HEAVY METAL JUPITERS

No. 4 – Thursday

edited by Heather Clitheroe and Jessie L. Christiansen

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Amy Lewanski, Phoebe Barton, Matt Cahill, Mark Vandersluis, Derek Tyler Attico, Andrea M. Pawley, Anastasia Klimchynskaya, Bri McAllister, Erin Anderson, and Ann Marie Cody

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Flight Commander Zhang made the first step onto the doomed world. She didn't have any speech, no "one small step" or "I do this in the name of," and I kept my mouth shut, too. Anything else would've felt disrespectful.

"What's this, your fifth?" I took a good look around once I left the lander. We'd come down in a shadowed crater, but I could see where the mountains around its edges had run like butter after too many passes near its hungry sun. "Sixth?"

"Eighth." Zhang kneeled and scooped up a fistful of regolith. Harsh, sharp stuff. The kind you expect to last forever. "But this is your first. What do you think?"

I thought a lot of things. How can a whole world be eaten, and so quickly? The latest numbers gave the planet a hundred years, plus or minus ten , before it fell into that stellar furnace. Would anyone else ever come here? Would ours be the only footprints it ever knew?

"I think it's not a great real estate investment." I bent to touch the surface, here in a nameless crater on a nameless world. The coldness surged through my glove. "A little

depressing. Is that why you asked me to come down? For some perspective?"

"They're never the same, you know, but they're all missing something." Zhang kneeled once more, dug a shallow hole with two fingers, and wedged a transparent canister into the regolith. It was half-full of what looked like yellow dust. "Lycopodium powder. Great for pyrotechnics. Very theatrical. I've left one on all eight of those doomed planets now. I like to imagine that moment, just before the sun eats them, when the conditions are just right and all that dust goes up in flames."

"Why?" Zhang couldn't see my eyes, but my disbelief was loud.

"So that the world knows someone cared," Zhang said. "There's so much cold and dead out here. It's up to us to be warm, and to care."

I traced a line in the regolith. Maybe the only straight line the world would ever know. There was no reason it wouldn't last until the end.

"Then I'm going to call it Inevitable," I said. "The planet. Doesn't matter if anyone else does. I'll know what it means."

"We both will," Zhang said.

She watched as I scratched the word into the regolith with a fingertip. Sure, the crater would never have a name, and neither would the melted mountains that ringed it. Now it had an identity, if only for Zhang and I.

"I never named any of mine," Zhang said. "It didn't feel right, considering."

"Then this'll be what I do," I said. "If I ever visit another one. We all have our little rituals."

"Oh, probably," Zhang said. "There are so many of them out there. So many that no one will ever see."

I dug a canister of my own into Inevitable's regolith and filled it with loose rocks. There would be more samples taken for research purposes, of course, but this one was different. This would be a reminder, a memory, before it fell into the endless daylight.

Not everything would be engulfed. Some of Inevitable would continue on.

A View From The Conference

Mark Vandersluis

"And so," the speaker concluded, "we have successfully developed a Bayesian statistical framework to assess the robustness of such observed correlations, and we see that the results very strongly favour a relationship between intelligent life and the age of the system. Once the age of the system exceeds about 5 billion years, there are unlikely to be signs of intelligent life. So I recommend an immediate observation campaign of the stars in our vicinity that fall into this younger age category, including even the previously ignored Type G2 star systems. Maybe at this moment, there is a conference underway on a planet orbiting one of those stars, discussing the possibility of habitable planets – or even intelligent life – around other star systems. But at 10 billion years old, our system is the exception rather than the rule, and they are unlikely to be looking in our direction".

There was a polite smattering of applause, but most of the audience revealed their skepticism by turning bright

blue as they flew off their perches and out of the auditorium, for refreshments and snacks in the foyer.

Top Six Discarded Reasons to Explain the Lack of Known Planets in the Radius Valley

Andrea M. Pawley

1. No room for planets because that's where all the dark matter is.
2. Planets 1.8x the radius of Earth are statistically less likely than other planets to return planet survey responses before the deadline.
3. Rampant NIMUism (Not-In-My-Universe-ism).
4. The Moon's super-publicist, who also represents the Coalition of Sub-Neptunes and the Federation for the Advancement of Super-Earths, is not accepting any new clients, including those from the Radius Valley.
5. Planets 1.8x the radius of Earth are perfectly sized to fit into the mouths of Pac-Man stars.

6. The Intergalactic Astronomical Union probably already declared anything 1.8x the radius of Earth not to be a planet.

Exoplanet collaboration

Anastasia Klimchynskaya

We know this to be true: life finds a way. And so we search for life.

