

HEAVY METAL JUPITERS – FRIDAY

edited by Heather Clitheroe and
Jessie L. Christiansen



CATHRIN MACHIN
CONTEMPORARY

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Bri McAllister, Brittney Hauke, Daniel M. Bensen, David deGraff, Denise Sutton, Fred Coppersmith, Laci Brock, Paul Bowden, Raphael Sutton, and Ann Marie Cody

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From The Editors

It's been such a privilege to have been entrusted with so much wonderful writing, poetry, and art! I had no idea what to expect when we embarked on this project, and I have been delighted, enthralled, and touched by every contribution. Thank you so much to all the writers and artists who participated in this project. Thank you as well to the scientists who provided the inspiration, and especially to those who sat down with the writers to discuss the concepts in more detail. Thank you as well to the conference support staff, especially Ellen O'Leary, for helping to distribute 'Heavy Metal Jupiters and Other Places.' Finally, the biggest thank you to Heather Clitheroe, for putting this all together! It wouldn't have happened without you.

– *Jessie Christiansen, PhD*

What a week! The stories, poems, and artwork created for 'Heavy Metal Jupiters and Other Places' have been a real pleasure to curate, and I'm very grateful to the writers and artists for their work. Special thanks to Andrea M. Pawley for proofreading skills extraordinaire, and to Jessie

Christiansen for making this collaboration possible. And of course, many thanks to the real stars of the show (I couldn't resist): the writers, artists, and researchers. You are truly supergiants.

– *Heather Clitheroe*

DAVID DEGRAFF

Ross 128 b

The team visited Ross 128 b, not because it was the most likely habitable zone planet to harbor life, but because it was the closest. They arrived with low expectations so no one was disappointed. No one except Carolyn.

###

Carolyn looked down at the white plastic stick again. One horizontal blue line without a hint of its vertical counterpart. Negative. She massaged the muscles in her temple as she floated in front of the vacuum toilet. Maybe it was for the better? Who know what effect the Travel Branes would have on a developing fetus. They should hold off until the end of three-month survey, but the family leave timing wouldn't work out as well.

She wrapped the plastic stick in toilet paper and popped it into the waste shoot, pulled up her pants and kicked off the wall to float into the main cabin. The orange wisps that filled the Interstellar Brane flew past the observation window, reminding Carolyn of soaring a sail plane along the top of a cloud bank. Jared looked back at her and

wincing. “We’ll be popping back into normal space in about forty-five minutes.”

When the glare of the jump faded, Ross 128 pierced the sky like a hot garnet, but all the stars were steady pricks of light making it hard to spot any planets in an unfamiliar sky. When Carolyn held up her finger to block the star, she could make out three ruddy pinpricks, but she couldn’t tell which was planet *b*. The two-color plots said it would be blue, but that was relative to the flux from the star. Was one of those spots more purple than the others? She couldn’t tell.

Jared’s arms wrapped around her shoulders and he kissed the back of her neck. “We can keep trying.”

After a quick hoe through the Slow Brane, Jared inserted them into orbit around *b*. Carolyn strapped into the VR rig and launched the probe. Winds were calmer than expected for a tidally locked planet, and she sampled from the night side, the day side and three spots over the crepuscular zone. The surface looked as dry as Mars. Dryer – there were no signs of dried river beds or washed out craters.

Nikole found no trace of organics in the samples. Maybe this color test for habitability wasn’t as good as it seemed.

###

Gliese 581 c

Gliese 581 had three planets that could have been in the habitable. As expected, *c* turned out to have a runaway greenhouse, and *d*’s eccentric orbit took it far away from the star’s habitable zone. It was near aphelion and looked like a giant version of Europa, only smoother. From Earth, astronomers had noticed the colors changed. That it looked closer to earth in the winter had been taken as a good sign, but it was the lack of clouds increasing the Rayleigh scattering that fooled them.

Carolyn was ovulating, so she took Jaren away from the controls every chance she had. Nikole was not very good at hiding her smirks and the glances she gave Bruce.

Planet g looked more promising. The ground was variegated with blues and reds and greens, and the bays lacked large waves. “It looks like bacterial mats,” Bruce said.

When Carolyn brought back the air samples, Nikole couldn’t stop cooing about the amino acids and their chiralities for the two weeks it took to reach the next star.

###

GJ 1265 b

GJ 1265 b was the one they argued about the most, and Nikole even stopped talking about her chemistry for a bit. Was it a super-Earth or a mini-Neptune? Mass measurements were too uncertain to use the density to distinguish between the two, and the color-color plot placed it squarely between Neptune and Earth. The colors suggested a cloudy planet which also had patches of clear sky. The light curve suggested the planet had weather.

And now they were about to find out.

They popped out of the Interstellar Travel Brane too far to make out the planet in its tight 3-day orbit. “You still have time to change your bets,” Jared said when he reached the group standing in front of the observation window.

“I’m sticking with six,” Bruce said. “Compressed rock all the way.”

“I’m hoping for nothing but water, density of one,” Nikole said. “That chemistry would be fascinating, even without life.”

“Two,” Carolyn said. “Flying in a gas giant would be a dream.”

“I’m still torn,” Jared said. “On the one hand, I want to see what kind of animals would develop in Bruce’s gravity.

But on the other hand, I want Carolyn to get everything she wants.”

Carolyn looked at him and smiled, hoping she wasn't giving too much away. She'd taken the test again that morning and was waiting for a private moment to share the good news.

Jared popped them through the green mist of the Slow Brane and a minute later they were in sight of a purple orb, looking larger than the garnet star to their left. “One more jump and we'll be in orbit, but I'm going to tell you now that Carolyn has what she wants.”

Nikole looked at her and raised an eyebrow. Carolyn tried not to smile and give away her news.

The clouds that appeared below them after a quick flash looked like nothing Carolyn had ever seen. Tall cliffs like Yosemite or the karsts of Guilin. Except. Except these were hundreds of kilometers tall. Standing straight despite the strong winds blowing from the sub-solar point. Lightning flashed as they crossed the terminator into night.

