

Sample Return

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Above the ship's clearalloy cupola loomed Io, a pimpled canvas of desert camo so close Katy imagined she could smell its sulfurous plumes. Ahead, ochre bands slashed the sunlit limb of Jupiter like mud on a bloody scythe. Against this backdrop, gleaming in the light, hung the impactor, ready to accelerate down into the Jovian night.

Katy floated behind Xavier, gripping the frame of his chair.

He touched her hand, "You okay?"

"Just send it."

Twenty minutes before the maneuver, she'd got word her mother had died. Twenty minutes before the most important moment of her life, if not all human history, and the reason she'd left her mother to die alone, a billion kilometers away.

"Hurry!"

Without the shaped fusion charge, all the impactor's pent up momentum would be squandered as it tore through the target layer, ejecting its substance indiscriminately through the Jovian atmosphere instead of up in a focused pulse toward space. And if they didn't arm it now, before plasma exhaust blotted out the link, they might not be able to when they next had a clear line of sight—from thirty times farther away and straight through the magnetospheric bridge between these worlds.

Xavier patted her hand. "I don't want it armed if you're not—"

"Dammit, Xav!"

Captain Collinsworth called up from her dias, "Ignition in six . . . five . . ."

Katy grabbed Xavier's hand and twisted. "Now!"

He jerked his hand away. "Relax. Talkbacks are good. I already armed it."

She punched him, went flying, caught a handhold. "I'm gonna kick your ass."

"That's gonna be hard in zero-g."

"I'll wait till we spin back up."

"Well that won't be till we clear Jovian space. I better get all my annoying in now so you don't remember the score."

Katy grabbed his seat and drew her face up to his ear. "Oh, I'll remember," she said, "Your wife sent me an app."

The captain snorted.

“Very funny.” Xavier turned to his displays. “But if we’re gonna do this, you need to buckle your ass down.”

“This” was the launching of *Proteus*, the space tether system Katy had spent over a decade bringing to fruition. It was a highfalutin concept: a big fishing net in space. No practical rocket could escape Jupiter’s deep gravity well, and the impactor had no hope at all of reaching the depths where the planet’s titanic pressures forged solid metallic hydrogen. But in theory, some of that hydrogen should form polyhydrides stable enough and buoyant enough to float up and form a sort of metallic hydrogen pack ice atop the liquid hydrogen sea. Radar said the layer was there, though the atmosphere was too thick for definitive spectroscopy, so no one knew for sure what it was. The impactor was meant to find out by blasting a sample out into space. The cartwheeling *Proteus* would do the rest, scooping it up, transferring rotational momentum to it, and flinging it out into an orbit stable enough to hold it till *Jovian Queen* looped back in from the elliptical track that would spare her crew the worst of Jupiter’s radiation belts.

There wouldn’t be much yield, but even a few kilograms would revolutionize physics. If solid metallic hydrogen really was metastable outside the laboratory—if, like diamond, it could survive beyond the preternatural conditions that forged it, well . . . It’d be the holy grail of holy grails, a true high-temperature superconductor to transform Earth’s power grid, the ultimate rocket fuel, the wonder material of the next anthropological age.

But first they had to get it, and that would take a delicate orbital quadrille. The impactor had already sailed ahead toward Jupiter’s atmosphere. *Proteus* would follow, approaching the god-planet on a tangential track that would see it sweeping its kilometers-long arms down toward the clouds just as ejecta came hurtling up toward it. If all went to plan, the two would meet like trapeze artists performing a flying return. *Jovian Queen* would monitor from a distance, safely clear until gravity pulled her around in a month to take on the sample.

That’s if everything went to plan, which of course things always did in space. They’d already lost the other impactor—probably to more counterfeit parts, another result of the intermittent funding that had made the last decade feel less like the Apollo Program than like trying to build the next big particle-collider in a garage by holding bake sales. So much had gone wrong or been whittled away—including the last two years of her mother’s life. It was a lot of effort for so small a return, but if it worked . . . it would vindicate her mother’s ideas and cement her place in history. They’d limp home with a sample so valuable the whole global economy would pivot to developing a more practical follow-up. If, that is, her mamma had been right—and she didn’t screw it all up.

Katy ran down her checklist, calling key values and switch settings out to Xavier for confirmation. Then she checked the telemetry feeds and moved her hand across the console. “Deploying on my mark, three . . . two . . . one—” She swiped and tapped and . . . “Um . . .”

Instead of the expected shudder and gentle acceleration, there was silence.

Xavier’s hands flew over his console. “I see it. It’s probably . . . Oh no. No no, no, no, no!”

“What?”

“Faults on all the pyros. Zero amps, but the clamps haven’t—”

Katy released her buckle, sidled over, confirmed what he was seeing. “Let’s go.”

Xavier balked. “Go? Where? We need to—”

But Katy was already through the hatch and climbing the central tunnel back toward the suit locker.

“Let the others debug,” she called, “We need to go cut those bolts before our window closes.”

Xavier called up through the hatch. “But it could just be . . .”

