

GRAVITY'S ANGEL

By Tom Maddox

Here's an informed and thoughtful look at the megabuck world of Big Science—and a reminder that even with the very biggest of projects, you can't afford to overlook even the *smallest* of possibilities . . .

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The Invisible Bicycle burned beneath me in the moonlight, its transparent wheels refracting the hard white light into rainbow colors that played across the blacktop. Beneath the road's surface the accelerator tunnel ran, where the SSC—the Superconducting Synchrotron Collider—traced a circle 160 kilometers in circumference underneath the Texas plains.

Depending on how you feel about big science and the Texas economy, the SSC was either a superb new tool for researching the subatomic world, or high-energy physics' most outrageous boondoggle. Either way, it was a mammoth raceway where subatomic particles were pushed to nearly the speed of light, then crashed together as violently as we could contrive—smash-ups whose violence was measured in trillions of electron volts.

Those big numbers get all the press, but it's only when particles interact that experiments bear fruit. The bunches of protons want to pass through each other like ghosts, so we—the High Beta Experiment Team, my work group—had all sorts of tricks for getting more interactions. Our first full-energy shots were coming up, and when the beams collided in Experimental Area 1, we would be rewarded for years of design and experiment.

So I had thought. Now I rode a great circle above the SSC, haunted by questions about infinity, singularity—improbable manifestations even among the wonderland of quantum physics, where nothing was—*quite*—real. And more than that, I was needled and unsettled by questions about the way we—not my group but all of us, the high-energy physics community—did our business. I'd always taken for granted that we were after the truth, whatever its form, whatever our feelings

about it. Now even that simple assumption had collapsed, and I was left with unresolvable doubts about it all—the nature of the real, the objectivity of physics—riddles posed by an unexpected visitor.

Two nights earlier I had returned from a ride to find a woman standing in front of my house. “Hello,” I said, as I walked the Invisible Bicycle up the driveway toward her. “Can I help you?”

“I’m Carol Hendrix,” she said, and from the sound of her voice, she was just a little bit amused. “Are you Sax?”

“Yes,” I said. And I asked, “Why didn’t you tell me you were coming?” Really I was just stalling, trying to take in the fact that *this* woman was the one I’d been writing to for the past six months.

We had begun corresponding in our roles as group leaders at our respective labs, me at SSC-Texlab, her at Los Alamos, but had continued out of shared personal concerns: a mutual obsession with high-energy physics and an equally strong frustration with the way big-time science was conducted—the whole extra-scientific carnival of politics and publicity that has surrounded particle accelerators from their inception.

Her letters were sometimes helter-skelter but were always interesting—reports from a powerful, disciplined intelligence working at its limits. She had the kind of mind I’d always appreciated, one comfortable with both experiment and theory. You wouldn’t believe how rare that is in high-energy physics.

Women in the sciences can be hard and distant and self-protective, because they’re working in a man’s world and they know what that means. They tell each other the stories, true ones: about Rosalind Franklin not getting the Nobel for her X-ray work on DNA, Candace Pert not getting the Lasker for the first confirmation of opiate receptors in the brain. And so they learn the truth: in most kinds of science, there are few women, and they have to work harder and do better to get the same credit as men, and they know it. That’s the way things are.

Carol Hendrix looked pale and tired, young and vulnerable—not at all what I’d expected. She was small, thin-boned, and her hair was clipped short. She wore faded blue jeans, a shirt tied at the waist, and sandals over bare feet.

“I didn’t have time to get in touch with you,” she said. Then she laughed, and her voice had a ragged, nervous edge to it. “No, that’s not true. I didn’t get in touch with you because I knew how busy you were, and you might tell me to come back later. I can’t do that. We need to talk, and I need your help . . . *now*—before you do your first full-beam runs.”

“What kind of help?” I asked. Already, it seemed, the intimacy of our letters

was being transformed into instant friendship in real time.

“I need Q-system time,” she said. She meant time on QUARKER, the lab’s simulation and imaging system. She said, “I’ve got some results, but they’re incomplete—I’ve been working with kludged programs because at Los Alamos we’re not set up for your work. I’ve *got* to get at yours. If my simulations are accurate, you need to postpone your runs.”

I looked hard at her. “Right,” I said. “That’s great—just what Diehl wants to hear. That you want precious system time to confirm a hypothesis that could fuck up our schedule.”

“Diehl is a bureaucrat,” she said. “He doesn’t even understand the physics.”

Yeah, I thought, *true, but so what?* Roger L. Diehl: my boss and everyone else’s at the lab, also the SSC’s guardian angel. He had shepherded the accelerator’s mammoth budgets through a hostile Congress, mixing threat and promise, telling them strange tales about discoveries that lay just at the 200 TeV horizon. All in all, he continued the grand tradition of accelerator lab nobility: con men, politicians, visionaries, what have you. Going back to Lawrence at Berkeley, accelerator labs prospered under hard-pushing meg-alomaniacs whose talents lay as much in politics and P.R. as science, men whose labs and egos were one.

