

# approaching perimelasma

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*Here he takes us along on a suspenseful and hair-raising cosmic ride in company with an intrepid future adventurer bound for someplace nobody has ever gone before: a headlong plunge into a black hole, and out of it again—if he can figure a way to get out of it, that is, with all the forces of the universe against him.*

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There is a sudden frisson of adrenaline, a surge of something approaching terror (if I could still feel terror), and I realize that this is it, this time I am the one who is doing it.

I'm the one who is going to drop into a black hole.

Oh, my god. This time I'm not you.

This is real.

Of course, I have experienced this exact feeling before. We both know exactly what it feels like.

My body seems weird, too big and at once too small. The feel of my muscles, my vision, my kinesthetic sense, everything is wrong. Everything is strange. My vision is fuzzy, and colors are oddly distorted. When I move, my body moves unexpectedly last. But there seems to be nothing wrong with it. Already I am getting used to it. "It will do," I say.

There is too much to know, too much to be all at once. I slowly coalesce the fragments of your personality. None of them are you. All of them are you.

A pilot, of course, you must have, you must be, a pilot. I integrate your pilot persona, and he is me. I will fly to the heart of a darkness far darker than any mere unexplored continent. A scientist, somebody to understand your experience, yes. I synthesize a persona. You are him, too, and I understand.

And someone to simply *experience* it, to tell the tale (if any of me will survive

to tell the tale) of how you dropped into a black hole, and how you survived. If you survive. *Me*. I will call myself Wolf, naming myself after a nearby star, for no reason whatsoever, except maybe to claim, if only to myself, that I am not you.

All of me are you. But, in a real sense, you're not here at all. None of me are you. You are far away. Safe.

Some black holes, my scientist persona whispers, are decorated with an accretion disk, shining like a gaudy signal in the sky. Dust and gas from the interstellar medium fall toward the hungry singularity, accelerating to nearly the speed of light in their descent, swirling madly as they fall. It collides; compresses; ionizes. Friction heats the plasma millions of degrees, to emit a brilliant glow of hard X-rays. Such black holes are anything but black; the incandescence of the infalling gas may be the most brilliantly glowing thing in a galaxy. Nobody and nothing would be able to get near it; nothing would be able to survive the radiation.

The Virgo hole is not one of these. It is ancient, dating from the very first burst of star-formation when the universe was new, and has long ago swallowed or ejected all the interstellar gas in its region, carving an emptiness far into the interstellar medium around it.

The black hole is fifty-seven light years from Earth. Ten billion years ago, it had been a supermassive star, and exploded in a supernova that for a brief moment had shone brighter than the galaxy, in the process tossing away half its mass. Now there is nothing left of the star. The burned-out remnant, some thirty times the mass of the sun, has pulled in space itself around it, leaving nothing behind but gravity.

Before the download, the psychologist investigated my—your—mental soundness. We must have passed the test, obviously, since I'm here. What type of man would allow himself to fall into a black hole? That is my question. Maybe if I can answer that, I would understand myself.

But this did not seem to interest the psychologist. She did not, in fact, even look directly at me. Her face had the focusless abstract gaze characteristic of some-body hotlinked by the optic nerve to a computer system. Her talk was perfunctory. To be fair, the object of her study was not the flesh me, but my computed reflection, the digital maps of my soul. I remember the last thing she said.

"We are fascinated with black holes because of their depth of metaphor," she said, looking nowhere. "A black hole is, literally, the place of no return. We see it as a metaphor for how we, ourselves, are hurled blindly into a place from which no information ever reaches us, the place from which no one ever returns. We live our lives falling into the future, and we will all inevitably meet the singularity." She paused, expecting, no doubt, some comment. But I remained silent.

"Just remember this," she said, and for the first time her eyes returned to the outside world and focused on me. "This is a real black hole, not a metaphor. Don't treat it like a metaphor. Expect reality." She paused, and finally added, "Trust the math. It's all we really know, and all that we have to trust."

Little help.

Wolf versus the black hole! One might think that such a contest is an unequal one, that the black hole has an overwhelming advantage.

Not quite so unequal.

On my side, I have technology. To start with, the wormhole, the technological sleight-of-space which got you fifty-seven light years from Earth in the first place.

The wormhole is a monster of relativity no less than the black hole, a trick of curved space allowed by the theory of general relativity. After the Virgo black hole was discovered, a wormhole mouth was laboriously dragged to it, slower than light, a project that took over a century. Once the wormhole was here, though, the trip became only a short one, barely a meter of travel. Anybody could come here and drop into it.

A wormhole—a far too cute name, but one we seem to be stuck with—is a shortcut from one place to another. Physically, it is nothing more than a loop of exotic matter. If you move through the hoop on this side of the wormhole, you emerge out the hoop on that side. Topologically, the two sides of the wormhole are pasted together, a piece cut out of space glued together elsewhere.

Exhibiting an excessive sense of caution, the proctors of Earthspace refused to allow the other end of the Virgo wormhole to exit at the usual transportation nexus, the wormhole swarm at Neptune-Trojan 4. The far end of the wormhole opens instead to an orbit around Wolf-562, an undistinguished red dwarf sun circled by two airless planets that are little more than frozen rocks, twenty-one light-years from Earthspace. To get here we had to take a double wormhole hop: Wolf, Virgo.

The black hole is a hundred kilometers across. The wormhole is only a few meters across. I would think that they were overly cautious.

The first lesson of relativity is that time and space are one. For a long time after the theoretical prediction that such a thing as a traversable wormhole ought to be possible, it was believed that a wormhole could also be made to traverse time as well. It was only much later, when wormhole travel was tested, that it was found that the Cauchy instability makes it impossible to form a wormhole that leads backward in time. The theory was correct—space and time are indeed just aspects of the same reality, spacetime—but any attempt to move a wormhole in such a way that it becomes a timehole produces a vacuum polarization to cancel out the time effect.