It *could* be a lot of things, but this was exactly why they were out here, knocking elbows and sucking up resources. Machinery this new, complex, and costly couldn’t be trusted to one-shot robotics, programmed in advance, tucked away for months of deep space storage, then expected to wake up and whip miracles out like a wind-up Jesus-in-the-box. It *might* be a bad sensor, mis-wiring, counterfeit parts, radiation rot . . . or a flaw in her design. It didn’t matter. *Proteus* wasn’t loose, and there was only one sure way to fix that.

“We’ve got two man-hours’ work and forty minutes to do it in,” she said, her voice echoing in

the tunnel, “So get up here and suit up.”

“Are you nuts?” Xavier was behind her, but clearly not *behind* her.

The captain’s voice echoed below him, “Have you any idea what the rads are out there?”

She did. The ship’s magnetoplasmadynamic shield would protect them adequately. She barked something to that effect, stripping to her skivvies so that by the time Xavier reached the suit locker, it was an obstacle course of derelict clothing.

The hard-shelled rad-suits hung outside, over a porch built into the pressure hull. They were accessed through double hatches—one that opened through the hull, and the other into the back of the rigid suit torso. Together, the two formed a low-volume airlock straight through the hull into the suit. Katy opened the nearest suit-port and scanned the integral display to verify the suit’s readiness. Then she pulled the blue biostocking from inside the suit, shucked off her panties, and thrust her legs into the stocking.

“Jesus, Kate.” Xavier turned away but steadied her by the arm as she wiggled and squirmed into the stocking’s various accommodations.

“We can do this, Xav. But we have to go now.”

“We’re too deep in the radiation shells, Katy. With no time to plan a safe—”

“We’re not having this conversation,” she said, balling up in the fetal position as she connected the cables leading into the suit. “This is what we’re here for. We screw this pooch, we won’t get another chance in our lifetimes.”

He grabbed her by the wrist. “At least we’ll *have* lifetimes—”

She glared until he released his grip. “My mother won’t.”

“Jesus, Kate, I know you’re upset—”

She shucked him aside and sent him flying, then braced in the suit-port opening to finish tucking and strapping. “I won’t lose this mission to another Goddamned counterfeit part.”

Counterfeits had been the bane of aerospace since the advent of 3D printer technology that could mass-produce high-resolution mixed-alloy components without any *detectable* grain. It was a great tool—but it did great harm in the wrong hands, especially when building a spacecraft on a shoestring.

“Katy . . . I know how you must—”

She glared up at him, hanging by his socked toes from the opening into the tunnel—those big brown eyes pleading for her to see reason. But this wasn’t a reasonable situation. Her career and untold billions hung by those bolts. The whole mission. The mission she’d given up her mother’s last months to fly on. She couldn’t let it end like this.

She ground her incisors together, estimating how much time she could gamble on persuasion, how long she had before he pushed off and tried to subdue her. Not enough.

Gripping the frame of the open suit-port, she thrust herself feet-first down into the suit—amazed at how easily she accomplished the task when caution was thrown to the vacuum—and slammed the suit-port behind her. Before Xavier could reach her, she’d vented the lock space. He’d now have to get past five thousand kilos of air pressure on that hatch if he wanted to pull her out.

She squirmed her arms into the sleeves, reached up and keyed the heads-up display built into the helmet visor. At a triple-tap from her glove, the suit disconnected from the bulkhead. Another few slides and taps, and the biomed cuff inflated around her thigh and pneumatically injected a cocktail of medicines to help ward off radiation damage. She keyed the radio to the intercom.

“We came out here to do a job, Xav. You can get out here and help me or you can let me die trying, but you’re damn well not going to stop me.”

* * *

Jovian Queen stretched the length of a football pitch, from the radiator and plasma drive arrays blooming around the reactor like floral urban sculpture, forward along a central spine of tanks and storage bays, and finally to a habitation module like a blistered aluminum melon. *Proteus* lay alongside, its central hub a pair of cement trucks rutting beneath disheveled space blankets and flanked fore and aft by the skeletal frames of its massive telescoping booms. It was

hung as far forward as space permitted because it had had to balance the massive impactors in order to facilitate spin gravity. Now it had to go, both to restore that balance and to lighten the load on *Jovian Queen*'s high-efficiency, low-thrust plasma engines for the upcoming orbital realignment burns.

Katy climbed out to *Proteus*'s central hub where three woven straps secured it to *Queen*'s belly. Each looped around the hub and through *Queen*'s anchor plates, then was drawn tight by a clamp like a prom dress taken up by a safety pin. It was all arranged so that upon cutting the frangible bolts, bow-like springs would pull the straps clear and fling them away into space, freeing the antenna masts and carrying off several covers and shields meant to control solar heating nearer the Sun and to protect sensitive instruments from micrometeoroids and contamination during the cruise. It was the bolts, three here and four more just like them at the ends of the booms, which had failed to explosively separate.

Plan A was to simply reach in and unthread the bolts. Unfortunately, they were hidden between the two spacecraft and had been installed using special tools. It was all Katy could do to reach that far with the longest socket extension. Even if the bolts were still intact, she'd never get the socket on them working blind and constrained by the spacesuit.

