

COOL NEIGHBOR

by Michael Shara and Jack McDevitt



Illustration by Broeck Steadman

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The best legacies may be things of no immediate obvious value.

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Greg Cooper had been sitting in the control center of the Weber gravity wave observatory, eating popcorn and calibrating *Icewave*, when he realized he had about a minute to live.

He'd been writing a letter to Kristi Lang, hinting at the discovery he was about to make public, and suddenly it was over. The order-of-magnitude calculation took ten seconds, and told him he was a dead man. Bad karma. He choked off a wave of panic and self-pity. No time for regret. He knew exactly what was coming. The portholes would fluoresce ferociously, down-converting the X- and gamma rays to optical photons for a few spectacular seconds. The last thing he'd ever see.

Warn the people on Clarke: get the tourists back inside.

He opened a channel. “Mayday, Ana, Mayday. Incoming hard radiation. Get everyone back onboard, into the shelter. Do it now!”

Five kilometers away, Ana Vassileva, the observatory manager, gaped at the transmission. The real-time solar X-ray images and radiation monitor live-feed were working perfectly. It was near solar minimum, so Ana wasn’t surprised to see nothing at all brewing on Sol. “What are you blathering about, Greg? I haven’t seen a sunspot, let alone a serious flare, in weeks. Sol’s asleep.”

“Ana, the local spatial strain went totally off-scale twenty seconds ago ... a gravity tsunami just went by. Einstein never dreamed something this big could happen. There’s a gamma ray burst right behind it. Get everyone into the shelter!”

“My God,” she said, “Marnie’s out there in the shuttle.”

Ana wasted no time. She hit the alarm and klaxons sounded through the station and its cash-cow hotel. Tourists dropped everything, crowded into the passageways, and headed toward the water and lead-lined chamber nestled in the heart of Clarke. A middle-aged woman with blonde hair askew grabbed Ana in the hallway. “What’s going on?” she demanded. “This had better not be a drill, dammit, we had one yesterday.”

“It’s okay,” Ana said. “Just hurry, please.” She needed another twenty seconds to reach the Shuttle Control Center.

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In the cockpit of the shuttle, Marnie Leeds had backed slowly away from Clarke, allowing her French Canadian guests to ooh and ahh at the view. The hotel-spa was shaped like a clamshell, with ceiling-to-floor windows on the concave side facing Earth. Many tourists spent their entire time on the station savoring the sight, reluctantly leaving the picture windows only to sleep. The Neugebauer Infrared Array hung four hundred meters above the hotel. A thirty-meter telescope anywhere is a remarkable sight, but permanently perched thirty-five thousand kilometers above Africa, it was riveting. The segmented primary mirror glistened with a yellowish hue from its bacteria-thin gold coating.

She looked down at the carbon nanowire space elevator cable, which snaked from the geosynchronous station to the summit of Kilimanjaro. Nearly cloud-free today, the continent was framed between

the Atlantic and Indian Oceans. Marnie activated the shuttle's electron beam pointer. She highlighted Cairo, Algiers, Casablanca, Gibraltar, Abidjan, Lagos, Kinshasa, Capetown, Dar es Salaam, Nairobi, and Addis Ababa, circumscribing the cradle of mankind in less than two minutes. Her passengers responded with delight. She opened a channel to Ops. "Shuttle One to Weber. We're on our way. ETA twenty minutes, over." Whichever astrophysicist was on duty in the gravitational wave telescope, he or she knew well in advance when tourists were coming. Marnie always hailed them anyway. Tourists were a minor time-sink for the scientists and techs, but their steady revenue stream was a godsend, so they were treated like visiting royalty.

Of the whole crowd that rotated in and out of the Weber, she most liked turning the tourists over to Greg. He was one of the few scientists on the project who really enjoyed engaging the public, and he did it with wit and charm. Kids initially reacted cautiously to his sharply chiseled face and intense eyes. His captivating talk of voracious black holes, punctuated with energetic violin playing for illustration, had them pleading for more by the end of a tour. Marnie relished his enthusiastic explanations of collapsing stars and warped spacetime. "The life of every star is a war between gravity and pressure," he inevitably began. "Hydrogen fuses into helium. Then the helium fuses into carbon and oxygen. That supplies the outward pressure to balance the crushing pull of gravity. Gravity is the stellar angel of death." All the while accompanying himself on the fiddle, he usually made a scary face with that one and the kids whooped. "Gravity always wins when a star's nuclear fuel is exhausted."