After we—the spaceship I am to pilot, and myself/yourself—come through the wormhole, the wormhole engineers go to work. I have never seen this process close up, so I stay nearby to watch. This is going to be interesting.

A wormhole looks like nothing more than a circular loop of string. It is, in fact, a loop of exotic material, negative-mass cosmic string. The engineers, working telerobotically via vacuum manipulator pods, spray charge onto the string. They charge it until it literally glows with Paschen discharge, like a neon light in the dirty vacuum, and then use the electric charge to manipulate the shape. With the application of invisible electromagnetic fields, the string starts to twist. This is a slow process. Only a few meters across, the wormhole loop has a mass roughly equal to that of Jupiter. Negative to that of Jupiter, to be precise, my scientist persona reminds me, but either way, it is a slow thing to move.

Ponderously, then, it twists further and further, until at last it becomes a lemniscate, a figure of eight. The instant the string touches itself, it shimmers for a moment, and then suddenly there are two glowing circles before us, twisting and oscillating in shape like jellyfish.

The engineers spray more charge onto the two wormholes, and the two wormholes, arcing lightning into space, slowly repel each other. The vibrations of the cosmic string are spraying out gravitational radiation like a dog shaking off water—even where I am, floating ten kilometers distant, I can feel it, like the swaying of invisible tides—and as they radiate energy, the loops enlarge. The radiation represents a serious danger. If the engineers lose control of the string for even a brief instant, it might enter the instability known as “squiggle mode,” and catastrophically enlarge. The engineers damp out the radiation before it gets critical, though—they are, after all, well practiced at this—and the loops stabilize into two perfect circles. On the other side, at Wolf, precisely the same scene has played out, and two loops of exotic string now circle Wolf-562 as well. The wormhole has been cloned.

All wormholes are daughters of the original wormhole, found floating in the depths of interstellar space eleven hundred years ago, a natural loop of negative cosmic string as ancient as the Big Bang, invisible to the eyes save for the distortion of spacetime. That first one led from nowhere interesting to nowhere exciting, but from that one we bred hundreds, and now we casually move wormhole mouths from star to star, breeding new wormholes as it suits us, to form an ever-expanding network of connections.

I should not have been so close. Angry red lights have been flashing in my peripheral vision, warning blinkers that I have been ignoring. The energy radiated in the form of gravitational waves had been prodigious, and would have, to a lesser person, been dangerous. But in my new body, I am nearly invulnerable, and if I can't stand a mere wormhole cloning, there is no way I will be able to stand a black hole. So I ignore the warnings, wave briefly to the engineers—though I doubt that they can even see me, floating kilometers away—and use my reaction jets to scoot over to my ship.

The ship I will pilot is docked to the research station, where the scientists have their instruments and the biological humans have their living quarters. The wormhole station is huge compared to my ship, which is a tiny ovoid occupying a berth almost invisible against the hull. There is no hurry for me to get to it.

I'm surprised that any of the technicians can even see me, tiny as I am in the void, but a few of them apparently do, because in my radio I hear casual greetings called out: how's it, *ohayo gozaimasu*, hey glad you made it, how's the bod? It's hard to tell from the radio voices which ones are people I know, and which are only casual acquaintances. I answer back: how's it, *ohayo*, yo, surpassing spec. None of them seem inclined to chat, but then, they're busy with their own work.

They are dropping things into the black hole.

Throwing things in, more to say. The wormhole station orbits a tenth of an astronomical unit from the Virgo black hole, closer to the black hole than Mercury is

to the sun. This is an orbit with a period of a little over two days, but, even so close to the black hole, there is nothing to see. A rock, released to fall straight downward, takes almost a day to reach the horizon.

One of the scientists supervising, a biological human named Sue, takes the time to talk with me a bit, explaining what they are measuring. What interests me most is that they are measuring whether the fall deviates from a straight line. This will let them know whether the black hole is rotating. Even a slight rotation would mess up the intricate dance of the trajectory required for my ship. However, the best current theories predict that an old black hole will have shed its angular momentum long ago, and, as far as the technicians can determine, their results show that the conjecture holds.

The black hole, or the absence in space where it is located, is utterly invisible from here. I follow the pointing finger of the scientist, but there is nothing to see. Even if I had a telescope, it is unlikely that I would be able to pick out the tiny region of utter blackness against the irregular darkness of an unfamiliar sky.

My ship is not so different from the drop probes. The main difference is that I will be on it.

Before boarding the station, I jet over in close to inspect my ship, a miniature egg of perfectly reflective material. The hull is made of a single crystal of a synthetic material so strong that no earthly force could even dent it.

A black hole, though, is no earthly force.

Wolf versus the black hole! The second technological trick I have in my duel against the black hole is my body.

I am no longer a fragile, fluid-filled biological human. The tidal forces at the horizon of a black hole would rip a true human apart in mere instants; the accelerations required to hover would squash one into liquid. To make this journey, I have downloaded your fragile biological mind into a body of more robust material. As important as the strength of my new body is the fact that it is tiny. The force produced by the curvature of gravity is proportional to the size of the object. My new body, a millimeter tall, is millions of times more resistant to being stretched to spaghetti.

The new body has another advantage as well. With my mind operating as software on a computer the size of a pinpoint, my thinking and my reflexes are thousands of times faster than biological. In fact, I have already chosen to slow my thinking down, so that I can still interact with the biologicals. At full speed, my microsecondreactions are lightning compared to the molasses of neuron speeds in biological humans. I see far in the ultraviolet now, a necessary compensation for the fact that my vision would consist of nothing but a blur if I tried to see by visible light.

