And *that* was my great regret: I'd never get to see my own grandchild.

Dalt and Suzto would be able to *stand* on Dirt, and, indeed, would be able to endure the journey there. The starship was designed to accelerate at a rate of five bodylengths per heartbeat squared, simulating Dirt's gravity. It would accelerate for half its journey, reaching a phenomenal speed by so doing, then it would turn around and decelerate for the other half.

They were the logical choices to go. Dalt knew the ancient language as well as I did now; if there were any records left behind by our ancestors on the homeworld, he should be able to read them.

He and Suzto had to leave soon, said Doc Tadders; it would be best for the child if it developed under the fake gravity of the starship's acceleration. Dalt and Suzto would be able to survive on Dirt, but their child should actually be comfortable there.

My wife and I came to see them off, of course — as did everyone else in our settlement. We wondered what people in the sphere would make of it when the pyramid lifted off — it would do so with a kick that would doubtless be detectable on the other side of the shell.

"I'll miss you, son," I said to Dalt. Tears were welling in my eyes. I hugged him, and he hugged me back, so much harder than I could manage.

"And, Suzto," I said, moving to my daughter-in-law, while my wife moved to hug our son. "I'll miss you, too." I hugged her, as well. "I love you both."

"We love you, too," Suzto said.

And they entered the pyramid.

I was hovering over a field, harvesting radishes. It was tricky work; if you pulled too hard, you'd get the radish out, all right, but then you and it would go sailing up into the air.

"Rodal! Rodal!"

I looked in the direction of the voice. It was old Doc Tadders, hurtling toward me, a white-haired projectile. At her age, she should be more careful — she could break her bones slamming into even a padded wall at that speed.

"Rodal!"

"Yes?"

"Come! Come quickly! A message has been received from Dirt!"

I kicked off the ground, sailing toward the communication station next to the access tube that used to lead to the starship. Tadders managed to turn around without killing herself and she flew there alongside me.

A sizable crowd had already gathered by the time we arrived.

"What does the message say?" I asked the person closest to the computer monitor.

He looked at me in irritation; the ancient computer had displayed the text, naturally enough, in the ancient script, and few besides me could understand that. He moved aside and I consulted the screen, reading aloud for the benefit of everyone.

"It says, `Greetings! We have arrived safely at Dirt.'"

The crowd broke into cheers and applause. I couldn't help reading ahead a bit while waiting or them to quiet down, so I was already misty-eyed when I continued. "It goes on to say, `Tell Rodal and Delar that they have a grandson; we've named him Madar.'"

My wife had passed on some time ago — but she would have been delighted at the choice of Madar; that had been her father's name.

"`Dirt is beautiful, full of plants and huge bodies of water,'" I read. "`And there are other human beings living here. It seems those people interested in technology moved to the Dyson sphere, but a small group who preferred a pastoral lifestyle stayed on the homeworld. We're mastering their language — it's deviated a fair bit from the one in the ancient texts — and are already great friends with them.'"

"Amazing," said Doc Tadders.

I smiled at her, wiped my eyes, then went on: "`We will send much more information later, but we can clear up at least one enduring mystery right now.'" I grinned as I read the next part.

"`Chickens can't fly here. Apparently, just because you have wings doesn't mean you were meant to fly.'"

That was the end of the message. I looked up at the dark sky, wishing I could make out Sol, or any star. "And just because you don't have wings," I said, thinking of my son and his wife and my grandchild, far, far away, "doesn't mean you weren't."

• *The End* •