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"Negative, Marnie." Greg's voice, unlike she'd ever heard it before. "Radiation surge coming. Didn't Ana get to you yet? Go back to Clarke. Get everybody under cover."

"Greg, when?"

"Now, goddammit. Do it now."

She switched over to the passenger comm system. "Everybody belt down."

Moments later Ana was on the circuit. Her voice stayed level, but Marnie knew frantic when she heard it.

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“Greg.” She was having trouble breathing. “Marnie’s got six aboard Shuttle One, two adults and four kids. She’s coming around. Headed back. Just a kilometer away. Three minutes out, tops. Shuttle Two’s still down. We’ll turn One around as soon as Marnie’s group is back onboard.” Her voice quavered. She desperately wanted to order Marnie and Shuttle One to pick up Greg. But even with her fiancée’s life at stake she knew the rules. Tourists come first, no exceptions. Ever. “Greg, what can we do?”

A long silence. “Ana, I haven’t a clue, sweetheart. I wish I’d said it more often, but you’re beautiful and I love you.” A pause. Then: “I think we’re at the end here.”

“There must be something—”

He went quiet again. “Give Kristi a hug. And listen; tell her to read her e-mail. It’s important.”

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Marnie pitched the shuttle 180 degrees in the ten seconds after she’d spoken with Greg. Guidebooks ricocheted off the cabin walls. Frantic yells came from the passenger section. “It’s okay,” she told them, while she turned sharply toward Clarke’s airlock. One of the kids started to whimper. “Hold tight, everyone. Brace yourself!” She gave it a solid thirty seconds of thrust. The sudden acceleration pushed them all into their seats. The shuttle raced back toward the hatch at an illegal fifty knots. The approach was slightly off-center. She tapped the port thruster, and was horrified to see it remain ON after she released the button.

The shuttle bounced hard off the emergency bumpers. Her head snapped sideways into a restraint. Metal tore. Thank God for the pressure suits. Marnie struggled to remain calm as the deploying airbags punched at her. Her youngest charge, Lissette, was screaming. The emergency lights glowed angry red, then failed as the passenger cabin split along its main seam. A hurricane of escaping air tried to suck out her passengers. They were all screaming now.

Stay calm, stay calm, stay calm.

Marnie remembered her training as the airbags deflated.

Don't panic.

Her suit was intact. So was everyone else's. She flipped on her helmet lights, unbuckling the six terrified tourists. Holding Lissette herself, she pushed and pulled the family toward safety. The airlock was meant for four. No time for that luxury. She jammed her six wards inside and pushed in after them. Ana's face was on the monitor, giving her a thumbs-up. The inner door closed on her arm and rebounded open. She tried again and held her breath until the hatch closed. The green lamps came on and she slapped the emergency re-pressurize knob. Air flooded the chamber. "Keep your suits on," she told everyone. When the pressure equalized, Ana yanked open the outer hatch. "Around the corner," she said. "Don't stop, keep going, turn right, thirty meters to the shelter." When one of the kids tried to ask a question, she simply shook her head. "Go! Go!" she barked.

Marnie watched her take a moment to look back at the wrecked shuttle. Ana bit her lip. Then she pulled herself into the shielded station core.

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Greg saw the seismograph needle twitch twice, then jerk back and forth with growing fury. The oscillations surged, and he watched the arm snap off in mid-swing. Pulling himself to the digital console, he read a peak strain of 10-17 on *Icewave*, his cryogenic diamond gravity-wave detector. *No way*, he thought. *Can't be that high. It must be a major system glitch.* But the hundred-kilometer interferometer gave him the same impossible result. "Savor this," he told himself. "You just recorded a gravity wave a hundred million times more powerful than any on record. The neutrino detector guys are about to experience the biggest flash in history. Incredible. Probably fry half their equipment." The cold realization that other, far deadlier radiation was also coming froze the thought and turned his face chalk-white.

It had been over a minute since the seismograph needle had sent its warning. The radiation monitors hadn't budged. *I'm not dead yet*, Greg thought. *It can't be a collapsing neutron star, I'd be toast by now.* "Ana," he radioed, "the strain is so big that it's got to be something nearby."

"What, Greg? What could it possibly be?"

"A supernova. Something massive. Maybe a Wolf-Rayet star. The core might have run out of nuclear fuel and imploded, but the star's outer

envelope runs behind the process. The gamma rays coming from the interior would have needed a few more minutes to break through the envelope. Call Kamiokande in Japan, okay?"

