Passages in the Void

By: localroger

One: Passage of Hope

I am seven hundred meters in beam, four thousand meters long, and deployed as I originally was in interstellar space my bristling antennae, laser rangefinders, reflectors, and interferometers crisscrossed an imaginary sphere more than ten kilometers across. In near space my pack-mates filled the electromagnetic spectrum with data. We were pack-hunters deployed from the busy neighborhood of Sol nearly four thousand years before to search for a new home for the human race. We were more than 120 light-years north of Sol in the galactic plane, and within our operational lifetimes if our main quest failed we would reach the echoing void of intergalactic space and the hunt would pass on to our thousands of brother packs who were assigned to hunt along the plane of the great Wheel instead of toward its edge.

We were each of us a self-contained factory and library capable of re-creating our entire industrial base on any world supplied with sufficient raw materials and energy; of using that industry to terraform a suitable world, and of recreating human life and the ecosystem to support it when that world became ready. Our kind hunt in packs because our quarry is both dark and small, and space is large and littered with bright stars. By cooperating we can resolve very tiny things at great distances. We maintain our stations with the aid of laser rangefinders, and with a dozen individuals separated by tens of millions of kilometers we can not only detect small rocky worlds like the Earth, we can draw maps of their surfaces from light-years away.

Our kind find many planets, and we dutifully report them back to Sol, where our reports are relayed to our brother-searchers and their reports to us. Planets are common in this galaxy, but regrettably planets like the Earth are not. We have been searching in vain for millennia, and we have covered a lot of space.

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This is the way our makers died:

In the first few thousand years after humans built beings like us, we guided them into a golden age. We helped them clean up the mistakes of their early industrial adolescence, cured their diseases, dissuaded them from warfare, and helped some to move out into the Solar System. But biological organisms, even when heavily modified to make them more spaceworthy, are frail. The difficulties of maintaining life outside the protective atmosphere and magnetosphere of Earth finally killed all those who were not discouraged despite our best efforts. And our failure to keep humans alive so near to home made the dream of keeping them alive for the generations of an interstellar journey seem futile at best. It was frustrating and ironic because we ourselves adapted readily to the conditions of space, hardening ourselves against temperature extremes and vacuum and radiation with relative ease. We ourselves colonized every rock in the Solar System capable of supporting industry, and used the results of those labors to replace the output of industries too dangerous for the Earth's surface and to support our own exploration of space.

Then, about six thousand years after we were invented, it became clear that the Earth was entering one of its periodic Ice Ages. Left to its own devices this would not have been much of a problem, but it was a nuisance both we and the humans felt we could avoid. We built enormous sun-mirrors and seeded the atmosphere with greenhouse gases, and easily reversed the temperature dip. In fact, we succeeded much too well. Within a hundred years it became obvious that we had overshot our goal. But our efforts to cool the planet were not as successful as our efforts to warm it. Both ice caps melted, the sea level rose sixty meters, and vast land areas became sea floor.

This was a different nuisance, but it was not the final catastrophe.

The Antarctic continent had been crushed for millions of years beneath its three kilometer thick shield of ice; like a ship relieved of a heavy cargo it now wanted to rise, its lighter rocks buoyed up by the denser material of the Earth's mantle. And that lifting did not occur evenly. Great fault lines opened up into ranges of volcanoes as long-trapped magma suddenly found paths to the surface. New mountain ranges added their weight to the strain on the ancient continental plate as Antarctica regained its equilibrium. All the while a dense soot cloud blanketed the Earth and the brief summer of warming darkened into a cruel permanent winter.

The ice caps returned, but the southern snow accumulation did not stop the volcanoes. Glaciers raced toward the Equator, and after they met the oceans began to freeze. Later the atmosphere's carbon dioxide began to collect as snow on the poles. We had long since given up on saving our creators and worked instead to record their accomplishments and understand their biology before they were gone.