After several frustratingly time-wasting attempts, she decided to just cut the straps with the electric shears. That went better, though excruciatingly slowly. The shears were made for cutting sheet metal. The webbing was thick and slippery, and it prized the cutting blades apart like cheap kindergarten scissors. It worked, but one little nip at a time.

By this time, Xavier had climbed down from *Queen*'s hab module onto *Proteus*'s forward capture pod to tackle its restraining bolts. He bitched intermittently about tight working space and uncooperative equipment—and occasionally about his own, saying, “If I cook my nuts off out here Katy, I swear to God . . .”

But he had only two bolts to Katy's three, and by the diminishing pace of his cursing, she knew he was finishing up just about as her last strap gave way. That only left the two bolts on the other boom, that and this last strap that had hung up against the anchor ring. She jiggled it loose and guided it out into space. “Get a move on, Xav. If we each take one of the remaining two—”

Captain Collinsworth came on the radio. “Time.”

Xavier, now approaching along *Queen*'s longitudinal guide rails, keyed his mic. “Colleen . . . what if we just back away? Let *Proteus*'s inertia swing it down and snap the bolts—”

“Can you guarantee they'll break before we do?”

“Well . . . no, but—”

“Then get her ass off that spacecraft. I already gave you two thirds of our margin. I won't risk having that thing spring back and rupture our hull. Katy, I'm sorry but . . . Xav, where'd she go?”

Where she'd gone was down around *Proteus*, out of view of the cameras. She'd seen this coming and was mounting the open-truss boom just as fast as her bulbous, rad-suited limbs would carry her. Faster, in fact, as adrenaline surged through her veins. One slip and the recoil spring at the other end of her safety line would yank her back up to the hub like a big-mouth bass on a casting rod. Xavier would then haul her back to the air lock, and that would be that.

Colleen was no marionette. If she said they were out of time, they were out of time. The only safe thing was to abort, blow the anchor pads, and shed the dead weight so the ship and the crew could safely be on their way.

The thing was, the booms were secured by long alloy pins that both held them tight to the anchor pads and immobilized their telescoping parts. Cutting the frangible bolts allowed the spring-loaded pins to eject themselves into space, freeing the booms for extension. Jettisoning the anchor pads without cutting the bolts would leave the booms permanently shackled—and *Proteus* a useless hulk. Even Xav's scheme of snapping the bolts would likely have the same effect, jamming the pins in their guide channels.

So it was time for Katy to try the not-so-safe way. As Mamma had used to say, “you can't make an omelet without breaking a few eggs—and sometimes, we're the eggs.”

* * *

Katy reached the bulkhead of the aft capture pod and climbed back up into view. Xavier had already seen her, but he wasn't following. Or talking. He just hung motionless from the handrail above the hub.

Thunk.

Through her fingers, Katy felt the concussion of encased separation charges. *Proteus* was now adrift. That was the anchor pad jettison. She'd expected that, and by her estimate, she still had enough time to free the last two bolts and jet back to the *Queen* before the maneuver. It might not be safe but—

She missed the next handhold; she was falling in toward the hub.

Twisting around, she saw Xavier still hanging there, his tool tether clipped around her fully extended safety line. Her take-up reel was still shackled to *Proteus's* central hub, and as *Jovian Queen* eased away, her line was dragging through the clip at the end of his tether, tugging her right toward him. It was a clever move on his part, because it required no argument or persuasion. It wouldn't even help her to release her line, she'd just drift on the way she was going—right into his grasp.

"Goddammit, Xav!" She shouldn't really be angry; he was only trying to save her life. But dammit, he'd picked an annoying time to do it!

Soon they were close enough she could see through his visor, see the little wrinkles between his eyes that he got when he knew he'd crossed a line and was about to get his ass chewed. But his arms were out and ready to grab her and haul her aboard—kicking and screaming if necessary, and he could do it too. He was tied in to *Jovian Queen* and bigger and stronger than her. And his nuts were safe inside that rad-suit.

"I'm sorry, Kate," he said.

She glared and hardened her scowl. "Me too."

She jerked her safety line, setting the brake on her take-up reel so her line went slack. He hauled on his tether to reel her in, but as she drifted within reach of the webbing, she swept the shears forward and cut it, then jiggled her line to reset the brake and feed her slack back down into the take-up reel still attached to *Proteus*.

"Katy, no!"

Xav grabbed for her, but the line popped taught, and she spun and sailed down toward the hub.

"Dammit, Katy! Get back up here before you get yourself killed!"

He was probably right. She was probably committing suicide, but if she had to die to save the mission, then she had to. That was a calculation she'd made long ago, before they'd ever left Earth, long before that . . .

And goddammit anyway! If the mission failed now she'd be written off as hysterical, but if Xavier were down here, they'd already be writing his heroism up for the feeds back home. After all, they'd say, what was one life—any life—compared to iron or steam or stone tools or fire? The world's monuments were filled with the names of *men* who'd died for less. Who'd left families and fortunes and nations behind. Who every one shared the same dying wish: *that it all hadn't been in vain*.

But Katy wasn't dead just yet. It would be dicey now, but if she could free those pins quickly enough—before the *Queen* started her burn—she might still be able to make it. Maybe.