Carolyn strapped into the VR rig to launch the probes and waited for it to drop into the clouds, waited to feel the wind buffet her. She twisted her hips, testing the probe in the unfamiliar gravity and wind. It became more responsive as she dropped through the orange clouds.

Magenta lightning flashed, and a second later she heard the crash of thunder. The probe jolted right, harder than the VR rig could simulate. She lost control. The probe tumbled. She tumbled in the VR rig. Slowly, she danced with the wind and stabilized.

Magenta flashed from above. In the distance, black clouds blew to the left against an orange backdrop. The front cloud moved up and the clouds behind followed like

a school of fish. A silly thought – the wind over there had simply changed direction.

But they were only ten kilometers away, and Carolyn's wind blew steady. She leaned forward to fly to the school of clouds. The front cloud was higher now, and turning right. The rest followed like a murmuration. After a minute, the pattern stabilized again, moving toward her. Had the clouds seen her?

No. That wasn't rational. Clouds couldn't move on their own. She held her course, and took an air sample for Nikole.

The clouds were closer. Lightning flashed when they changed course. Magnetohydrodynamic clouds?

Two dozen headed straight toward her.

The first cloud passed to her left. It was a kilometer long.

More passed to her right. Above her. Below her. Like the time on her grandfather's boat when a pod of whales swam by, not noticing her at all.

But these clouds had noticed her.

The clouds had matched her velocity. The clouds surrounded her.

Carolyn closed her eyes and steadied her breathing.

Lightning flashed within the closest clouds. Thunder rocked the probe. More lightning to her left, above and below, but there were no patterns she could see.

Nikole could crow about the chiralities of her amino acids all she wanted. Carolyn had something better.

She shifted her fingers to control the probe's lights.

Off.

On. Off.

On, off, on, off.

On, off, on, off, on, off.

Lightning flashed in a frenzy all around her, still too complicated to find a pattern.

Then they were dark.

At once they flashed. Once.

Then twice.

Then three times.

Carolyn flashed four. The clouds flashed five.

She shouted with joy and pulled back, pulling the probe into a loop.

She would be bringing more than life back home. She had proof of intelligent life. She couldn't wait to tell Jared.

Unveiling the Planet Population at Birth

BRI McALLISTER



This World of Strange Design

FRED COPPERSMITH

Building a planet used to be harder.

There was a real art to it once, Joseph remembers. Years of stellar engineering and geo-architectural study, of course, but also something more than that, something indefinable: raw talent polished to a diamond's edge. Back then, the spacefaring guild paid handsomely for that kind of artistry, that kind of prodigious talent, if only you were the kind of planet-builder who could master it.

Nowadays, you can build a planet out of a box kit. Almost anybody can, with just a small orbital ship and a choice investor. There's no ounce of artistry involved at all.

There's also no guild left, Joseph thinks, which is the only reason he's stuck out here doing clean-up duty in the first place.

He taps the viewscreen of his own orbital ship gently, pinging the data net. Three of the messenger birds he sent out to the planet below haven't returned, nor even relayed preliminary data through the temporary satellite ring. Still,

it's too early to read anything into that, much less leap to any kind of conclusions. Instead he scrolls through the handful of atmospheric readings that have already returned and compares them against the design packet the client uploaded to his ship's computer before departure.

What he sees is troubling, to say the least, and it's little wonder they were willing to pay so much, and so quickly, to procure his services. Joseph didn't build this planet himself, of course, but even at a glance he could tell it was a hack job, barely stable tectonics and unbreathable air, the kind of hurried and half-measured work that would have gotten him laughed out of the guild. It's only gotten worse down there in the standard month since they built the thing: primordial atmosphere starting to strip away, but at nowhere near the rate they'll need if the client actually wants to mount a settlement anytime this century.

That's what you get from trusting in box kits, Joseph thinks. Better to write off the cost and just bomb the rock out of the sky.

Why they even built it out here, he doesn't know. There are exo-planets aplenty in nearby sectors, and nothing particular to recommend this one. No established trade routes, no mining prospects, not even a sun they didn't have to cart in and build from scratch themselves. At least that jury-rigged fusion reactor looks stable enough, but that's only because they outsourced the tiny ersatz star to a more reputable crew. (Joseph recognizes his old competitor's handiwork.) If the client wanted a settlement in this part of space so bad, they had a lot of other options that didn't involve store-bought planets in the first place.

But then the last of his messenger birds radio back and he finally understands. It's all right there in the data. The coalescing atmosphere, the unsteady core composition, the

telltale footprint of prokaryotes where there shouldn't yet be any. They've got the whole thing half-backwards, too much seasoning in the primordial soup, but it's suddenly clear to Joseph what they thought they were trying to do.

They were trying to build another Earth.

No wonder they wanted to tuck it away where no one would see it.

Back when there was a guild, Joseph would have warned clients away from this kind of mad folly. He'd never have taken this commission. Planetary construction is about architecture, engineering, house-building. Anybody who promises you more than that should have their license revoked or their head examined. A planet-builder can give you the house, even a beautiful one, but if what you really want is a garden—a bona fide, workaday, terrestrial settlement—then you can't cut corners like the client tried to do here. You can't expect your new Earth to do the work for you. You need to seed the planet, well after the initial assembly, with the basic building blocks of life that you've brought in from off-world.

Nobody's ever had any luck getting a bespoke planet to spontaneously create a biome on its own. Not in any sustainable way, at least, and certainly nobody equipped with just a box kit. Even the guild, when it was collapsing in on itself and desperate for work, wouldn't have pretended they could coax a planet into creating life all by itself.

Joseph has to laugh, and not simply because he knows his hourly rate has just gone up. It'll take weeks, maybe even months, to fix what they've done wrong here. The client thought they'd be able to skip a few steps, forgo that costly seeding process and still get their hands on a new world they could safely live on. Instead, what's down there is a broken and dangerous mess. Some scattered pockets of

unicellular lifeforms, sure, but nothing that'll last or make it past even the mildest of extinction events.

It's going to take a lot of extra work to make this planet anything like habitable.

But Joseph thinks he's up to the task. Now that he understands exactly what's gone awry with the build, he thinks there's a clear way to salvage the place. Maybe even re-introduce a little artistry in the process, do his old guild-mates proud.