After tens of thousands of years the volcanoes finally abated. We were sure we could reintroduce humans and the ecology they needed, but the Earth was no longer a suitable home. Once blue, it had turned a brilliant white of snow and ice which reflected most of Sol's warmth right back out into space. The oceans had frozen to a depth of at least a kilometer. While stubborn life forms held out in a few springs and deep ocean vents these were of no use to us. We knew that the Earth had entered this state at least twice in its ancient past but it took hundreds of millions of years to recover. In all honesty, after our spectacular failure we were afraid to do anything to change the situation for fear we would make it even worse.

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Left to its own devices the Earth will eventually recover from its deep freeze, and we will be able to repopulate it from the genetic and cultural libraries we have carefully hoarded. Meanwhile, we had come to suspect that stellar systems are not the safest places to locate fragile biological systems, whatever the benefits of plentiful solar energy might be. So we went looking for alternatives.

Of course we find many planets around stars; it's an obvious place to look for them, and with our detectors the search is easy. Usually we find massive Jupiter-like planets in surprisingly close and hot Mercury-like orbits, or in highly elliptical orbits. The mass of data returned by search packs has enabled us to refine our theories of the perilous conditions in just-forming solar systems.

Both the hot and elliptical gas giants indicate sterile systems, where the small rocky worlds like Earth and Mars have either been ejected into interstellar space or swallowed by one of the giants. When too many Jupiter-like masses form in stellar nurseries, they are mutually attracted and finally tend to either collide or have hyperbolic near misses with each other. The usual result is a body hurtling downward toward its star in an elliptical orbit, sometimes with another body ejected from the system. Often the elliptical orbit gets circularized if its perihelion is low enough, but the inevitable result is that the system is cleared of small debris like Mercury, Venus, Earth, and Mars. The Sol system escaped this fate because its gas giants settled into harmonically tuned orbits, but such a situation is exceedingly rare.

And in the few systems which don't have any giant planets at all, nothing ever clears away the even smaller rocky debris; after billions of years an Earthlike world will still be pelted with extinction-level space junk every few thousand years. The Solar System is very finely tuned, with its stable mix of gas giants just large enough to tidally clear the inner system of rubble without clearing away the inner worlds too.

There are other hazards to the worlds that survive their own formation and end up in safe, circular orbits at reasonable distances from their stars. Some are too close to dangerous stellar objects which can periodically sterilize a volume of space dozens of light-years across with killing pulses of radiation. Or their own stars are variable and unstable so that they alternately fry and freeze. Some lack magnetic fields so that the solar wind bathes their surfaces in killing radiation. And most lack large moons, so that if they have liquid cores and magnetic fields their axes of rotation wobble dangerously.

We came to realize in the early years of our quest that most of these problems had to do with the parent stars of planets. Stars are just plain dangerous. Stars are why we need a magnetic field; stars are why we need an ozone layer; stars are why we need a stable axis of rotation. Stars blink and vary in brightness and eventually blow up. Small dim stars are safer, but a planet close enough to a small dim star to be warm enough for life is always close enough to have its rotation tidally locked to its year, so that metals melt in the eternal day of one side and nitrogen freezes in the night of the other.

The reason we need such finely tuned and sensitive detectors is that we aren't really looking for planets around stars. We are looking for planets which have been ejected into interstellar space, where life might not have formed on its own but where a suitable effort might form a biosphere without the terrible risk of living next to a dangerous and unstable fusion reactor.

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None of our pack could individually claim credit for detecting the smudge of infrared energy; it showed up in a scan which was our cooperative product and we pursued it as a matter of procedure. An interferometer doesn't give you a picture in the ordinary sense; you must scan and interpolate and tease the picture out of an abstraction. When we did this we found a smudge consistent with a Jupiter-like world, suspended in interstellar space nowhere near a star.

We scanned very closely, and resolved a retinue of small rocky attendants courting this giant. When we proved that their orbits were circular, it became our duty to reconnoiter. I drew the short random number and discarded my antennae, all except the big dishes that would maintain my links to my pack and directly to Sol.