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"Kamiokande IV is reporting eight hours of right ascension, minus forty-seven degrees of declination," said Ana tensely. "Somewhere in Vela." It had taken her just a minute to reach the duty technician of the world's largest neutrino telescope. Its cubic kilometer of ultra-pure water was two miles underground to prevent false signals from cosmic rays. Most neutrinos raced through the entire Earth without being stopped. But a tiny fraction crashed into protons in Kamiokande's water, generating minuscule flashes of light. Many of the Japanese telescope's trillion photo-detectors had saturated during the neutrino onslaught, but the neutrino flash's position in the southern Milky Way was firmly in hand. "Plus minus two degrees is their guess, near Gamma Velorum. Roughly an hour before they can refine the position, but at 810 light years, Gamma's the closest Wolf-Rayet star in the sky. I wish that helped."

Maybe. At the moment, Greg had other priorities. "Okay, Ana, Thanks. It means I have a few minutes more. When Marnie gets back, if you could send the shuttle PDQ, I'd be grateful."

She was silent a long time.

And he knew. "What's wrong?"

"Greg, Shuttle One is scrap." She added a few details as she finished sealing the shelter doors. She was trying not to lose control in front of the bewildered tourists.

"No chance at all?" Greg asked.

"No," she said. "I'm sorry."

They were on a visual hookup, so she could see him. He nodded and pressed his lips together. Sometimes things like this happen. Nobody's fault. "It's okay, Ana," he said. "Thanks for trying."

He pushed back in his chair, as if it might be possible to draw it around him, to hide in it. *Not exactly my day. I hope it isn't too painful when it comes.* There was nowhere to run. He'd put on his spacesuit for the shuttle trip, but it couldn't protect him from a gamma ray burst. Vela

was visible through the portside hatches. He moved as far starboard as possible, behind some computer racks. Tying up the loose strands of his life took just a few minutes online. He was finishing when the comm link suddenly roared with static and his visor blazed like the midday Sun.

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As they suspected, it had been Gamma Velorum. The star had undergone core collapse, producing a supernova brighter than the full moon. Kristi Lang was shattered by the news from Clarke. Greg was the only casualty, thank God, but he had been her mentor and friend, and had provided encouragement and support three years earlier during her Ph.D. research. She now had an international reputation for outside-the-box thinking, and a bit of media renown to boot. She'd concluded, on strong evidence, that a class of brown dwarfs, failed stars, were being used to mark black holes. They were being pressed into service as interstellar lighthouses. It was a wild idea, of course. And, like all wild ideas, it was still not widely accepted. But it would be one day.

Greg would not be there to see it.

Ana had called her within an hour, although the story was all over the media by then. The director had been fighting back hysteria, and Kristi had lent her strength. Hang on, Ana. He had a good life. Our lives are richer because he lived.

Words. What the hell good were they at a time like that? And in the morning, when she was able to get herself together, she found the e-mail from Greg.

It was routine stuff. How much he was enjoying himself on the Weber. How he was at that moment watching a shuttle filled with tourists headed his way. And then there was a P.S.:

There's big news in Sagittarius. A Clyde Tombaugh special. Gotta go. More later.

Clyde Tombaugh was the guy who'd discovered Pluto. What the hell was Greg talking about?

More later.

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She gave it a few weeks, and then tried to reach Ana. But she was in transit, on her way to Baltimore. Kristi located her on a glide train and arranged to meet her for dinner.

Ana could not have been called beautiful, but she was an attractive woman, with blue-green eyes, lush chestnut hair, and the kind of presence you associate with leading ladies. Kristi was shocked by how much she'd changed over the few weeks since they'd last seen each other. Ana looked gaunt and her skin was sallow. She was bitterly unhappy and it showed. Kristi gave her a hug. "Are you okay?" she asked.

Ana shrugged. "Not really." Her eyes avoided Kristi, and wandered instead around the interior of the Crab Pot. It was early, and there were only a few customers present. Piano music was being piped in. "I finally got all the reports," Ana began. "Greg got an awful dose. Around 90 Sieverts. Five is fatal." Her voice caught, and tears began running down her cheeks. She managed a smile and wiped her eyes. "It took us over a day to get him out of Weber. He was horribly burned, comatose, and—well, the details don't matter."

"Ana, there's no need to talk about this."

"I need to, Kristi. I really need to."

A waiter appeared. His name was Richard, and could he get anything for the ladies?

They ordered Maryland microbrews and crabcakes.

Ana took a deep breath. "He's in cryo-susp and his daughter won't let the doctors pull the plug."

"Pity. But I can understand it."

"Did you know we're getting sued, too?"

"No. By whom?"

