how we lost the moon,
a true story by frank w. allen
PAUL J. McAULEY

Born in Stroud, England, in 1955, Paul J. McAuley now makes his home in London. A professional biologist for many years, he sold his first story in 1984, and has gone on to he a frequent contributor to Interzone, *as well as to markets such as* Amazing, The Magazine of Fantasy & Science Fiction, Asimov's Science Fiction, When the Music's Over, *and else-where.*

McAuley has a foot in several different camps of science fiction writing, being considered one of the best of the new breed of British writers (although a few Australian writers could be fit in under this heading as well) who are producing that brand of rigorous hard science fiction with updated modern and stylistic sensibilities that is sometimes referred to as "radical hard sci-ence fiction," in addition to being one of the major young writers who are producing that revamped and retooled widescreen Space Opera that has sometimes been called the New Baroque Space Opera. But, something of a literary millipede, McAuley refuses to be limited to a mere two camps in which to put his feet, and also writes Dystopian sociological speculations about the very near future, some elegant and literate Alternate History, and even some unabashed fantasy and supernatural horror stories, all with equal fluency and skill. His first novel, Four Hundred Billion Stars, *won the Philip K. Dick Award. His other books include the novels* Of the Fall, Eternal Light, *and* Pasquale's Angel; *two collections of his short work,* The King of the Hill and Other Stories *and* The Invisible Country; *and an original anthology co-edited with Kim Newman,* In Dreams. *His acclaimed novel* Fairyland *won both the Arthur C. Clarke Award and the John* W. *Campbell Award in 1996. His most recent books are* Child of the River *and* Ancients of Days, *the first two volumes of a major new trilogy of ambitious scope and scale,* Confluence, *set ten million years in the future. The third book in the trilogy,* Shrine of Stars, *is due out soon. Currently he is working on a new novel,* The Secret of Life. *His stories have appeared in our Fifth, Ninth, Thirteenth, Fifteenth, and Sixteenth Annual Collec-tions. His web site is at http://www.omegacom.demon.co.uk.*

On the busy, bustling, colonized future Moon, McAuley reminds us

that although everyone makes mistakes, some *mistakes have far greater consequences than others…*

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I probably think that you know everything about it. After all, here we are, barely into the second quarter of the first century of the Third Millennium, and it's being touted as the biggest event in the history of humanity. Yeah, right. But tossing aside such impossibly grandiose claims, it was and still is a hell of a story. It's generated millions of bytes of Web journalism (two years after, there are still more than two hundred official Web sites, not to mention the tens of thousands of unofficial newsgroups devoted to proving that it was really caused by God, or aliens, or St. Elvis), tens of thousands of hours of TV and a hundred schlocky movies (and I do include James Cameron's seven-hour blockbuster), thousands of scientific papers and dozens of thick technical reports, including the ten-million-page congressional report, and the ghostwritten biographies of scientists Who Should Have Known Better.

Now you might think that I'm sending out my version because I was either misrepresented or completely ignored in all the above. Not at all. I'll be the first to admit that my part in the whole thing was pretty insignificant, but nevertheless I *was* there, right at the beginning. So consider this shareware text a footnote or even a tall tale, and if you like it, do feel free to pass it on, but don't change the text or drop the byline, if you please.

* * * *

It began in the middle of a routine calibration run in the Exawatt Fusion facility. All the alarms went off and the AI in charge shut everything down, but there was no obvious problem. The robots could find no evidence of physical damage, yet the integrity and radiation alarms kept ringing, and analysis of experimental data showed that there had been a tremendous fluctuation in energy levels just *after* the fusion pulse. So the scientists sent the two of us, Mike Doherty and me, over the horizon to eyeball the place.

You've probably seen a zillion pictures. It was a low, square concrete block half-buried in the smooth floor of Mendeleev Crater on the Moon's far

side, sur-rounded by bulldozed roadways and cable trenches, the two nuclear reactors which powered it just at the level horizon to the south. At peak, the Exawatt used a thousand million times more power than the entire U.S. electrical grid to fire up, for less than a millisecond, six pulsed lasers focused on a target barely ten mi-crometers across, producing conditions which simulated those in the first picosec-onds of the Big Bang, before symmetry was broken. Like the atom bomb a century before, it pushed the envelopes of engineering and physics. The scientists respon-sible for firing off that first thermonuclear device believed that there was a slight but definite chance that it would set fire to the Earth's atmosphere; the scientists running the Exawatt thought that there was a possibility that it might burst its containment and vaporize several hundred square kilometers around it. That was why they had built it on the Moon's far side, inside a deep crater. That's why it was run by robots, with the actual labs in a bunker buried over the horizon.