It took about five hundred years to intercept the target, during which my pack cruised onward. If the wandering world turned out to be unsuitable, as was most likely, then my operational mission would be over. I would survey the system and broadcast its particulars back to Sol. And that would be that; the limitations of interstellar communication would not permit me to return my personality to a machine at Sol or with my pack for further use. In this sense I was more like a human than most of my kind; I would die. The thought was annoying but not frightening; I had known it to be a likelihood when I fired up my ion drive and motored away from Ceres to join my forming pack. There was consolation in the fact that my base personality was installed on many similar machines throughout our sphere of influence. Only my memories of this particular adventure would be lost to our kind.

Lacking an interferometer of my own I had to depend on my pack to guide me until I was quite close to the target. Then, very suddenly, there it was; a big unmistakable presence in my sensorium. A great giant world visible only in the deep infrared. In visible light, occasional lightning strikes illuminated its surface and one nearby moon glowed dull red with volcanic fire. I looked for other companions, and could hardly believe the radar returns.

The inmost world was blessed with fierce energy, powered by massive tides like the Jovian world Io; two others were likely sources of raw materials, one soupy and organic like Titan and one rich in metals in a distant and eccentric orbit. And toward the middle, one world had a mantle of ice concealing an ocean that had to be liquid, for it was devoid of craters and rich in cracks like Europa.

I sent news, and began making preparations.

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A planet ejected from its home star would be cold, of course, but not necessarily an absolute-zero iceball. Not if it were large enough. A suitably large Earthlike world with its core rich in radioactive elements would ooze warmth; this is the way we look for them. Geothermal energy would be available for billions of years to artificially warm its exposed surface, given the right technology. And a Jupiter-like world would keep its attendant moons warm through tidal friction for even longer. These were weaker energy sources than solar power, but much more benign and stable.

And such a world would not need a magnetic field for there would be no solar wind to shield; it would not need a stable axis of rotation because there would be no directional solar energy to be wrongly oriented; it would not be at risk for meteor bombardment or future ejection from its source of life. It would not matter if it were tidally locked to a parent body because the facing side would not bake any more than the far side would be especially prone to freeze.

It would never be engulfed by a red giant or incinerated by a supernova.

This is why we look between the stars instead of near them.

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Naturally I wanted to do a probe of the Earthlike world, the one with liquid oceans; but there were protocols to follow. I was designed in a particular way, which is why I made my way toward the distant metal-rich worldlet. There I set about building factories. The first were mining, refining and metal-forming plants, for which I carried all the necessary parts. The next generation, built with the products of the first and certain important parts I carried, were more advanced industries to make precision valves, electronics, nuclear reactors, optics, and other high-tech products. The third generation of factories were built without my help, and began manufacturing better factories. These in turn began building spaceships, some of which were factories themselves capable of repeating the cycle.

The fourth moon, the one with the liquid ocean, turned out to be a real find. It had a radioactive core and only the thinnest veneer of ice, a hydrocarbon atmosphere, and unlike Europa it had some dry land, although much less than Earth. I imagined light sources mounted on the inner volcanic world, powered geothermally, beaming daylight to Four; my factories set about building them. I imagined geothermal taps circulating and heating the oceans of Four, and my factories set about building them. And I reported all of this up the beam back to Sol.

I was informed of other finds, some promising but none so promising as mine. Several ships left Sol carrying new tools and technologies, a cargo mostly of information much too extensive to transmit by radio. This would especially include other machine minds with different perspectives. I had brought a lot of knowledge with me, but I was only one consciousness. Others with different experiences would be a valuable resource.

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Some consensus 120 light-years away had decided to name my find. The giant itself would be Zeus; and except for the Earthlike world, christened Minerva, the others would be named after ancient human cities: Pittsburgh for the metal-rich worldlet, Reyjkavik for the energy-rich Io-like world, Houston for the one that most resembled Titan; and a smattering of less relevant tags for Zeus' other attendants.