There's no way it'll come cheap, but then again, it also won't be the end of the world.

Desolate

LACI BROCK



Well, Boom

DANIEL M. BENSEN

Energy curdled back into mass as the ship translated out of light speed. After a pause for the crew to get used to experiencing time again, the ship's instruments extended.

From the crew's perspective, they'd finished an extensive survey of this part of space just a moment ago. For this part of space, however, six hundred years had passed, so it was important to make sure nothing had changed.

Something had.

"It used to be a star like the sun," said Gaviria. "It had a family of planets ranging in size from a little larger than Earth to a little smaller than Neptune, all of them orbiting closer than the orbit of Jupiter."

Marletta spoke over Gaviria in his excitement. "So far, so similar to many other star systems. Really, it's closer to the galaxy's standard average than the Solar System."

"Or it was when we translated to light," said Gaviria.

"But?" asked Zhang.

Once a biochemist, he'd been elected to the post of "Social Coordinator," or as he called himself, "cat herder."

"Its planets have shrunk," said Gaviria.

“Huh.” Zhang wondered why he was having this conversation with a couple of astrophysicists. Aha. There it was. “You want me to authorize an away team.”

In free fall, Marletta could not jump up and down with excitement. The best he could do was anchor himself to a hand-rail and vibrate in place. “It’s close. It’s *super* close!”

Zhang looked at Gaviria. “Point nine eight light years,” she said.

“Would a two-year-ship-time trip fit our flight plan?” Zhang’s question was directed at the ship’s computer, which cleared the mission. Soon, the three of them were packed and in their landing pod, which the ship translated into light. The team was away.

###

After either a year or no time at all, the landing pod re-materialized above a planet. Zhang, Marletta, and Gaviria watched as the hazy, blue-white ball flickered in their portholes. As their pod translated itself into a safe landing trajectory, the planet vanished and reappeared, changing position and orientation. It grew closer.

Now, the planet filled all the portholes on one side of the pod. The diamond light of its home star limned its upper edge. Now that light was tinged red by atmosphere, and the edge had become the horizon. The horizon developed mountains. Finally the pod settled, the planet became the ground, and Gaviria, Marletta, and Zhang walked out onto it.

Zhang hopped experimentally, feeling his suit flex under the extra half gee. He couldn’t smell anything except his own canned air, but his mics picked up the sound of running water, wind over rocks, and a distant bass pulse that might be surf.

They’d touched down on a hill overlooking a floodplain,

where a river flowed into an ocean. The sun rose above the mountains on the other side of the plain, casting pink-yellow light onto clouds, folded rocks, and the forest growing out of the river.

The plants, if they were plants, had no leaves, branches or trunk. The green, blunt-nosed cones simply sat there, their roots – if they had roots – invisible under the water.

They might still prove to be some strange kind of geology, but Zhang allowed himself to take a leap of faith, and sighed. “Life.”

It wasn't the first extraterrestrial biosphere that the Von Neumann Fleet had discovered, but it was a first for his individual ship. Part of the reason Zhang had accepted the post of cat herder was that there wasn't usually much call for a biochemist.

“Samples, samples...ahh,” Gaviria hummed to herself. She headed for a cone-plant growing in a nearby stream.

Marletta looked out over the blue ocean and green floodplain. “Life how? Six hundred years ago, this place was a sub-Neptune.”

“It's much closer to its star than our Neptune,” said Zhang. “Right?”

Marletta flapped his hands. “And with a denser core. And not as close as Earth...really, it was intermediate between Earth and Neptune.”

“Which is unusual?”

“Well, usually you either have a terrestrial planet like Earth,” Marletta held his hands apart, as if measuring a grapefruit. “A secondary atmosphere out-gassed from the rock. Or,” He spread his hands out to the diameter of a beach ball. “Or, you get a gas giant like Neptune, with an envelope of hydrogen and helium gathered out of the primordial matter that built its star. Those light gasses

spread out farther, so the planet looks bigger from space.” He moved his palms inward, the space between them now the size of basketball. “But then over time, heat from the planet and the star would have blown that primordial atmosphere away, which is why we assumed that the intermediate diameters, like this planet used to have, were so rare.”

“Rarer now!” said Gaviria. She chipped away at the green cone-plant with her multi-tool. The surface of the organism was as hard as the heat shielding of their landing pod. “Since we left Earth, every planet in this system has shrunk down.”

Zhang watched Gaviria work. “And in only six hundred years,” he mused. “I’m assuming that’s much faster than any stellar or geological process could account for.”

“Don’t jump to conclusions,” said Gaviria.

But Zhang didn’t have to line up his evidence for a review board. He was a cat herder now, and he could jump to whatever he wanted.

“Marletta, did the observations we made from Earth indicate oxygen in this planet’s atmosphere?”

“Well, we don’t know,” said Marletta. “We never recorded any absorption spectra through the original atmosphere. All we have are the transit and radial velocity data that told us the size and mass of this system’s planets. But...” His brain caught up with his mouth.

On Earth, Marletta would have spun around to face Gaviria and her cone-plant. In 1.5 gees, he wobbled like a penguin, but eventually got himself turned in the right direction. “You mean photosynthesis?”

“How much longer?” Zhang asked Gaviria. His logic was leading him into uncomfortable places.

Gaviria gave her cone-plant another whack with her

multitool, which didn't even scratch the surface. "Let me get my sample. It's not going to go off right now, just because we're talking about it."

Marletta thought out loud. "Water and carbon dioxide go in, oxygen and carbohydrates come out. O₂ gas rises to mix with the H₂, and now every time there's a bolt of lightning or other spark..."

"Well," said Gaviria, "boom."

Marletta swore in English.

"We need to go," said Zhang.

"Stop being paranoid, this all happened hundreds of years ago." Gaviria grunted and scratched at the cone again.

Marletta stopped, his colleague's assumptions overriding his sense of self-preservation. "Wait. That's *still* not fast enough. The entire atmosphere couldn't have, uh, explosively oxidized in only six hundred years."

"There must have been biological processes actively speeding things up. Sequestering the hydrogen? Controlling the rate of reaction?" Zhang shook his head, remembering he was supposed to be herding these cats. "Let's go, Gaviria. We can print out better tools on the pod." *After a light-speed jump into deep space*, he added silently.