"The tourists. They've launched a class action claiming negligent design and inadequate radiation protection. A wonder they aren't suing God for setting off Gamma Vel so close to us."

"Any of them get sick?"

“As far as I know, they’re fine. They’re claiming mental trauma, or that their health was put at risk, or some damn fool thing.”

The beers arrived. Kristi was used to touching glasses when she dined with old friends. But Ana simply swept hers up, gazed at it sadly, and took a long swallow.

“Don’t they sign a legal release before they go up?”

“Yes. We’re not responsible for acts of God. And if a nearby supernova isn’t an act of God, I’ve no idea how you’d define the term. But it’ll be at least a year before we can bring back tourists. No tourists, no money. So Neugebauer and Weber and all the other telescopes are mothballed. Everyone is on unpaid leave.”

Kristi tried her own beer. “What are you going to do in the meantime, Ana?”

“I don’t know. A couple of places have offered me temporary positions. The University of Maryland wants me to come on board permanently.”

“I’d consider it.”

“You know, Kristi, I don’t think I realized how much I was going to miss him.”

Salads came. Kristi’s was a Caesar. “I got an e-mail from him,” she said. “Right at the end. And I can’t figure it out.”

Ana frowned. “Why not?”

Big news in Sagittarius. A Clyde Tombaugh Special. “You have any idea what he might have meant?”

Ana gazed at the ceiling, and then poked a fork into her salad. Finally she shook her head. “I don’t have a clue.”

“Nothing you’re aware of that he was looking at in Sagittarius?”

“Not that I know of.”

“Odd.”

“There *is* something, though. I’d forgotten.”

“What’s that?”

“He told me to make sure you read your e-mail.”

Kristi nodded. “The center of the Milky Way,” she said, “is in Sagittarius, so that part of the sky is choked with stars. I don’t know where to begin, Ana. I don’t know what he was talking about.”

Their dinners arrived. Ana paid no attention to the food. The door opened and eight or nine people came in, an office party. The hostess showed them into the next room. Lots of laughter and, almost immediately, a round of applause. Ana took a deep breath, and those dark intelligent eyes finally found Kristi. “I’m sorry. Whatever it was, I think Greg’s taken it with him.”

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Kristi went to the memorial service, and said a few words trying to explain what Greg had meant to her, both professionally and as a friend. Then she’d choked up, as several people had before her. She listened to the minister say how Greg was with God now, and in better hands. He was alive and well in a better place than this. She wished she could believe it.

When it was over, she flew back to Pasadena, where she was a junior assistant professor at Caltech. She resumed work, and did her best to forget Clyde Tombaugh.

But it didn’t take.

Tombaugh had been born in Illinois to a family of farmers. Despite a limited formal education, he developed a fascination for telescopes at an early age. But he didn’t think highly of the telescope he’d gotten at Sears. So he’d built his own. He eventually put together his own reflector and took it to Mt. Lowell in Arizona. The observatory director was looking for an amateur astronomer to try to find Percival Lowell’s Planet X. Tombaugh hunted through thousands of photographic plates, comparing the positions of millions of celestial objects on successive nights, looking for something that moved. Looking for Pluto. On February 18, 1930, he found it.

She put a picture of Tombaugh on her desk. Clear eyes, good features. Probably in his mid-twenties then. What did you do, Clyde, that connected with Greg?

She got occasional e-mails from Ana, who had taken a position of some sort with the International Space Commission. Then, one evening close to Christmas, she called.

“Hey, kid, how are you doing?” she asked. The winsome smile was back. “You spending another scintillating Saturday night at the office?”

Kristi nodded ruefully. “Yup. It’s just the Yottabytes and me. No other way to win that Nobel before I’m forty.” Kristi stared hard at the screen. The Spacecraft Control Center logo glowed dimly over her shoulder. “Ana, are you where I think you are? How did you get up there?”

“The yo-yo tourists settled out of court, Kristi. I came back up to Clarke yesterday with a skeleton crew. Just in time. Five months earthside almost killed me. Be happy for me; I’m alive again.”

“I am, Ana. You know that.”

“I have something here for you. Where did I put it?” She pretended to fumble with her e-pad. “Aha! Yes. A little something for the holidays.”

Kristi’s e-pad beeped. She looked at what had arrived and gasped. All of Greg’s logs. “I owe you another crabcake dinner, Ana.”

“No chance I’ll collect that meal, Kristi, unless you bring the crustaceans up here yourself on your next observing run. I’m done with Earth. Too crowded, too dirty, too noisy.”

