

Impact Parameter

by Geoffrey A. Landis

1. Parameters of the Problem

The terminal whistled for his attention, a theme by Paganini in E-flat. Ben got up and stretched, trying to clear the fuzz out of his brain. He hadn't even realized he had been napping. It seemed that he was just about to say something to Barbara, something important, and now he had forgotten what it was. He shook his head and smiled as he walked over to the coffee pot. He hadn't been married to her for well over five years.

It was almost four in the morning. His guaranteed-observer time, two hours on the three-meter gamma ray observatory, came when scheduling bureaucrats said it came, not when it was convenient. Smooth-talking astronomers with billions in grant money and lecture fees got the convenient times. With the low priority and ragged funding of Ben's project, he was lucky to get on the GO list at all.

Time to get moving. He started the coffee dripping and went to his computer. While the previous run was finishing, he put a request into the satellite's command queue for it to locate and lock onto his guide stars with the finder scope. He pulled the celestial coordinates out of disk and uplinked them to the satellite, then sat back to wait.

As soon as he leaned back in the chair, Rajiv walked in. Ben looked at the clock. Four on the nose. "Right on time."

"We are working together so long, are you still thinking I would be late?"

"You, late? Never."

The console whistled again, a theme from Paderewski in a minor key. He looked at the message. The computer had found his guide stars, but one of them was not quite in the position he had specified. He downlinked a visual. There was his guide star, Omicron Ceti, with the reticule showing its starchart position in the center of the screen. The star was noticeably off the crosshairs -- five microradians, maybe more. Ben pounded his fist on the console. "Damn you, why can't you work right just one time, just one lousy time?"

"What is the problem?" asked Rajiv.

"Damn star in the wrong place."

"Oh, but that is not possible, surely, no? How could a star be moving places?"

"Oh, the star's in the same old place, Raj, you can bet on it. The damn satellite is out of alignment." Most likely the satellite position sensors had drifted again.

Rajiv frowned. "We will be recalibrating? Or perhaps we just observe and let the maintenance people do their job on their own shift?"

Ben looked at the schedule. Recalibrating would take half an hour, a good quarter of his week's observing time, and it wasn't his job. The maintenance and calibration people had huge blocks of time, why couldn't they do their job right? Damn it, the telescope had been calibrated just three days ago. It wasn't fair. Every instinct told him to let it slide, to let somebody else do it. His project didn't require

absolute positions anyway. He was searching for modulated gamma-ray laser signals from alien intelligences, and his search area was big enough that it really didn't matter if the absolute pointing was off by a tiny bit. When he found a signal, a real signal, then he could go back and calibrate the scope.

But in twenty-two years of searching they had never found a signal.

He'd been with the old radiotelescope SETI group at Arecibo, listening in to the stars for alien radio messages, hearing only the ocean-roar of static and the atonal singing of hydroxyl radicals. He'd been part of a fruitless search at optical wavelengths, looking for alien lasers. Infrared and UV, no luck either. Slowly the search had progressed up the spectrum. Not very many astronomers were left in the SETI camp; most of them had drifted off into other fields when success never came. Ben was one of the last. He had made a case that aliens could be sending their messages at the extremely high energy end of the spectrum, using gamma-ray lasers to send narrow-beam look-I'm-here messages. It was enough of an argument that he'd gotten GO status on the gamma ray satellite, but not enough to climb the priority queue.

But knowing there was a problem with the telescope and not fixing it was something he just couldn't do. It would just shuffle the problem onto the next observer, who likely needed the time just as badly as he did. He sighed. "Boot up the calibration procedure, Raj. I'll message the institute, tell them we're using a chunk of our time to do their job. Maybe they'll look fondly on us and give us some time out of the TOO register later in the week, huh?"

Rajiv brightened up. "Really, you are thinking so? That would be very considerate of them, yes indeed. Surely that is what they will be doing, you are quite right."

Right, hell. There were a hundred observers fighting for scraps of time on the satellite.

But it had to be done. He might as well feel virtuous about doing it. He and Rajiv buckled down to work.

Half an hour later Omicron Ceti was still out of position. The telescope was working flawlessly. Rigel, Aldebaran, Fomalhaut; all the calibration stars were rock steady. But Omicron Ceti was still out of place.

He sighed. He'd never succeeded in recalibrating his ex-wife, either.