"I suppose so," Gaviria reluctantly put away her multitool and hoisted herself out of the stream.

Marletta couldn't snap his fingers in his suit, but he tried. "And it didn't just happen on this planet, did it? Every planet in the system lost its hydrogen atmosphere within the same six hundred year window!"

"Panspermia!" crowed Gaviria.

Zhang groaned because he had always hated the idea of panspermia. Also, because steam was rising from the cone-plant behind his geologist.

###

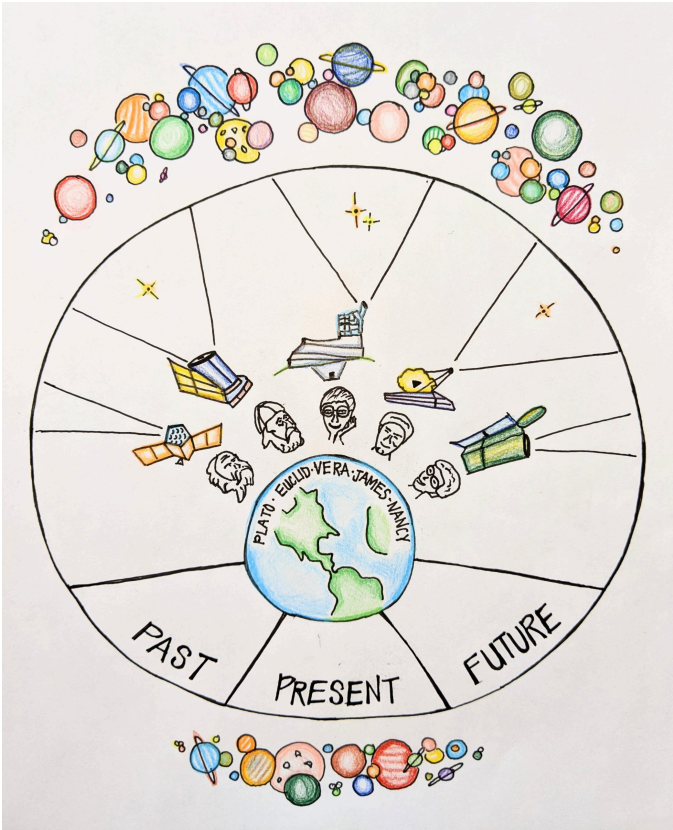
It was a good thing, they decided later, that Gaviria hadn't been able to crack the ablative shielding on the cone-plant. If she had, it could well have exploded.

As it was, though, the plant only launched.

Back in the safety of their pod, the three humans watched as the green, ceramic-shelled organism lifted into the sky on its pillar of fire, and began its mission to spread life to other stars.

Coming Full Circle

ANN MARIE CODY



Let's Make It Fun!

RAPHAEL SUTTON

The interior of a meeting room located on an alien planet near the center of the galaxy. The room is furnished with only a long table and chairs around it, providing evidence that bureaucratic structures are pretty much the same anywhere you go. Five aliens from various species are currently sitting around the table.

TAGACON REL: Okay, now that we're done with this, let's move on to the next item on the list. <pauses to read from tablet> Crap!

HOJ BO: What?! What's wrong?

QENN: No idea. My agenda only says Earth. What's an "earth"?

ELLYRIA: Isn't that a planet?

RIX: Yeah, quaint place, pre-contact civilization.

TAGACON REL: Not for much longer.

QENN: Which part? The quaint or the pre-contact?

TAGACON REL: The pre-contact. Probably the quaint as well.

RIX: Really? How come?

TAGACON REL: They will soon be launching a new

infrared space telescope called, <checks tablet> Nancy Grace Roman. This telescope will allow them to make better use of gravity microlensing to map exoplanets in the galaxy, and it will be equipped with a coronagraph to image exoplanets in reflected starlight.

QENN: So? That's not a qualification for First Contact. Wait, is it? Did they change things again?

ELLYRIA: No, everything's still the same. But I think I see where this is going.

RIX: Yeah, if they can study cold and temperate planets, it's only a matter of time before they find out they're not alone. At which point we'll have to contact them.

HOJ BO: What's the problem then? We do these contacts all the time. It's a spacewalk.

TAGACON REL: The problem is that Moxi's in charge of Earth's Contact.

QENN: Are you kidding me?! Why is he still in charge of Contacts?!

ELLYRIA: He's fast and thorough. I've never seen one of his teams make Contact with anything less than full knowledge about the planet and population.

QENN: True. But his smooth First Contacts are always followed by nothing but headaches for anyone who has to clean up after him.

HOJ BO: It can't be that bad. Sure, I heard he's a bit of a prankster but—

ELLYRIA: A bit of a prankster? The last planet he contacted, he told them that they were a long-lost colony of ours. The courts were tied up for weeks with claimants seeking restitution of ancestral "home planets."

RIX: And the one before that, he made it look like we had mistaken one of their popular fictional shows for reality, and patterned our whole society around it. It's still

impossible to go anywhere in their system without having someone issue you a Ponko Feud Challenge; whatever that is.

QENN: That's nothing, did you forget the time he told the local population that all their deities were actually aliens? The religious wars that that started wiped out most of the planet. I was sure he'd never get another Contact after that one.

TAGACON REL: Okay, settle everyone. I'm not happy with this either, but we're stuck with Moxi on this one. And I see that he's outside already waiting to come make his presentation.

TAGACON REL motions to Moxi through the window, signaling that he should come in. Which he does, carrying a medium-sized box.

MOXI: Hey everyone! How are you? I know you're all busy and I have some exciting plans for Earth, so I'll cut right to the chase.

QENN: Plans? Exciting plans?!? Moxi, First Contacts are supposed to be boring, and by-the-book. Can't you just do that for once?

MOXI: I could, but what's the fun in that?

Qenn tries to jump across the table to strangle Moxi but is restrained by Hoj Bo's tentacles and Ellyria's living hair.

MOXI: Wow, someone's in a mood today. Okay, here's what I propose. I did some extensive research but couldn't locate any records of Earth having ever been visited by any alien species. Many Earthlings are convinced otherwise, so

I say we go along with it and tell them that aliens have walked among them.