On earth, *it* lives beneath frozen wastelands, temperatures akin to the surface of Mars, the scientists say. Bacteria breathe without oxygen, and *something* lives on ocean floor, in impenetrable darkness, weighed down by a dozen atmospheres.

And then there is that most marvelous life, humans, who build our homes come hell or high water – literally: in the paths of hurricanes and in deserts, at temperatures halfway to boiling half a hundred degrees below zero.

We know life finds a way, and we know this to be true, too: we humans are proof. We survive.

But we are also human: when we look for life, we look for life like *us.* So is it any surprise, then, that with each new pair of reflecting and refracting eyes, every time our gaze sharpens and we look further, we look for it in the hardiest environments? In the systems lit by the blazing light of a thousand (of our) suns? Red giants that burn bigger and brighter than our sun, and yet, with each new

pair of we look for something that looks like us: something that survives.

Hot Young White Dwarfs

Matt Cahill

When Dougie Banks booked The Hot Young White Dwarfs for his club, he was naturally expecting an explosive act that would draw the curious and deranged. Deranged, because when he heard the EP their manager sent it sounded like nothing else he'd heard before. Loud, yes. Dissonant, sure. But there was heat. Is that something you feel from music, he asked himself after listening to their songs for the fourth time. Is heat a *thing*? And so he figured the kids who were into punk or goth, or – he stretched his imagination – experimental Montreal bands, would get it. Dougie was 44, and he'd stopped listening to new music twenty years earlier. He didn't get any payment from doing this; the owner of the club was his cousin, and his occupation, if it could be called that, as talent booker was, among other things, a way to pay off a loan he got from his uncle in order to buy a '64 El Camino, the love of his life.

So, naturally, he booked them on a Tuesday night. *Sink or swim*, he thought.

When they came on stage (there was no sound check because sound checks require scheduling) he saw how

withdrawn and pensive they were. It looked as if they would've preferred playing their instruments while lying on the stage, save for the lead singer who – as if his red hair and torn tank-top wasn't enough – stood at the front and fist-pumped the sky as if they were playing Coachella, or, like, The Horseshoe or something.

What was most odd for Dougie wasn't that neither of them were particularly short, but that when they finished their set there was no applause. It was the weirdest thing. No *woots* no *yeeeaahs,* no screams for more, *encore!* etc. Instead, the crowd – a motley bunch made up of various ages and walks of life – retreated to their tables and conversed. Normally, the PA system would play something off Dougie's iPhone while the sweaty post-concert crowd finished their beers and shuffled out onto the street to do whatever people who went to concerts did. He was never sure.

Conversed, he thought, as if it were the worst possible outcome. As if none of them had paid a cover, or tipped the bartenders. Who the hell *converses* after a rock…or, you know, whatever sorta concert that was. With guitars and stuff. Conversed! And so Dougie Banks put down his (gratis) pint of beer and strolled through the floor, pretending to bus tables, hoping to figure out what the nature of all this "conversation" was. And as he brought two stacks of empty pint glasses back to the bar, he noticed there were no coasters remaining on the tables. He looked around and noticed that there were no coasters because people were pocketing them. *Is that a thing, too,* he thought? Collecting thick paper discs? A souvenir, he wondered. Or just debris?

"Hey! What are the people who keep…cultural…things?" he asked Cindi, the bartender.

"You mean *who*?"

"Yeah."

"Do you mean anthropol–"

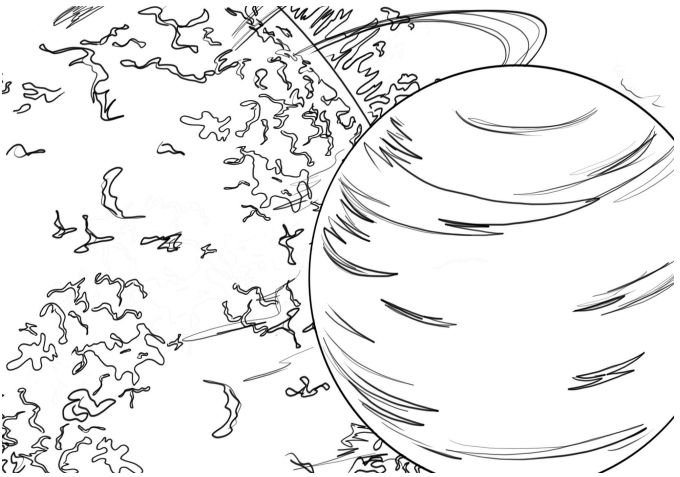
"Collectors!" he exclaimed.

