

The Right Question

By Mike Combs

mikecombs@aol.com

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Bruce Franklin was working at the CAD/CAM station in his office on the GEO-18 space station when the call came through. He was in the midst of defining the operational parameters for a proposed space launcher to be built on the moon. He pressed the "save" button on the screen and then brought up the communications channel.

The face now staring back at him from the screen belonged to Harold West. Harold was a colleague of Bruce who was currently working over at the GEO-12 station.

"Hey, Harry, what's happening?"

"Not a whole lot, and that's the problem," was the somber reply.

"That gravimetric research getting you down?" Bruce gently probed.

Harold looked back at him, mildly alarmed. "What have you heard?"

"Oh just the scuttlebutt that's circling the Earth in this orbit."

"Which is...?"

"Which is that American Spacecraft has made GEO-12 tighter than Fort Knox. That it has something to do with gravity. That they're being strangely hush-hush about it all. No one knows what your massive construction project is going to be yet, though."

Puzzled now, Harold asked, "Who says we've got a 'massive construction project' planned?"

Bruce smiled cagily. "Well, it's common knowledge that American Spacecraft recently captured a Near Earth Object. NEO capture means big-time orbital construction. Unless you're now in the business of stockpiling asteroidal ore by the mega-ton."

"There is no massive construction project. However, I'm authorized to let you know we have made a rather startling breakthrough, but have reached an impasse. I'd like you to come over to have a look at our work thus far and tell us what you think. We hope to benefit from the opinion of one of the greatest engineering researchers of our age," Harold added with a teasing grin.

The compliment referred to Bruce's undeniably brilliant accomplishment in Sky Bridge. That staggeringly-long space launcher which he had designed and built in Brazil had revolutionized space travel. The cheap, easy access to space the launcher provided was the only thing which made most of the space activities now taking place economically feasible.

Bruce didn't even consider turning Harry down. He was curious about the mysterious research being done essentially next door and now had a chance to see it first-hand. After making arrangements with Harold, he closed all of his files and made his way to the elevator. The elevator took him from the outer rim of the rotating station to the hub. As Bruce ascended, the artificial gravity dropped from 1-G to

less than 1/10 of a G. He as much soared as walked out of the elevator and bounded off in the direction of the docking bay.

Bruce stopped to don a space suit and then hopped into a small, one-man craft. A system of grapplers carried the tiny spherical ship up to the spin-axis of the revolving space station and into an airlock. Once the lock was depressurized, the outer door rose to reveal the cavernous docking bay. Firing low-powered thrusters, Bruce guided the one-man craft past the wide variety of larger ships docked at this station. The craft flew out through the wide exit and coasted into free space. A brief thruster fire killed the slow rotation which the ship still carried from the spinning station.

An automatic guidance program sent the tiny vessel along the arc of Geosynchronous Earth Orbit, weaving its way past the myriad stations and satellites circling the world at this altitude. Within an hour, Bruce was approaching GEO-12. He lined his craft up with the station's spin axis, matched rotation rate, and then entered the docking bay.

Harold met him just inside of the airlock. "Don't bother to take off your space suit. You're going to need it where we're going."

The engineer led Bruce to his lab which was located precisely on the spin axis in the hub of the space facility. Artificial gravity was essentially nonexistent. Harold slid into a space suit and then guided Bruce through an air-lock and into an evacuated chamber. While Bruce hung onto a hand-hold, Harold coasted over to a boxy console with rounded corners and began to adjust various controls. Now vibrations ran through the hand-hold, although there were no sounds from the mysterious device due to the lack of air.

Something strange was now happening in the center of the cylindrical chamber. It wasn't that there was any object in the center of the room to look at, but a peculiar distortion of the patterns on the far wall seemed to indicate something was there. It was as though the other side of the room were being viewed through a sheet of glass with a poorly-formed spot in the middle which bent the image in that area. Suddenly, the distortion intensified and there was a brief glimpse of some weird kind of tunnel-effect. It was a little like when one stuck one's head between two parallel mirrors and can see an infinite row of heads arcing away. Or like the feedback effect produced when a video camera is pointed at a screen displaying the output of the camera. Then the shimmering haze which permeated the round blob winked out, now replaced by an ebon patch over half a meter wide.

Closer examination of the circular black spot revealed stars slowly moving by. Bruce suddenly remembered that as he clung to the wall, the constant rotation of the space station was carrying him around in a complete circle about once a minute. The stars filing past in the dark area were moving at about the right speed. It was as though a window had been opened showing a view outside of the station. However, this was not a window in the wall, but one which hung suspended in the middle of the air.