You could have made my body any shape, of course, a tiny cube or even a featureless sphere. But you followed the dictates of social convention. A right human should be recognizably a human, even if I am to be smaller than an ant, and so my body mimics a human body, although no part of it is organic, and my brain faithfully executes your own human brain software. From what I see and feel, externally and

internally, I am completely, perfectly human.

As is right and proper. What is the value of experience to a machine?  
Later, after I return—if I return—I can upload back. I can become you.  
But return is, as they say, still somewhat problematical.

You, my original, what do you feel? Why did I think I would do it? I imagine you laughing hysterically about the trick you've played, sending me to drop into the black hole while you sit back in perfect comfort, in no danger. Imagining your laughter comforts me, for all that I know that it is false. I've been in the other place before, and never laughed.

I remember the first time I fell into a star.

We were hotlinked together, that time, united in online-realtime, our separate brains reacting as one brain. I remember what I thought, the incredible electric feel: ohmigod, am I really going to do this? Is it too late to back out?

The idea had been nothing more than a whim, a crazy idea, at first. We had been dropping probes into a star, Groombridge 1830B, studying the dynamics of a flare star. We were done, just about, and the last-day-of-project party was just getting in swing. We were all fuzzed with neurotransmitter randomizers, creativity spinning wild and critical thinking nearly zeroed. Somebody, I think it was Jenna, said, we could ride one *down*, you know. Wait for a flare, and then plunge through the middle of it. Helluva ride!

Helluva *splash* at the end, too, somebody said, and laughed.

Sure, somebody said. It might have been me. What do you figure? Download yourself to temp storage and then uplink frames from yourself as you drop?

That works, Jenna said. Better: we copy our bodies first, then link the two brains. One body drops; the other copy hotlinks to it.

Somehow, I don't remember when, the word "we" had grown to include me.

"Sure," I said. "And the copy on top is in null-input suspension; experiences the whole thing realtime!"

In the morning, when we were focused again, I might have dismissed the idea as a whim of the fuzz, but for Jenna the decision was already immovable as a droplet of neutronium. *Sure* we're dropping, let's start now.

We made a few changes. It takes a long time to fall into a star, even a small one like Bee, so the copy was reengineered to a slower thought-rate, and the original body in null-input was frame-synched to the drop copy with impulse-echoers. Since the two brains were molecule by molecule identical, the uplink bandwidth required was minimal.

The probes were reworked to take a biological, which meant mostly that a cooling system had to be added to hold the interior temperature within the liquidus range of water. We did that by the simplest method possible: we surrounded the probes with a huge block of cometary ice. As it sublimated, the ionized gas would carry away heat. A secondary advantage of the ice was that our friends, watching from orbit, would have a blazing cometary trail to cheer on. When the ice was used

up, of course, the body would slowly vaporize. None of us would actually survive to hit the star.

But that was no particular concern. If the experience turned out to be too undesirable, we could always edit the pain part of it out of the memory later.

It would have made more sense, perhaps, to have simply recorded the brain-uplink from the copy onto a local high-temp buffer, squirted it back, and linked to it as a memory upload. But Jenna would have none of that. She wanted to experience it in realtime, or at least in as close to realtime as speed-of-light delays allow.

Three of us—Jenna, Martha, and me—dropped. Something seems to be missing from my memory here; I can't remember the reason I decided to do it. It must have been something about a biological body, some a-rational consideration that seemed normal to my then-body, that I could never back down from a crazy whim of Jenna's.

And I had the same experience, the same feeling then, as I, you, did, always do, the feeling that my god *I* am the copy and I am going to die. But that time, of course, thinking every thought in synchrony, there was no way at all to tell the copy from the original, to split the me from you.

It is, in its way, a glorious feeling.

I dropped.

You felt it, you remember it. Boring at first, the long drop with nothing but freefall and the chatter of friends over the radio-link. Then the ice shell slowly flaking away, ionizing and beginning to glow, a diaphanous cocoon of pale violet, and below the red star getting larger and larger, the surface mottled and wrinkled, and then suddenly we fell into and through the flare, a huge luminous vault above us, dwarfing our bodies in the immensity of creation.

An unguessable distance beneath me, the curvature of the star vanished, and, still falling at three hundred kilometers per second, I was hanging motionless over an infinite plane stretching from horizon to horizon.

And then the last of the ice vaporized, and I was suddenly suspended in nothing, hanging nailed to the burning sky over endless crimson horizons of infinity, and pain came like the inevitability of mountains—I didn't edit it—pain like infinite oceans, like continents, like a vast, airless world.

Jenna, now I remember. The odd thing is, I never did really connect in any significant way with Jenna. She was already in a quadrad of her own, a quadrad she was fiercely loyal to, one that was solid and accepting to her chameleon character, neither needing nor wanting a fifth for completion.

Long after, maybe a century or two later, I found out that Jenna had disassembled herself. After her quadrad split apart, she'd downloaded her character to a mainframe, and then painstakingly cataloged everything that made her Jenna: all her various skills and insights, everything she had experienced, no matter how minor, each facet of her character, every memory and dream and longing, the myriad subroutines of personality. She indexed her soul, and she put the ten thousand pieces of it into the public domain for download. A thousand people, maybe a million people, maybe even more, have pieces of Jenna, her cleverness, her insight, her skill at playing antique instruments.

But nobody has her sense of self. After she copied her subroutines, she deleted herself.

And who am I?

Two of the technicians who fit me into my spaceship and who assist in the ten thousand elements of the preflight check are the same friends from that drop, long ago; one of them even still in the same biological body as he had then, although eight hundred years older, his vigor undiminished by biological reconstruction. My survival, if I am to survive, will be dependent on microsecond timing, and I'm embarrassed not to be able to remember his name.

He was, I recall, rather stodgy and conservative even back then.