"It is maybe a software error?" asked Rajiv.

"Maybe," said Ben. "I can't make myself believe it, though. A software error that would just move one star? Unlikely. Next to impossible."

"Is there something peculiar about this star?"

"Nothing I can think of. Red giant, maybe seventy, eighty parsecs away. Not the type of star we'd ordinarily look at -- if it had planets, it swallowed them thousands of years ago when it went into the giant phase."

"Nobody could be moving this star?"

Ben laughed. "No. No way the star could move."

"And so what we are doing next?"

Ben sighed. "Hell, I don't know. Check it on one of the other 'scopes." He called up the listing of

astronomical satellites and printed out a hardcopy of the list. "Looks like we could request target-of-opportunity time on Herschel." He shook his head. "Buddy, we sure are going to look like fools if there's something obvious we missed." He picked up the phone.

The scheduler was obliging. "Omicron Ceti? No kidding? Sure, we can get you TOO time -- it's a snap. Why don't you ask Harvard Astrophysical, though? They just requested target-of-opportunity scheduling on Herschel twenty minutes ago to look at Omicron Ceti. What is it with this star, anyway? Can you tell me? Hello? Hey, are you still there?"

Ben put down the phone and crumpled up the hardcopy. "Looks like we're on to something. And we've been scooped." He sighed. "Might as well go ahead with what's left of the usual session, Raj. Maybe we can salvage something out of the morning."

* * *

The Harvard astronomer was Janilee Stormer, an old gamma-ray astronomer from the pre-satellite days when they still put telescopes on the peaks of mountains. He knew her slightly from seminars. He arranged to meet her for lunch in Harvard Square. He spent the morning calling up archived photos of the region, trusting her to make the proper measurements during her observing run.

She'd already ordered when he arrived. She handed him a stack of hardcopy without a word, and started her lunch as he leafed through her data.

At last he dropped the data on the table and looked up at her. "Any idea what it is?"

"None at all," she said. "You saw the spectra we took. Normal."

"We got some old pictures out of the archives for comparison."

"Good. I put in a request for that, but I've been too busy to get to them. Find anything?"

"Yeah. It's right at the limit of resolution, but by my best guess, this has been going on for five years, maybe a bit more. Right about five years ago the star started drifting slowly out of position."

"Hmmm. Funny." She sipped her hot chocolate. "Have you checked the background stars yet?"

"No, I haven't. Why? Have you?"

"Just an idea. Tell me what you find, will you? Get together again about eight?"

"Right-o."

"Good." She gathered up her data and left. He hadn't even ordered yet. He decided that he wasn't interested in lunch anyway, and went back to his lab.

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He compared the most recent star photo with an old photo from the archives. When he overlaid the two, it was quite obvious that all the stars in the region were affected, even background stars thousands of parsecs away. In a tiny region of space, only a few seconds of arc across, some cosmic hand had nudged all the stars away from one spot in the sky. More peculiar, one faint star had disappeared entirely. It would have been exactly in the center of the avoided zone.

He had Rajiv print out an extra hardcopy of the overlays and brought the photos with him when he met again with Stormer. She brought out her own data, a computer plot where the distance of displacement

had been plotted against the distance from the extrapolated center of the anomaly. Clearly, the closer the stars were to the center, the more they had been moved to the side.

"What about the missing star? What happened to it?"

She smiled. "Take a look at this one. I had the Herschel integrate the photon count over a ten minute interval, editing out the foreground stars." She showed him a photograph. The background was a chaos of irregular brightness. He could almost see the pattern, stars toward the center smeared away in a thumb-sized circle. "And the missing one?"

She reached over with a fork and traced out an arc. "Here."

Once it had been pointed out, he could see it clearly. A narrow ring surrounded the blank spot, so faint as to be almost indistinguishable from the noise of the photo. He traced the circle all the way around. "My god. An Einstein ring."

"Bingo. We've found ourselves a big ol' gravitational lens."

"It must be incredibly massive."

"Or incredibly close. But what's causing it? Brown dwarf? A neutron star?"

"My god, Jan, that's not the real question." He spread out his photos, ordering them from oldest to most recent. Over the last five years, the anomaly had been growing stronger, but the center stayed firmly in the same region of Cetus. "No proper motion. Whatever it is, it's coming right at us."