The suit's AI was already complaining as the ship backed away with its electromagnetic radiation shield. Even this close to Io it would take hours to absorb a lethal dose, but she released the AI to pump more Radiox into her veins, and whatever else it thought would keep her alive and coherent for the most important minutes of her life.

Shaking with anger and urgent resolve, she launched herself back down the boom, hooking her shins and feet around the framing where she could free her hands for propulsion—a trick she'd learned surveying orbital solar farms back home. The movement was less agile simian than tree sloth on amphetamines, but it got her quickly back down to the capture pod.

Everyone seemed to be on the radio. Xavier wanted to risk coming after her on emergency suit thrusters. Kaliah Khatri, ship's doctor, insisted they turn around. Others were speculating

about ad-hoc rescue tethers and life buoys and such. Colleen shot it all down and tried in vain to clear the channel.

It didn't matter. Katy had reached the pins. With no ship holding them back, the anchor pads had pulled flush against the boom's frame—held there by the springs trying to eject the pins out the other side. The pins themselves, and the latching mechanisms with the frangible bolts, had been pulled down into the guide channels passing through the boom, out of reach. *Great.*

She tried climbing around to the other side of the boom to see if the far end of the pins had a hex head or anything a tool could grab onto and turn. They didn't, though this end of the pins now projected about half the width of her fist. That at least was something.

Righty-tighty, lefty-loosey, right? Releasing a clasp at her right elbow, she pulled the anti-radiation gauntlet from her forearm and let it float on its keeper. Bracing against the frame, she grabbed the end of the pin as hard as she could and—Xavier's voice rasped in her ear.

"Katy, stop what you're doing!" The volume dipped as he shouted, "Everybody shut up," to the others around him. "Katy, the bolts at my end had both fired, but the latch had jammed in the channel. If yours are the same and you manage to wrench 'em loose, the pin will shoot out and eject you into space."

"Roger."

Okay. Well, she could stay clear of the pins, but it didn't matter. This one hadn't budged a micron. The little forged ridge that retained the ejector spring, on the other hand, had ripped a hole in the outer wear layer of her glove. She'd have to find another way.

Colleen came on the radio, offering stolen seconds. There would be no more after these.

Katy called Xavier and scuttled back around toward the attachment pads.

Xavier piped the others down again, "Go ahead."

"Xavier, execute CS-32."

CS-32 was the computer script that would arm *Proteus's* systems and disinhibit its pyrotechnics and thrusters. It was a fail-safe. It wouldn't do to have a giant space tether trying to deploy and spin up while still attached to the mother ship. It wouldn't be great if it did it with her on board either, but she was out of time, and Xav could run the script easily where she'd have to stop what she was doing to interface her suit to *Proteus's* computer.

"Katy, no. Not with you still aboard."

"Just do it, Xav!" *For once, just do what I say because I asked you.* "Please."

The radio was silent for a moment. "Yeah. Yeah . . . okay."

Back down below, she pulled and heaved on the anchor point, but the springs were much too tight. Whoever designed them hadn't wanted the pins getting hung up on the way out—like they were now . . .

That would be you, girl genius.

They hadn't had the funds to adequately test the mechanism in the vacuum thermal chamber, so she'd made the springs extra strong. So strong, apparently, they must have jammed the tips of the latches in the ends of the channels during cruise. When the pyros fired, it made no difference. The latches were frozen shut. *Brilliant.*

If she could just pull them free of the channel, they'd pop open and release the pins. What she needed was a pry-bar, something to lever . . .

"Captain," she said, "If you can give me sixty seconds, I think I've got it!"

She grabbed the power drill-like socket driver and made sure the extension was locked in place. She wedged it beneath the anchor pad and pulled—heaving with both feet against the boom until the anchor pad shifted and . . . Bingo!

The pin shot away, and with it went all resistance to her prying. She flew spaceward, startled and helpless, but her tool tether snagged on something, saving her from flailing away her last precious seconds trying to get back down.

She regained the frame, then scrambled to the last anchor pad. Just as before, she wedged in the extension and pulled . . . *pulled* . . . and nothing. The pad moved just as before, but the pin didn't give way. Had this last bolt been a dud after all?

She stuck her toe under the anchor plate, then kneeled and replaced it with the gauntlet. With

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the helmet on, there wasn't enough space to see beneath the plate. She reached in and felt to see if the bolt was intact, found the shackle, moved up and . . .

Pop!

"Ow!"

The pin had ejected. Again she tumbled skyward, but this time her attention was drawn to a flash of red—blood pouring from her glove, globbing out into space, sizzling and popping across the white beta cloth, then graying to icy gunk. She stared at her glove in shock. The palm had been sliced open, the skin gaping wide between the layered insulation. Glistening tendons dulled as the moisture flashed away. Boiling fluids and searing cold felt like ants tracking salt through the wound.

Jesus.

The sky flashed behind her; the ejection had been like pulling the pin from a hand grenade. The thrusters were spinning up *Proteus* to deploy its tethers. The universe whirled. Vertigo. Tunnel vision. Shock. Any one potentially deadly in space. Her visor display flashed alarming pronouncements about her plummeting suit pressure and erratic vitals, and about emergency medical protocols.