We joke and trade small talk as the checkout proceeds. I'm still distracted by my self-questioning, the implications of my growing realization that I have no understanding of why I'm doing this.

Exploring a black hole would be no adventure if only we had faster-than-light travel, but of the thousand technological miracles of the third and fourth millennia, this one miracle was never realized. If I had the mythical FTL motor, I could simply drive out of the black hole. At the event horizon, space falls into the black hole at the speed of light; the mythical motor would make that no barrier.

But such a motor we do not have. One of the reasons I'm taking the plunge—not the only one, not the main one, but one—is in the hope that scientific measurements of the warped space inside the black hole will elucidate the nature of space and time, and so I myself will make one of the innumerable small steps to bring us closer to an FTL drive.

The spaceship I am to pilot has a drive nearly—but not quite—as good. It contains a microscopic twist of spacetime inside an impervious housing, a twist that will parity-reverse ordinary matter into mirror-matter. This total conversion engine gives my ship truly ferocious levels of thrust. The gentlest nudge of my steering rockets will give me thousands of gravities of acceleration. Unthinkable acceleration for a biological body, no matter how well cushioned. The engine will allow the rocket to dare the unthinkable, to hover at the very edge of the event horizon, to maneuver where space itself is accelerating at nearly light-speed. This vehicle, no larger than a peanut, contains the engines of an interstellar probe.

Even with such an engine, most of the ship is reaction mass.

The preflight checks are all green. I am ready to go. I power up my instruments, check everything out for myself, verify what has already been checked three times, and then check once again. My pilot persona is very thorough. Green.

“You still haven't named your ship,” comes a voice to me. It is the technician, the one whose name I have forgotten. “What is your call sign?”

One way journey, I think. Maybe something from Dante? No, Sartre said it better: no exit. “*Huis Clos*,” I say, and drop free.

Let them look it up.



Alone.

The laws of orbital mechanics have not been suspended, and I do not drop into the black hole. Not yet. With the slightest touch of my steering engines—I do not dare use the main engine this close to the station—I drop into an elliptical orbit, one with a Perimelasma closer to, but still well outside, the dangerous zone of the black hole. The black hole is still invisible, but inside my tiny kingdom I have enhanced senses of exquisite sensitivity, spreading across the entire spectrum from radio to gamma radiation. I look with my new eyes to see if I can detect an X-ray glow of interstellar hydrogen being ripped apart, but if there is any such, it is too faint to be visible with even my sensitive instruments. The interstellar medium is so thin here as to be essentially nonexistent. The black hole is invisible.

I smile. This makes it better, somehow. The black hole is pure, unsullied by any outside matter. It consists of gravity and nothing else, as close to a pure mathematical abstraction as anything in the universe can ever be.

It is not too late to back away. If I were to choose to accelerate at a million gravities, I would reach relativistic velocities in about thirty seconds. No wormholes would be needed for me to run away; I would barely even need to slow down my brain to cruise at nearly the speed of light to anywhere in the colonized galaxy.

But I know I won't. The psychologist knew it, too, damn her, or she would never have approved me for the mission. Why? What is it about me?

As I worry about this with part of my attention, while the pilot persona flies the ship, I flash onto a realization, and at this realization another memory hits. It is the psychologist, and in the memory I'm attracted to her sexually, so much so that you are distracted from what she is saying.

I feel no sexual attraction now, of course. I can barely remember what it is. That part of the memory is odd, alien.

"We can't copy the whole brain to the simulation, but we can copy enough that, to yourself, you will still feel like yourself," she said. She is talking to the air, not to you. "You won't notice any gaps."

I'm brain-damaged. This is the explanation.

You frowned. "How could I not notice that some of my memories are missing?"

"The brain makes adjustments. Remember, at any given time, you never even use 1 percent of 1 percent of your memories. What we'll be leaving out will be stuff that you will never have any reason to think about. The memory of the taste of strawberries, for example; the floor-plan of the house you lived in as a teenager. Your first kiss."

This bothered you somewhat—you want to remain yourself. I concentrate, hard. What do strawberries taste like? I can't remember. I'm not even certain what color they are. Round fruits, like apples, I think, only smaller. And the same color as apples, or something similar, I'm sure, except I don't remember what color that is.

You decided that you can live with the editing, as long as it doesn't change the essential you. You smiled. "Leave in the first kiss."

So I can never possibly solve the riddle: what kind of a man is it that would deliberately allow himself to drop into a black hole. I cannot, because I don't have

the memories of you. In a real sense, I am *not* you at all.

But I do remember the kiss. The walk in the darkness, the grass wet with dew, the moon a silver sliver on the horizon, turning to her, and her face already turned up to meet my lips. The taste indescribable, more feeling than taste (not like strawberries at all), the small hardness of her teeth behind the lips—all there. Except the one critical detail: I don't have any idea at all who she *was*.

What else am I missing? Do I even know what I don't know?

I was a child, maybe nine, and there was no tree in the neighborhood that you could not climb. I was a careful, meticulous, methodical climber. On the tallest of the trees, when you reached toward the top, you were above the forest canopy (did I live in a forest?) and, out of the dimness of the forest floor, emerged into brilliant sunshine. Nobody else could climb like you; nobody ever suspected how high I climbed. It was your private hiding place, so high that the world was nothing but a sea of green waves in the valley between the mountains.

It was my own stupidity, really. At the very limit of the altitude needed to emerge into sunlight, the branches were skinny, narrow as your little finger. They bent alarmingly with your weight, but I knew exactly how much they would take. The bending was a thrill, but I was cautious, and knew exactly what I was doing.

It was further down, where the branches were thick and safe, that I got careless. Three points of support, that was the rule of safety, but I was reaching for one branch, not paying attention, when one in my other hand broke, and I was off balance. I slipped. For a prolonged instant I was suspended in space, branches all about me, I reached out and grasped only leaves, and I fell and fell and fell, and all I could think as leaves and branches fell upward past me was, oh my, I made a miscalculation; I was really stupid.