"Have you told anybody yet?"

Ben shook his head. "My graduate assistant Rajiv knows."

"Same here. Let's keep this quiet a bit longer, okay? Until we know a bit more?"

"We'll need to bring an astrophysicist in on it."

"I have one in mind. A relativist, too. What I meant, let's not spread it around too much outside just yet. Maybe there's something we're missing."

Ben shook his head. "I hope so. I really hope so."

* * *

Ben reserved a small conference room in the physics center for the discussion. One by one the various participants arrived. When the last had entered, Dr. Stormer closed the door, walked to the front of the table, and started the discussion without any preamble. "We have now searched for an object in the center of the gravity lens in every wavelength range available," she said. "If it were a brown dwarf, we'd see it in the IR or microwave. A neutron star would shout out across the spectrum. Nothing. I think we can confidently eliminate everything except a black hole."

"Everything we know of, that is," said Ben.

"It's invisible, it's massive, it bends light -- what else could it be?"

"I don't know. Just covering the bases."

"But a black hole would be having an accretion disk," Rajiv said. "Such a thing would be jumping with

gammas, no? Are we seeing nothing in the gamma ray spectrum?"

"No." Dr. Stormer sketched a circle in the air with her forefinger. "Nothing there but cosmic background."

"Doesn't mean anything," said the astrophysicist, Tim Deloria. He was a tall, dark-haired postdoc wearing a gold earring and a leather vest. "If it's a mature hole, and hasn't passed through a dense gas cloud in the recent past, it might not have anything to accrete."

Isu Yokomono, the relativist, cleared his throat and spoke. "I have plotted the gravitational lensing effect against theory." He tapped his keypad to flash a slide onto the screen. "As you can see, the agreement is excellent, except at very low impact parameter. Tim suggests this may be a refraction effect from compression of the interstellar medium near the hole. He's working on a model. I can't give you a good value for the mass until you can give me a distance, but the best guess would be between point one and point oh one solar masses, which I am told is unusually low by astrophysics standards."

"Ben?"

"Right. It's hard to measure distance of something we can see only by looking at where it isn't, but we've managed to make tentative parallax measurements from the archive data. About a thousand astronomical units."

Somebody whistled. "That close? Are you sure?"

Ben shook his head. "I'm sorry, folks. It doesn't matter just exactly how far it is. What matters is how fast it's coming."

"And that is?"

He put his graph on the screen. The line showing the projected trajectory neatly cutting across the Earth's orbit. "Give or take a small margin of error, in ten days the black hole intersects the Earth."

"How much is the margin of error?"

Ben shook his head slowly. "Not enough, gentlemen. Not enough by half."

* * *

When evening fell Ben went out into the apartment's tiny back yard. The lawn was unkempt and the grass choked with weeds. No point in fixing it up now. He set up his little telescope next to an abandoned washing machine and with little difficulty found Cetus low in the east. Cetus was more familiar to him than the yard was; for decades they had searched the star Tau Ceti at every frequency for every modulation scheme they could think of. Omicron Ceti was lost in the haze of the horizon and the skyglow from the city. It didn't matter; there was nothing there to see with his little telescope anyway.

Day by day the anomalous region grew larger. The amount of distortion in the starfield was minute, far too small to be visible with the naked eye, but knowing exactly what to look for, the effect was enormous and ominous.

They met four days later to discuss their most recent results.

"Can you tell us just what, exactly, is going to happen?" Ben asked. "Tides? Earthquakes? What?"

Tim looked at Isu. "It's coming a little too fast for us to see much in the way of prelude effects, I think."

The exact details will depend on the impact parameter. For all of the scenarios, we'll get the atmosphere ripped off first, of course."

"And the oceans," said Isu.

"The planet then gets stretched out like a sausage."

"Like pulling on silly putty," said Isu. He smiled. "At this point viscous mantle material oozes out through the cracks in the crust, like stepping on a tube of toothpaste."

"More likely the frictional effect just melts the crust," said Tim. "After this, at low impact parameter, the planet breaks up. Somewhere between half and ninety percent of the material forms a ring around the hole and gets slowly swallowed, while a small portion gets sprayed out into space in the form of droplets of magma. Presumably these then cool into asteroidal material, unless they're flung entirely free of the sun. At higher impact parameter the planet simply gets stretched out into a sausage and breaks up into droplets. This effect is rather interesting, actually --"

"I think I get the picture. Any chance of surviving?"