That's why, when it went wrong, they sent in a couple of GLPs to take a look.

We went in an open rover, straight down the service road. We were wearing bright orange radiation-proof shrouds over our Moon suits, and camera rigs on our shoulders so that the scientists could see what we saw. The plant looked intact, burning salt-white in the glare of a lunar afternoon, throwing a long black shadow toward us. The red-and-green perimeter lights were on; the cooling sink, a bore-hole three kilometers deep, wasn't venting. I drove the rover all the way around it, and then we went in.

The plant was essentially one big hall filled with the laser-pumping assemblies, huge frames of parallel color-coded pipes each as big as one of those old Saturn rockets and threaded through with bundles of heavy cables and trackways for the robots which serviced them. We crept along the tiled floor in their shadows like a pair of orange mice, directing our camera rigs here and there at the request of the scientists. The emergency lights were, still strobing, and I asked someone to switch them off, which they did after only five minutes' discussion about whether it was a good idea to disturb anything.

The six laser-focusing pipes, two meters in diameter, converged on the bus-sized experimental chamber. Containment was a big problem; that chamber was crammed with powerful magnetic tori which generated the fields in which the target, a pellet of ultra-compressed metallic hydrogen, was heated by chirped pulse amplification to ten billion degrees Centigrade. It was surrounded by catwalks and hidden by the flared ends of the focusing pipes, the capillary grid of the liquid sodium cooling system,

and a hundred different kinds of monitor. We checked the system diagnostics of the monitors, which told us only that several detectors on the underside had ceased to function, and then, harangued by scientists, crawled all around the chamber as best we could, sweating heavily in our suits and chafing our elbows and knees.

Mike found a clue to what had happened when he managed to wriggle into the crawl space beneath the chamber, quite a feat in a pressurized suit. He had taken off his camera rig to do it, and it took quite a bit of prompting before he started to describe what he saw.

“There’s a severed cable here, and something has punched a hole in the box above it. Let me shift around…Okay, I can see a hole in the floor, too. About two centimeters across. I’m poking my screwdriver into it. Well, it must go all the way through the tiles, I can’t see how deep. Hey, Frank, get me some of that wire, will you?”

There was a spool of copper cable nearby. I cut off a length and passed it in.

“You two get on out of there now,” one of the scientists advised.

“This won’t take but a minute,” Mike said, and started humming tunelessly, which meant that he was thinking hard about something.

I asked, because I knew he wouldn’t say anything otherwise, “What is it?”

“Looks like someone took a shot at this old thing,” Mike said. “Shit. How deep does the foundation go?”

“The concrete was poured to three meters,” someone said over the radio link, and the scientist who’d spoken before said, “It really isn’t a good idea to mess around there, fellows.”

“It goes all the way through,” Mike said. “I wiggled the wire around and it came back up with dust on the end.”

“This is Ridpath,” someone else said. Ridpath, you may remember, was the chief of the science team. Although he wasn’t exactly responsible for what hap-pened, he made millions from selling the rights to his story, and then hanged himself six months after it was all over. He said, “You boys get on out of there. We’ll take it from here.”

Five rolligons passed us on our way back, big fat pressurized vehicles making speed. “You put a hair up someone’s ass,” I told Mike, who’d been real quiet after he crawled out from beneath the chamber.

“I think something escaped,” he said.

“Maybe some of the laser energy was deflected.”

“There weren’t any traces of melting,” Mike said, with a preoccupied air. “And just a bit of all that energy would make a hell of a mess, not leave a neat little hole. Hmm. Kind of an interesting problem.”

But he didn’t say any more about it until a week later, about an hour before the president went on the air to explain what had happened.