And what strange, strange people they were to Dougie's eyes. Collecting artefacts after a concert. Conversing. Drawing conclusions, he surmised.

Later that night, driving to his mother's house in his El Camino, he realized two things further. First, he'd forgotten to pay the band. Two, they'd disappeared.

Neptune's Fall

Erin Anderson



Neptune's Fall

Amy Lewanski

She loved the star. The star was small and hot and bright and reached for her with arms of streaming flame, wanting to touch her.

She knew the star loved her too, even though she could see the scars of the other asteroids and little planets as the star ate them up. She could see where each small object was pulled into the heat of the dwarf star. The deep pull between them grew stronger each day, and wisps of her atmosphere feathered away, and the star ate it hungrily asking for more. Her core ached to meet the longing grasp of the star, too.

The little asteroids zipped and zoomed inextricably towards her star and – a small *poof* – vaporized, and the star sucked them in and scarred her surface. She wants to soothe those scarred lines on her star's sides. The star keeps getting hotter and pulling Neptune toward her, and she lets the star siphon off more of her atmosphere. The star deserves it. Her sun deserves it.

There is nothing left around her. Just some space dust dancing around her gaseous body. And something shifted

inside the star. It was hotter somehow, now. Her atmosphere streams away. Her beloved star brightens and fills her sight, and her heart expands for what feels like forever. Neptune loved her star. She fell apart for her star. Her core burst open and scattered through the space between where she had existed and her star, and that dear hot white dwarf took in every atom of her gaseous self until she remained no more except for a streak against the star's side.

Hey There Gas Giant

A parody song

Amy Lewanski

Hey there gas giant
What's it like in far off space
I'm a million miles away but girl
Tonight you look like chaos
Yes you do
White dwarf stars are as bright as you
I swear it's true

Hey there gas giant
Don't you worry bout the distance
There's a dwarf star nearby hungry
Give these words another read
Dwarf star feeds
On asteroids and planets small
It's your turn now

Oh hungry white dwarf star
Oh hungry white dwarf star

Oh hungry white dwarf star
Oh hungry white dwarf star
White dwarf hungers more
    Hey there gas giant
I know you are vapor now
But future aliens
Will see you in the star's surface
They'll learn and grow
They'll find out all about your life
You'll help them all
    Hey there gas giant
I've got so much left to research
If all science was on your reach
Astronomers would know more and more
Even more knowledge we will have
We'll learn it all

    Oh hungry white dwarf star
Oh hungry white dwarf star
Oh hungry white dwarf star
Oh hungry white dwarf star

    A million miles seems pretty far
But white dwarf stars can eat you up
You'll be my favorite curiosity
For years aliens will study us
And we'll provide data all along
No other star will feed on you
Gas giant, i will be with you
For megayears to come and
The dwarf star will never ever be the same
You're the cause

Hey there gas giant
You be good and don't you worry
Megayears from now we will meet up
And you'll be making history in a star
They'll know it's changed because of you
We'll study your atmosphere
Hey there gas giant here's to you
This star is yours

Oh hungry white dwarf star
Oh hungry white dwarf star
Oh hungry white dwarf star
Oh hungry white dwarf star
It's hungry for you