Tim shook his head. "Even at the three sigma point, the atmosphere gets ripped off."

"Oh."

The room was quiet for a moment.

"It's too damn unlikely, you know?" said Tim. "To be coming right at us, right exactly precisely at us -- give me a break, will you? That's not coincidence, that's conspiracy. Here's what I think. I think that we've been polluting the galaxy with radio waves, old Happy Days reruns, My Favorite Martian, Days of Our Lives, that crap, and I think that somebody out there just got pissed. In the radio spectrum the Earth is brighter than most stars, you know that? We put out megawatts, gigawatts of garbage. I think somebody got so tired of old Gunsmoke reruns that they just lobbed a black hole our direction, no offense buddy but just shut up permanently, okay?"

"You don't really believe that, do you?" said Ben. "Any civilization that had the ability to push around black holes...."

"I know, I know. You'd think they'd talk to us first, and you've been looking, and they're not talking. Hell, maybe they're just the silent type. Maybe they're critics. I don't know."

Isu cleared his throat. "In any case, I think we have quite enough data to publish," he said. "Should we prepare a press release first? I think on this one we may get some attention."

Jan looked at him with contempt. "It's a bit pointless to do that, don't you think?"

Isu shrugged. "I don't see why not."

"I can," said Tim. "Why get everybody upset over something they can't do anything about? I'd say we should very definitely not tell anybody. Keep it close, or there'll be panic in the streets. Chaos."

"Heck, that's not half of it," said Jan. "Do you really want to spend your last days giving interviews to reporters? Think carefully. You know what it's like being followed around by cameras? Explaining the same basic principles of physics over and over to people who wouldn't understand them if you pounded it into their skulls with an air-hammer? Living without any privacy at all, with reporters camping in your living room, following you everywhere, into bed, into the bathroom?"

"Yeah," said Tim. He made a face. "Interviews on television shows with psychics who said that they predicted this ten years ago and it will go away if we all think rosy thoughts and chant Om."

"And holy-rollers who say that it was all revealed in the Bible, but don't worry because the faithful -- of their particular faith, that is -- will be saved," said Jan. "Dimwits who tell you that it's all the scientists fault; if we had never invented black holes in the first place everything would be fine. No, thanks."

"I didn't think of that," said Isu. "You really think people would panic? Okay, okay, maybe you're right. It's too bad, though -- the first thing I've ever been on really hot. It just seems we ought to tell somebody."

Jan shrugged. "Anybody else think we should go public? Take a vote on it?" She looked around. Nobody spoke up. "I think it's settled, then."

"But this thing, it is going to kill us," said Rajiv. "Is there nothing that we can be doing?"

The room was silent. Finally Ben answered him. "Afraid not, Raj. It's just too big. There's no handle, no way to get a grip on it. We're like an ant about to get stepped on by an elephant -- maybe we can see what's coming, but that's not going to stop us from getting squished."

"It's the cosmic lottery," added Tim. He shook his head. "And we just went bankrupt."

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2. Just Before the End

And then there were only a few days left. The project team has stopped meeting regularly. There was nothing left to do. "It's the end of the world, Ben," the astronomer Jan said. "What are you going to do?"

"Party?" he answered. "I don't know. How about you?"

"Abandon my diet, that's for sure." She laughed. "Clean my desk. I'd like to face my maker with a clean desk."

"Think you'll find anything interesting?"

"I don't know. That's what's so exciting. On the other hand, I've been thinking that maybe I'll just clean it right out the window. What the heck.

"And after that, I think there are a few people over in administration I'm going to tell exactly what I think of. Something they've been needing for a long time." She smiled. "I thought about taking my pistol -- I shoot every weekend, did I tell you? Third in the state championships -- I was thinking about some live target practice using administrators for targets. But I figure, why bother? They'll be dead in a week, too."

Ben laughed. There was a bit of life in the old astronomer after all. "You going to tell anybody? Your family?"

"God, no! It would only get them upset -- why make their lives miserable now? Hell, if I tell anybody, I'll tell somebody I detest."

"Makes sense. How about you, Raj? What are you going to do?"

"I am going home to India. I will see all my friends again, my cousins and grandparents and my two little nieces. I will bring many many gifts for them. Oh, they will be so happy to see me! Yes."