Curious, Bruce began to drift around to see the strange zone from different angles.

"Careful," Harold cautioned, "Don't touch it."

"What the heck is it?" Bruce asked breathlessly.

"A wormhole."

"You've got to be kidding."

"No kidding. We've developed the technology to create artificial wormholes."

"How?" Bruce wanted to know.

"Well, it involves producing standing gravity-waves by oscillating a golf-ball sized mass of neutronium," Harold explained.

Bruce was thoroughly impressed. He knew how dense neutronium was and appreciated that a golf-ball sized chunk of it would have the same mass as a good-sized mountain. Make that a good-sized asteroid. Now he knew what American Spacecraft had done with the Near-Earth-Object which they had intercepted. Bruce realized the whole mass was now inside of that console Harry was operating.

The pair descended to the 1-G gravity level of the station and went to Harold's office.

"It's the ideal spacedrive," Harold began. "One that could lead to practical interstellar travel. The problem we have faced with rockets of all kinds has been the staggeringly large amounts of fuel which would have to be expelled. Even assuming anti-matter as a power source, we're still talking about megatons of reaction mass in order to accelerate anywhere close to the speed of light."

"And acceleration is only part of the problem," the disgruntled engineer complained. "You have to slow down and stop at the other end. Doing that requires the same amount of fuel as it took to get up to speed in the first place. Unfortunately, you have to carry that fuel along with you too, so you need still more fuel to carry that fuel. Then you need more to carry that much more. Before you've finished, the whole thing has ceased to be practical."

"But the advantage of a wormhole drive is that there's no fuel involved. Well, other than for orbital maneuvering, anyway. The drive creates a wormhole stretching from a point in front of the ship all the way to the destination. The ship then slips into the hole and "down" the slope of the hyper-dimensional tunnel. The effect is like being pulled forward by a very intense gravity field. You accelerate at hundreds of G's, but don't feel anything because you're falling, see? The only stress on the ship would be from gravity tides and we could get into the several hundred G's range before that effect became very noticeable. The craft dips "down" "below" space-time, losing potential energy and gaining kinetic energy. You're within spitting distance to the speed of light in no time."

"And then here's the real beauty of the scheme: Once past the half-way point, you begin coasting "up" the slope of the wormhole. Now you're trading back speed for the potential energy you lost. At the end of the tunnel you've re-attained enough potential energy to once again exist in three-dimensional space and your speed is back down to what it started out at. Just enough to maintain orbit around another star. It's a perfect system!"

There was a pause. "But....?" said Bruce. "There must be a 'but' or else you wouldn't have called me over here."

"But...there's a problem," Harold confirmed. "No matter what we do, we can't seem to generate wormholes with a diameter any larger than what you just saw."

Bruce looked concerned now. "I had assumed it was a smaller size just for demonstration purposes."

"Nope, that's it. About three-quarters of a meter." Harold put his head in his hands and hunched over his desk a little. "We've tried higher-powered super-conducting coils, harmonic amplification, everything. Never a hole bigger than three-quarters of a meter. So unless we invent very tiny people to pilot very tiny starships, it's never going to be good for anything other than small automated probes."

"No, we can't settle for that," Bruce said with determination. "We've got to invent a space drive

which will take humanity out to the stars."

Harold looked up at Bruce. A bit of a smile briefly relieved the perpetually dour expression on his face. "We figured you would feel that way about it. So here's the deal: We will loan you all of our data and our oscillation apparatus. Mess around with it. If you can come up with anything useful, then half of it belongs to American Spacecraft and the other half to Franklin Enterprises. I've convinced my managers that we can't take this technology any further on our own, and they agree with me that half of something is better than all of nothing."

A handshake plus a contract later, and Bruce was heading back to GEO-18. He was trailed by a gigantic ore tug which had been designed to haul megatons of asteroidal material but was now struggling to push one small box barely the size of a clothes dryer.

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Eight months later, Harold and several other American Spacecraft representatives were invited to Bruce's station for a demonstration. For these last few months, all of their attempts to get an update from Bruce on his progress had been met with frustrating silence. Thus it was with high anticipation that the men followed their gliding escort to an observation blister in a de-spun section of the space station. Bruce was floating in the harsh sunlight, waiting for them.

Without preamble, the designer signaled for a nearby space-hanger to send out the test vehicle. The ship was impressively huge. Judging from the portholes, it seemed to be designed as a manned craft. However, it lacked the two counter-rotating rings which typically indicated crew compartments with artificial gravity. Were the crew supposed to float around the ship for the many months a voyage might take? Another thing which made the new craft look different from other long-haul interplanetary ships was the ridiculously tiny size of its fuel tanks.