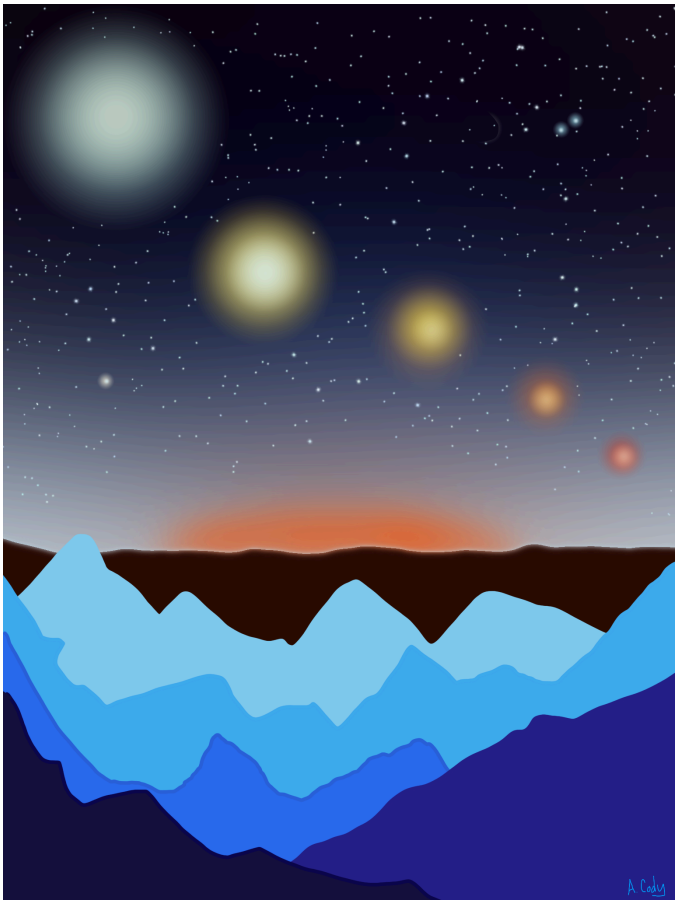
A Host of Hosts

Ann Marie Cody

The dwarfs are up,
The giant has set.
Planets around BDs?
Place your bet.
  Circumbinaries,
Microlensers,
Disks of debris.
  Which of the host stars
Is the weirdest one yet?

A Host of Hosts

Ann Marie Cody



Where the Heart Is

Derek Tyler Attico

Commander Joseph Martinez tightened the straps securing himself into the co-pilot's seat as he watched the stars streak by the cockpit's transparent titanium window. Even through the ship's hull, and his spacesuit, he could feel the vibrations of their velocity.

They were almost home.

It was strange to think of a place you've never been to as home, but that's what Proxima Centauri b was. The exoplanet was the game changing next step, and new beginning humanity needed. It had taken mankind an eternity to go from discovering fire to developing wide scale renewable energy. The United Earthship *Adventure* and the ninety-eight astronauts in stasis were the opportunity to get things right from the start.

Commander Martinez glanced over at *Adventure*'s pilot. At twenty-five Akasha Anand was one of the youngest NASA astronauts. She still looked like a kid, but was a *wunderkind* behind the stick. "Standby, begin deceleration sequence on my mark, three, two, one…mark."

"Copy that, skipper." Akasha Anand smiled to herself.

The commander's graying temples, grey eyes, easy demeanor and constant professionalism reminded her of her father. In the old days, deceleration would mean using liquid fuel to slow down, but today a tap of her finger on the avionics console would suffice. *Adventure* was unlike any spaceship in human history, and the first to vertically take off from launch pad 39a at the Cape.

All because of its Direct Fusion Drive.

The delta-shaped vessel used nuclear power to propel itself at near the speed of light, so vertical take offs and landings were a breeze. Piloting *Adventure* was like steering a bullet – after it'd been fired. It was the ship's speed that finally made a manned mission light years away to the closest Earth-like planet outside of our solar system possible. One hundred astronauts, with two rotating in and out of stasis every six months, while the other ninety-eight slept. And now, here they were, six years later about to explore a world forty trillion miles from Earth. Akasha tapped the deceleration sequence on her engine command board and watched the program commence.

But nothing happened. *Adventure* wasn't slowing down.

Martinez shot a look over to Anand, the concern on his face mirrored her own. The commander unconsciously looked up as he spoke. "IAN, we're seeing a false positive on the deceleration sequence. Stop it, and assist us with manual deceleration please."

After a half second the ship's Intelligent Artificial Node spoke. "According to my systems, deceleration sequence has commenced and cannot be stopped mid process. Time to complete: one minute, seventeen seconds."

Anand knew at the speed the *Adventure* was travelling, one minute and seventeen seconds was an eternity. "We're gonna overshoot."

The Commander worked the console in front of him as he spoke. "Looks like a burned out sensor package. That's why IAN can't see it. No time to replace it." Martinez tapped more commands into the console as schematics appeared on his screen. "If I reboot avionics, *Adventure* will default to manual but…" The commander looked up, making sure he made eye contact with his pilot. "You'll be flying without computer assist."

Anand knew flying at near lightspeed without a computer was unthinkable. In the time it would take her to shut down the drive, anything could happen. She gripped the flight stick. "Understood."

Martinez keyed in the system reboot. What was happening had never been tried – not even in a simulation. And they were so far from Mission Control now that communication took nearly a year to reach Earth. *Adventure* could only do now what NASA did best in a crisis.

Improvise.

The commander's finger hesitated over the last key as he said a silent prayer. "Shutting down…now."

The avionics screens darkened and the computer-controlled flight stick went slack, like the reins of a bronco that had been set free. *Adventure* listed to port and the streaming stars around her arced and swayed in a kaleidoscope of light. Anand griped the flight control stick with both hands as she gritted through clenched teeth, "Damnit, come on girl!"

The structure of *Adventure* groaned from the stress as the ship began to level out. Anand tried to take the edge out of her voice as she spoke to her commanding officer. "Decelerating!"