QENN: Alien deities again? After what happened last time? Are you insane?

MOXI: Deities? No, of course not. We've done that before, I like trying new things. I want us to do a variation on the fictional alien bit. This time, instead of aliens being inspired by their fiction, I want to tell them that some popular pieces of fiction are accounts of actual aliens.

TAGACON REL: <Sighs> Fine, Moxi. I know better than to waste time trying to change your mind. What do we have to do?

MOXI: It's nothing too complicated. I wrote everyone a Guide that I'll cast to you soon. But first...

Moxi reaches into the box and hands out a few props, keeping the last one to himself.

MOXI: Rel, you get this "laser sword". Don't worry, it doesn't really cut through things, it just produces a nice light when turned on. Hoj Bo, Earth's atmosphere is a bit toxic to your species so I had a containment suit made for you; it looks like the model you're holding.

HOJ BO: Looks a bit bulky. Does it have to be so...rectangular?

MOXI: I'm not the two-ton tentacled Plargh here. I needed to find something where you'd fit comfortably and still work with the theme. Just try to keep your answers short around them, got it?

HOJ BO: ...Yes.

MOXI: Great! Ellyria, your hair works perfectly for something I have in mind; we'll just have to change it's color to red. Congratulations, you get to be a queen.

ELLYRIA: Queen of what, exactly?

MOXI: You'll see. It will be fantastic!

RIX: What about me and Qenn? We didn't get anything.

MOXI: You don't need anything Rix, we'll just emphasize those lovely pointy ears of yours. <turning to Qenn> You're a quick healer, right? Okay, you don't need a prop either. Just remember to shout "THERE CAN BE ONLY ONE!" whenever it may seem appropriate. It will be good for a laugh. <pause> Come to think of it, maybe you should have a sword... No, wait, Rel already has a sword, let's make it an ax.

Qenn glares at Moxi, thinking of what he'd like to do once he gets that ax. Moxi doesn't notice, or doesn't care.

TAGACON REL: What about yourself, Moxi? What's that piece of cloth you're holding?

MOXI: Earthlings call this a "towel." Awfully useful thing. I'm just going to make sure to always know where my towel is, and go from there.

Obstacle

PAUL BOWDEN

I awoke to the ship's alarms.

Robbie loomed over my hibopod. "We have a situation, Dave. Microlensing has detected a Free Planet directly on our trajectory. We have dropped into realspace to investigate."

Later, after Robbie had served up stimulating beverages, I checked out the discovery.

"It's a big one..."

"Yes, Dave. A rocky planet, ejected from its star at about two hundred kiloyears ago, judging by its surface and near-surface temperature profiles."

"Only just yesterday, then..."

"Yes, Dave. Trajectory observations suggest it came from a G-type star only a few hundred light-hours away." The display showed a harsh yellowish star. Much bigger and brighter than our own mild red dwarf.

"Er... there's something else..." said the robot.

"Go on, Robbie... what is it?"

"There appear to be survivors. We have picked up radio signals. Video and audio..."

“Play them!” I almost shouted.

The video showed a peculiar creature, obviously talking. Robbie had already watched it, so was able to proffer a translation:

HELLO. THIS IS PLANET EARTH. WE ARE HUMANITY.
PLEASE HELP US!

First Don't Interfere

DENISE SUTTON

“This session of the Galactic Council is about to begin. Esteemed members, please take your places,” said Lareak, the scaly, blue-skinned moderator.

The twelve members of the council entered the room single file; each of them wearing a shiny silver hooded robes that hid their faces and all other distinguishable features. The identities of these high ranking judges had always been a secret to prevent outside influence or threats. ‘The 12,’ as they were more commonly known, were tasked with deliberating on all cases that occurred across the universe. This was one such case. The council pulled out their chairs and calmly sat down, taking their assigned positions around the semicircle platinum table. They were ready to begin.

Lareak addressed the two council guards who were standing by the entrance to the hall. Standing sixteen feet tall and nearly five thousand pounds each, the wolf-like creatures were the biggest brutes anyone could find in the known universe; that was a job requirement. Their sole task

was to keep the members safe and the meetings in order. “Please bring in the accused.”

The guards opened the heavy metal doors. In walked two new alien creatures. The only thing they had in common was their downcast heads and eyes, as dictated by protocol. They were each escorted to a different triangle marking on the floor facing the Galactic Council – like arrowheads pointing at their table.

“You have been called here,” Lareak continued, “because you have broken our pledge of non-interference. You each have been allotted five minutes to plead your cases before the council. Morvderck of planet Theta b-RS88 you will begin. Proceed.”

Morvderck lifted his head. “Your Excellencies, I have been stationed on planet Earth as an observer for my planet for the past fifty-seven years.” He turned to look at each of the 12, then continued. “It is my pleasure to serve and I do so with the utmost respect to the Code. When the humans launched the space telescope called ‘Hubble’ in 1989, my planet began to panic about what this might mean, but I respectfully monitored the situation closely as opposed to taking any immediate action.” Morvderck stood up a bit straighter, gazing into their cloaked faces. “We honor this great council and its principles. Our planet is obedient and faithful to a fault. However, our worry began to escalate when, in 1996, the humans started developing its eventual successor: the James Webb Space Telescope. This was initiated when they realized their window into the universe would be limited with ‘Hubble’ and so they tried to make massive improvements and upgrades to their original design. They wanted to see farther and deeper into the darkest corners of the galaxy than Hubble could provide.”

He paused to catch his breath, then started again.

“Hubble’s last recorded image was in 2016; of which they named GN-z11, about 32 billion light years away. James Webb will not only allow them to see farther away, it will also enable detailed studies of the atmospheres of transiting exoplanets, which will lead to them discovering the existence of our civilizations. My people don’t want to be discovered by the humans out of fear of what they might do to us. We are all well aware of how they treat each other; what would they do to true outsiders? Aliens like us? Truth is, in my time on Earth I have been researching this very question. What would they do? How would they act? I pored over every Earth-made document: written, audio, and visual. Any interaction with extraterrestrials was included in my analysis. In a majority of cases I found that they do not respond well to us. It is more likely that they exterminate or experiment than befriend or respect; so yes, I interfered.