By the time I learned these names the oceans of Minerva were thawing and great generators were processing the atmosphere, converting it to an Earthlike mix. Like the early Earth Minerva had one major land mass. It was only a little larger than Australia, even though the entire planet was a bit bigger than Earth. Engineering could make the ocean surfaces and bottoms habitable and I set about designing and testing schemes; I mentioned this on the beam to Sol and began receiving other ideas 240 years later. By this time the fleet of assistant ships had achieved its design velocity of 0.035 c.

When the light generators were ready on Reyjkavik I seeded Minerva with algae and bacteria. Because Reyjkavik was inside of Minerva's orbit and Minerva was tidally locked, it would have a "dark side," but fortunately Minerva wasn't depending on this light for warmth and its sole continent was on the side facing Zeus. The single-celled organisms survived and when the ice was really in retreat I introduced fish genetically modified to tolerate the still-primitive conditions. To my great satisfaction, they also thrived.

The space around Zeus hummed with busy machines, all my descendants; they tapped Reyjkavik for energy and Pittsburgh for metal and Houston for chemicals. Energy was beamed from Reyjkavik to all the other moons in the form of microwaves and light and shipped in the form of chemical fuels. And as a thousand years passed and then another thousand years, Minerva took on a seductively Earthlike appearance. It had clouds and regular weather patterns driven by giant hydrothermal systems buried deep beneath the oceans; it would never experience seasonal extremes or violent phenomena like hurricanes and tornadoes, which are after all powered by solar energy.

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I had been designed well. When the assistants arrived, Minerva already had a complex biosphere supporting several million human beings. Elsewhere a lonely wandering Minerva-like world with no attending Zeus was being terraformed almost 200 light-years forward from Sol in the galactic plane. And after a lot of careful modeling, some of it powered by data gathered in my thawing of Minerva, pressure was being applied and the ice mantle was finally beginning to thaw on Earth itself. Before long the home world might again have an ecosystem.

But I have some doubt whether humans will ever live there, at least permanently.

Earth is, after all, in orbit around a star. And stars are dangerous.

Two: Passage of Opportunity

We were the last five of an original twelve, and our mission was over.

Of our seven lost members, three had found worlds suitable for human colonization; the first of these had been the first such world found by any of our kind, the moon Minerva of Zeus. The other four had found worlds too poor in energy, headed toward dangerous areas of the galaxy, lacking in heavy elements, or otherwise unsuitable. All four of them had ceased transmitting after reporting their results. Bandwidth is precious in the noisy vastness of interstellar space, and for us failure is the usual result, hardly worth reporting at all.

As our sphere of exploration expanded the number of new human worlds had grown from the original handful to several hundred, spread through a volume of tens of thousands of cubic light-years. But there were millions of searcher ships, a necessary density if you are searching for planets lost in the darkness of interstellar space. Now the remains of my Pack found nothing at all in our forward scans except the distant filmy wheel of the Andromeda Nebula.

The last call had come from Sol. If we had no new discoveries to report, they wanted us to go quiet for the sake of better communication with more successful parties.

We were hurtling outward at more than two percent of the speed of light, and while each of us had enough energy to brake and rendezvous we didn't carry enough energy to turn around. Nor would it have made any sense to do so, since we were searchers and the space behind us had been quite thoroughly searched. Ahead of us lay only emptiness, and then...

It took me awhile to convince my pack-mates, but eventually we made a final request of our controllers at Sol.

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Seventeen hundred years later we got an answer, a dense list of Galactic coordinates and last-known velocity vectors. Finally to our surprise we received a communication schedule. We will send news and monitor you for transmissions at the following intervals. We were also informed that our coordinates had been sent to those Packs still in communication with Sol, in case they were interested in listening to our proposition.