"Yeah?" Ben raised an eyebrow. "Where'd you get the cash to buy a ticket?"

Rajiv smiled. "I am borrowing money on my credit card. Low interest, two years to pay."

"Why not? Guess you can do anything you want. Rob a bank. Why not just steal a Learjet -- what are they going to do, kill you?"

"Oh, no -- I would never rob a bank. That would be quite dishonest. How could you think that of me?"

Ben patted him on the arm. "I know, Raj. Have a good trip home."

As he was leaving, Ben ran into Tim and Isu. Tim was holding a bottle of wine, Isu a pile of books and papers. "I'm just in to pick up some of my stuff," said Isu. "Guess I won't be around for the rest of the week -- for the rest of my life, for that matter."

Ben shrugged.

"I wrote a haiku. You want to hear it?"

"Sure."

Tim handed Isu the bottle of wine.

"Thanks, pal." He took a sip, handed the bottle back to Tim, and cleared his throat. "Singularity:

"This is it.

"Nothing else you ever did matters

"The place where all your words mean nothing

"Doorway to forever...."

Isu paused and looked at Ben. "You like it?"

Ben shrugged. He never could find much to say about poetry. "Aren't Haiku supposed to have only three lines?"

"So I'm not a purist. You don't like it, sue me."

"Hey, no problem. So -- you have plans yet how to spend the last week?"

"Sure. Yesterday I went to church. The Baptist church on Boylston, and the Epis -- Episcop -- Episcopalian church downtown. Tomorrow I'm visiting the Bahai temple and the Quaker meeting. Sunday I'll get baptized."

"Covering all the bases, huh?"

"Oh, no, there are many more. I have much studying to do." He smiled ruefully. "The final exam is coming, and I've been skipping my homework."

"Yeah. Well, I guess it's your last final, anyway. Hope you do well on it." They shook hands.

"How about you, Tim? You going with Isu?"

"Heck, no. I've already got religion." He winked. "Her name is Candy -- can you believe that? Candy?"

No baloney." He shook his head, and took a sip of wine. "For the rest of the week, you can bet your ass I intend to worship at her shrine as often as possible and in as many different positions as I can think of. When the end of the world comes, we're not even going to notice it."

"Uh, I'd think that there was only so much of that you'd be able to do."

"Yeah, maybe -- so I'm going on an all-oyster diet. How about you, Ben? You got some body-heat you can turn to for a little comfort for the dying?"

"Uh, guess not. No."

Tim clapped him on the shoulder. "Hey, no crime, buddy. Some guys got it, some don't. Tell you what you do. Find yourself a high-priced downtown call-girl, one that takes plastic, and rent her for a week. You know what I'm saying? I tell you, you will forget all about the end of the world, guaranteed."

"It's a thought."

"Righto. Gotta go, got something to put in the oven, so to speak."

"See ya."

"I doubt it. Have a good life." He left.

Ben walked out the door, and realized that there was nothing he wanted to do, no place he wanted to go.

He could go home, he supposed. Tell his family he loved them, tell them goodbye. They'd be surprised to see him, but glad, of course, in their low-key fashion. But what would he tell them? Was there any real point in telling them the world was ending in a week? It could only upset them.

Religion wasn't for him, either. Try Tim's solution? One of the graduate students, maybe? That kind of thing was rather frowned on by the admin, but what could they do, fire him? But the students had lives of their own that he was mostly ignorant of. He wouldn't even know where to start.

On an impulse he called up his ex-wife Barbara.

"Ben? I don't believe it. Are you drunk or something? High?"

"Is there some law I can't call you? I just thought I'd like to see you again. Is that a crime?"

She was silent for a long time. "It's been a long time, Ben. I don't know. Are you sure you want to stir up those old ghosts again?"

"I remember some good times. Don't you remember the time we went walking down the old boardwalk on Revere --"

She laughed. "Gosh, I haven't thought about that in years. And the abandoned roller-coaster. You think it's still there?"

"I think it got washed away a long time ago, when the water started to rise."

"Yeah. A lot of things got washed away. Too many things."

"So, how about it? For old times?"

"I just don't know. I don't think it's such a good idea, Ben. I mean, but, well...."

"Uh, I guess I should have asked. Are you, ah, seeing somebody?"