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Kristi looked at the logs, and at Tombaugh’s picture.

Greg had been up there almost continuously for three years. As she paged through the transmission, she saw that she had all his observations and calibrations. Everything.

The proprietary period was normally two years, so part of it was already public. Kristi had long since thumbed through that, hoping to find something that would put her on the track of the Sagittarius sighting. But the recent stuff was something else. It had been released early, probably because of a family stipulation. Kristi scrolled through the lists, trying to get a feeling for what he’d been doing during the past two years. And she

discovered he'd been observing every brown dwarf in the Milky Way. *My God, he was trying to prove I'd been right.*

He had also observed every brown dwarf wannabe in her thesis, at higher resolution. He'd collected a billion spectra. *He worked harder than I did.* A lot of his observations were of cataclysmic binary stars, and she stripped those out of the file. She also removed the obvious quasars and Seyfert galaxies that masqueraded as brown dwarfs in her survey. That got her down to twenty million objects. Well, hell, it was a start. Sagittarius occupies just over 2 percent of the sky, but it includes the dense core of the Milky Way. Deleting everything not in Sagittarius decreased the sample size to four million. But now what?

Clyde Tombaugh's photographic plates were her last hope, and she knew it. The plates were taken a few nights apart and Tombaugh had compared them, star by star. Pluto gave itself away by moving nightly, relative to the background stars. Greg's reference to a "Clyde Tombaugh special" didn't make any sense. Only solar system objects move enough in a few nights to be detectable. The nearest brown dwarf is twelve light-years away. Its nightly motion would have been far too slight for Tombaugh to have seen. Brown dwarf surveys of the early twenty-first century should have found anything closer. *Greg, what did you mean?*

The riddle gnawed at her. Her other research was beginning to suffer and Sills, the department chair, was visibly worried. "You're up for tenure in a few years, Kristi. Don't get sidetracked by unsolvable problems. You've got to keep publishing."

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Months went by with no progress and no publications.

She called Ana. "I think he saw something that moved."

"But you've no idea what."

"No. I'm looking for a needle in a haystack of four million straws."

"It might not be as difficult as it sounds," she said. "If you're right, one must be different from all the others. If you examine Greg's four million spectra for one second each, you'll be done in seven weeks. That's assuming you don't eat, sleep, or bathe, but those are overrated anyway."

The words hit home. *One must be different from all the others.*

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The four million Sagittarius objects were an astrophysical smorgasbord. They included twelve classes of cool variable stars whose spectra sometimes mimicked those of brown dwarfs. In her original work with brown dwarfs, she'd needed a year to eliminate these interlopers from her catalog. *Which baby did I throw out with the bathwater?* Every sorting algorithm in *Numerical Recipes* divided the objects into one of the twelve classes. Actually, though, there were thirteen classes. Twenty-two *bona fide* brown dwarfs had slipped into the detritus heap, and Greg had managed to scoop them back out. For the hundredth time, she idly glanced at the first few. They were similar, late T dwarfs, with temperatures around seven hundred Kelvins, hardly worth a second look. Something clicked. *These spectra weretoo good.* The resolution and signal-to-noise were better than anything she had ever seen. *How did he get such great data?*

She displayed the next six of Greg's spectra. They were all virtual clones. Holding her breath, she overlaid all twenty-two plots on top of each other. *Tiny shifts in radial velocity between them,* she noted. *Otherwise, they're absolutely identical.* "Let's see where they are." She scanned the list of celestial coordinates. All twenty-two objects lay within an area five hundred times smaller than the full moon. *It can't be a cluster of brown dwarfs because they'd have a much larger spread of radial velocities.* She placed the coordinates in a plotting package, and two twists of a corkscrew stared back at her. Bingo! Not twenty-two objects. Just one.

Kristi, you're as dumb as a rock. She sagged into a chair, shutting her eyes tight. The enormity of what Greg had found overwhelmed her. And he'd died in the middle of it. His loss was suddenly clear and crushing. She held the spectra to her chest and began to cry.

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Ana was leading the efforts to reactivate the geosynchronous telescopes. There was no way to confirm or extend Greg's discovery without Neugebauer. Kristi called and, on an encrypted line, told her what she'd found.

Ana listened and paled. "Are you sure?" Her voice trembled.

“I need to do some more checking. But yes, I don’t think there’s much question.”

“Thanks, Kristi,” she said. “I’m glad you told me. It’s helpful to know what he did.” She took a deep breath. “Do you need more data? What can I do to help?”