“Let’s talk,” I said. “Come inside, tell me your problem.”

“All right,” she said.

“Where are you staying?” I asked.

“I thought I’d find someplace later, after we’ve talked.”

“You can stay here. Where are your bags?”

“This is it.” She pointed to the sidewalk beside her. At her feet was a soft black cotton bag.

“Come on in,” I said.

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I figured she would be doing interesting work, unusual work; maybe even valuable work, if she’d gotten lucky. I wasn’t the least bit ready for what she was up to,

We cranked up “The Thing,” a recent development in imaging. It had a wall-mounted screen four feet in diameter; on it you could picture detector results from any of the SSC’s runs. When it was running, the screen was a tangle of lines,

the tracks of the particles, their collisions, disappearances, appearances; all the wonderland magic so characteristic of the small, violent world of particle physics, where events occur in billionths of a second, and matter appears and disappears like the Cheshire cat, leaving behind only its smile—in the form of brightly-colored particle tracks across our screens.

Still, setting up and running simulations is an art, and at any accelerator lab there'll be one or two folk who have the gift. When a series of important shots is coming up, they don't get much sleep. At Los Alamos, Carol Hendrix, despite her status as group leader, was the resident wizard. At Texlab, we had Dickie Boy.

She stretched, then sat at the swing-arm desk with its keyboard and joystick module and logged on to QUARKER with the account name and passwords I gave her. Her programs were number-crunching bastards, and QUARKER'S Cray back end would be time-slicing like mad to fit them in.

"Tell me what this is all about," I said. "So I'll know what we're looking at when this stuff runs."

"Sure," she said.

While we waited for QUARKER, she drew equations and plots on my whiteboard in red, green, black, and yellow, and she explained that she was postulating the existence of a new kind of attractor that came into being in a region of maximum chaos, its physical result an impossible region of spacetime, where an infinite number of particle events occupied a single, infinitesimal point.

Mathematically and otherwise, it is called a singularity, and in cosmology something like it is assumed to be at the center of black holes. There were all sorts of theorems about singularities, few of which I knew, none rigorously. Why would I? This stuff went with astrophysics and the gravitational forces associated with huge chunks of mass.

When she finished her explanations and turned from the whiteboard, I could see that she was wired and sleepy at once. Mostly, though, she was exultant: she felt she'd hit the jackpot. And of course she had, if any of this made sense ... it couldn't, I thought.

The Thing gonged, to tell us we had our results. I pulled up a canvas-backed chair beside her as she sat at the console. "We'll walk through the simulation," she said. "If you have a question, ask."

At first there were just cartoon schematics of the detectors; line drawings of the big central detector and its surrounding EM boxes, hadron calorimeters, and gas chambers. Then the beam shots started coming, and in a small window at the top of the screen, the beam parameters reeled by. Running Monte Carlos is one hell of a lot

easier than doing an actual run; you don't have the actual experimental uncertainties about good beam, good vacuum, reliable detector equipment; it's a simulation, so everything works right.

As we watched, the usual sorts of events occurred, particles and antiparticles playing their spear-carrying roles in this drama, banging together and sending out jets of energy that QUARKER dutifully calculated, watching the energy-conservation books the whole time, ready to signal when something happened it couldn't fit into the ledger. Complex and interesting enough in its own way, all this, but just background.

QUARKER shifted gears all of a sudden, signaling it had so many collisions it could not track them accurately. The screen turned into what we called a "hedgehog," a bristly pattern of interactions too thick to count.

"We don't care," Carol Hendrix whispered. "Do it." And she forced QUARKER to plunge ahead, made it speed up the pictures of events. She didn't care about the meanings of the individual events; she was looking for something global and, I thought, damned unlikely.

Events unrolled until we seemed to be in the middle of the densest particle interactions this side of the Big Bang, and I almost forgot what we were there for, because this stuff was the product of my work, showing that, as promised, we would, give the experimenters higher beam luminosity than they'd dreamed of having.

Then the numbers of collisions lessened, and that was the first time I believed she was on to something. Things were going backward. The beam continued to pour in its streams of particles, but all usual interactions had ceased: inside the beam pipes, one utterly anomalous point was absorbing all that came its way. We both sat in complete silence, watching the impossible. The screen cleared. then said:

END SIMULATION
Quantitative evaluation appears impossible
employing standard assumptions. The conclusions
stated do not permit unambiguous physical
interpretation.

We lay outside in reclining chairs and watched the sky. The moon was down, and stars glittered gold against the black. Meteors cut across the horizon, particles flashing through the universe's spark chamber. We'd been drinking wine, and we were both a little high—the wine, sure, both of us drinking on empty stomachs, but more than that, the sense of discovery she had communicated to me.