"Well... yes. Sure, lots of people. Not the way you mean it, though. I've got my circle of friends. It's enough."

"So, why not? Just this one time, I promise. Please?"

"Well... okay. You know where I live now?"

He stopped on the way for a bouquet of flowers. He picked out two dozen lilies, all colors, charging them on his card.

She was a little older, a little more weathered than his memory. Her hair was long now, a thick braid tossed casually over her left shoulder, but still as deep a shade of black as ever. He handed her the flowers. "You're looking good."

She hesitated, but finally took them from him. She thrust her face into the bunch and inhaled deeply. "I always liked lilies."

"I remember."

"Here." She handed the flowers back to him and went into the kitchen for a vase. He looked at the posters. They were different from the movie posters she had when he married her, but the same types of old movies. Casablanca. Gone with the Wind. Jewel of the Nile. She came back with an enameled brass vase, one he'd brought back for her once long ago when he'd gone to India for a conference.

"You still have that? You said you threw out all my stuff."

She shrugged. "I lied. I always liked that one."

"I know something else you always liked." He took her in his arms. As he leaned over to kiss her she turned her face aside.

"Oh, Ben... I'm not sure this is a good idea. We don't have that type of a relationship any more. Ben...."

He brought his hand up and traced the line of her jaw with a fingertip, lingering at the hollow of her throat. "Just this one last time."

"Well... okay." She tipped her head back, and he kissed the tip of her nose. She giggled. "I guess sometimes maybe I do miss you. A little bit."

* * *

The morning sunlight was faded and tinted vaguely pink. The cat sleeping on the windowsill stretched, blinked, turned around to center herself more fully in the faded sunbeam, and went back to sleep. Barbara looked at him. "That was nice. You can be so nice sometimes, I almost miss being married to you."

He didn't say anything, just continued stroking her breast slowly, almost absently, with his hand.

"But you were always self-centered. Sometimes you would just ignore me, treat me like an object."

"I guess I was busy."

"Oh, yes, busy watching for your aliens. Busy? You were obsessed. Imagine, fifteen years ago I thought that a man with an obsession was sexy. All that intensity. Damn, I was naive." She rolled out of bed, searched around on the floor for her panties, pulled them on and then looked around for her bra.

"In the living room, remember?"

"Oh, yeah."

"Barb? Would you stay with me?"

She walked back into the bedroom and looked him in the eye. "No."

"Please? Just for a while?"

"You always were a little hard of listening, Ben. No. I remember too much of what it was like. I'm finally doing what I want, and I like it fine. No. Period. Final."

"Please?"

"Five years, Ben. So why all of a sudden?"

"Because the end of the world is coming, and I don't want to be alone." His voice sounded childish, even to himself. He hadn't meant to say it. It had just sort of slipped out.

She laughed. "I can't believe it. You, getting religion? You always were one to go diving off the deep end. Remember what the marriage counselor told you, way back? That you ought to try talking with a therapist, it would do you good? Maybe she was right. You might think about it.

"I told you, Ben. The night was fun, it really was. You can be sweet sometimes. Don't spoil it, okay? If I stayed with you, we'd only get back into the same old rut. I couldn't take it again. So let's just say goodbye, okay?"

He sighed. "Okay." He paused. "Then one last breakfast at the Crêpe Stop?"

"No more talking foolish? No pressure on me?"

"Not if you don't want to."

"Okay. But after that, I'm going."

The day had not yet built up to the furnace heat of a Cambridge summer, and they found an empty table out on the boardwalk. It was built up almost a foot above the old street level. He looked out across the water.

"The blue of the sky," he said, suddenly.

"Huh? What about it?"

"How blue, so poignantly blue it is. Nothing else is quite that color, so vibrant, so full of life."

She shrugged. "I suppose it is. Not any more than any other day."

"I never notice. Every day I walk to work, the miracle of sky is luminous above me, and I never even look up. So many things. Look." He gestured at the buildings across the way. They were dilapidated brick apartment buildings, the upper stories faced with wood. "Look at them, really look. Look at the

color and texture of the brick. The brickwork. Look at the carvings on the lintels, on the cornices. Just old buildings? Look at the work some ancient stonemason did, long ago. You can see the love and care he put into the job."

"Irish," she said. "The old stonemasons were Irish and Italian. My mother told me that once. I guess you don't see workmanship like that any more. Today it's all aluminum and plexi boxes."