The flash memory ends with no conclusion. I must have hit the ground but I cannot remember it. Somebody must have found me, or else I wandered or crawled back, perhaps in a daze, and found somebody, but I cannot remember it.

Half a million kilometers from the hole. If my elliptical orbit were around the sun instead of a black hole, I would already have penetrated the surface. I now hold the record for the closest human approach. There is still nothing to see with unmagnified senses. It seems surreal that I'm in the grip of something so powerful that is utterly invisible. With my augmented eyes used as a telescope, I can detect the black hole by what isn't there, a tiny place of blackness nearly indistinguishable from any other patch of darkness except for an odd motion of the stars near it.

My ship is sending a continuous stream of telemetry back to the station. I have an urge to add a verbal commentary—there is plenty of bandwidth—but I have nothing to say. There is only one person I have any interest in talking to, and you are cocooned at absolute zero, waiting for me to upload myself and become you.

My ellipse takes me inward, moving faster and faster. I am still in Newton's grip, far from the sphere where Einstein takes hold.

A tenth of a solar radius. The blackness I orbit is now large enough to see without a telescope, as large as the sun seen from Earth, and swells as I watch with time-distorted senses. Due to its gravity, the blackness in front of the star pattern is a

bit larger than the disk of the black hole itself. Square root of twenty-seven over two—about two and a half times larger, the physicist persona notes. I watch in fascination.

What I see is a bubble of purest blackness. The bubble pushes the distant stars away from it as it swells. My orbital motion makes the background stars appear to sweep across the sky, and I watch them approach the black hole and then, smoothly pushed by the gravity, move off to the side, a river of stars flowing past an invisible obstacle. It is a gravitational lensing effect, I know, but the view of flowing stars is so spectacular that I cannot help but watch it. The gravity pushes each star to one side or the other. If a star were to pass directly behind the hole, it would appear to split and for an instant become a perfect circle of light, an Einstein ring. But this precise alignment is too rare to see by accident.

Closer, I notice an even odder effect. The sweeping stars detour smoothly around the bubble of blackness, but very close to the bubble, there are other stars, stars that actually move in the opposite direction, a counterflowing river of stars. It takes me a long time (microseconds perhaps) before my physicist persona tells me that I am seeing the image of the stars in the Einstein mirror. The entire external universe is mirrored in a narrow ring outside the black hole, and the mirror image flows along with a mirror of my own motion.

In the center of the ring there is nothing at all.

Five thousand kilometers, and I am moving fast. The gravitational acceleration here is over ten million gees, and I am still fifty times the Schwarzschild radius from the black hole. Einstein's correction is still tiny, though, and if I were to do nothing, my orbit would whip around the black hole and still escape into the outside world.

One thousand kilometers. Perimelasma, the closest point of my elliptical orbit. Ten times the Schwarzschild radius, close enough that Einstein's correction to Newton now makes a small difference to the geometry of space. I fire my engines. My speed is so tremendous that it takes over a second of my engine firing at a million gravities to circularize my orbit.

My time sense has long since speeded up back to normal, and then faster than normal. I orbit the black hole about ten times per second.

My god, this is why I exist, this is why I'm here!

All my doubts are gone in the rush of naked power. No biological could have survived this far; no biological could have even survived the million-gee circularization burn, and I am only at the very beginning! I grin like a maniac, throb with a most unscientific excitement that must be the electronic equivalent of an adrenaline high.

Oh, this ship is good. This ship is sweet. A million-gee burn, smooth as magnetic levitation, and I barely cracked the throttle. I should have taken it for a spin before dropping in, should have hot-rodged *Huis Clos* around the stellar neighborhood. But it had been absolutely out of the question to fire the main engine close to the wormhole station. Even with the incredible efficiency of the engine, that million-gee perimelasma burn must have lit up the research station like an unexpected sun.

I can't wait to take *Huis Clos* in and see what it will *really* do.

My orbital velocity is a quarter of the speed of light.

The orbit at nine hundred kilometers is only a parking orbit, a chance for me to configure my equipment, make final measurements, and, in principle, a last chance for me to change my mind. There is nothing to reconnoiter that the probes have not already measured, though, and there is no chance that I will change my mind, however sensible that may seem.

The river of stars swirls in a dance of counterflow around the blackness below me. The horizon awaits.

The horizon below is invisible, but real. There is no barrier at the horizon, nothing to see, nothing to feel. I will even be unable to detect it, except for my calculations.

An event horizon is a one-way membrane, a place you can pass into but neither you nor your radio signals can pass out of. According to the mathematics, as I pass through the event horizon, the directions of space and time change identity. Space rotates into time; time rotates into space. What this means is that the direction to the center of the black hole, after I pass the event horizon, will be the future. The direction out of the black hole will be the past. This is the reason that no one and nothing can ever leave a black hole; the way inward is the one direction we always must go, whether we will it or not: into the future.

Or so the mathematics says.

The future, inside a black hole, is a very short one.

So far the mathematics has been right on. Nevertheless, I go on. With infinitesimal blasts from my engine, I inch my orbit lower.

The bubble of blackness gets larger, and the counterflow of stars around it becomes more complex. As I approach three times the Schwarzschild radius, 180 kilometers, I check all my systems. This is the point of no rescue: inside three Schwarzschild radii, no orbits are stable, and my automatic systems will be constantly thrusting to adjust my orbital parameters to keep me from falling into the black hole or being flung away to infinity. My systems are all functional, in perfect form for the dangerous drop. My orbital velocity is already half the speed of light. Below this point, centrifugal force will decrease toward zero as I lower my orbit, and I must use my thrusters to increase my velocity as I descend, or else plunge into the hole.