"Finding the order behind the visible," she said. "I've wanted to be part of that for as long as I can remember. And at Los Alamos I've gotten a taste. They

offered me a job two years ago, and the offer just caught me at the right time. I had done some work I was proud of, but it was frustrating—it's easy for a woman to become a permanent post-doc. And to make things worse, I'd always worked in my husband's shadow."

"He's a physicist?"

"Yes. At Stanford, at SLAC. We've been separated since I took the job. The two things, the job and the split-up, sort of came as a package." She stopped, and the only sound was the faint roar of cars down the Interstate nearby. She said, "Tell me what happens tomorrow."

"That depends on Diehl's reaction. I'll see him in the morning. First I'll ask to borrow our resident imaging expert. That is, if I can pry him loose. I'm figuring Diehl won't want to look at any of this stuff; he might want a report on it, if I can talk to him just right. After that, we'll see."

"Okay," she said. "Look, I'm really tired .."

"I'm sorry. I should have said something." I started to get up, but she said, "No, I'm fine. I'll see you in the morning." She waved goodnight and headed into the house; I'd shown her the guest room earlier and folded out the couch for her.

I lay watching the sky, my mind circling around the strangeness we'd seen earlier. I wanted to understand it all more clearly than I did, and I hoped that Dickie Boy would be a help. In particular, he might know where her simulations had gone wrong. They had to be wrong, or else . . .

I sipped at wine and wondered at the possibility that I was present at one of those moments in physics that get embalmed and placed into the history books. I suppose I was still wondering when I fell asleep.

I was jerked awake some time later by a noise like high wind through metal trees. Amber flashes of light came from the side of the house, and a piano-shaped machine rolled out on clear plastic treads, ripping chunks of sod with its aerating spikes as it came. The machine was a John Deere "Yardman," apparently run amok.

I went into the house and called Grounds and Maintenance. A few minutes later a truck pulled up, and a man in dark blue overalls got out and called the robot to him with a red-lighted control wand, then cracked an access hatch in its side. Optic fibers bloomed in the robot's interior like phosphorescent alien plants.

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I awoke around eight-thirty the next morning. Carol Hendrix was still in bed; I let her sleep. I left a message on Diehl's machine asking for a few minutes

person-to-person, then I drank coffee and worked again through her Monte Carlos: lovely work, plausible and elegant, but almost certainly not enough to move Diehl. How could it? As she had said, he wouldn't understand it.

However, I knew who would. In the event that Dickie Boy vetted her simulations, we'd take them to the Thursday Group that evening. We met weekly at Allenson's house. Every important work-group at the lab was represented, and every significant problem the groups worked on was discussed there. Thursday Group was the locus of oral tradition, the place where the lab's work was revealed and its meaning decided upon. By the time experimental results saw print, they were old news to anyone who had been to Thursday Group. Usually there were ten or so people there, all men, most in their mid-thirties, most of them white and the rest Chinese.

Mid-morning she came in, wearing old Levi's and a black tank top. "Any news?" she asked, and I told her no. She got a cup of coffee and sat next to me and watched as her simulations played.

Shortly after noon a message popped up in a window on the screen: "If you want to talk, meet me in section 27 within the next hour. Diehl."

"Do you want me to come along?" she asked, and I said, "No way. He's a tricky bastard to handle at the best of times." I left her sitting at the console, starting the Monte Carlos up again.

I rode the Invisible Bicycle to the shuttle station at Maingate and locked it in the rack outside. Down concrete steps I went and into the cold, musty air of the tunnel. A dark blue, bullet-shaped shuttle car sat waiting. I was the only one boarding. I told the car where I was going. "Section 27," it confirmed in its colorless voice.

The repetitive color scheme of the lattice flashed by the windows. Radiofrequency boosters were in red, superconducting dipoles in blue, quadrupoles in orange; the endless beam pipes, where the straw-thin beams of protons and antiprotons would circle, were long arcs of bright green. If there were a universal symbolism of colors, these would say, *intricate, precise, expensive, technologically superb*—the primary qualities of the SSC.

About ten minutes later, the car slowed to a stop. The doors slid back, and I stepped down into the tunnel. About fifty meters away, Diehl stood talking to a man wearing blue overalls with the yellow flashes of a crew chief. The man looked taut, white-faced. "So pull every goddamned dipole with that batch number and replace the smart bolts," Diehl said. They walked toward me, and the crew chief stopped at a com station and plugged in his headset, no doubt beginning the evil task Diehl had set him.

“What can I do for you, Sax?” he asked.

“I’ve got a visitor,” I said. “From Los Alamos. And she’s got some interest-ing simulations of our full-power shots. I think you ought to see them.” He looked startled; he hadn’t expected me to ask for his time—money, resources, priority, yes, but not *his time*. “Or maybe not,” I said. “Maybe you should let me have Dickie Boy put her Monte Carlos on the Thing. She’s got some strange stuff there, and if it works out, we need to be prepared.”