Kristi nodded. “The radial velocities are crucial.” She was trying hard not to sound excited. “The variations were tiny. Greg must have missed them. I need a set of high dispersion observations every six hours for a month. Can you do it?”

Ana could. “You bet. I’ll get started tomorrow.”

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The Neugebauer data accumulated on her computer for three weeks before Kristi allowed herself to inspect it. The direct images were saturated, just as she had expected. *No wonder*, she thought, *it’s so bright*. But the spectra were exquisite.

And they confirmed her suspicions.

She called Ana. “It’s what we thought.” She bubbled with enthusiasm as she described the results.

“Now what?” asked Ana.

“We need access to the coronagraph.” The coronagraph was designed to block the glare of a distant sun, allowing its planets to be seen. “Joel,” Kristi said.

Ana nodded.

Joel Dayan had designed and built the coronagraph at Clarke. He was on the staff at Caltech, just down the hall.

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Joel blinked in surprise as she walked into his office and shut the door. “Tongues will wag, Kristi,” he smiled.

“You wish, big fella.” Joel was one of the brightest people Kristi had ever met. He had done breakthrough work on instrument design, was a superb classroom instructor, and had won a Shaw Foundation Prize four

years earlier for his imaging of terrestrial planets in nearby star systems. In his spare time, he partnered with an airline pilot as the California state bridge champions. He was also pretty good-looking.

“I need your help, Joel,” she said.

He sighed. “What can I do for you, Kristi?”

“I want to make you an offer you can’t refuse.” She described her discovery, told him yes there was no question, and no she wasn’t kidding. She showed him the new data from Ana.

He listened, looked skeptical, nodded. “Greg’s work, you say?”

“Yes.”

“I never got to meet him.” He sat quietly, considering what she’d said. “My loss.”

“Can you help?”

“You’re asking me if the coronagraph is available.”

“Yes.”

“Not really. It’s never available, Kristi. You know how that is.”

She knew. People were lined up for months ahead. “We’d have to get somebody to give up their time.”

“I know,” she replied. “But you have seven days, beginning this Friday.”

“You’re offering me a junior partnership in a risky enterprise that might be in the textbooks for centuries.” She smiled and nodded. “Let me think about it and I’ll get back to you.”

He walked into her office an hour later. “Okay,” he said. “We can do it.”

“This Friday?”

“Yes. But there’s a price.”

“Sounds like the end of my virtue.”

He laughed. “I’ll take it if it’s available. In any case, I want to go with you.”

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Three years earlier, Kristi had almost frozen to death in a snowstorm when her car slipped off the Kilimanjaro summit road. This time it was sunny right to the top. The auto-drive let them both enjoy the view. They relaxed and laughed and snacked as the pressurized car climbed more than five kilometers above the surrounding savannah. The *Yuri Artsutanov* Space Elevator was celebrating its thirtieth year of operation. Large banners hailing the international consortium lined the road. This would be her sixth trip up, and his tenth. Security had been beefed up since her last visit. The guards put their suitcases through X-ray, terahertz, and pion imagers. She hated being swabbed for a DNA sample. Joel just shrugged. “Standard operating procedure where I come from. Better that than a lunatic bringing a polio-smallpox cocktail onboard in her own body.”

The cable seemed to hang from infinity, contrary to the laws of common sense. *Yuri’s* base towers were surrounded by enormous structures extruding new nanowire ribbon. The lifting capacity was being doubled to one hundred tons. Competition from the rival elevator, the *Bradley C. Edwards*, anchored due south of Hawaii, remained fierce. Joel and Kristi were the only passengers, so the steward ushered them into the first-class section. *Nice*, she thought. *This is how the other half lives.* They strapped themselves in as the hatches clicked shut. The carbon nanowires stiffened and the elevator lifted away from Kibo, the summit crater. Minutes later they spotted Kigali and Kampala across Lake Victoria. The Indian Ocean came into view and the Earth became round. Venus and Saturn appeared as the sky turned dark blue, then black. Their eyes adapted to the night, and the star clouds in Sagittarius became visible. They talked, drank coffee, and enjoyed each other’s company. Toward the end of the nine-hour ride, she fell asleep on his shoulder. He stroked her cheek to wake her just before the clamps on Clarke locked the elevator in place. “Hey, kid,” he said, “it’s showtime.”

Ana was waiting for them. She hugged Kristi and shook hands with Joel. Kristi had warned her to wait for dinner, and Ana laughed when she saw the crabcakes. A complex Stellenbosch Chenin Blanc with a hint of citrus enlivened the evening.