"And we walk by it every day. That building, that tired building with peeling paint and clotheslines on the roof flying somebody's flowered sheets, that's what it is to be human. It's beautiful, beautiful."

"And listen." He was silent for a moment. Behind the traffic noises, the babble of conversations around them, the lapping of wavelets against the boardwalk, was a soft trilling chireep, chireep, chireep. Tiny frogs. Spring peepers? He'd heard them every spring, but never bothered to look up what they were. Since the waters had started to rise they were peeping all through midsummer. "The sounds of life, just singing its joy at being alive."

"My, aren't you poetic today." She was silent for a moment. "You really believe it," she said softly. "You really do believe that the world is coming to an end."

He nodded. He couldn't trust himself to say anything. His eyes were full of tears.

"What will you do when it doesn't? When the end of the world comes, and the world doesn't notice, just keeps on going?"

"I wish I could believe that, Barbara. But it's coming. There's nothing we could do to stop it."

"But what if, just suppose, it didn't? You won't do anything foolish, will you? You'll see a professional then, won't you? Please? Promise me?"

He smiled. "Barbara, if the end of the world doesn't come, I'll laugh out loud. I'm going to hug everybody I know. I'll parade naked down the middle of the street in front of the State house playing a trombone, at noon. And I'll never, not for one day, forget to be glad I'm alive."

She shook her head, vagrant wisps of hair blowing across her face. "Sometimes I really like you, Ben, in spite of all the bad times. I really do. Take care of yourself, will you?" She blew him a kiss and walked away. A block down the boardwalk, almost lost in the morning pedestrian traffic, she hesitated and looked back. He waved, and she turned and disappeared into the crowd.

"Goodbye," he said. She'd left her crêpe untouched.

* * *

He'd spent so long at the telescope listening for voices. They weren't there. Or if they were, they weren't talking. Maybe everybody was listening, nobody broadcasting.

He'd had an uncle who had spent his life looking for little green men; under the bed, behind the curtains, in the bottom of a whisky bottle. He'd said they were beaming messages into his brain, that he heard them every day. "Eccentric," the family had called him on good days. "Crazy" on the worse days. He'd finally allowed himself to be put away. But at least he had heard the voices he'd spent his life searching for.

The facility at Arecibo had been mostly shut down by the time he'd left. There was little it could do that couldn't be done better by one of the radio interferometers in space. But he still had the access codes from his time there, and he doubted that they would have changed them.

They hadn't.

He had trouble deciding what to broadcast. At first he thought the Encyclopedia Britannica would be best, but at the last minute, after accessing the Arecibo computer and programming his request, he changed his mind. Somehow something as dry as the encyclopedia didn't fit his mood. He chose Mahler, the crazy, romantic old Austrian, to tell the universe that once there had been a planet with life and intelligence, and occasionally a little bit of wisdom. As the Earth slowly turned, it would be broadcast out across the entire sky. Maybe sometimes we did make a mess of things, he thought, but we could love life, too. The universe may crush us, but we had style, damn it. We were here. Where were you? Where the hell were you?

* * *

One day left. He tried calling Barbara again, but there was no answer. Perhaps she'd unplugged the phone. He called his parents, and his sister, but found he didn't have anything to say. He had never been very good at long phone calls. He settled for just telling them that he loved them.

"Why, thank you, Benjy," his mother said. "That's very nice. And we love you, too."

He walked the streets of the city, not going anywhere in particular, just taking in the sights and sounds of life. It really was beautiful, he thought. Even the discarded papers swirling in the wind were beautiful.

Mists rose from the canals as night fell over the city. He was in a part of town he wouldn't ordinarily think of walking in at night. Neon flashed from the bars at every street corner. Fragments of music and rapid women's conversation in some foreign language spilled out of open doorways. Three Cambodian men in tee shirts sat on a doorstep drinking wine and talking. They stopped talking to watch him pass, and one of them called out. "Hey, brother, how's it going?"

"Fine," he said. "Everything's fine. How about you?"

"Doing okay, yes, think I'm doing okay, thank you."

He walked on.

He thought for a moment that perhaps he should be at the observatory, taking notes on the approach of the black hole right up to the end. Like a good scientist. Hell with that.