Katy keyed her mic. "Colleen I . . . I screwed up. Get the ship out of here."

The radio barked in chorus. They were all seeing the same telemetry. Colleen had been shouting, threatening to leave. Now she promised earnestly to somehow stay. But that was a battle-field lie, and they both knew it. Katy's oxygen had been low when she left; now it struggled to make up for the leak. Katy herself was feint, exhausted, dehydrated—trembling.

Under its emergency protocols, the suit's AI was already filling her glove with the cold expanding sealant foam meant to stop leaks and stabilize injuries—but the ship was a kilometer away now, and she'd never learned to use the suit's gestural emergency thrust interface left handed.

With maxed-out thrust and a dead-on vector, she might *just* have made it far enough for Xav to pick her up on a line. The suit AI could fly, but it couldn't improvise a rendezvous over that kind of distance with no time to plan or coordinate. It was just too far—too late. Colleen already had the ship venting drinking water and propellant reserves to buy the time she'd already given. There wasn't any more, and each passing second increased the radiation her crew would be bathed in for the duration of Jovian orbit.

"Colleen," Katy said. "Please. Don't get everyone else killed because of me."

The radio fell silent at last, then Colleen's voice came back—less forcefully than she'd ever heard it. "Rog . . . Roger."

As *Proteus* spun itself up, Katy's world spun with it. So . . . that was a problem to solve. She gave her safety line a double pull to release the brake, then kicked off when the recoil swung her back down to the boom—and repelled up toward the hub.

Xavier was still on the radio, ignoring Colleen's demands to get back inside even as main propulsion coughed to life. He just wasn't ready to let go yet. "Katy! Get to the hub! Your suit can keep you alive if you can shield yourself while I work out some kind of—"

"Xav, stop." Katy said, pulling her radiation gauntlet back on before her glove became too stiff and swollen. Even after *Proteus* passed inside the main belts, the radiation would still be lethal. The suit and the Radios could buy time, but it would be nearly four weeks until retrieval. There was only so much she—or the AI in her suit—could do.

Katy fought to keep her tears off the radio. "See to the mission, Xav. Get a sample back home. Promise me."

She didn't wait for a reply. She swiped her helmet display, triple-tapping to confirm left-handed control of her emergency jets. "And thanks—"

Jovian Queen's plasma thrusters came on line, roaring static that blotted out anything Xav might have said in reply.

With her left hand, Katy couldn't aim worth a damn, but she could make a fist, amping her thrusters to maximum. She sailed—was it up or down?—contrary to the growing centrifugal acceleration, closer toward the hub, on until the combined efforts of her emergency thrust and

the safety line being drawn into the take-up reel could no longer balance her growing weight. Then she slammed into the boom, knocking about as stars wheeled past in nauseating sheets. Shadows flicked like an old-time zoetrope as the truss telescoped out beneath her. She climbed, no longer weightless as before but Earth style, child on attic ladder style, quick to get past the rickety part, slow to keep from slipping—and in this case flying off into space.

It was a silly thing to worry about really: staying alive when she was doomed anyway—how and when to die if she had to. But then, everyone did that, didn't they? Her death was no more certain now than the moment she came into the world. She was no more doomed—in the scheme of things—than she had been sitting in Mamma's lap, breathing in her Virginia Slims as she read Peter Rabbit with all the voices.

But she'd given up everything to be here—to make this work—and what she'd traded away had been bought for her with tears. So many rifts, she wished she could go back and heal. So many thanks, she now could never give. There was no going back, life wasn't kind that way, but there was still one recompense to be offered—and this was it. Do or die, she'd never get another shot, and as long as she was alive, there was hope, there were chances, if not to somehow get out of this fix, at least to help secure the payoff.

She reached forward against the mounting centrifugal force, hauled on the crossbracing, and pushed with both legs. With every second, she grew heavier. Each labored breath echoed inside her helmet. But there were echoes yet to come.

If she'd clipped on closer to the center of the hub, the line might have wrapped around the antenna mast and hauled her up. That was what these booms were for after all, to stop the space tether spindling around the core instead of stretching kilometers out into space and scooping down into Jupiter's atmosphere. But she'd done what she'd done, and she was where she was. And now, that was exhausted and too heavy to go any farther. In a moment she'd slip, plummet, snap the line, and fall into her own lonely graveyard orbit between the stomach-turning complexity of the Jovian sky and the terrible vastness of space.

It might not have mattered, but it terrified and fortified her. She held on tight—braced gauntlets and boots against the frame and heaved against her mounting weight . . .

The boom shuddered. Far beneath her feet, flames shot out in a giant "X" as the capture modules fired their tractor rockets and blasted away into space, playing out tether behind them.

Exhilaration burned out from her heart and pushed a lump into her throat. She'd done it! She might die right here, all alone in the dark, but *Proteus* was doing its thing. If it could just hold up a little longer, whatever that layer really was beneath the writhing cauldron of ink-splattered sky, humanity would get a look at it. And that meant it was worth it. Dying alone out here. Sacrificing the chance to say goodbye.