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The Moon was a good place to be working then. It was more-or-less run by scientists, the way Antarctica had been before the drillers and miners got to it. There were about two thousand people living there at any one time, either working on projects like the Exawatt or the Big Array or the ongoing resource mapping surveys, or doing their own little thing. Mike and I were both part of the General Labor Pool, ready to help anyone. We’d earned our chops doing Ph.D.s, but we didn’t have the drive or desire to work our way up the ladder of promotion. We didn’t want responsibility, didn’t want to be burdened with administration and hustling for funds, which was the lot of career researchers. We liked to get our hands dirty. Mike has a double Ph.D. in pure physics and cybernetics and is a whiz at elec-tronics; I’m a run-of-the-mill geologist who is also a fair pilot. We made a pretty good team back then and generally worked together whenever we could, and we’d worked just about every place on the Moon.

When the president made the announcement, we’d moved on from the Exawatt and were taking a few days’ R&R. I’d found out about a gig supervising the con-struction of a railway from the South Pole to the permanent base at Clavius, but Mike wouldn’t sign up and wouldn’t say why, except that it was to do with what had happened at the Exawatt.

We’d been exposed to a small amount of radiation when we’d gone into the plant—Mike a little more than me — and had spent a day being checked out before getting back on the job. The scientists were all over the plant by then. The reaction chamber had been dismantled by robots, and we brought in all kinds of monitoring equipment. Not only radiation counters, but a gravity measuring device and a neutrino detector. We helped bore a

shaft five hundred meters deep parallel to the hole punched through the floor, and probes and motion sensors and cameras were lowered into it.

Mike claimed to have worked out what had happened as soon as he stuck the wire in the hole through the foundation, but he wouldn't tell me. "You should be able to guess from what they were trying to measure," he said, the one time I asked, and smiled when I called him a son of a bitch. He's very smart, but sort of fucked up in the head, antisocial, careless of his appearance and untidy as hell, and proud that he has four of the five symptoms of Asperger's Syndrome. But he was my partner, and I trusted him; when he said it wasn't a good idea to take up a new contract, I nagged him for a straight hour to explain why, and went along with him even though he wouldn't. He was spending all his spare time making calculations on his slate, and was still working on them at the South Pole facility.

I raised the subject again when news of the special presidential announcement broke. "You'd better tell me what you think happened," I told Mike, "because I'll hear the truth in less than an hour, and after that I won't believe you."

We were in an arbor in the dome of the South Pole facility. Real plants, cycads and banana plants and ferns, growing in real dirt around us, sunlight pouring in at a low angle through the diamond panes high above. The dome capped a small crater some three hundred meters across, on a high ridge near the edge of the South Pole-Aitken Basin and in permanent sunlight, the sun circling around the horizon once every twenty-eight days. It was hot and humid, and the people splash-ing in the lake below our arbor were making a lot of noise. The lake and its scattering of atolls took up most of the crater's floor, with arbors and cafes and cabins on the bench terrace around it. The water was billion-year-old comet water, mined from the regolith in permanently shadowed craters. A rail gun used to lob shaped loads of ice to supply the Clavius base in the early days, but Clavius had grown, and its administration was uncomfortable with the idea of being bombarded with ice meteors, which was why they wanted to build a railway. In the low gravity, the waves out on the lake were five or six meters high, and big droplets flew a long way, changing shape like amoebas, before falling back. People were body surfing the waves; a game of water polo had been going on for several days in one of the bays.

I'd just been playing for a few hours, and I was in a good mood, which was why I didn't strangle Mike when, after I asked him to tell me what he knew, he flashed his goofy smile at me and went back to scratching figures on his slate. Instead, I snatched the slate from his hands and held it over the edge of the arbor and said, "You tell me right now, or the slate gets it."

Mike scratched the swirl of black hair on his bare chest and said, “You know you won’t do it.”

I made to skim it through the air and said, “How many times do you think it would bounce before it sank?”

“I thought I’d give you a chance to work it out. And it isn’t as if there’s anything we can do. Didn’t you enjoy the rest?”

“What’s this got to do with not taking up that contract?”

“There’s no point building anything anymore. You still haven’t guessed, have you?”

I tossed the slate to him. “Maybe I should pick *you* up and throw you in the lake.”

I meant it, and I’m a lot bigger than him.

“It’s a black hole,” he said.

“A black hole.”