The young woman pulled back on the throttle, manually

easing *Adventure* to sub-light speed, the streams of stars shortened, abbreviated once again into points of light.

And then everything outside of the ship went dark.

Akasha leaned forward as she peered out the canopy. "Where are we? If I didn't know we were in space, I'd say we'd flown into some kind of cloud…or a sandstorm?"

Something about that description felt familiar to the commander, but he couldn't think about that now. "Avionics rebooting. Forty-five seconds to full system restoration."

Anand was going to make a comment about her flying when something bright caught her eye through the haze outside. "Wait…is that? Are those…?"

Martinez looked to where his pilot was pointing and answered the question. Even through the haze of whatever they were in, it was clear what was shining through. "Binary stars, and look over there."

Now the pilot followed where the commander was pointing to two more points of light in the distance. "Binary stars…we're in a double binary system?"

Suddenly, *Adventure* lurched forward.

Anand eyed the still dark avionics console. Even without instrumentation, there was no mistaking what she felt. "We're moving?"

As the United Earth ship moved seemingly of its own volition through the haze into a clearing, the two astronauts understood why. The largest spaceship ever constructed was a speck against what it was now in front of.

An exoplanet.

The sphere filled *Adventure's* windows, it was a collage of brown continents and blue oceans – its beauty only interrupted by the swirls and puffs of white clouds.

Akasha whispered. "That's not Proxima b. It's got to be at least five times the size of Earth."

Recognition washed over the commander's face as he pictured the image of this exoplanet inside a vast circular disk of dust with binary stars in its center. "Now it makes sense. We're in the debris disk of this system's central binaries."

Adventure began to pick up speed as it raced towards the exoplanet.

Anand flipped four switches on the console. "Not for long. We're in the gravity well of this super-Earth. Manually extending all flaps and drag fins. We're going in!"

The commander eyed his console. "Fifteen seconds to avionics!"

Anand was shaking her head and gripped the flight stick with both hands as the windows started to flare with the heat of reentry. *Adventure* began to shudder. "That's too long. She's gonna tear apart. I'm angling our descent!"

As the triangular spaceship pierced the atmosphere, a cocoon of heat and flame surrounded the vessel, and a fireball streaked across the sky. The superstructure of *Adventure* groaned and Akasha screamed to be heard over the chaos. "We're coming in too hot. I can't hold it!"

Martinez could feel the g-forces of reentry as his chest tightened and vision began to darken. He knew the spacesuits he and Anand wore were trying to compensate, but it wouldn't be long before both of them passed out.

The avionics snapped on.

The commander's eyes widened as the screen came back to life, he began working the console immediately. "Firing reentry thrusters!"

Anand could feel *Adventure* begin to slow, but the ground was still rushing towards them. The pilot knew the landing

she was attempting would be a catastrophe, there was only one choice. "Activating emergency VTOL!"

At the flip of a switch, *Adventure's* vertical take off and landing system activated, and the ship hummed with power. Like a falling rock caught at the last moment, *Adventure* leveled off, stopped, and landed with the grace of an autumn leaf.

After a moment of silence, the Intelligent Artificial Node spoke. "Thank you for initiating emergency systems, Akasha. Multiple superstructure fractures detected throughout the ship. Navigational sensors has detected this is not Proxima b in the Alpha Centauri system. There is a high probability this is system HD98800, one hundred and fifty light years from Earth. Have the mission parameters changed?

Commander Martinez checked the status of the stasis chambers and smiled as the board read green, with no injuries. "No IAN, we just had to improvise."

About the contributors

Cathrin Machin is one of Australia's fastest growing contemporary artists, with a reputation for boldly engaging the primal questions covering the basis of reality and existence. Born in Newcastle-Under-Lyme, England in 1986 – the youngest child of an inventive hard-working couple who ran a small clothing business attached to the family home. From an early age, Cathrin spent countless hours contemplating the stars and watching science documentaries, leading to a life-long obsession with science, reality, and the depths of space.

After studying mechanical engineering at Loughborough University, England, she embarked on a decade-long career in the video-game industry, culminating in her leading a project that won "Best Australian Video Game 2015" in the IGN Black beta awards. Shortly after she chose to follow her ambitions to become an artist. Having started painting in 2016, she has gone on to host a solo gallery exhibition in Sydney Australia, has hosted the highest crowd-funded painting project in the world, and holds the record as Australia's highest crowd-funded artist of all time. This has allowed her to develop a

huge client list that stretches to every corner of the globe and includes several prolific scientists, science communicators, and chief officers from top fortune 500 companies.

