Cosmology Part 2 with Dr. Katie Mack
Ologies Podcast
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Heeeyyyyy. This is Alie Ward here with Ologies. Now, a few things up top: if you like Ologies, I personally would love it if you took a second to rate and/or review it on iTunes. Have you done that yet? It doesn't cost any money, you just do it. This week we were in the top 20 of science podcasts, which gets the show seen by so many people. It was nestled between literally four shows about "ghost crimes," which is like... okay. But I think the Ologists I've gotten to talk to deserve to be heard and I would love to see Ologies climb up.

I also totally read all of your reviews. I'm thrilled by them. Today someone named Smilenessssss (there are six s's in that) said,

> The actual best. Yep. The actual best. When things get all jargony Alie fills in the gaps. Great guests, great topics, and a genuinely lovable host.

… which by the way, I read that while walking into the post office and I almost started crying… or skipping. So, thank you everyone for these, when you leave reviews and rate it, other people say "hey, what's this thing?"

Now, Cosmology, Part Two. If you listened to the very very end of part one last week with the, just, phenomenal Dr. Katie Mack, a.k.a. AstroKatie, then you learned a lot about particle physics and the Large Hardon Collider, ahem, string cheese, black holes, the world's most expensive selfie and your own aching insignificance – all of ours. If you haven't listened, give it a go. I also tell you a somewhat embarrassing secret at the very end of the podcast. Maybe I'll do that again.

So, part two with Dr. Mack means getting right into the nitty gritty: your questions. Trust me, I had [*high pitched, dramatic voice*] a million, but Katie and I were late to meet up with friends to see *Murder on the Orient Express*, so I could only ask about half an hour's worth of questions. I may have to nab her in the future to ask the rest because there's so many good questions.

[*Intro Music*]

Alie: I have so many questions for you. It's like a rapid-fire round.

Katie: Sure. Yeah. I'm here for it.

Alie: Okay. I'm going to throw a bunch of questions at you, if you want to skip any of them you can just pass. The first questions I'm going to ask are from the Patreon page. So these people are patrons.

Katie: Yeah. We appreciate them very much. They're great people.

Alie: They are great people!

Katie: They're fantastic and we want them to continue and ask lots of questions, which are all very good questions.

Alie: Yes, exactly! You can be a patron for 25 cents an episode, so...

Katie: Which is an amazing deal.

Alie: Isn't it a good deal?!

Katie: People should totally do that.

Alie: I wanted to make it accessible.

Aside: If you did feel like tossing a dollar a month to keep this podcast continuing free of obnoxious ads, then get yourself over to Patreon.com/ologies. I post calls for questions, some behind-the-scenes photos, patron-only videos and for $25 a month I'll be your emergency contact. Which I hope you never need. And also... I may not be reliable.

Alie: So for a dollar a month your questions get bumped to the top. This is a question, I'm just going to say one of the questions, but three different people asked a variation of it.

Aaron Herdman and Alex Introini both wanted to know, is there a name for the disorientation and panic one feels when considering the vastness of the universe? Also, do you know of a way to get past it?

Katie: So, there are a couple of names. One is cosmic vertigo, the other is cosmophobia. I don't know if these are official names but these are names that I've heard. A couple of friends and colleagues of mine have a podcast called Cosmic Vertigo where they talk about cosmology and stuff, and space and things, but it's based on that topic. And cosmophobia I know about because I occasionally get emails from people who say that they have severe cases and want my help.

So it is a thing. Sometimes people get really, really upset about the vastness of space or just the fact that we have no control over these huge forces. I mean that is something I have moments where I'm like "whoa," right? Because black holes are colliding with each other and the universe is expanding and it's accelerating in its expansion, it's getting bigger and bigger and faster and faster and sometimes that stuff is really... You know, I mean, you think about your little life and what's going on in your day-to-day, and at the same time stars are exploding [*sound effects of explosions*]. And we can look at the Big Bang, we can actually see the primordial fireball of the Big Bang. We can see that.

Alie: How?!

Aside: Ladies and gentlemen, Alie Ward, zero chill.

Katie: The reason is that… *The Big Bang Theory*, TV show, at the beginning of the show; [*The Big Bang Theory Theme plays, lyrics: "Our whole universe was in a hot dense state..."*] ... then nearly 14 billion years ago expansion started... That's the Big Bang Theory. That's a very good explanation of the Big Bang theory.

Aside: Thank you, Barenaked Ladies. Which is the first and maybe only time I'm going to say that sentence. [*The Big Bang Theory theme continues: "It all started with a big bang – Bang!"*]

Katie: The whole universe was hot and dense, and smaller than it is now. So the Big Bang theory is just the idea that the universe in the past was smaller, and denser, and hotter than it is now and so if you kind of dial back the current expansion of the universe then you get to the universe being very, very small, and dense, and hot. And so every point in the universe now was at some point much hotter and filled with radiation.

So this part of the universe now, in the very distant past was full of radiation and very hot and very dense. When we look out into other parts of the universe, because light takes time to travel, every time we look farther away we're looking farther into the past. So we're looking at that part of the universe as it was maybe a billion years ago, or five billion years ago, or whatever. And there's a part of the universe that's so distant that when we look at it we're looking at it as it was during the time when it was still on fire.

Alie: Whaaat?!