He'd never been much of a drinking man, even in grad school, when the Friday night parties were about the only entertainment around. But it seemed he had to do something to celebrate, no, to memorialize the last night of the world. He stopped in at a liquor store. He wasn't sure what to get. Champagne, certainly. He wasn't sure if he could tell one from another, but he picked the most expensive. It was a week's salary. Some hundred year old brandy. Bailey's Irish cream -- that had always been Barbara's favorite. Why not? He grabbed a dozen other liquors, picking them for the oddly shaped bottles and interesting names. He'd never get another chance to try them. He brought the collection to the front.

"End of the World Coming, Says Harvard Astronomer," proclaimed the tabloids at the checkout counter. "Black Hole Will Swallow Earth." He laughed, quietly at first and then with an almost hysterical energy. So Isu had spilled the news after all -- and nobody cared.

The cashier looked at him, and at the assortment of liquor, with a dubious stare.

"A going-away party," he said. "So to speak."

She shook her head. "Odd selection. Some party -- you started early, eh? Well, hope y'all have fun,

y'hear?"

"I hope so, too. Say, you do take credit cards, I assume?"

* * *

3. The Day the World Ended

He woke up groggy and nauseated. Painfully bright sunlight was streaming in the window, and the doorbell was ringing insistently. It took him a moment to realize that the ringing was real, and not part of the painful confusion in his cranium.

He hadn't expected to wake up at all. After a moment he recognized the voice of his neighbor from upstairs, an old Mexican immigrant who sometimes came over on Sundays to share the newspaper.

"Hello? Hello?"

"What is it?" he shouted back. His voice was more of a croak. He found his pants and pulled them on.

"Aren't you awake? God, you missed it! It was incredible!"

"The black hole?" he said, confused. It just passed by? How could it?

"What are you talking about? The parade! I thought everybody in Boston was there!"

"Parade?" Now he was more confused than ever. "What parade?"

"Haven't you even seen the news? Join the real world, Ben! They're here! Aliens! From outer space!" He went over to the window and flung back the curtains. "Look!"

In the distance, something floated over Boston harbor. Ben squinted. A giant balloon? It was hard for him to focus. Then he caught the scale of it. It was floating behind the towers of the financial district, and, whatever it was, it was huge. It was no balloon the world had ever seen. He suddenly realized the alienness of it. It was nothing at all the world had ever seen. He felt an uneasy feeling in the pit of his stomach. All his life he had spent searching for aliens, and here they were. He turned away from the world, childishly afraid to show his tears. They were here. Nothing would ever be the same again.

"But... the hole," he said, stumbling over the words. "What about the black hole?"

"Hole? Oh, you must mean the loophole? That's right, I remember. The teevee man explained something about the loophole. They brought it with them. It's a, uh, a "loophole in the theory of relativity..., right. What allows them to travel. I forgot the details. They said it would be parked somewhere out by Saturn or something, we could use it if we want to."

He remembered now. Wormholes, he'd heard them called. A wormhole was precisely the same as a black hole from the outside, but deep inside, at the throat, a wormhole connected to another wormhole somewhere else, instead of to an infinitely dense singularity. Back in the 'eighties a couple of physicists had claimed that a sufficiently advanced civilization might be able to make a wormhole and keep it open, use it to travel across interstellar distances. It had caused a stir at the time, but was eventually forgotten.

It made sense. It all made sense. While he had wasted his life listening to the sky, desperately listening for a distant voice, all that time they had been coming. Why beam radio waves when you can just bring a loophole and get there in an instant?

On an impulse he hugged his neighbor. The old man was surprised, but after a moment he hugged Ben

back. "It's wonderful," Ben said. "It's the end of the world, it really is."

"Ah, the world ends every day," the old man said. "The secret of it is, it is made anew every morning."

"That's deep."

The old man nodded. "Something my father used to say, long ago."

Ben realized that the job he'd been doing all his life had become obsolete overnight. He could do whatever he wanted. Sail around the world. Climb Mount Everest. But first he had a promise to keep.

He hadn't missed the parade. He'd be a little late, that's all. He would be his own parade, down the steps of the state house at noon, celebrating the way the world had been born again.

"Say, you wouldn't happen to have a trombone, do you?"

The old man only gave him a puzzled look. Skipping to the tune of an old childhood song, Ben danced out the door, laughing like the world was new.

And it was.

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