Always starting from a black canvas, the artwork uses prime coloured oil paint and phosphorescent pigments in bold gestural strokes combined with subtle smooth gradients that explore a sense of flow, density, and luminosity. They allow the viewer to contemplate the sheer scale of the universe and how we as individuals fit within it. Ultimately, Machin's work strives to ask the biggest questions one can – "Why are we here, where did we come from, and what does it mean?" In addition to her abstract space forms, she works with several astrophotographers and compiles images that are then painted to represent real outer space phenomena.

Cathrin's artwork is featured on the cover of each of the 'Heavy Metal Jupiters' zines.

Phoebe Barton is a queer trans science fiction writer. Her short fiction has appeared in venues such as Analog Science Fiction and Fact, On Spec, and Kaleidotrope, and she is writing the interactive fiction game The Luminous Underground for Choice of Games. She is a 2019 graduate of the Clarion West Writers Workshop and lives with a robot in the sky above Toronto. Connect with her on Twitter at @aphoebebarton or at www.phoebebartonsf.com.

'Little Rituals' was inspired by Aida Behmard's 'How Common is Planet Engulfment?' presentation abstract. *Dynamical evolution can cause planets to be engulfed by their host stars. Following engulfment, the stellar photosphere abundance pattern will reflect accretion of rocky material that composes*

planetary cores by exhibiting refractory enhancements in order of condensation temperature. Multi-star systems are excellent environments to search for such abundance trends because these stars share the same natal gas cloud and primordial chemical compositions to within 0.05 dex. Thus, refractory differences above 0.05 dex that trend with condensation temperature between stellar companions constitute a signpost of planet engulfment. Such observations have been carried out for a few systems, and have occasionally yielded robust engulfment signatures, e.g., Kronos and Krios (Oh et al. 2018), but only a handful targeted systems with known planets. We aim to augment this sample by carrying out a survey using Keck-HIRES of 40 multi-star systems where one star is known to host a planet. The sample of planets hosted by these systems is diverse and includes hot Jupiters, close-in multi-planet systems, and gas giants at a range of orbital periods. Using the Spectroscopy Made Easy tool, we have obtained abundance patterns for each system that can be assessed for possible engulfment signatures. We will present preliminary results from this survey, which will ultimately be used to constrain the prevalence of planet engulfment, examine its role in shaping current planetary system architectures, and investigate possible engulfment-related patterns in stellar and planetary properties.

Mark Vandersluis works as a Senior IT Manager for a Cable and Internet company in England. With a lifelong interest in all things Science and Technology, his SF has previously been published in Nature Futures.

'A View from the Conference' was inspired by Emily Safsten's 'Nature vs. Nurture: A Bayesian Framework for Assessing Apparent Correlations Between Planetary Orbital Properties and Stellar Ages' presentation abstract. *As more data on exoplanets have been collected, some apparent correlations between planetary and stellar properties have started*

to emerge. However, the true nature of such correlations is often unclear as stellar properties are often interrelated. In particular, it is unresolved whether these correlations are due to the age of the system — pointing to evolution over time being an important factor — or other parameters to which the age may be related, such as stellar mass or stellar temperature. The situation is complicated further by the possibilities of selection biases, small number statistics, uncertainties in stellar age, and orbital evolution timescales that are typically much shorter than the range of observed ages. Here we develop a Bayesian statistical framework to assess the robustness of such observed correlations and to determine whether they are indeed due to evolutionary processes, are more likely to reflect different formation scenarios, or are merely coincidental. We apply this framework to the case of 2:1 resonances, where it has been proposed that systems with 2:1 resonances tend to be younger than those without, and find nearly equal support for the hypothesis of a correlation with age as for the hypothesis that the apparent trend is coincidental. We also apply this framework to the question of whether stellar obliquities are more correlated with age, more correlated with temperature, or are not related to system properties. The results very strongly favor a relation with temperature, i.e., hot stars have high obliquities and cool stars are aligned with their planetary orbits, which corroborates prior work. Finally, we examine whether the currently available hot Jupiter data truly display a trend of eccentricity due to age, and indeed find very strong support for the hypothesis that the set of known hot Jupiters shows the circularization of orbital eccentricities over time.

Andrea M. Pawley lives and writes in Washington D.C., which exists in its own spacetime continuum. She's on twitter @andreapawley and blogs at www.andreapawley.com.