It also meant, since most of *Proteus's* mass was in those tethers, that as they flew outward with the deployment, they carried away angular momentum like an ice skater slowing from a fast, tight spin down into a graceful camel. The spinning slowed. The pain in Katy's knees eased. She shook her tears away and looked up at the hub, the railing, her safety line take-up reel, the scant few handholds between here and that one final objective.

The thing was, it did matter—when or how she died. As long as she was alive, there was always something to strive for, to wait for, to prepare for—even if only tomorrow, the next handhold, or the next glimpse beyond the shadows. If, that was, she could just keep the radiation from cooking her. She climbed. . . .

* * *

The impactor plummeted toward its doom, a sleek black cylinder of depleted uranium like a house-sized trashcan in a witch's hat. As it plunged toward a Jovian dawn a dozen Earths wide, Katy drifted in endless night, now and then tracking its progress by the glowing blips on her visor display. She'd found refuge in a deeply sheltered equipment cove between *Proteus's* central dump tanks. Thus ensconced, she'd held on as the space-tether cycled around her, as it and the impactor accelerated toward Jupiter, as the radiation outside dropped from promptly lethal to . . . eventually lethal, and her suit did its best to preserve her.

All things considered, it wasn't a bad home. *Proteus's* fuel cells could spare her oxygen and

power a dozen times over, and she'd even found a way to tap their wastewater. People had survived a month on nothing more—plumper people, probably. Katy was bloody-mindedly hungry and had never felt so weak. At least her suit, after stabilizing the hand, had persuaded its peripheral nerves to rest, and so from time to time, so could she.

The drugs and the radiation, though, took a toll. After drifting in and out of sleep the first day, she'd found a flaw in the space-tether's rotational dynamics software, which wasn't accounting for the variable drag induced by Io's volcanic emissions. She'd pushed through the mental haze long enough to debug the problem and stabilize the rotational plane of the space tether. But after a few more days of starvation and misery, she'd started hallucinating—aliens and Coast Guard cutters and rescue at sea, and alarmingly, hacking off her arm with the metal shears, then popping open her helmet for a bite . . . That one still made her shudder. Where were the sharks when you needed them?

Through it all though, curiosity kept her going. Would *Proteus* hold together? What would the tether latch onto? Would the capture system work and haul it up, whatever it was? Would it enter the predicted orbit, so the ship could pick it up? Would it be what they'd come looking for? Do what it promised to do?

As the impactor dove into the atmosphere, *Proteus's* computer drew plots of pressure, velocity, bow shock separation, heat shield performance, unexpected atmospheric stratigraphy that would write someone's dissertation for them if the data ever reached Earth, X-ray flux, electromagnetic spikes, and finally—loss of signal.

Now she really *was* curious. Who else would ever get to see impact ejecta streaming *up* through Jupiter's atmosphere? She pushed aside cabling and an insulation bat and climbed out around the tanks and pumps and the forks of superstructure that had shielded her thus far. In amber twilight, she crawled over crinkled, mirrored sheets, around fairings like killer whales sculpted from Airstream trailers, and . . .

Oh my God.

The radio barked a cacophony. She switched off the audio and “stood,” holding *Proteus's* antenna mast and gaping down at the king of planets, at a salmon dawn impossibly wide, cut by endless currents and whorls, vast belts of red and orange and yellow and cyanotic blue—all swirling ink, margins spinning off vortexes and eddies and smaller vortexes and smaller eddies, down to the limits of perception. Sunlight caressed the shifting contours of the multihued clouds, as deeply textured as a van Gogh, as translucent as sapphire, as boldly hued as if forged from ribbon candy. And across it all, lightning struck from cloud to cloud, band to band, and horizon to horizon.

It was hard to comprehend the scale or distance or even the beat of time. The computer had answers, but Katy could no longer squeeze her thoughts into coherent queries it might comprehend. Instead, she waited, dumb and shuffling before the vast grandeur as *Proteus* revolved beneath her, as the booms marched past, one after the other, their tether lines glinting past and tapering into infinity.

Her visor display flashed a medical warning. The suit had fought a valiant battle as doctor, nurse, and quartermaster, but her organs were finally giving out. Just a little longer . . .

A boom swept around, the capture pod at its far end slicing down into wisps of Jovian cloud at fantastic speed. But it had been too long already, surely. All this way, perhaps as close as humanity would ever come to sailing the seas of a gas giant, and had all of it been for nothing?

She hugged the antenna mast, lacking the energy even to curse. The thought recalled an old lecture: *Life is a temporary exception to the Second Law of Thermodynamics, made possible by energy from the sun. Without that outside energy, there could be no life. Without external energy, entropy reigns.* Her quest for metallic hydrogen had been all about energy. Energy to run Earth's industries without pollution and war. Energy to repair the damage done to Earth by centuries of ignorance and neglect. Energy to protect its life from the vagaries of time, to free humanity to measure dreams against the stars—to escape the destruction that must one day visit every planet-bound species.