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Joel had stenciled HARSH MISTRESS (HM) on his coronagraph, because of the sub-nanometer precisions required to make it work. He'd anchored the core of the device to carbon-silicon nanorods in liquid helium to eliminate flexure. Cooling and testing the alignment was a three-day blur of activity. The instrument was trivial in principle—it used a small metal disk to occult the glare of a star. Its ten-billion-times-fainter planets could then be seen. Detailed images of Jupiters and Neptunes around nearby stars were like shooting fish in a barrel for HARSH MISTRESS. Joel had built HM for his Ph.D., to take the first resolved images of Earth-like exoplanets. A decade later, he had a hundred discoveries to his credit. All were like Mars or Venus, with atmospheres utterly devoid of oxygen. Religious fundamentalists were using this to “prove” that life on Earth was unique and divinely created. He rolled his eyes when Kristi teased him about it. “Nutcases,” he said. “I’ll need a bodyguard when I find an oxygen-dominated terrestrial world.”

A few months earlier, Joel had serendipitously detected two Ceres-sized asteroids orbiting Barnard’s star. They were the first exo-asteroids known. The precious observing time they were going to use now had originally been awarded to look for more asteroids around other nearby stars. Greg and Kristi’s discovery took precedence, so Joel was going to sacrifice all seven days of his hard-won Neugebauer time to make the necessary observations. *A small price for astronomical immortality*, he thought. *If it works*. And he didn’t mind having a very attractive redhead like Kristi Lang feeling indebted to him.

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Caltech’s press officer reminded Kristi of a bulldog. His cylindrical body and stubby legs supported a square head with sad brown eyes, short golden hair, and a white beard over large jowls. Alan Boxer loved his job and the eclectic scientists whose work he publicized. This morning promised to be a high point in his career. Two hundred media representatives were munching donuts and downing coffee in Feynman Hall, waiting for him to begin the press conference. He nodded, and the Astrophysics chair of Caltech stepped to the podium.

Albert Sills was beaming. He wore a vest that portrayed the Earth on a navy blue background of stars. It was his way of signaling an Event. “Most scientists count themselves lucky if they make one significant discovery in a lifetime.” He gazed out across the audience. “Professors Kristi Lang and Joel Dayan have each done that already. She has found a type of star that nature cannot manufacture. That might be synthetic. He

has taken the first pictures and spectra of Earth-sized planets orbiting other stars. All of these planets are barren. Her results suggest that intelligent life exists in the cosmos. His results suggest that extraterrestrial life is absent or very rare. Isn't science *wonderful?!?*" When the laughter subsided, he looked toward them, standing off to one side. "This is their day. Doctors Lang and Dayan, please tell us what you have found."

Joel raised the microphone for Kristi and it promptly emitted a deafening squeal. He fiddled with the controls, and a second try brought it quietly within range. "That's why a skilled instrumentalist is so essential for every astronomy team," she began. He laughed with the reporters but looked nervous, so she gave him a broad smile and faced the media. The *New York Times* and *Science* correspondents had been tipped off, and were sitting on the edges of their seats. *They get it*, she thought. She savored the moment, gloriously happy, for herself and for Greg. She almost felt his presence in the room. "Welcome," she said. "I'm pleased that so many of you are here. We want to gratefully acknowledge our co-author, Ms. Ana Vassileva, who couldn't be here today. She is spacewalking at geosynchronous altitude right now. Ana manages the health and safety of our instruments, and has gathered some of the data for our work. We're going to take fifteen minutes to summarize our discoveries, and then we'll be happy to answer questions." The corkscrew appeared on the holoscreen beside her.

"Greg Cooper sifted through a billion rejected brown dwarf candidates from my doctoral thesis. Only members of our own solar system move enough, relative to the background stars, to be easily detectable in a few days. That's why I rejected all rapidly moving star-like objects. They must be asteroids or Kuiper Belt objects. Greg re-observed them, and all the other rejects that varied. One, and only one, of my rejects displays the spectrum of a brown dwarf. And it turns out, it *is* a true brown dwarf. Greg re-observed it every month for almost two years. The twenty-two points of the corkscrew that you see on the screen plot the apparent path of this object across the sky. A single turn of the corkscrew has 1/30 the apparent diameter of the full moon. That's huge." She took a deep breath. "The only way that can be true, ladies and gentlemen, is if the brown dwarf is a binary companion"—she paused—"of the Sun."

The audience sat stunned. Somebody murmured in back. Shocked expressions appeared on the reporters' faces.