“Sure. My guess is that the experiment caused a runaway quantum fluctuation that created a black hole. It had to be bigger than the Planck size, and most probably was a bit bigger than a hydrogen atom, because it obviously has been taking up other atoms easily enough. Say around ten to the power twenty-three kilograms. The mass of a big mountain, like Everest. The magnetic containment fields couldn’t hold it, of course, and it dropped straight out of the reaction cham-ber and went through the plant’s floor.”

I said, “The hole we saw was a lot bigger than the width of a hydrogen atom.”

“Sure. The black hole disrupted stuff by tidal force over a far greater distance than its Swartzschild radius, and sucked some of it right in. That’s why there was no trace of melting, even though it was pretty hot, and spitting out X-rays and probably accelerated protons, too —cosmic rays.”

I didn’t believe him, of course, but it was an interesting intellectual exercise. I said, “So where did the mass come from? Not from the combustion chamber fuel.”

“Of course not. It was a quantum fluctuation, just like the Universe, which also came out of nothing. And the Universe weighs a lot more than ten to the power twenty-three kilograms. Something like, let’s see — “

“Okay,” I said quickly, before Mike lost himself in esoteric calculations. “But where is it now?”

“Well, it went all the way through,” Mike said.

“Through the Moon? Then it came out, let’s see” —I tried to visualize the Moon’s globe —”somewhere in Mare Fecunditas.”

“Not exactly. It accelerated in free fall toward the core, went past, and started to fall back again. It’s sweeping back and forth, gaining mass and losing amplitude with each pass. That’s what the president is going to tell everyone.”

I thought about it. Something just bigger than an atom but massing as much as a mountain, plunging through the twenty-five-kilometer-thick outer layer of gardened regolith, smashing a centimeter-wide tunnel through the basalt crust and the mantle, passing through the tiny iron core, gathering mass and slowing, so that it did not quite emerge at the far side before falling back.

“You were lucky it didn’t come right back at you,” I said.

“The amplitude diminishes with each pass. Eventually it’ll settle at the Moon’s gravitational center. And that’s why I didn’t want to sign the contract. After the president tells everyone what I’ve just told you, all the construction contracts will be put on hold. What you should do is make sure we’re first on the list for evacuation work.”

“Evacuation?”

“There’s no way to capture the black hole. The Moon, Frank, is fucked. But we’ll get plenty of work before it’s over.”

He was half right, because the next day, after the president had admitted that an experiment had somehow dropped a black hole inside the Moon, a serious problem that would require an international team to monitor, we were both issued with summonses to appear at the hastily set up congressional inquiry.

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It was a bunch of bullshit, of course. We went down to Washington, D.C, and spent a week locked up in the Watergate hotel watching bad cable movies and endless talk shows, with NASA lawyers showing up every now and then to rehearse our Q&As, and in the end we had no more than half an hour of easy questions before the committee let us go. Our lawyers shook our hands on the steps of the Congress building, in front of a bored video crew, and we went back to Canaveral and then to the Moon. Why not? By then Mike had convinced me about what was going to happen. There would be plenty of work for us.

We signed up as part of a roving seismology team, placing remote stations at various points around the Moon's equator. The Exawatt plant had been dismantled and a monitoring station built on its site to try and track the period of the black hole, which someone had labeled Mendeleev X-1. Mike was as happy as I had ever seen him; he was getting some of the raw data and doing his own calculations on the black hole's accretion rate and orbital path within the Moon. He stayed up long after our workday was over, hunched over his slate in the driving chair of our rolligon, with sunlight pouring in through the bubble canopy while I tried to sleep in the hammock stretched across the cabin, my skin itching with the Moon dust which got everywhere, and our Moon suits propped in back like two silent witnesses to our squabbling. His latest best estimate was that the Moon had between two hundred and five thousand days.

"But things will start to get exciting before then."

"Excitement is something I can do without. What do you mean?"

"Oh, it'll be a lot of fun."

"You're doing it again, you son of a bitch."

"You're the geologist, Frank," Mike said. "It's easy enough to work out. It's just—"

"Basic physics. Yeah. Well, you tell me if it's going to put us in danger. Okay?"

"Oh, it won't. Not yet, anyhow."

We were already picking up regular moonquakes on the seismometer network. With a big point mass swinging back and forth through it, the

Moon’s solid iron core was ringing like a bell. There were some odd subsidiary traces, too, smooshy echoes as if spaces were opening in the mantle —hard to believe, because pressure should have annealed any voids. I was pretty sure that Mike had a theory about these anomalies, too, but I kept quiet. After all, I was the geologist. I should have been able to work it out.