“Sax, what the fuck are you talking about? I’m tired, you know? We’re in the home stretch here, on budget, on time . . . now take Hoolan—you know, who heads the Meson Group—he knows nothing about this. He knows his experiments are coming up soon, his simulations do not make shit for sense, and Dickie Boy is the one to help him. But if he is not not available because you have him doing what you consider the Lord’s work, Hoolan’s going to be pissed, because he *cannot* understand why, in light of these approaching deadlines, he should have to come begging for assistance.”

“Then maybe you should come look at what she’s got.” I was playing a tricky game, using my position as group leader to put pressure on him but betting he wouldn’t want to give up valuable time and maybe expose his ignorance. “I think this is really important.”

He was watching the crew chief explaining to six men that they would be working in the tunnel until the troublesome smart bolts had been replaced. None of them looked happy. “Jesus,” Diehl said. “Take Dickie Boy if you can convince *him*.”

“Thanks,” I said. He looked at me like he tasted something sour. I owed him one, and one thing was sure: he’d collect when and where he wanted.

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“You really like this thing, don’t you?” Carol Hendrix asked as she reached up to touch one of the Invisible Bicycle’s clear polystyrene tires. It hung from rubber-covered hooks just inside my front door.

“Yeah,” I said. “I got it in Germany. It’s just plastic, but there’s something wonderful about it—almost the Platonic idea of a bicycle. There’s one in the Museum of Modern Art.” Hanging above her head, it seemed to glow in the soft light given off by baby spots. “I usually ride it to think.”

“What do we do now?” she asked. She wasn’t interested in my toy.

“We get Dickie Boy over here,” I said. “If we can. I’ll call him.”

“New physics,” I told Dickie Boy on the phone. “Nothing you’ve ever seen.”

“Bullshit,” he said.

“No bullshit. Wrong physics, maybe—that’s what we want you to help with, find out if we’re missing something tricky.”

“Or something obvious.” He had no respect for anyone’s ability on The Thing but his own.

“I don’t think so. I think we’ve got a whole set of tracks here like nothing you’ve ever seen.”

“I’ve got the Meson Group on my schedule.”

“I know. Diehl said I could borrow you today.”

“Where you want me?”

“Come over to my house.” No way I wanted anyone looking over our shoulders.

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Dickie Boy had made his name as a post-doc at Fermilab, where Diehl had recruited him when the SSC was nothing but a stack of plans, an empty tunnel, and mounds of heaped dirt. He hadn’t been brought on for his good looks: he stood just over six feet tall and weighed maybe a hundred and thirty pounds; his dull brown hair was tied into dreadlocks; he had a long, thin nose and close-set eyes and usually seemed slightly dirty. However, in his brief time at Texlab he had already made legendary forays on The Thing—the last, a tricky sequence of pion studies, lasted nearly seventy-two hours, during which time Dickie Boy had worked through several shifts of physicists and finished by asking the group leader if he needed anything more.

Carol had heard about Dickie Boy, but she had her own reputation, and so when they said hello and looked each other over, I could almost hear the wheels turning, the question being posed, “Are you as good as they say?”

We went to the terminal, and Carol ran the Monte Carlos as Dickie Boy sat almost squirming with impatience to have a look at what she was doing. When she got out of the chair, he almost leapt into it and said, “You two go somewhere else, okay? The other room’s all right; just leave me alone.”

“I need to do some work at the office,” I told Carol. “What about you?”

“Yeah,” she said. “I should check my mail at the lab, see who’s angry that

I'm gone. You got another terminal with a modem?"

"In the bedroom," I said. "I'll see you two later."

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At HBET I found a line of people waiting for me to talk about or approve their experimental arrangements, and so I spent the afternoon there, amid the chaos of getting the SSC ready for its first full-energy runs, scheduled for just a month away.

Carol and Dickie Boy were seated next to one another when I returned, with another variation on her Monte Carlos on the screen in front of them. "What's up?" I said, and Dickie Boy said, "This is fantastic." Carol was smiling.

"Think we can take it to Thursday Group?" I asked.

"Tough audience," Dickie Boy said.

"Is it the one that counts?" Carol asked.

"Yes, it is," I said. "If we can convince them, they'll go up against Diehl or anyone else."

"Let's do it, then," she said.

"Can you do a presentation?" I asked. "Good talk, good pictures?"

"Yes," she said. "I've been getting ready to do it."

"Fine," I said. "I'll call Allenson and ask if I can take over the agenda. I don't think anyone's got anything hot working."