“The brown dwarf’s orbital motion around the Sun carries it continuously in one direction,” she continued. “The position from which *we* view it varies cyclically over one year as the Earth moves around its orbit. Combining those two motions produces the helical path in the sky. The apparent size of the corkscrew helix places our newfound neighbor about one hundred times farther from the Sun than Neptune: five hundred billion kilometers away. That’s a pretty long walk. But it’s *still* a hundred times closer than the nearest star.”

Hands were going up all over the conference hall. The reporter from *Science* didn’t wait to be recognized. “If it’s so close, why hasn’t anyone discovered it before?”

“There are five reasons,” Kristi said. “Our companion is almost a million times less luminous than the Sun. It’s three thousand times further away. We can never see it in the same spot twice, because it takes 150,000 years to complete one orbit. For the past eight thousand years, it’s been moving through Sagittarius, the most crowded part of the sky. And finally, it’s eight times cooler than Sol, so it only emits infrared light. That’s why nobody’s ever noticed our cool neighbor until recently. Until Greg Cooper did.” She took a sip of water, and touched her e-pad.

“We’ve measured the brown dwarf’s radial velocity. It’s wobbling back and forth with perfect periodicity every seven days.” A sinusoidal curve with data points and error bars replaced the corkscrew on the holoscreen. “This means that a significant mass must be orbiting our neighbor, tugging it back and forth.”

A hand went up. “Are we talking about a *planet*, Professor Lang?”

“One second, please, and I’ll explain. Dr. Dayan’s state of the art instrumentation permits us to measure the object’s speed as it orbits the brown dwarf. That helps us pin down the masses of our two discoveries. The brown dwarf is forty times the mass of Jupiter. If it were eighty Jupiters, it would fuse hydrogen, and be visible to the naked eye as a blood-red star.

“The orbiting mass is three times that of the Earth. But it’s divided.” She looked at the reporter, and at her audience. “To answer your question: No, we do not have a an orbiting planet.” She paused. “We have *two*.”

“Ladies and gentlemen, we apparently have a miniature solar system, just eighteen light-days away.” The hands had gone down, and

the excitement had turned to stunned silence. “We thought you would like to see them. Dr. Dayan?”

Joel touched his e-pad and two fuzzy crescents appeared on the screen. “Dr. Lang and I spotted *these*, in the first image we took. At first I was certain that the double image was an internal reflection in the coronagraph. We rotated the optics by 90 degrees, but the crescents didn’t budge. They are real, nearly identical twins. We are seeing both night and day on each world’s surface, hence the crescent shapes.” Another touch and two much sharper crescents filled the screen. “Several hours of focusing the instrument brought us to where we could take a crisp image every minute. Concatenating them gives us the first movie of twin terrestrial worlds, which we’ll now see.”

The planets came alive, circling their common center of gravity. They orbited the brown dwarf in perfect lock step. On one world, cloud masses swirled over continents, islands and oceans. The second planet was totally enshrouded in clouds. Flashes that could only be lightning were visible on its night-side. Many of those present broke into spontaneous applause. Joel smiled and nodded. “During the last few hours of our observing run, Dr. Lang measured each world’s spectrum, and I now ask her to describe what she found.”

Kristi returned to the microphone. “Humanity has the technology today to send a robotic spacecraft to our neighboring brown dwarf star and its twins. If we use the Clarke cable as a whip, we could be there in twenty years. And we *are* going to go. Let me show you why.” The holoscreen displayed another pair of spectra. “The ocean world has water in its atmosphere, of course. There’s oxygen, ozone, and methane, too.” She stopped, took a deep breath, and thought again of Greg. *I wish you were here.*

“The spectrum also shows a distinctive feature *here* that can only be produced by chlorophyll. The other planet, the cloudy one, shows nothing but carbon dioxide and nitrogen. *The ocean world is alive.*”

The academics in the audience sat spellbound. Many of the reporters were already filing stories with their e-pads.

“Life has taken hold on a planet just eighteen light-days from Earth. It has failed on the twin planet right next to it. If we choose to do so, we can learn why life established itself on one and not on the other. And then, perhaps, we will understand how life got started on Earth.”

Joel squeezed her hand beneath the podium. “Great, Kristi,” he whispered. Lise Meitner must have experienced the same wave of joy when she proved that an atomic nucleus could be broken into smaller parts. Kristi had never felt more alive. “Ladies and gentlemen, thanks for your attention.”

A forest of hands mushroomed in front of her.

(EDITOR’S NOTE: Kristi Lang and Greg Cooper appeared earlier in “Lighthouse,” April 2006)

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