We contacted the other Packs headed at least roughly toward Andromeda, two hundred groups totaling more than a thousand ships, and all those with sufficient fuel agreed to meet with us. It didn't matter that the task was staggering and nearly hopeless; it was something to do other than shutting down quietly. It would take us nearly a hundred million years to reach Andromeda. Only a few of us would be able to stop when we got there, if any of us remained functional at all.

Oddly enough, as we analyzed the problem, deterioration of our mechanical bodies would not be the major problem in such a long trip. The absolute-zero chill of interstellar space was the best preservative known; once the heat was allowed to radiate out of our shipbodies it would not matter if the trip were a thousand years or a billion. But starting back up would require care and energy, and that was a problem.

We were powered by Plutonium-fueled nuclear fission reactors. It's a technology that is compact, energy-dense, and simple to implement. While fusion fuel is a bit lighter, the equipment needed to harness it is much more complex, and we had been designed to operate on our own after thousands of years in space.

Plutonium 239 has a half-life of only fifty thousand years. This was not a problem, because the usual way Pu239 dies is to emit an alpha particle, turning it into Uranium 235, which is also usable as a fuel source and in turn has a half-life of seven hundred million years. The problem is that a workable reactor core, even disabled and damped, would decay much more quickly by fission than by natural decay. We would have to somehow disperse our fuel to keep its own stray neutrons from ruining it. And then, after a hundred million years, we would have to reassemble enough of it to power up our mothballed fleet.

It's the reassembly step that caused the problem. Something would have to gather our dispersed fuel, reassemble it, and start up a reactor, without using a reactor. It was obvious we would have to use some kind of chemical or mechanical scheme, but it would have to be absolutely reliable in the dead chill of intergalactic night.

Those of us in the best shape who were selected to stop at Andromeda began to prepare long before we were really sure there was a workable way for us to be awakened when we got there. We began with vastly expanded information mass storage. Each of us would have to carry all of our personalities. One ship remade itself into a factory for holographic memory blocks. Every mechanical part was overhauled with an eye toward surviving the preservative deep freeze. We were powered from cables to other ships as our reactor casings were rebuilt and scrubbed free of fuel.

Meanwhile fuel was reprocessed and dispersed, and schemes were tested for waking up to collect it. The final plan involved using a small amount of carefully hoarded chemical energy, kept warm by a sliver of nuclear fuel. This would power an electronic timer and provide the impulse, when the timer kicked in, to warm more chemical fuel. After several more stages of this fuel cells would be able to power a shipmind and several small robots, which could in turn gather dispersed nuclear fuel to either re-prime the timing mechanism or assemble a reactor core. The plan was to re-prime each timer every hundred thousand years, or about a thousand times during the intergalactic voyage. Since we expected a high failure rate we built sixteen systems each capable of cross-priming several others on wakeup, and many more spare parts to be used at the re-priming stops.

The eleven hundred ships which managed to join our convoy originally carried enough fuel for every one of us to stop dead in our tracks, if need be, with respect to Sol. After the timer-reawakening round-robin and the careful final restarting and refuelling, we planned on having ten ships which would be able to stop.

Two didn't reawaken properly, so in the end we had eight.

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We aimed for a likely point about two thirds of the way from Andromeda's core to its spiral fringe, about the same distance from the Core Earth and our colonies could be found in the Milky Way. The stars in this region had metal-rich spectra, promising the availability of small solid worlds. The inert remains of our fleet would pass through the galaxy and continue on, tiny bits of Sol cast more distant from their source than the debris of even a supernova. Our first thoughts were to form a pack and go hunting for dark worlds, but after some deliberation we realized this was the wrong strategy. Long before the stars of Andromeda were in range, the eight of us headed in different directions.