* * * *

Bad haircuts, cheap clothes, and an attitude—that's the way I once heard a gathering of theoretical physicists described. They—*we*—consider ourselves aristocrats of the mind, working in the deepest and most challenging science there is. Getting there first with good ideas, that's the only thing that counts—under all circumstances, that was the unspoken credo.

The whole group showed up that night. The living room of Allenson's house was shabby and comfortable, with couches, chairs, and large pillows enough to hold the sixteen of us: thirteen regulars and me, Carol, and Dickie Boy. Eight Caucasians and five Orientals, three Chinese and two Japanese. Most were in their late thirties, though a few were in their middle forties. No one under thirty, no one over fifty. These were the theoretical heavyweights at the lab, men in their short-lived prime as it

exists in high-energy physics. A few were drinking coffee; most just sat waiting, talking.

I gave her the simplest possible introduction. I said, “This is Carol Hendrix, who is here from Los Alamos, where she is Simulations Group Leader. She has some very interesting simulations she would like to present to us.”

Carol Hendrix knew her audience. She had gone into sexless mode as much as possible. Her face was pale and scrubbed, no makeup, and she wore baggy tan trousers and a plaid wool shirt—in short, the closest approximation she could get to what the men in front of her were wearing. From her first words, she spoke calmly and authoritatively, for they’d listen to nothing else from her, and she allowed none of the passion I’d heard to animate her presentation.

She gave it all to them, dealt it out on a screen in the front of the room. The slides came up showing pretty pictures from *The Thing*, equation sets from QUARKER, annotations in her own hand: each idea led straightforwardly to the one after, theory and practice brought together with casual elegance.

Leaving the last slide’s “**END SIMULATION**” on the screen, she summarized: “We know little about the physical attributes of a singularity; in fact, its essential nature is lawless.” She stopped, smiled. “Though we would anticipate its interactions with the nonsingular world of spacetime to be governed by the usual conservation laws, this may not be the case. In short, the consequences of creating a singularity are not well understood, and I would suggest that further analysis is required before any experiments are undertaken that could bring such a peculiar region of spacetime into close proximity with instruments so delicate as those in an experimental area.” She paused and looked at all of them, said, “I will be glad to hear your questions and comments.”

This is where it would happen, I thought. Guests to Thursday Group often got taken on the roughest intellectual ride of their lives, as this group of brilliant and aggressive men probed everything they had said for truth, originality, and relevance—or the converse. I went very tense, waiting for the onslaught to begin.

“Dickie Boy,” Bunford said. If this group had an alpha male, Bunford was it. He was a big man—around six three and more than two hundred pounds—with a strong jaw, a lined face, and sunburned skin. He had elaborated the so-called “Standard Model” in new and interesting ways. The “semi-unbound quark state” was his particular interest—and the smart money had it that he and his group could pick up a Nobel if the SSC found the interactions he was predicting. “Did you validate her simulations?” Bunford asked. Rather an oblique approach, I thought, probably in preparation for going for the throat, theoretically speaking. Carol Hendrix turned to see how Dickie Boy would answer.

“Sure,” Dickie Boy said. “Very sweet, very convincing. Take for instance the

series of transforms...”

“Fine,” Bunford said. And to Carol Hendrix: “Thank you. If Dickie Boy validates your Monte Carlos, I’m sure they’re well done.” He paused. “The physics is interesting, too . . . though quite speculative, of course.”

And he stopped there, apparently having finished.

I waited for him to go on, but he didn’t—he was whispering quietly to Hong, one of his group members. And no one else was saying a word. Finally, Allenson stood from the pillow where he’d been sitting cross-legged and said, “Shall we make it an early evening tonight? I don’t know about you guys, but I could use some sleep.” He turned to Carol Hendrix and said, “I’d like to thank our guest for speaking to us this evening.” Murmured voices said much the same thing. “At a later time, perhaps we can discuss the implications of this work, but this week we are all very busy getting the SSC up to spec.”

Carol Hendrix stood white-faced and silent as all the men got up, nodded goodbye to her, and left, some alone, others in small groups of their col-leagues.

“I don’t understand,” I said. We were walking along one of the suburb-like loops that led from Allenson’s house to mine. For the present, many of us lived in Texlab-owned housing as a matter of convenience. “They didn’t even want to argue with you.”

“I’m an idiot,” she said. “I forgot some of the most important lessons I’ve ever learned. In particular, I forgot that I’m a woman, and anything I say gets filtered through that.”

“Do you really think that?”

“Sax, don’t be so fucking naive. Why do you think they were polite? Because I was a *visitor*?” Her voice was filled with scorn; she knew as well as I did what treatment visitors got.

“Your conclusions are radical. You can’t expect them to assent right off.”

“I’ll grant you that, and it would have been hard to convince them of anything substantive, but I could have *begun* tonight. They dismissed me, they dismissed what I was saying. Bastards. Smug male bastards—it’s no wonder they can’t hear anything they’re so filled with their own importance.”