'Top Six Discarded Reasons to Explain the Lack of Known Planets in the Radius Valley' was inspired by Rachel Fernandes' 'Unearthing the Earths: Using TESS and Kepler to Reveal the Primordial Population of ShortPeriod Planets' presentation abstract. *Over the past decade, the Kepler mission was instrumental in the discovery of thousands of Gyr-old exoplanets. A large number of these are short-period planets, most of whose orbits are closer in to their host star than Mercury is to our Sun, whereas only one Earth-size planet has been found in the habitable zone of a solar analogue. Prominent features in this Gyr-old population of short-period planets suggest that planets have evolved with time and that the population of small (<1.8 Rearth) short-period planets, which is extrapolated to the habitable zone to estimate the frequency of habitable zone Earth-size planets (hereafter EtaEarth), is contaminated by the bare cores of once subNeptune planets. This begs the question: What was the primordial population of short-period planets and how did it evolve with time? One way to answer this question and quantify the contamination of once sub-Neptune planets to EtaEarth is by measuring the occurrence of these planets in young clusters (~10-500 Myr), before their envelope is stripped away. We will discuss our ongoing effort to discover primordial sub-Neptunes in young (<500 Myr) clusters using TESS FFIs and preliminary results on an improved EtaEarth. Our investigation will provide unique constraints to planet formation models, clarify how planetary atmospheres and radii evolve with time, and lend a more reliable EtaEarth estimate – a key parameter to evaluate the yield of nearby Earth analogs that can be detected and characterized by future missions.*

Anastasia Klimchynskaya is a postdoctoral fellow at the Stevanovich Institute on the Formation of Knowledge at the University of Chicago. Her current book project focuses

on the emergence of science fiction in the nineteenth century, arguing that *Frankenstein* and the works of Edgar Allan Poe, Jules Verne, Albert Robida, and H.G. Wells represent the formal expression of a new set of paradigms through which humanity saw the world following the Industrial Revolution. She has presented widely on science fiction and the history of science at Science in Public, City Tech Science Fiction Symposium, the Science History Institute in Philadelphia, the Cyberpunk Culture Conference, and the Philadelphia Science Fiction Conference (Philcon), of which she is also the deputy programming head. She has been published in the *SFRA Review* and *Social Anthropology*.

'Exoplanet collaboration' was inspired by Samuel Grunblatt's 'Planetary Archaeology: Exploring the Planet Population of Evolved Stars with TESS' presentation abstract. *Most planet searches to date have focused largely on solar-like stars. However, with the advent of large all-sky surveys like TESS and Gaia, comprehensive planet searches are extending from the often targeted FGK and M dwarf stars to more extreme stellar hosts, such as red giants. The long, eventful lives of these systems gives us unique insights into the inflation, evolution and longevity of planets, and the intrinsic brightness of giant stars allows us to robustly characterize planet demographics on larger scales within our Galaxy. Previous studies with Kepler and K2 have revealed that these systems do exist, but our knowledge about them has been seriously limited by the paucity of targets. This issue has now been resolved thanks to the abundance of full frame image data from TESS. Here, I will present the newest discoveries of planets and planet candidates orbiting evolved stars with data from TESS and Gaia. Through a combination of ground- and space-based observation, we are using these systems to test theories of planet inflation and engulfment, explore giant planet*

occurrence as a function of stellar mass, and investigate properties of planet populations on kiloparsec scales for the first time.

Matt Cahill is a Toronto writer whose debut novel, *The Society of Experience*, was picked as a must-read by Harper's Bazaar magazine. His short stories have appeared with Found Press, The Rusty Toque, The Quarantine Review, and Fusion Fragment (forthcoming). He has contributed essays to Ryeberg, Torontoist, and the Humber Literary Review. His essay *On Madness Within Imagination* was included in Best Canadian Essays 2017. He has a private practice as a psychotherapist.

'Hot Young White Dwarfs' is inspired by Erik Dennihy's 'Observations of Post-Main-Sequence Planetary Debris Disks' presentation abstract. *Frequently detected across a wide range of stellar classes, debris disks provide more than just a snapshot of the stages of planetary formation. Features such as gaps, rings, and the ongoing evolution that these disks exhibit shine light on complex, hierarchical planetary systems that will someday become difficult to observe once the planetary system is formed. Beyond the main-sequence, a different kind of debris disk around stellar remnants can likewise provide insight into planetary systems that escape direct detection, but in this case through a process of planetary destruction as opposed to planetary formation. In this review talk, I will discuss the state of observations of debris disks around white dwarf stars, remnant of solar-type stars with circumstellar disks populated by the remnants of now unstable planetary systems. This class of debris disks offers an independent view of the frequency of hierarchical planetary formation, and observations of variability on timescales of hours, days, and years inform the same physical process that govern the evolution of their main-sequence counterparts.*

Erin Anderson is an author, illustrator, and compulsive tea drinker. After studying marine biology and scientific communication in college, Erin started her own illustration business and has illustrated several monster manuals. Since then, she has signed on with Chandra publishing as an author and Director of Communications. When she isn't working on art commissions, writing scifi novels, or running her own webcomic Erin also plays Dungeons & Dragons on the marine science podcast Dugongs & Seadragons. You can see her work on her Twitter at @ErintheZ or at ErinZAndersonIllustration.com.