When I grew up, in the last years of the second millennium, nobody thought that they would live forever. Nobody would have believed me if I told them that by my thousandth birthday, I would have no concept of truly dying.

Even if all our clever tricks fail, even if I plunge through the event horizon and am stretched into spaghetti and crushed by the singularity, I will not die. You, my original, will live on, and if *you* were to die, we have made dozens of back-ups and spin-off copies of myself in the past, some versions of which must surely still be living on. My individual life has little importance. I can, if I chose, uplink my brain-state to the orbiting station right at this instant, and reawake, whole, continuing this exact thought, unaware (except on an abstract intellectual level) that I and you are not the same.

But we are not the same, you and I. I am an edited-down version of you, and the memories that have been edited out, even if I never happen to think them, make me different, a new individual. Not *you*.

On a metaphorical level, a black hole stands for death, the blackness that is sucking us all in. But what meaning does death have in a world of matrix back-ups and modular personality? Is my plunge a death wish? Is it thumbing my nose at death? Because I intend to survive. Not you. *Me*.

I orbit the black hole over a hundred times a second now, but I have revved my brain processing speed accordingly, so that my orbit seems to me leisurely enough. The view here is odd. The black hole has swollen to the size of a small world below me, a world of perfect velvet darkness, surrounded by a belt of madly rotating stars.

No engine, no matter how energetic, can put a ship into an orbit at 1.5 times the Schwarzschild radius; at this distance, the orbital velocity is the speed of light, and not even my total-conversion engine can accelerate me to that speed. Below that, there are no orbits at all. I stop my descent at an orbit just sixty kilometers from the event horizon, when my orbital velocity reaches 85 percent of the speed of light. Here I can coast, ignoring the constant small adjustments of the thrusters that keep my orbit from sliding off the knife-edge. The velvet blackness of the black hole is almost half of the universe now, and if I were to trust the outside view, I am diving at a slant downward into the black hole. I ignore my pilot's urge to override the automated navigation and manually even out the trajectory. The downward slant is only relativistic aberration, nothing more, an illusion of my velocity.

And 85 percent of the speed of light is as fast as I dare orbit; I must conserve my fuel for the difficult part of the plunge to come.

In my unsteady orbit sixty kilometers above the black hole, I let my ship's computer chat with the computer of the wormhole station, updating and down-loading my sensors' observations.

At this point, according to the mission plan, I am supposed to uplink my brain state, so that should anything go wrong further down the well, you, my original, will be able to download my state and experiences to this point. To hell with that, I think, a tiny bit of rebellion. I am not you. If you awaken with my memories, I will be no less dead.

Nobody at the wormhole station questions my decision not to upload.

I remember one other thing now. "You're a type N personality," the psychologist had said, twitching her thumb to leaf through invisible pages of test results. The gesture marked her era; only a person who had grown up before computer hotlinks would move a physical muscle in commanding a virtual. She was twenty-first century, possibly even twentieth. "But I suppose you already know that."

"Type N?" you asked.

"Novelty-seeking," she said. "Most particularly, one not prone to panic at new situations."

"Oh," you said. You did already know that. "Speaking of novelty seeking, how do you feel about going to bed with a type N personality?"

"That would be unprofessional." She frowned. "I think."

"Not even one who is about to jump down a black hole?" She terminated the computer link with a flick of her wrist, and turned to look at you. "Well—"

From this point onward, microsecond timing is necessary for the dance we have planned to succeed. My computer and the station computer meticulously compare clocks, measuring Doppler shifts to exquisite precision. My clocks are running slow, as expected, but half of the slowness is relativistic time dilation due to my velocity. The gravitational redshift is still modest. After some milliseconds—a long wait for me, in my hyped-up state—they declare that they agree. The station has already done their part, and I begin the next phase of my descent.

The first thing I do is fire my engine to stop my orbit. I crack the throttle to fifty million gees of acceleration, and the burn takes nearly a second, a veritable eternity, to slow my flight.

For a moment I hover, and start to drop. I dare not drop too fast, and I ramp my throttle up, to a hundred megagee, five hundred, a billion gravities. At forty billion gravities of acceleration, my engine thrust equals the gravity of the black hole, and I hover.

The blackness has now swallowed half of the universe. Everything beneath me is black. Between the black below and the starry sky above, a spectacularly bright line exactly bisects the sky. I have reached the altitude at which orbital velocity is just equal to the speed of light, and the light from my rocket exhaust is in orbit around the black hole. The line I see around the sky is my view of my own rocket, seen by light that has traveled all the way around the black hole. All I can see is the exhaust, far brighter than anything else in the sky.

The second brightest thing is the laser beacon from the wormhole station above me, shifted from the original red laser color to a greenish blue. The laser marks the exact line between the station and the black hole, and I maneuver carefully until I am directly beneath the orbiting station.

At forty billion gravities, even my ultrastrong body is at its limits. I cannot move, and even my smallest finger is pressed against the form-fitting acceleration couch. But the controls, hardware-interfaced to my brain, do not require me to lift a finger to command the spacecraft. The command I give *Huis Clos* is: down.

My engine throttles down slightly, and I drop inward from the photon sphere, the bright line of my exhaust vanishes. Every stray photon from my drive is now sucked downward.

Now my view of the universe has changed. The black hole has become the universe around me, and the universe itself, all the galaxies and stars and the wormhole station, is a shrinking sphere of sparkling dust above me.

Sixty billion gravities. Seventy. Eighty.

Eighty billion gravities is full throttle. I am burning fuel at an incredible rate, and only barely hold steady. I am still twenty kilometers above the horizon.

There is an unbreakable law of physics: incredible accelerations require incredible fuel consumption. Even though my spaceship is, by mass, comprised mostly of fuel, I can maintain less than a millisecond worth of thrust at this acceleration. I cut my engine and drop.