We stood in front of my house. She said, “I think I’ll walk around for a while, if that’s all right. I don’t want to talk right now.”

“Sure,” I said. “Go anywhere you want. In fact, I think I’ll go for a bicycle

ride. I'll see you later."

So moonlight flashed through the bicycle frame as I rode the berm road above the SSC, and finally I realized I had no answers to what perplexed me, and I turned around and headed back toward home.

I rode through sheets of darkened homes and came to my driveway, where a light burned on a pole, walked the Invisible Bicycle up to the door, and went in to absolute silence. On a low table in the living room, I found a note:

Dear Sax,

I have gone back to Los Alamos.

Don't worry about me, I'm fine. I just need to think about what happened here.

Thank you for all you've done.

Carol

Over the next weeks, as the full-energy trials came closer, I thought often about Carol Hendrix, her singularity, and the treatment she'd gotten.

I went back to Thursday Group the next week but found I had little to say to any of them—the whole bunch seemed to be strutting apes, obsessed with their own importance and show. If they were interested in the truth, and particularly in new, interesting truths, then why hadn't they treated Carol Hendrix with the seriousness her ideas deserved? Her ideas were strange, but important ideas always were. She was a woman, but so what? How could that matter?

All of a sudden, I felt a fool. Their conversation excluded everyone who was not a member of the group, and their masculinity, while entirely free of conscious malice, effectively recognized only its own kind. A young, small woman simply did not exist for them as a physicist to be taken seriously.

I left early that evening and decided I would not go back.

But what I had seen at Thursday Group was everywhere at the lab. Secretar-ies were women, scientists and administrators were men—white men by and large, with a sprinkling of Orientals. Carol Hendrix was right: I was incredibly naive. But I understood why. As a high-energy physicist, I had been devoted to what I thought of as an unbiased search for the truth, a search that creates intense tunnel vision, because of how difficult it is, it demands absolutely everything you can bring to it, and often that isn't quite enough. Now I had awakened, and what I saw appalled and confused me.

I got one note from Carol Hendrix, apologizing for leaving so abruptly and saying that she would write again when she had gotten her thoughts straightened out. Then, five days before the first full-energy, high—beta runs, she called me at the

office. “Sax,” she said. “I’d like to come watch the runs. Would you mind?”

* * * *

Carol leaned over me, slid her body down mine, pulled the gown over her head. She was astride me, hands at her side as she moved in rhythmic arcs. “The stars,” she said. Through the window I could see points of light strobing, red-and-blue shifting through the spectrum. “Something is poking through behind them,” she said. “It wants in.” A sheet of blue light poured through the window, burned through us, X-raying flesh and bone. In it we were translucent, the intricate network of our nerves burning in silver fire. We were fusing together, so close to an orgasm that would annihilate us.

I woke, got up, and drank some water for my burning throat, fell back on the bed. I hung suspended between waking and sleeping as a flood of images passed across my eyes. Bright, blurred shapes vanished before I could see them clearly.

She was coming in the next day, the day before the first big runs.

* * * *

She wore khaki shorts and a dark blue T-shirt. We were sitting in my back yard again, under a moonless sky—a thousand stars above us and meteors cutting brief, silent arcs at the horizon. She sniffed at the glass of cold Chardonnay she was holding, drank, and leaned back in the reclining chair.

“I owe you an apology,” she said.

“What do you mean?”

“You did everything you could to help, and I walked out on you.”

“You were troubled.”

“I was, but I shouldn’t have treated you like one of them.”

“That’s okay. Apology accepted.”

“Tomorrow morning, what do you think will happen?”

“Truthfully, I don’t know. If we get good beam, we’ll have the right conditions for your simulation.”

“That’s what I thought. I’ve gone over it and over it, worked it through time and again, had a work group tear my analysis apart. It all adds up to the same thing: my simulations are realistic, plausible . . . and unverifiable without experimental

evidence. All of that's fine. What worries me is this: if I'm right, your people are going into what could be a dangerous situation, and no one has a clue about it; no one wants to hear about it. At least not from me."

"You've done everything you can."

"Maybe."

"No, I mean it. Listen." And I poured it all out to her, what I'd seen in recent weeks, how incredibly closed and self-confident our world was, unbelievably blind about its own nature, which within the community was seen as inevitable. I'm not sure how long I talked or how I sounded—I just know that the frustration and anger and amazement I had lived with for the past weeks came tumbling out in one long screed.

"Oh, Sax," she said, finally. "You poor innocent." And she laughed, then laughed again, harder, and carried on laughing as I sat there embarrassed. Finally she stopped and said, "Sometimes I get so wrapped up in all of this, I forget how things really are. Thanks for reminding me. To hell with them all. I've tried, you've tried. If the SSC's turned into the world's most expensive junk pile, it won't be our responsibility."