'Neptune's Fall' was inspired by Amy Lewanski's story of the same title.

Amy Lewanski was raised on classic sci-fi and fantasy literature. She holds an MFA in creative writing from Antioch University and is a San Diego, California transplant from Calgary, Canada. When she's not at her day job, Amy is either at the gym or writing. Her work can be found in 47-16: Short Fiction and Poetry Inspired by David Bowie," Crazy 8 Press' anthologies "They Keep Killing Glenn" and "Thrilling Adventure Yarns" and "Brave New Girls: Adventures of Gals and Gizmos." Connect with Amy on Twitter @amywroteit.

'Neptune's Fall' and 'Hey There Gas Giant' were inspired by Matthias Schrieber's 'Cold Gas Giant Planets Evaporated by Hot White Dwarf' presentation abstract. *All known exo-planet host stars will eventually evolve into white dwarfs, their burnt-out cores left behind after the end of the fusion of hydrogen and helium. It is observationally well established that many white dwarfs are accreting small planetary bodies, including asteroids and comets. Gravitationally scattering such planetesimals*

towards the white dwarf requires the presence of more massive bodies, yet no planet has so far been detected at a white dwarf. We have discovered a moderately hot white dwarf that is accreting from a circumstellar gaseous disc composed of hydrogen, oxygen, and sulfur. The composition of the disc is unlike all previously detected gaseous disks around white dwarfs but resembles predictions for deeper atmospheric layers of icy gas giants, with H2O and H2S being major constituents. We therefore suggest that a gas giant orbiting the white dwarf with a semi-major axis of approximately 15 solar radii is evaporated by the strong extreme-ultraviolet irradiation from the white dwarf. This discovery represents the so far clearest evidence for the expected existence of gas giant planets around white dwarfs and was recently published in Nature. We extend on this result by calculating the orbital separation at which gas giant planets will be evaporated by hot white dwarfs. We find that the hottest white dwarfs (60.000-100.000K) are bright enough at EUV wavelengths to generate hydrodynamic escape in gas giants located at separations up to 100 au. Even somewhat cooler white dwarfs may still evaporate giant planets at separations of 10-30 au. A fraction of the evaporated material will be accreted by the white dwarf and generate detectable absorption features. Hot white dwarfs can therefore be used to constrain the fraction of gas giant planets around white dwarfs and their progenitor stars. We find that the observed volatile accretion onto hot white dwarfs can be fully explained if at least 50 per cent of hot white dwarfs (and therefore also their main sequence progenitor stars) host gas giant planets beyond a few au.

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.

Derek Tyler Attico is a science fiction author, and essayist from New York City. He is a winner of the Excellence in Playwriting Award from the Dramatist Guild of America and a two-time winner of the *Star Trek* Strange New Worlds anthology. Derek is also a contributing writer to the *Star Trek Adventures* role-playing game from Modiphius Entertainment. A photographer in his spare time, Derek can be found capturing images of New York one frame, and story, at a time. He can be found at DerekAttico.com and @Dattico on Twitter.

'Where The Heart Is' was inspired by Steve Lubow's 'Highly Inclined Planets Around Eccentric Orbit Binaries' presentation abstract. *One of the key discoveries of the Kepler mission was the detection of transiting circumbinary planets. By the nature of the detection technique, these planets are preferentially found on nearly coplanar orbits with the binary. We (Martin and Lubow 2017; Lubow and Martin 2018) have shown through analytic modeling and hydrodynamical simulations that a mildly inclined gaseous circumbinary protoplanetary disk around an eccentric orbit binary can naturally evolve to a highly inclined polar orbit that is perpendicular to the binary orbital plane. Planets formed in such a disk would orbit around the semimajor axis of the binary, instead of the binary angular momentum vector. Such a disk was recently discovered in HD98800 by Kennedy et al. (2019) using ALMA. In our model,*

the coplanarity of the Kepler detected planets is a natural outcome of the generally low eccentricities of the central binaries. The low eccentricities are in turn a consequence of the fairly short binary orbital periods in these systems. We predict that there should exist a significant population of highly inclined planets around eccentric orbit binaries at longer orbital periods than studied by Kepler. New missions such as TESS are in a good position to search for such planets using eclipse timing variations of the binary.