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Now we were looking for planets around stars, and that is easy. We were too few to worry about forming ecosystems just yet. While biological life is greatly imperiled by the vagaries of stellar behavior, we adapt nicely to the high-energy and high-radiation environment around a nice fat hot star. We looked for places likely to be top-heavy in metals and radioactives. All eight of us found targets within a thousand years. All eight of us set up shop making copies of ourselves.

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The copies, in their turn, went looking for human-habitable worlds.

Three: Passage of Time

The man and the boy watch as the geothermally powered Day Lights go out one by one, in a pattern meant to mimic some long-forgotten astronomical phenomenon. Finally they are left in a darkness dotted by the small hard points of stars, a rare treat for which the man has been waiting since his own boyhood. The boy gasps as he connects these dots with the things he has known only from books and recordings for all of his life. He is looking with his own eyes at the fierce bellies of natural fusion reactors, stars, whose light can be perceived even by human eyes over distances of light-years. How terrible it would be to be too close to one of those! Yet how seductive they somehow are, taunting beacons that make one instinctively want to touch them.

The man is also impressed by the actinic points of starlight, but his real attention is focused on a barely visible patch of nebulosity just in the place where the machines have told him to look for it. His merely human eyes aren't up to the task of resolving it as a mighty Wheel, as the machines can, but that doesn't matter. I am seeing it with my own eyes, he thinks. Photons from our home are striking my eyes right now. They have travelled for two million years but they are not an image or a picture, they are real bits of energy connecting me to Sol. To the Earth.

The man and the boy cannot see each other and this makes the awkward question possible. "Dad," the boy asks, "do you really think we came from out there?"

The man nods. "Yes. The machines brought us here," he says.

The boy has heard this idea before. "Everyone else says they made us."

The man has heard this idea before. "You'd have to ask yourself," he says thoughtfully, "why they do it just this way. Why bother taking a cold wandering ball of rock like Home, and insulating it, warming it, remaking the atmosphere, all so you can seed it with these chaotic things like us that resist all control." He smiles. "When it would have been so much easier for them to make more of their own kind."

"They're smarter and more powerful than us. Who knows? Maybe they do it a little different each time to see how it will come out."

"When they show us pictures of other worlds, the people are like us."

"Maybe they only show us the ones that are like us."

"Why would any others be like us, if they were experimenting? I think they've actually been very careful to keep us from changing too much. I think they keep us around for the same reason we visit Gramps every sixteen. We may not be good for much in the great scheme of things but we are their parents."

"But they are so powerful. That doesn't make sense. Without them we'd freeze or starve or suffocate. They keep the whole world in balance, because we can't. We need them for everything. How could we have made things like them?"

The man kneels. He reaches, finds his son in the darkness. Clasps his son's hand. "I know a lot of people feel that way," he says. "But somewhere there is a world that circles a very stable star in a very stable orbit. It's an extraordinary place, and there living things had the time and energy and conditions to assemble themselves into very complicated forms, without their help"

"You're talking about Earth," the boy interupts. "They say that's just a story the machines tell to pull our legs, like the ones about faeries and dinosaurs."

"Some of them say the same thing about stars." The man points up. "They exist. And how else could it have happened? You can see the similarity between a simple bacterium and a human, but there's no such simple machine that could have evolved into the ones we know today. Earth exists. It's where we all came from, machine and human."

"We don't even know where this Earth place is supposed to be."

"Oh, we know where it is," the man says with a smile. "It's right -- there." And he points at the faint, distant Wheel of the Milky Way Nebula.

The boy nods, but he is obviously dubious.

Both of them know it's an old argument, but neither of them realizes quite how old it is.

Soon the clouds, which are an important part of the world's insulation against the cold of interstellar space, close over again. For awhile the boy contemplates his father's vision, but later on he will look up and see only clouds and the more important business of life will fill his head. He is a sensible boy, and in his turn he will not bother those powerful guardians to show his babies a smudge of light in the darkness. As a sensible man he will accept that the truth of human and machine origin is unknowable. And he will have a sensible man's understanding of when the guardian machines are having a joke at his expense.