We talked a bit more until we had finished the bottle of wine, then she said, "When do we have to be there?"

"Seven A.M. We should leave here around six-thirty, so I guess it's time to go to bed."

* * * *

She found me standing at the sliding glass door in my bedroom, looking out onto the night. I turned and saw her in the doorway, backlit by the light from the hall behind her. "Are you all right?" I asked.

"Who knows?" she said. She came across the room to me, stood in front of me, and put her hands on my bare shoulders. She said, "Want to make love, pen pal?"

She leaned against me, and I could feel her body under the thin jersey. "Yes," I said. "I do."

Through the night we moved to the rhythms of arousal and fulfillment: making love, lying together in silence, sleeping, waking again. All the frustration, anger, anxiety, excitement we had both felt the past weeks funneled into those moments, sublimed into active, driven lust.

Shortly after five I was awakened by a sweep of amber light through the window and the sound of wind. I found the groundskeeper robot outside. It had settled onto one patch of ground; its aerating spikes flashed out of the bottom of the machine, their blind repetition chewing turf into fine much.

I said, “You ought to go back to the barn or wherever they keep you and just kind of relax. Keep this shit up and they’ll scrap you.” It stopped and sat there emitting a low-pitched hum punctuated with occasional high harmonic bursts. “That’s sensible,” I said. “Think it over.” It decided: it crawled over to a row of stunted ornamental shrubs and began to slice them into very small pieces.

I went back inside, called the thing’s keepers, and tried to go back to sleep. Instead I lay awake, thinking of what might happen that morning, until Carol turned over to me and whispered, “One more time?”

“Oh yes,” I said. “One more time.”

* * * *

Around six-thirty we walked out of the house and ten minutes later were at Maingate shuttle station, where we went down into the tunnel with five members of a tech team. They wore orange overalls and helmets and had respirators dangling over their shoulders, protection against any accident where helium would boil from the superconducting magnets and drive the air out of the tunnel.

Harry Ling, the BC 4 supervisor, was directing people at the shuttle stop. “How’s it going, Harry?” I said.

“Ask me later,” he said.

At Experimental Area 1, teams were making final adjustments to their instruments and hoping no last-minute gremlins had crept in. The room was fifty meters square, dominated by the boxcar-sized composite detector. Inside it, the storage rings came together; at their intersection the protons and antiprotons would meet and transform. Two men were levering a bulky, oblong camera—SONY in red letters on its side—into position at an external port. People picked their way through snarls of cable.

Fifty meters up the tunnel was the control room. It was on two levels: ground floor, where technicians sat in rows at their consoles, and the experiments command above, where the Responsible Person sat with his assistants and controlled the experiments.

I introduced Carol Hendrix to Paulsen, my assistant, who was crouched over his screen like a big blonde bear over a honeycomb. “Hello,” he said, then went on muttering into his headset—I often wondered how anyone understood him.

I said to her, “Let’s find you a headset, and you can plug in to my console and watch what develops.”

The next hour was taken up with the usual preparations for a run: collecting protons and antiprotons in their injector synchrotrons, tuning the beams. The “experiments underway” clock had started when the first particles were fed out of the injector synchrotron and into the main rings. Now the particles would be circling in the rings at a velocity near the speed of light, their numbers building until there were enough for a sufficiently violent collision.

“I have initiated the command sequence,” Diehl said on the headphones.

About a minute later a voice said, “We’re getting pictures,” and there was a round of sporadic clapping from the people on the ground floor. On one of the screens in front of us, QUARKER was providing near real-time views of the collisions, which appeared as elaborate snarls of red and green, the tracks color-coded to distinguish incoming from outgoing particles. “Beautiful,” the man in front of us said.

On the screen next to this one, data flickered in green type. I saw that everything was, as they say, “nominal.” Then all lights in the control room went out, every screen blank, every com line and computer dead. Under amber emergency lights, everyone sat stunned.

And the world *flexed*, the wave from the singularity passing, shape of spacetime changing. Puffs of gray dust jumped off the walls, and there were the sounds of distant explosions.

Carol jumped out of her chair and said, “Come on.” I took off my headset and followed her. We passed through the door and into the tunnel, where settling clouds of dust were refracted in yellow light. I stopped at a locker marked “Emergency” and took out two respirators—false faces in clear plastic with attached stainless steel tubes. If enough helium escaped into the tunnel, it could drive out the oxygen and suffocate anyone without breathing apparatus. “Here,” I said and gave her one.

The door to the experiments room was askew. Behind us I heard loud voices and the sounds of feet pounding up the stairs to the surface. Turning sideways, I slipped through the door’s opening.

Blue blue blue blue, the slightest pulse in it, then suddenly as the conjurer’s dove flying from the hat, *white*, swords or crystals of it jammed together, vibrating as if uncertain, then turning as suddenly to *blue*.

The composite detector unit and surrounding equipment had disappeared.