It will not be long now. This is my last chance to uplink a copy of my mind hack to the wormhole station to wake in your body, with my last memory the decision to upload my mind.

I do not.

The stars are blueshifted by a factor of two, which does not make them noticeably bluer. Now that I have stopped accelerating, the starlight is falling into the hole along with me, and the stars do not blueshift any further. My instruments probe the vacuum around me. The theorists say that the vacuum close to the horizon of a black hole is an exotic vacuum, abristle with secret energy. Only a ship plunging through the event horizon would be able to measure this. I do, recording the results carefully on my ship's on-board recorders, since it is now far too late to send anything back by radio.

There is no sign to mark the event horizon, and there is no indication at all when I cross it. If it were not for my computer, there would be no way for me to tell that I have passed the point of no return.

Nothing is different. I look around the tiny cabin, and can see no change. The blackness below me continues to grow, but is otherwise not changed. The outside universe continues to shrink above me; the brightness beginning to concentrate into a belt around the edge of the glowing sphere of stars, but this is only an effect of my motion. The only difference is that I have only a few hundred microseconds left.

From the viewpoint of the outside world, the light from my spacecraft has slowed down and stopped at the horizon. But I have far outstripped my lagging image, and am falling toward the center at incredible speed. At the exact center is the singularity, far smaller than an atom, a mathematical point of infinite gravity and infinite mystery.

Whoever I am, whether or not I survive, I am now the first person to penetrate the event horizon of a black hole. That's worth a cheer, even with nobody to hear. Now I have to count on the hope that the microsecond timing of the technicians above me had been perfect for the second part of my intricate dance, the part that might, if all goes well, allow me to survive.

Above me, according to theory, the stars have already burned out, and even the most miserly red dwarf has sputtered the last of its hydrogen fuel and grown cold. The universe has already ended, and the stars have gone out. I still see a steady glow of starlight from the universe above me, but this is fossil light, light that has been falling down into the black hole with me for eons, trapped in the infinitely stretched time of the black hole.

For me, time has rotated into space, and space into time. Nothing feels different to me, but I cannot avoid the singularity at the center of the black hole any more than I can avoid the future. Unless, that is, I have a trick.

Of course, I have a trick.

At the center of the spherical universe above me is a dot of bright blue-violet; the fossil light of the laser beacon from the orbiting station. My reaction jets have kept on adjusting my trajectory to keep me centred in the guidance beam, so I am directly below the station. Anything dropped from the station will, if everything works right, drop directly on the path I follow.

I am approaching close to the center now, and the tidal forces stretching my body are creeping swiftly toward a billion gees per millimeter. Much higher, and even my tremendously strong body will be ripped to spaghetti. There are only microseconds left for me. It is time.

I hammer my engine, full throttle. Far away, and long ago, my friends at the wormhole station above dropped a wormhole into the event horizon. If their timing was perfect—

From a universe that has already died, the wormhole cometh.

Even with my enhanced time sense, things happen fast. The laser beacon blinks out, and the wormhole sweeps down around me like the vengeance of God, far faster than I can react. The sparkle-filled sphere of the universe blinks out like a light, and the black hole—and the tidal forces stretching my body—abruptly disappears. For a single instant I see a black disk below me, and then the wormhole rotates, twists, stretches, and then silently vanishes.

Ripped apart by the black hole.

My ship is vibrating like a bell from the abrupt release of tidal stretching. “I did it,” I shout. “It worked! God damn it, it really worked!”

This was what was predicted by the theorists, that I would be able to pass through the wormhole before it was shredded by the singularity at the center. The other possibility, that the singularity itself, infinitesimally small and infinitely powerful, might follow me through the wormhole, was laughed at by everyone who had any claim to understand wormhole physics. This time, the theorists were right.

But where am I?

There should be congratulations pouring into my radio by now, teams of friends and technicians swarming over to greet me, cheering and shouting.

“*Huis Clos*,” I say, over the radio. “I made it! *Huis Clos* here. Is anybody there?”

In theory, I should have reemerged at Wolf-562. But I do not see it. In fact, what I see is not recognizably the universe at all.

There are no stars.

Instead of stars, the sky is filled with lines, parallel lines of white light by the uncountable thousands. Dominating the sky, where the star Wolf-562 should have been, is a glowing red cylinder, perfectly straight, stretching to infinity in both directions.

Have I been transported into some other universe? Could the black hole’s gravity sever the wormhole, cutting it loose from our universe entirely, and connect it into this strange new one?

If so, it has doomed me. The wormhole behind me, my only exit from this strange universe, is already destroyed. Not that escaping through it could have done me any good—it would only have brought me back to the place I escaped, to be crushed by the singularity of the black hole.

I could just turn my brain off, and I will have lost nothing, in a sense. They will bring you out of your suspended state, tell you that the edition of you that dropped into the black hole failed to upload, and they lost contact after it passed the event horizon. The experiment failed, but you had never been in danger.

But, however much you think we are the same, *I am not you*. I am a unique individual. When they revive you, without your expected new memories, I will still be gone.

I want to survive, I want to return.

A universe of tubes of light! Brilliant bars of an infinite cage. The bright lines



in the sky have slight variations in color, from pale red to plasma-arc blue. They must be similar to the red cylinder near me, I figure, but light-years away. How could a universe have lines of light instead of stars?

I am amazingly well equipped to investigate that question, with senses that range from radio through X-ray, and I have nothing else to do for the next thousand years or so. So I take a spectrum of the light from the glowing red cylinder.

I have no expectation that the spectrum will reveal anything I can interpret, but oddly, it looks normal. Impossibly, it looks like the spectrum of a star.

The computer can even identify, from its data of millions of spectra, precisely which star. The light from the cylinder has the spectral signature of Wolf-562.