But Katy herself had no more energy. Her suit said she was dying, her heart stuttering, her

blood poisoned by the effects of prolonged starvation and the constant repair of radiation damage. She relaxed her grip on the antenna mast. . . .

* * *

A flash in the distance—shooting stars—lots of them, flitting up through the clouds and unbearably bright. Perhaps she should take a picture—

Proteus lurched—shook like the bed of Mamma’s truck bouncing down a muddy swamp road when they used to go fishing. Her visor flashed warnings and jabbered. . . .

Something was wrong. Through the mast came a vibrational chorus of tortured metal—and a bang, as to either side, car-sized fairings blasted away into space. Engine bells rocked forward, coughed and shook to life. Their hydrogen fires flared, then became invisible in operation, all but for a yellow aura that danced and enveloped her spacesuit.

Proteus’s logs scrolled down her visor. Kilometers behind her, the aft pod tractor rockets had fired. Kilometers ahead, the forward pod was hauling itself up the tether as fast as its fibers could endure. Still, *Proteus* struggled, quaking like an angler with a marlin on the line, and almost bucking Katy overboard.

The boom swung up from Jupiter, and Katy felt the shift in momentum as *Proteus* repositioned all its thrust. Like a kid leaping on a teeter-totter to launch his lunchbox from the other end, it was going down, sacrificing itself to get the sample into orbit. The booms shook and rattled. Gouts of escaping gas carried insulation bats into space. Katy clung to the antenna mast like Odysseus before Poseidon’s wrath.

Proteus swung down as the tether rose toward the quaking horizon.

She had to get forward, down that boom, down the tether—somehow—to the capture pod. When it reached the optimal angle, *Proteus* would cut it loose. The momentum transfer would be complete. The capture pod would go into orbit, leaving *Proteus* behind. She might be dying anyway, but she didn’t want to burn up in Jupiter’s atmosphere or be crushed under the obscene immensity of its titanic depths.

She jerked the safety line to release the brake and jumped—all her remaining energy channeled into a swan dive down the boom.

Logical or not, she just couldn’t bring herself to “go gentle into that good night”—not one stale, stinking, nauseating breath sooner than she had to.

She keyed the suit thrusters, rocketed down the boom till her safety line snapped. Then she tumbled, thrusters exhausted, the line recoiling and gathering around her. She flew on, past the boom’s extended sections, past the “obelisk” core where the tether had been stored, and on into the nothing beyond. The tether line glowed orange in the Jovian light—tantalizing and real, but no more accessible than the base of a rainbow.

As her tumble brought *Proteus* back into view, fire spewed from the hub—and her safety line take-up reel smacked her in the face.

Startled, she fumbled to swat it away, then to catch it, and heard Mamma’s voice in a memory, yelling from the sidelines, “Hail Mary!” What did she have to lose?

She threw the take-up reel. It shot toward the tether, a clump of line tangled around it. The attempt was hopeless. Even in perfect health, she could never climb up to the tether and all the way down it to the capture pod in the few seconds before it cut loose. But fortune favors the foolish.

Her display flashed a message from her suit AI, “INITIATING EMERGENCY PROTOCOLS,” and the logs from *Proteus* winked out. Fire ballooned out from the hub, framing and machinery flew in all directions, and the tether rippled as, severed from its mooring, jolted it free. The safety line wrapped it and caught a few times, but wouldn’t hold. Then the mooring plate by which the tether had been secured to the boom shot past, snagged the rat’s nest and bang!—jerked Katy around like a calf lassoed by a jumbo jet.

And darkness came crashing upon her.

* * *

Warning alarms . . . that were not from her suit AI.

What the? Katy cracked an eyelid. Bright white light—too bright—her arms wouldn’t move to

shield her eyes. Interwoven voices worked in studious consultation: “Ninety-six and rising. Cut the propofidine. Intracranial . . . administer . . .”

The chime was a heart-rate monitor. A fantasy. She was floating, wrapped in towels like a child made up to play the mummy—in a hospital. She needed to puke, to speak, to shiver violently—but could will none of these things to happen.

The scalding light dimmed. Fingers pushed her eyelids. “Katy, you in there?”

It was Xavier. Somehow, she’d survived. And now, finally, she could surrender.

* * *

Sometime later, the world came into tentative focus. Katy had been stripped of her bio stocking and was instead wired and plumbed into a nest of equipment arrayed at one end of the infirmary. She was back on *Jovian Queen*, and it looked like half its systems had been scavenged to build a life support system around her.

“Xav . . .” The strange voice was that of a ghost with a smoker’s rasp.

Xavier stopped his prattling, gave her ice chips, gave her paste that smelled like shoe leather.

“How?” she sputtered.

Xavier smiled. “We cannibalized the skiff—”

She nodded, prodding him to skip ahead. She’d heard that part. They’d hot-rodged the skiff with spare parts and spit and sent it ahead to retrieve her. That must have been weeks ago now.

“H . . . how?”

“How are you alive? Your suit induced a coma—”

“Not a coma.” Kaliah was behind him, busily fussing with tangled wires. “Managed hypothermic arrest.”

“Arrest?”

Kaliah grabbed Xav’s arm and popped around into view. “Your suit killed you, baby, and kept your body on ice.”