Carol Hendrix had become a translucent, glowing figure that left billowing trails of color as she moved. The world was a sheet of light and a chattering of inhuman voices, high-pitched and rising.

Etched images in gold against white, flickering, the reality tape shrieking through its transports as every possible variation on this one moment un-folded, the infinitesimal multiplied by the infinite.

Sometime later, hands pulled on me, dragging me backward across rough cement to a world that did not burn like the middle of a star. My heels drummed against the floor, my back was arched, every muscle rigid.

* * * *

Riding the Invisible Bicycle past Building A, I saw two men bent over the partially disassembled carcass of a groundskeeper robot. Sprays of optic fiber, red lengths of plastic tubing, and bright clusters of aluminum spikes lay in the grass beside it. One man was holding a dull gray, half-meter cube—the container for the expert system that guided the robot and was the apparent source of its problems.

The state of things at Texlab: big science—grandiose and masculine and self-satisfied—lay in ruins all around, shattered by its contact with an infinitely small point, the singularity.

On the steps of Building A, camera crews and reporter had gathered. They just milled aimlessly at this point, waiting for the Texlab spokesman—presumably Diehl—who would have to come out and recite a litany of disaster. Then would come the questions: *How did this happen? What does it mean?*

As I headed out the perimeter road I was passed by lines of vehicles: vans carrying tech teams, flatbed trucks loaded with massive chunks of bent metal, cars with solemn, dark-suited bureaucrats in their back seats. No shuttle rides today—the tunnel was strictly off-limits.

Near Station 12 an orange quadrupole assembly lay next to the hole it had made coming out of the ground. Part of its shrouding had torn away to reveal the bright stainless-steel ring that held its thousands of intertwined wires together. At other stations I passed there were stacks of lumber for shoring the tunnel, repair crews in hardhats milling near them.

Little more than an hour after the medical team had carried me out of the tunnel, I was apparently fully recovered. The rest of my morning had been spent with me the focus of doctors, nurses, and lab techs. I had suffered an episode of *grand mal*, an epileptic fit, they told me—apparently a reaction to the singularity.

Today there were fifty-six injured, one dead, two more probably to die. The

collider had been destroyed: beam pipes deforming and spraying those high-energy particles all over the place—explosive quench in the lattice, it was called.

And Carol Hendrix was one of the fifty-six injured. A chunk of concrete had fallen on her. Skull fracture, assorted lacerations. . . *Christ*. While they were testing me at the Texlab hospital, she was being flown toward Houston in a medivac helicopter brought in by the Air National Guard. She remained in a coma, but for reasons that escaped me, her doctors were hopeful, so mine had told me.

The men she had talked to couldn't listen, simply *couldn't*. She was a woman, her approach was unusual, her conclusions weird, and despite all their protestations to the contrary, the men she had spoken to were prisoners of their contexts, their presuppositions. Their scientific objectivity didn't exist, never had.

I wondered if they felt as Oppenheimer and company had on the morning of the Trinity explosion: bright light and EM pulse, shock wave throwing those nearby to the ground . . . then they all had to confront—whatever their jubilation, awe, fear, sorrow—their part in this thing, their complicity.

* * * *

At the above-ground entrance to BC 4, Texlab Security had placed on wooden sawhorses a yellow plastic ribbon with the words **“EXTREME DAN-GER”** repeating along its length. Several gray-uniformed men stood nearby.

“I'll keep your bicycle for you, Doctor Sax,” one said as I dragged it down the steps. “No,” I said, “that's all right. I'll take it with me.”

Rusty iron latticework showed where chunks of the tunnel walls had fallen, brushed by an angel's wing. In the hard yellow light, the Invisible Bicycle looked cheap, a stupid toy. Which it was: just a thing of plastic and conceit.

I wheeled the bicycle around the plywood barrier in front of the experiments room door and stopped to watch the *blue white blue*, which continued to some rhythm we did not understand. Robot cameras and recording instruments sat against the near wall.

Reduced to primitive magic, I hurled the Invisible Bicycle at the thing, a burnt offering: *take this, let me have her*. It slowed in midair as though moving through heavy liquid and began to deform. It seemed to turn inside out. Now the Topologically Bizarre Bicycle, no longer recognizable by shape or anything else as a human artifact, it was shot for a moment with rainbow colors, then was gone.

Unmoved, the singularity continued its transformations. Here was the angel, inscrutable as Yahweh answering Moses out of the whirlwind, “I am that I am.” It promised infinite levels of discovery, an order not inexplicable but complex and

deep as the night. And it promised that for every fragment of knowledge gained, for every level of understanding surmounted, there would be pain and sorrow. How puffed-up we become, filled with immense pride in our knowledge; and how quickly the universe reminds us of how little we know.

In the desert it was bright and hot. One of the security guards gave me a ride back to Maingate.