“In 2018 I caused James Webb’s sunshield to tear while they were testing it. After that I also did what little I could to delay the launch further. I wanted to buy my planet more time. Time to prepare. Time to plan. Time to push for a safe outcome. We had a stroke of luck when the project’s launch was delayed further due to COVID-19 in March 2020. Great Council, I admit to meddling in Earth’s affairs. I know this goes against our beliefs, but I stand by what I have done. I want to keep my planet safe and until we are certain that the humans will treat us justly and with compassion, I see the launch of the James Webb Space Telescope as a major threat. Please heed my warning. This telescope will have the capability to determine which of our planets are inhabitable for them.”

Desperation flooded Morvderck’s voice. “You see, they seek a new home since their actions, which led to a global

warming, is destroying theirs. My people do not want invaders to conquer them and to destroy all that we hold dear. Thank you for hearing me. I am at your mercy.” Morvderck lowered his head, signaling the end of his testimony.

A council member beckoned Lareak and handed him a written message. Lareak accepted it with a bow then turned to face Morvderck. “Council Member Number 8 has instructed me to ask you the following: If your planet is discovered, do the humans possess the technology to travel there in haste?” Lareak put the message down and looked up at Morvderck. “You have forty-five seconds to reply.”

Morvderck raised his head. “No, their technology is nowhere near what is necessary to accomplish such a trip. But humans are resourceful and eager to achieve and advance. They may not have it now, but they will in time. How much time is hard to speculate.” Morvderck bowed his head back down.

The 12 nodded their heads then shifted their attention to the other defendant. Lareak declared, “Ropfliux of planet DeltaX-DM74. You may begin.”

“Thank you, Galactic Council, for the opportunity to explain. My planet has forever been a loyal adherent to our philosophy and methods. As you know I have been an observer on Earth for over 200 years. My mission was strictly one of observation only. However, in 1996, at the birth of the James Webb Space Telescope, there were rumors other alien races sought to destroy it. I knew they didn’t have the technology they needed to complete it but would in time. Then I heard of ‘delays’ and issues with ‘cost’ and assumed it was due to extraterrestrial interference.” He looked over at Morvderck. “It was not until this moment that I realized I acted prematurely. He interfered in 2018 as

did I in 2005 when I nudged the humans into redesigning the telescope. I thought I was setting them back on the original track they were meant to be on. I see now that my actions were unwarranted and may have even sped up humanity's progress. For this I apologize. My error is clear and I await your judgement and beg for mercy." Ropfliux lowered his head in shame.

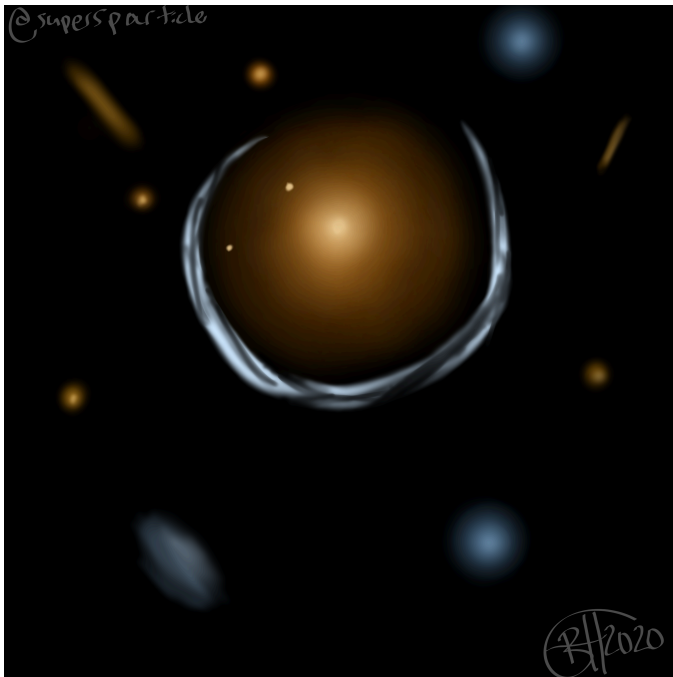
Lareak turned to the council and said, "So ends their testimony. It is now up to you, our Galactic Council, to deliberate and pass verdict."

The 12 sat still and quiet, statue-like. This was the norm. They had the special ability, bestowed on them upon induction into the council, of selective telepathy, which could only be used to converse with each other. No one else was privy to their discussions. After a few minutes Council Member 4 passed a message to Lareak. He took it and started to read it.

"At this, the Galactic Council's 73,011,613th meeting a decision has been made. I ask for acceptance, for so has decreed the Council." He cleared his throat. "The Galactic Council will take no action against the accused. Though wrongs were committed, no immediate harm to the involved parties or the universe as a whole has been found. The humans of Earth would have made their progress regardless of the outside help and sabotage bestowed on them. As of now we hold to our principal foundation of non-interference. You may return to your posts and continue to observe and report. Should matters escalate we will be ready to respond. Have faith that all will be well. So concludes this proceeding."

Gravitational Lensing

BRITTNEY HAUKE



Untitled

PAUL BOWDEN

Free-floating planet
Background star becomes donut
Microlensed event

About the Contributors

Bri McAllister is a recent graduate from University of Oregon. She is currently working in R&D, until the COVID-19 pandemic subsides, at which she wishes to return back to academia. She aspires to be a science communicator through different art mediums. Twitter handle is [@McallisterBri](https://twitter.com/McallisterBri) for other examples of her science communication work.

Her piece, 'Unveiling the Planet Population at Birth,' is inspired by James Rogers' panel abstract. *James Rogers (Imperial College London) Recent Kepler data has shown that the radius distribution of small, close-in exoplanets is bimodal. Such bimodality was expected from photoevaporation models of close-in super-Earths, where some planets are stripped of their primordial H/He atmospheres, whilst others retain them. We present a hierarchical inference model on the distribution of Kepler planets using the photoevaporation evolution model. This approach is used to place key constraints on the planetary distributions for core composition, core mass and initial envelope mass-fraction, as well as test other models of planet evolution such as core-powered mass-loss. This new information has interesting implications on planet*

formation models and also hints at additional atmospheric mass-loss mechanisms.