Meanwhile, we toured west across the Mare Insularium, with its lava floods overlaid by ejecta from Copernicus, and on across the Oceanus Procellarum, dropping seismometers every two hundred kilometers. We made good time, speeding across rolling, lightly cratered landscape, detouring only for the largest wrinkle ridges, driving through the long day and the Earth-lit night into brilliant dawn, the sun slowly moving across the sky toward noon once more. The Moon had its own harsh yet serene beauty, shaped mainly by vulcanism and impacts. Without weather, erosion took place on geological timescales, but because almost every feature was more than three billion years old, gravity and ceaseless micrometeorite bombardment had smoothed or leveled every hill or crater ridge. With the sun at the right angle, it was like riding across an infinite plain gentled by a deep blanket of snow. We rested up twice at unmanned shelters, and had a two-day layover at a roving Swedish selenology station which had squatted down on the mare like a collection of tin cans. A week later, just after we had picked up fresh supplies from a rocket lofted from Clavius, we felt our first moonquake.

It was as if the rolligon had dropped over a curb, but there was no curb. I was in the driving chair; Mike was asleep in the hammock. I told the AI to stop, and looked out through the canopy at the 180-degree panorama. The horizon was drawn closely all around. An ancient crater eroded by three billion years of mi-crometeorite bombardment dished it to the north and a few pockmarked boulders were sprinkled here and there, including a fractured block as big as a house. Something skittered in the corner of my eye — a little rock rolling down the gentle five degree slope we were climbing, plowing a meandering track in the dust. It ran out quite a way. The rolligon swayed gently, from side to side. I found I was gripping the padded arms of the chair so tightly my knuckles had turned white. Behind me, Mike stirred in the hammock and sleepily asked what was up; at the same moment, I saw the gas plume.

It was very faint, visible only because the dust it lofted caught the sunlight. Gas plumes were not uncommon on the Moon, caused by pockets of radon and other products of fission decay of unstable isotopes overpressuring the crevices where they collected. Earth-based astronomers sometimes glimpsed them when they tem-porarily obscured

surface features while dissipating into vacuum. This, though, was different, more like a heat-driven geyser, venting steadily from a source below the horizon.

I told the AI to drive toward it. Mike leaned beside me, scratching himself through his suit of thermal underwear. He smelled strongly of old sweat; we hadn't bathed properly since the interlude with the Swedes. I had a sudden insight and said, "How hot is the black hole?"

"Oh, the smaller the black hole, the more fiercely it radiates. It's a simple inverse relationship. It was pretty hot to begin with, but it's been getting cooler as it accretes mass. Hmm."

"Is it still hot enough to melt rock?"

Mike's eyes refocused. "You know, I think it must have been much bigger than I first thought. Anyway, anything that gets close enough to it to melt is already falling toward the event horizon. That's why there was no trace of melting or burning when it dropped out of the reaction chamber. But there's also the heat generated by friction as stuff pours toward its gravity well."

"Then it's remelting the interior. Those anomalies in the seismology signals are melt caverns full of lava."

Mike said thoughtfully, "I'm sure we'll start picking up a weak magnetic field soon, when the iron core liquifies and starts circulating. Of course, the end will be pretty close by then. Wow. That thing out there is really big."

The rolligon was climbing a long gentle slope toward the top of a curved ridge more than a kilometer high, the remnants of the rim of a crater which had been mostly buried by the fluid lava flow which had formed the Oceanus Procellarum. I told the AI to stop when I spotted the source of the plume. It was a huge fresh-looking crevice that ran out from a volcanic dome; gas was jetting out of the slumped side of the dome like steam from a boiling kettle. Dust fell straight down in sheets kilometers long. Already, an appreciable ray of brighter material was forming on the regolith beneath the plume.

"We should get closer," Mike said. He was rocking back and forth in his chair like a delighted child.

"I don't think so. There will be plenty of rocks lofted along with the gas and dust."