Xavier pushed Kaliah aside. “It did not. It kept you going with stimulated chest compressions.”

Kaliah humphed. “About one every half hour.”

Katy took a squirt from the tube. “For four weeks?”

Kaliah laughed, “Only one, honey. We picked up enough suit telemetry to know you were still—well, not entirely dead.”

Xavier offered water from a sponge. “We launched the skiff before you even reached periapsis, but we couldn’t get a channel to tell you. Then when we saw the sample wasn’t going to make orbit . . .”

Kaliah made a sweeping gesture. “We reprogrammed the skiff as a tug boat.”

“Which is a good idea for next time,” Xavier added.

Kaliah took Katy’s arm and tapped the display on the cast. “You were just a bonus, baby doll.”

Xavier scowled. “You set a new record for closed-loop life support. Your suit A.I. pumped you full of I.V. zombie juice synthesized from your rations. Dr. Kang and I are submitting papers to *JAMA* and the IEEE.”

Kaliah moved back to her wiring. “To be honest, I’d have just put you out of your misery.”

Xavier glared.

Katy furrowed her brow. “But . . . how could I possibly—”

“The radiation?” Xavier held out a plastic zipper bag. Inside was some kind of mineral like a fuzzy walnut with a gunmetal sheen. “We think this protected you.”

Is that? She looked from the mineral to his infectious grin. *But if that’s all they had to show for all this—*

“See for yourself,” he said. “Kaliah, pass me that panel . . . no, the big one . . .”

Kaliah pulled a display panel from a hook and loop pad on the bulkhead and sent it spinning his way. He snatched it and tapped at the surface, then flipped it around to show Katy the feed from an external camera—stars, and a sliver of Jupiter.

His eyes scanned her invalid body. “Now don’t get too worked up. I don’t want you popping a rivet.”

She glared.

Peering around the screen, he tapped and swiped, sliding the image over till an asteroid filled the screen—an oddly blue-gray, metallic iceberg in space. He pointed to a tangle in the middle.

“You were right there—deep in a cleft beneath where the mooring plate came to rest. We’d have never found you if the suit hadn’t triggered the locator. It’s like the A.I. was waiting for us.”

Katy gaped. “. . . Hail Mary.”

“Huh?”

“Nothing.”

Xavier nodded. “You ended up under sixteen tons of the best radiation shielding in the solar system.”

Katy’s eyes grew wide. “Metallic hydrogen.”

He nodded. “In a metastable complex of poly—Hey . . . hey, Katy, don’t cry.”

She couldn’t help it. It all came crashing in on her. Regret, fear, pain, hope, despair. Xavier and Kaliah tried to comfort her, saying they’d all be famous, but that didn’t matter. All that mattered was, *it hadn’t all been for nothing*.

She forced words past the pain in her throat. “We found solid metallic hydrogen!”

Xavier blotted her tears with a gauze pad, grinning like a proud parent. “Yep.”

“Enough to sink the Titanic!”

“Or send it to Alpha Centauri.”

Katy shrugged at her bedding. “We have to . . . We have to—”

Kaliah pushed her back. “Whoa there baby, what *you*’ve got to do is not die while Kaliah pumps in the secret sauce.”

“. . . characterize . . .” Katy’s head began to swim.

Kaliah shushed.

Xavier patted her head. “Is she all right?”

“She’s all right,” Katy heard Kaliah saying, the words like echoes in an empty hanger . . . “she just needs to sleeeeeeep . . .”

* * *

All was darkness, all but a ruddy sliver of Jovian dawn. The sample loomed close by, a jagged gunmetal gap in the stars. Katy’s hand found another, as warm and comfortable as if she’d held it a thousand times. Her heart flew into overdrive. “Ma . . . Momma?”

The smile warmed, as ephemeral in the gloom as the Cheshire cat.

Tears welled in Katy’s eyes. “Am . . . am I dead?”

Her mother’s eyes wrinkled with familiar mirth. “I don’t think so.”

It didn’t matter. She threw her arms around the welcome apparition and inhaled her mother’s scent. “Momma! Oh Momma, I’m so sorry!”

“Oh, why?”

“For leaving you, for letting you die alone—” Her mother pulled her close.

“Katy, don’t say that. I wouldn’t want you to die *with* me.”

“I know but . . . but . . .”

“My Katy,” said her mother, “I’m so very, very proud.”

Tears filled Katy’s eyes, globing in the microgravity. “This isn’t real,” she said, her voice quaking as she shook the teardrops away. “Is it?”

Katy’s mother smiled and rocked back on heels that had nothing to support them. “Well either I’m a ghost with a message from beyond the grave, or I’m a simulation inside your brain. Either way, I’m all that’s left of *me*. That and my work, which you’ve rescued from obscurity.”

“But I . . . Do you . . . have a message?”

Her mother nodded, beaming. “Tag!”

“What?”

“Go home. Live well. Be remembered for the good you do. And now . . . you have to let me go.”

“Oh Momma!” Katy stepped forward, but her mother pulled away, taking her place among the heavens. Katy slept, commanding her body to heal. She had so much left to do.

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