Laci Brock is a scientist, artist, and avid bird watcher residing in Tucson, Arizona. She is currently wrapping up her PhD in planetary sciences/astrophysics with a focus on clouds in substellar atmospheres. Laci loves to create artwork inspired by the cosmos and paints in all mediums (but loves oils and digital media the most). Follow her @stellararts on social media to see more of her work!

Brittney Hauke is currently a graduate student at Penn State University, pursuing a PhD in Materials Science. She received her Master's in Materials Science from Arizona State University and her BA in Physics and Studio Art from Coe College. Brittney is also a multimedia artist and has experience in throwing pottery, watercolor painting, traditional drawing, photography, and digital work.

'Gravitational Lensing' was inspired by Paul Bowden's untitled poem.

David DeGraff is an astronomer and science fiction writer who teaches at Alfred University in Alfred, New York. He can be found at DeGraffDavid.com and on twitter @DeGraffDavid. His fiction has (or will) appeared in Julie Czerneda's *Tales from the Wonderzone* series and *Carbide Tipped Pens: 17 Tales of Hard Science Fiction* and *Translunar Traveler's Lounge*.

'Survey of Three Habitable Zone Planets' was inspired by Kristin Sotzen's 'On the Taxonomy of Exoplanets Using Transmission Color Analysis' presentation abstract. *The majority of exoplanets found to date have been discovered via the transit method, and transmission and emission spectra represent*

the primary method of studying these distant worlds. Current methods of characterizing transiting exoplanets entail the use of spectrographs on large telescopes, requiring significant observation time to study each planet. However, Crow et al (2011) showed that color-color reflectance ratios can be used to broadly categorize solar system bodies, and Sing et al (2016) and Stevenson (2016) showed trends in hot Jupiter water abundances as a function of blue-optical vs NIR/MIR altitude differences and temperature/gravity respectively. Batalha et al (2018) also showed that it is possible to classify giant planets in color-color space using WFIRST-like filters for planets that do not have significant cloud coverage. Grenfell et al (2020) went on to show the utility of transmission depth differences for the filters of the PLANetary Transits and Oscillations of stars (PLATO) mission, showing that basic atmospheric types (primary and water-dominated) and the presence of sub-micron hazes could be distinguished for some planets. Building on these concepts, we are investigating the use of transmission color-color analysis for coarse categorization of exoplanets as well as assessing the nature and habitability of these worlds, with a focus on resolving the mass/radius degeneracy to aid in discriminating super-Earths and subNeptunes. We will present our results, including spectrum models, model comparison frameworks, and waveband selection criteria. This method could allow for broad characterization of a large number of planets much more efficiently than current methods permit. For example, a TESS follow-on mission could observe multiple band transits to identify exoplanets by category and to break degeneracies between planet size and density (e.g., rocky vs icy). Additionally, data collected via this method could inform followup observing time of large telescopes for more detailed study of worlds of interest. Finally, these data could be used to study planetary system structure for different types and ages of stars, with potentially

significant impact to our understanding of planetary system formation and evolution.

Fred Coppersmith's fiction has appeared in *Andromeda Spaceways*, *Every Day Fiction*, and *Stupefying Stories*, among others. He lives and writes in New York, where he also publishes the quarterly online SFF magazine *Kaleidotrope*. You can find him on Twitter at [@unrealfred](https://twitter.com/unrealfred).

'This World of Strange Design' was inspired by James Rogers' 'Unveiling the Planet Population at Birth' presentation abstract. *Recent Kepler data has shown that the radius distribution of small, close-in exoplanets is bimodal. Such bimodality was expected from photoevaporation models of close-in super-Earths, where some planets are stripped of their primordial H/He atmospheres, whilst others retain them. We present a hierarchical inference model on the distribution of Kepler planets using the photoevaporation evolution model. This approach is used to place key constraints on the planetary distributions for core composition, core mass and initial envelope mass-fraction, as well as test other models of planet evolution such as core-powered mass-loss. This new information has interesting implications on planet formation models and also hints at additional atmospheric mass-loss mechanisms.*

Daniel M. Bensen lives in Sofia, Bulgaria, where he teaches English and resides with his daughters, wife, and in-laws in the Balkan Tower of Matriarchy. He writes science fiction, alternate history, and fantasy such as *JUNCTION*, *First Knife*, and the Sidewise Award-winning *Treasure Fleet*. You can find him at <http://thekingdomsofevil.com/>

'Well, Boom' was inspired by William Misener's 'To Cool is to Keep: Residual H/He Atmospheres of Super-Earths

and sub-Neptunes' presentation abstract. *Current theory predicts that observed rocky super-Earths accreted large nebular hydrogen/helium envelopes before disk dispersal. These atmospheres have since been mostly lost through hydrodynamic outflows. Such super-Earth atmospheres may soon be observable, but their mass, composition, and redox state resulting from their evolution are largely unexplored, despite these processes' potential impact on habitability. I will present the observable outcomes of the evolution of super-Earths from their initial states since disk dispersal. Using theoretical models, I will demonstrate that loss of the primordial atmosphere can be incomplete, leading to a thin residual H/He envelope. The masses of these remnant atmospheres vary by orders of magnitude depending on the planet's mass and the flux it receives from its host star. Super-Earths finish mass loss with atmospheric masses ranging from 10^{-9} to 10^{-2} planet masses for typical parameters. I will discuss the implications of this residual hydrogen for subsequent secondary atmospheres, including their masses, composition, and observational signatures.*

Ann Marie Cody is a research astronomer working at NASA and the SETI Institute. Her professional interests lie at the intersection of star and planet formation. She uses space telescopes to monitor the variability of stars across the sky, in efforts to understand how brightness fluctuations can be translated into physical properties of the circumstellar environment. In her spare time, Ann Marie enjoys creating scientific cartoons and other artwork. She lives in Sunnyvale, California with her husband and their triplets. You can follow her on Instagram at [@annmariecody art](#). 'Coming Full Circle' was inspired by the Friday panel topics.