Coincidence? It cannot possibly be coincidence, out of billions of possible spectra, that this glowing sword in the sky has exactly the spectrum of the star that should have been there. There can be no other conclusion but that the cylinder is Wolf-562.

I take a few more spectra, this time picking at random three of the lines of light in the sky, and the computer analyzes them for me. A bright one: the spectrum of 61 Virginis. A dimmer one: a match to Wolf-1061. A blue-white streak: Vega.

The lines in the sky are stars.

What does this mean?

I'm not in another universe. I am in *our* universe, but the universe has been transformed. Could the collision of a wormhole with a black hole destroy our entire universe, stretching suns like taffy into infinite straight lines? Impossible. Even if it had, I would still see far-away stars as dots, since the light from them has been traveling for hundreds of years.

The universe cannot have changed. Therefore, by logic, it must be *me* who has been transformed.

Having figured out this much, the only possible answer is obvious.

When the mathematicians describe the passage across the event horizon of a black hole, they say that the space and time directions switch identity. I had always thought this only a mathematical oddity, but if it were true, if I had rotated when I passed the event horizon, and was now perceiving time as a direction in space, and one of the space axes as time —this would explain everything. Stars extend from billions of years into the past to long into the future; perceiving time as space, I see lines of light. If I were to come closer and find one of the rocky planets of Wolf-562, it would look like a braid around the star, a helix of solid rock. Could I land on it? How would I interact with a world where what I perceive as time is a direction in space?

My physicist persona doesn't like this explanation, but is at a loss to find a better one. In this strange sideways existence, I must be violating the conservation laws of physics like mad, but the persona could find no other hypothesis and must reluctantly agree: time is rotated into space.

To anybody outside, I must look like a string, a knobby long rope with one end at the wormhole and the other at my death, wherever that might be. But nobody could see me fast enough, since with no extension in time I must only be a transient event that bursts everywhere into existence and vanishes at the same instant. There is no way I can signal, no way I can communicate—

Or? Time, to me, is now a direction I can travel in as simply as using my rocket. I could find a planet, travel parallel to the direction of the surface—

But, no, all I could do would be to appear to the inhabitants briefly as a disk, a cross-section of myself, infinitely thin. There is no way I could communicate.

But I can travel in time, if I want. Is there any way I can use this?

Wait. If I have rotated from space into time, then there is one direction in space that I cannot travel. Which direction is that? The direction that used to be away from the black hole.

Interesting thoughts, but not ones which help me much. To return, I need to once again flip space and time. I could dive into a black hole. This would again rotate space and time, but it wouldn't do me any good: once I left the black hole—if I could leave the black hole—nothing would change.

Unless there were a wormhole inside the black hole, falling inward to destruction just at the same instant I was there? But the only wormhole that has fallen into a black hole was already destroyed. Unless, could I travel forward in time? Surely some day the research team would drop a new wormhole into the black hole—

Idiot. Of course there's a solution. Time is a spacelike dimension to me, so I can travel either direction in time now, forward or back. I need only to move back to an instant just after the wormhole passed through the event horizon, and, applying full thrust, shoot through. The very moment that my original self shoots through the wormhole to escape the singularity, I can pass through the opposite direction, and rotate myself back into the real universe.

The station at Virgo black hole is forty light years away, and I don't dare use the original wormhole to reach it. My spacetime-rotated body must be an elongated snake in this version of space-time, and I do not wish to find out what a wormhole passage will do to it until I have no other choice. Still, that is no problem for me. Even with barely enough fuel to thrust for a few microseconds, I can reach an appreciable fraction of light-speed, and I can slow down my brain to make the trip appear only an instant.

To an outside observer, it takes literally no time at all.

“No,” says the psych tech, when I ask her. “There's no law that compels you to uplink back into your original. You're a free human being. Your original can't force you.”

“Great,” I say. Soon I'm going to have to arrange to get a biological body built for myself. This one is superb, but it's a disadvantage in social intercourse being only a millimeter tall.

The transition back to real space worked perfectly. Once I figured out how to navigate in time-rotated space, it had been easy enough to find the wormhole and the exact instant it had penetrated the event horizon.

“Are you going to link your experiences to public domain?” the tech asks. “I think he would like to see what you experienced. Musta been pretty incredible.”

“Maybe,” I said.

“For that matter,” the psych tech added, “I'd like to link it, too.”

“I’ll think about it.”

So I am a real human being now, independent of you, my original. There had been cheers and celebrations when I had emerged from the wormhole, but nobody had an inkling quite how strange my trip had been until I told them. Even then, I doubt that I was quite believed until the sensor readings and Computer logs of *Huis Clos* confirmed my story with hard data.

The physicists had been ecstatic. A new tool to probe time and space. The ability to rotate space into time will open up incredible capabilities. They were already planning new expeditions, not the least of which was a trip to probe right to the singularity itself.

They had been duly impressed with my solution to the problem, although, after an hour of thinking it over, they all agreed it had been quite obvious. “It was lucky,” one of them remarked, “that you decided to go through the wormhole from the opposite side, that second time.”

“Why?” I asked.

“If you’d gone through the same direction, you’d have rotated an additional ninety degrees, instead of going back.”

“So?”

“Reversed the time vector. Turns you into antimatter. First touch of the inter-stellar medium—Poof.”

“Oh,” I said. I hadn’t thought of that. It made me feel a little less clever.

Now that the mission is over, I have no purpose, no direction for my existence. The future is empty, the black hole that we all must travel into. I will get a biological body, yes, and embark on the process of finding out who I am. Maybe, I think, this is a task that everybody has to do.

And then I will meet you. With luck, perhaps I’ll even like you. And maybe, if I should like you enough, and I feel confident, I’ll decide to upload you into myself, and once more, we will again be one.