We transmitted some pictures, then suited up and went outside to set up a seismology package. The sun was in the east, painting long shadows on the ground, which shook, ever so gently, under my boots. With no atmosphere to scatter the light, shadows were razor sharp, and color changed as I moved about. The dusty regolith was deep brown in my shadow, but a bright blinding white when I looked toward the sun, turning ashy gray to either side. The gas plume glittered and flashed against the black sky. I told Mike that it was probably from a source deep in the megaregolith; pressure increased in gas pockets with depth. A quake, prob-ably at the interface between the megaregolith and the rigid crust, must have opened a path to the surface.

“There’ll be a lot more of these,” Mike said.

“It’ll blow itself out soon enough.”

But it was still venting strongly when we had finished our work, and we drove a long way north to skirt around it, with Mike scratching away on his slate, fac-toring this new evidence into his calculations.

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We were out for another two weeks, ending our run in lunar night at the Big Array Station at Korolev. It was one of the biggest craters on the far side, with slumped terraced walls and hummocky rim deposits like ranges of low hills. Its floor was spattered with newer craters, including a dark-floored lava-flooded crater on its southern edge which was now the focus of a series of quakes of steadily increasing amplitude. Korolev Station, up on the rim, was being evacuated; the radio telescopes of the Big Array, scattered across the far side in a regular pattern, were to be kept running by remote link. Most of the personnel had already de-parted by shuttle, and although there were still large amounts of equipment to be taken out, the railway which linked Korolev with Clavius had been cut by a rock slide. After a couple of spooky days’ rest in the almost deserted yet fully functional station, Mike and I went out with a couple of other GLPs to supervise the robots which were clearing the slide and re-laying track.

It was a nice ride: the pressurized railcar had a big observational bubble, and I spent a lot of time up there, watching the heavily cratered highland plains flow past at two hundred kilometers an hour. The Orientale Basin dominated the west side of the Moon: a fissured basin of fractured blocks partly flooded with impact melt lava and ringed round with three immense scarps and an inner bench like ripples frozen ,in rock. The

engineers had cut the railway through the rings of the Rook and Cordillera Mountains; the landslide had blocked the track where it passed close to one of the tall knobs of the Montes Rook Formation, a ten-kilometer-high piece of ejecta which had smashed down onto the surrounding plain —the impact really was very big.

A slide had run out from one of its steeply graded faces, covering more than a kilometer of track, and we were more than a week out there, helping the robots fix everything up. When we finally arrived at the station in Clavius, it was a day ahead of the Mendeleev eruption and the beginning of the evacuation of the Moon.

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The whole floor of the Mendeleev Crater had fractured into blocks in the biggest quake ever recorded on the Moon, and lava had flooded up through dykes emplaced between the blocks. Lava vented from dykes beyond the crater rim, too, and flowed a long way, forming a new mare. Other vents appeared, setting off secondary quakes and long rock slides. The Moon shivered and shook uneasily, as if awakening from a long sleep.

Small teams were sent out to collect the old Rangers, Lunas, Surveyors, Lu-nokhods, and descent stages of Apollo LEMs from the first wave of Moon explo-ration. Mike and I went out for a last time, to Mare Tranquillitatis, to the site of the first manned lunar landing.

When a permanent scientific presence had first been established on the Moon, there was considerable debate about what to do with the sites of the Apollo land-ings and the various old robot probes and other debris scattered across the surface. There had been a serious proposal to dome the Apollo 11 site to protect it from damage by micrometeorites and to stop people from swiping souvenirs, but even without protection it would last for millions of years, and everyone on the Moon was tagged with a continuously monitored global positioning sensor so no one could go anywhere without it being logged, and in the end the site had been left open.

We arrived a few hours after dawn. It was a lonely place, not much visited despite its historic importance. A big squat carrier rocket had gone ahead, landing two kilometers to the north, and the robots were already waiting. There were four of us: a historian from the Museum of Air and Space in Washington, a photog-rapher, and Mike and me. The site was ringed around with laser sensors. As we loped through the perimeter, an automatic beacon on the common band warned us that we were