Raphael Sutton was born and raised in Sao Paulo, Brazil. He has loved science and science fiction for as long as he can remember and has fond childhood memories of waking up early on Saturday mornings to watch Carl Sagan's *Cosmos*. A lifelong love of reading, as well as finding himself surrounded by many talented writers, eventually lead to the desire to write stories of his own. He just had a story published earlier this year in *Brave New Girls*, a Science Fiction Young Adult Anthology series featuring teen girls with a knack for STEM, that raises money for the Society of Women Engineers scholarship fund. He currently lives in Brooklyn, New York, with his lovely wife and adorable children.

'Let's Make it Fun!' was inspired by Óscar Carrión-González's 'Roman: Direct-imaging in Reflected Starlight with NGRST: Detectability of Confirmed Exoplanets and Population Analysis' presentation abstract. *The Nancy Grace Roman Space Telescope (NGRST, formerly named WFIRST) will be the first mission to directly image exoplanets in reflected starlight. This will allow us to analyse cold and temperate exoplanets, which cannot be accessed by current facilities. So far, atmospheric characterization is achieved mainly through transit and occultation measurements, which biases these studies towards hot planets in close-in orbits. Direct-imaging observations of long-period planets in reflected starlight will increase our knowledge on the diversity of exoplanets and their atmospheres. This will also affect the theories explaining the formation and evolution of such planetary systems and their architectures. In this work, we studied the exoplanet detection yield of NGRST and future concepts such as LUVVOIR or HabEx. For that, we explored the NASA Exoplanet Archive and computed, for all confirmed exoplanets, a range of possible orbital solutions based on their Keplerian parameters and corresponding uncertainties. From that, we obtained the*

probability of detection and the observational configurations in each case. We analysed the particularities of this subset of detectable exoplanets in comparison with other populations such as the transiting planets. In addition, we discussed the possibilities of retrieving atmospheric properties from direct-imaging measurements of these exoplanets and identified the most favourable targets for such studies. Direct-imaging observations in reflected starlight are expected to be available in this decade. Here we conclude that NGRST will be able to detect a set of long-period exoplanets which is large enough to begin statistical studies of this population. This will help complete the big picture of exoplanet diversity. The coming years until this mission is launched should allow the community to define the most interesting targets to be observed and improve their orbital solutions.

Dr. Paul R. Bowden is a retired lecturer in computing at Nottingham Trent University, England, where he taught AI and Natural Language Processing, at both BSc and MSc level. His PhD was on automatic extraction of facts from text. Paul dabbles in short SF story writing, and is creating an AI-based chatbot as a hobby. He is a keen follower of everything exoplanet-related, and is delighted that the universe turns out to have trillions of exoplanets (probably)!

‘Obstacle’ was inspired by Samson Johnson’s ‘The Roman Galactic Exoplanet Survey: Predictions for the Free-Floating Planet Detection Rate’ presentation abstract. *The Nancy Grace Roman Space Telescope (Roman) will perform a Galactic Exoplanet Survey (RGES) to discover bound exoplanets with semi-major axes greater than 1 au using gravitational microlensing. Roman will even be sensitive to planetary mass objects that are not gravitationally bound to any host star. Such*

free-floating planetary mass objects (FFPs) will be detected as isolated microlensing events with timescales shorter than a few days. A measurement of the abundance and mass function of FFPs is a powerful diagnostic of the formation and evolution of planetary systems, as well as the physics of the formation of isolated objects via direct collapse. Roman will be sensitive to FFP lenses that have masses from that of Mars (0.1 M_{Earth}) to gas giants (roughly greater than 100 M_{Earth}) as isolated lensing events with timescales from a few hours to several tens of days, respectively. The number of detections will depend on the abundance of such FFPs as a function of mass, which is at present poorly constrained. Assuming that FFPs follow the fiducial mass function of cold, bound planets adapted from Cassan et al. 2012, we estimate that Roman will detect ~250 FFPs with masses down to that of Mars (including ~60 with masses < 1M_{Earth}). Roman will improve the upper limits on FFP populations by at least an order of magnitude compared to currently-existing constraints.

Denise Sutton lives in Brooklyn, New York, with her husband and their four sons. She graduated top ten of her class from Long Island University with a doctorate in Pharmacy. She loves serving her community alongside her parents as a pharmacist, but spends much of her time these days raising her 5-year-old twins, 3-year-old toddler, and 6-month-old baby. Denise moonlights as a birthday party entertainer, possessing a natural born talent for comedy and making children smile. Earlier this year she had short stories published in *Bad Ass Moms* from Crazy 8 Press and in *Brave New Girls*, a young adult science fiction anthology about teen girls with a knack for science, tech, engineering, and math.

‘First Don’t Interfere’ was inspired by Knicole Colon’s ‘Atmospheric Characterization of Exoplanet Populations

with the James Webb Space Telescope' presentation abstract. *The number of known exoplanets has skyrocketed over the past decade, thanks in large part to the Kepler and K2 missions and the Transiting Exoplanet Survey Satellite (TESS). From these missions, thousands of exoplanets and candidates have been discovered and distinct populations of exoplanets have emerged. One key way to understand different populations of exoplanets is to investigate the atmospheric properties of exoplanets, since the atmospheric composition of an exoplanet provides insight into its formation pathway. The James Webb Space Telescope (JWST), which is slated to launch in 2021, will offer unprecedented sensitivity enabling detailed studies of the atmospheres of transiting exoplanets in particular. In this presentation, I will provide an overview of JWST, including its current status, its capabilities for transiting exoplanet observations, and details about the goals, targets, and timelines of the Early Release Science (ERS) and Guaranteed Time Observations (GTO) transiting exoplanet programs. The ERS and GTO targets notably span a wide range of planet masses and temperatures, allowing us to explore a large parameter space and investigate how atmospheric properties correlate with other planet or stellar properties. Additional General Observer (GO) targets from the community will augment the ERS and GTO programs to provide an even more diverse population of exoplanets to study as well as additional opportunities for comparative exoplanetology. All together, we can expect to make significant progress in our understanding of the atmospheres of exoplanets and the formation pathways of different populations of exoplanets in the era of JWST.*