Harold was growing increasingly excited. "The diameter is what...500, 600 meters? How big a wormhole are you making now?"

"Same as you, three-quarters of a meter," Bruce related with an enigmatic smile.

"WHAT?"

"Sorry, it turns out the diameter is related to the gravitational constant of the universe," Bruce explained. "There's just no way to get around it with more clever technology. Not unless you're clever enough to modify the universe."

"Then how is the ship going to fit through the wormhole?" Harold demanded. Bruce just hung there, silent, impenetrable and inscrutable. Relenting, Harold drifted back to the giant porthole. "I just hope you're not fixing to make a big mess here."

Suddenly, a brilliant plume erupted from the test vehicle's single bell-nozzle engine. Everyone threw their arms over their eyes to ward off the overpowering glare. The ship was moving out. As his eyes adapted to the dazzling light, Harold could see the exhaust was nearly invisible when it first left the nozzle. It was beyond red-hot, beyond white-hot, beyond blue-white hot. It was x-ray and gamma-ray hot. He fervently hoped Dr. Franklin had suitable shielding in this observation blister or they would all regret it.

One hundred meters from the engine the plume became an intense violet color and then, shortly beyond, merely the hue and luminosity of the sun. It stretched out behind the accelerating ship for many kilometers. The ship was picking up speed rapidly and now only its engine could be seen as a brilliant, distant beacon visible only for its intensity.

"Astonishing," Harold said in a hushed tone. "I don't understand. I thought this was going to be a wormhole drive. And how did you expel all that reaction mass? The fuel tanks were nowhere near big enough to hold..."

"There was a wormhole," Bruce interrupted. "One end of it was inside the engine. The other end was...there..."

Bruce stretched out his arm to point straight at the sun.

"Deep below the surface, in a lower core layer. Temperature there is well over ten million degrees Celsius. Pressure is..." Bruce stopped to chuckle. "Well, I'd have to look at the specs to tell you the exact numbers. Suffice it to say that it is well beyond what we humans can casually understand. The resulting plasma is guided by magnetic fields which prevent it from touching the walls of the engine, for obvious reasons."

"Amazing," Harold murmured. "You are tapping the power of the sun's core to thrust your spacecraft."

"The plasma doesn't come out of the wormhole quite as hot as it was that deep in the sun, though," Bruce admitted. "It does lose some energy flowing "uphill", as it were. By tapping into the sun hyper-dimensionally, it is as though we had instantly drilled a hole that far down into the sun and was able to keep that hole open as a hard vacuum. The result would be a titanic flare which would go beyond the surface of the sun and far out into space. The drive should work better nearer the sun and not as good further away. But that's fine for interstellar travel. You would do most of your accelerating near our sun and then most of the decelerating near the target star, switching over your wormhole tap to it for the energy and reaction mass needed to come to a stop."

"Wait a minute," Harold interjected. "How long can we go tapping into our sun before we start to regret it?"

Bruce snorted. "We could have a hundred million ships just like this one roaming the entire system and points beyond before we could even begin to detect any difference in the mass of the sun. And besides, any matter we subtract won't make it go out quicker. Instead, it would actually extend the sun's life. The bigger a star is, the quicker it burns up its fuel. So if we have any effect on our sun at all, it will be to postpone the day of its death."

"Incredible. Well, this is just the sort of innovative thinking we were hoping for."

"It's just a matter of asking the right question," Bruce said with a smile. "I had a physics professor who once said that an ability to ask the right question is the hallmark of scientific discovery. The ancient Greeks spent hundreds of years asking 'Why do heavier objects fall faster than lighter ones?'. Then along came Galileo who asked 'Do heavier objects fall faster than lighter ones?'. After some simple experimentation, the answer was 'No, they don't'."

"And how does that relate to this?" Harold asked.

"Well, you were asking the question 'How can we make this wormhole bigger so we can use it for space travel?'. I asked the question 'How can we use this wormhole for space travel?'"

Still smiling, Bruce grabbed a hand-hold and pulled himself through the doorway out of the observation blister. The other American Spacecraft representatives drifted out after him. Before leaving, Harold looked again for the test vehicle. It was now a tiny point of light, like Venus in the morning.

Out beyond, a ship marked with the name 'Galileo' was crossing the orbit of Mars. It was still accelerating.

The End

[Return to](#)