trespassing on a U.N. heritage site and started to recite the relevant penalties until the historian found it and turned it off. The angular platform of the lunar module's descent stage had been scorched by the rocket of the ascent stage; the gold foil which had wrapped it was torn and tattered, white paint beneath turned tan by exposure to the sun's raw ultraviolet. One of its spidery legs had collapsed after a recent quake focused near new volcanic cones to the southeast. We lifted everything, working inward toward the ascent stage: the Passive Seis-mometer and the Laser Ranging Retroreflector; the flag, its ordinary fabric, stiff-ened by wires, faded and fragile; an assortment of discarded geology tools; human waste and food containers and wipes and other litter in crumbling jettison bags; the plaque with a message from a long-dead president. Before the descent stage was lifted away, a robot sawed away a chunk of dirt beside its ladder, the spot where the first human footprint had been made on the Moon. There was some dispute about which print was actually the first, so two square meters were carefully lifted. And at last the descent stage was carried off to the cargo rocket, and there was only a litter of cleated footprints left, our own overlaying Armstrong's and Aldrin's.

It was time to go.

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As the eruptions grew more frequent, even the skeleton crews of the various sta-tions were evacuated, leaving a host of robot surveyors in close orbit or crawling about the troubled surface to monitor the unfolding disaster. Mike and I went on one of the last shuttles, everyone crowding to the ports as it made a single low orbital pass before lighting out for Earth.

It was six months after the Mendeleev X-1 incident. The heat generated by the black hole's accretion process and tidal forces had remelted the iron core; pockets of molten basalt in the mantle had swollen and conjoined. A vast rift opened in the Oceanus Procellarum, splitting the nearside down its northwestern quadrant and raising new scarps as high and jagged as those in an old Chesley Bonestell painting. The Orientale Basin flooded with lava and the fractured blocks of the Maunder formation sank like foundering ships as new lava flows began to well up. Volcanic activity was less on the far side, where the crust was thicker, but the Mare Ingenii collapsed and reflooded, forming a vast new basin which swallowed the Jules Verne and Gagarin Craters.

It took two more months.

As the end neared, the Moon's surface split into short-lived plates

afloat on a wholly molten mantle, with lava-filled rifts opening and scabbing over and re-opening along their edges. There were frantic attempts to insure that the popu-lation of the Earth's southern hemisphere would all have some kind of shelter, for the Moon would be in the sky above the Pacific in its final hour. Those unlucky or stubborn enough to remain outside saw the Moon rise for the last time, half-full, the dark part of her disk riven with glowing cracks which spread as the black hole sucked in exponentially increasing amounts of matter. And then there was a terrific flare of light, brighter than a thousand suns. Those witnesses who had not been blinded saw that the Moon was gone, leaving expanding shells of luminous gas around a fading image trapped at the edge of the black hole's event horizon, and a short-lived accretion disk as ejected material spiraled back into the black hole, which, although it massed the same as the Moon it had devoured, had an event horizon circumference of less than a millimeter.

The radiation pulse was mostly absorbed by the Earth's atmosphere; the orbit of the space station had been altered so that it was in opposition when the Moon vanished. I was aboard it at the time, and spent the next six months helping repair satellites whose circuits had been fried.

There are still tides, of course, for the same amount of mass still orbits the Earth. Marine organisms which synchronized their reproduction by the Moon's phases, such as horseshoe crabs, corals, and palolo worms, were in danger of extinction, but a cooperative mission by NASA and the Russian and European space agencies lofted a space mirror which reflects the same amount of light as the Moon, and even goes through the same phases. There'll be a big problem in 5×10^{43} years, when by loss of mass through Hawking radiation the black hole finally becomes small enough to begin its runaway evaporation. But long before then the sun will have evolved into a white dwarf and guttered out; even its very protons will have decayed. The black hole will be the last remnant of the solar system in a cooling and vastly expanded universe.

There are various proposals to make use of the black hole —as the ultimate garbage disposal device (I want to be well away from the solar system when they try that), or as an interstellar signaling device, for if it can be made to bob in its orbit (perhaps by putting another black hole in orbit around it), it will produce sharply focused gravity waves of tremendous amplitude. Meanwhile, it will keep the physicists busy for a thousand years. Mike is working at one of the stations which orbit beyond its event horizon. I keep in touch with him by E-mail, but the correspondence is becoming more and more infrequent as he vanishes into his own personal event horizon.

As for me, I’m heading out. The space program has realigned its goals, and it turns out that the black hole retained the Moon’s rotational energy, so it provides a useful slingshot for free acceleration. After all, there are plenty of other moons in the solar system, and most are far more interesting than the one we lost.

(For *Stephen Baxter)*

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