Katie: Right? So as we look into the distance in any direction we're seeing that part of the universe as it was when it was still in that primordial fireball kind of state.

Alie: Which was how long ago?

Katie: Well, the fireball started to cool around 380,000 years after the Big Bang, or after the beginning, whatever you call that. Because that's still part of the hot Big Bang, which is the hot phase. We can actually see radiation, coming from every direction in the sky, that is the radiation of that heat, that radiation from that early time, just reaching us now, from really distant parts of the universe. So we can look at it and we're looking at the fireball universe. We're looking at that primordial plasma. We can see the Big Bang.

So we know that it happened because we can see it; we can watch it! We can actually see parts of the universe that are still there as far as we're concerned.

Alie: And that can give you cosmic vertigo.

Katie: Yeah! Just thinking about like, that was a big important event and so this sort of nice, gentle, stable universe is not how it always was and we don't know... Most cosmologists think at the beginning of the universe before that hot phase, there was a period of very rapid expansion of the universe called inflation. We don't know why that started. We don't know why it ended. We don't know that that couldn't just start happening again right here right now. There are theories where you could have the universe end, right here right now in this room! [*laughs*]

Alie: Oh God, oh God!

Katie: So this is an idea called vacuum decay where you can have a quantum event happen where one point in the universe transitions to this other state. It's called a true vacuum state and that would create this bubble of, like, death-

Aside: Again: [*echoing, doom-laden voice effects*] BUBBLE OF DEATH.

Katie: -that expands out at the speed of light in every direction. So you would never see it coming. And it's a probabilistic event, it's a quantum event so it could happen at any moment. It probably won't.

Alie: [*nervously laughing, high pitched*] Oh Gooddd!

Katie: We're probably just wrong about the theory, and even if we weren't wrong about the theory, the timescale that we calculate for it, it would probably take trillions of years or something. But it's a probabilistic event, it could happen at any moment technically it's just very low probability. So, that could freak you out. I've gotten e-mails from people, they read about that and they're like, "I can't sleep!" and I'm like, "I'm sorry!"

Alie: Do you have any advice for that?

Katie: So about vacuum decay, I can tell them a few things. One is that we don't know for sure that this is even possible. If it were possible it probably would've happened in the very beginning of the universe because the conditions for it happening then were much more favorable. So it probably would have already happened if it was going to happen already or if it was possible at all.

And then I say well, if it's going to happen there's nothing you could do. I mean, it's traveling at the speed of light, you won't even see it coming.

Alie: That's the best way to die.

Katie: Yeah, you won't notice. It is absolutely the best because you don't see it coming, so you can't be scared of it. You don't even really notice it because it's happening at the speed of light and you're not around afterward and nothing is around.

Alie: Everyone you love dies at the same time!

Katie: Yeah everything dies. Everything's gone and at the same time there's no there's FOMO, right? You're not missing out on anything because the whole universe is done now. So in some sense it's really inconsequential, because there's no consequences of it. It doesn't matter. You could just blink and maybe you open your eyes again, maybe you were consumed by a vacuum bubble of death. But like, who cares? You don't know.

Alie: If I could vote on a way for everything to end I would be like, vacuum decay. That's going to be my platform - I'm gonna run for 2020, vacuum decay as my platform!

Katie: It is the best way to end the universe.

Alie: Okay, so that's one way to chill out. Paula Herrera wants to know how scared should we be of a giant asteroid destroying Earth? Are any of the sci-fi movie methods to save the planet plausible or are we basically doomed should an asteroid come our way?

Katie: Yeah that's a little bit of a sadder point because we're basically not really monitoring about half the sky right now-

Aside: Whaaaaaaat?! [*breezily*] Okay, no big deal... No big deal.

Katie: -because we used to have some monitoring stations in the southern hemisphere and they lost funding. So we don't have as good of a handle on the number of objects out there that could cause really big problems. There's some goals about what fraction of objects above a certain size we should be aware of, and it's like, you're supposed to see 90 percent of objects above some size or whatever and we're not really there. So I think there are programs being put together now, and there's efforts to have a better catalog. It's not like we're due for a giant impact or anything. These are still things that are probably not going to happen anytime soon. But I can't honestly tell you that we're on top of it. We're monitoring a lot but we're not monitoring enough to say that we definitely don't have anything coming.

So whether or not we could stop it? There are a couple of methods. If we find out about it early enough, like five years ahead, ten years ahead, then there's a possibility of sending a spacecraft to it and changing the course of it in some way. You don't want to just blow it up, partially because some of these things are kind of loose rubble piles and so it wouldn't really work to try to blow it up. But also because if you have a huge asteroid and then you blow it up then you have a bunch of smaller asteroids and that's not always better.

But there are a bunch of really cool ideas for just nudging them a little bit and if you find out about long enough before it comes then you don't have to nudge it very far at all to get it totally off course so it will miss the Earth.

So, one of them is to take a really, really massive spacecraft and just park it next to the asteroid in the orbit for a while, so it gets pulled a little bit by the gravity of the spacecraft. If you get it early enough that's called a gravitational tractor. If you get it early enough that can work.

There are other ideas about creating, like, a giant sack and capturing it in the sack because it's not necessarily a solid thing.

Alie: [*Incredulous*] How are you going to make a bag big enough to put around an asteroid?!

Katie: I mean, it depends on the size of the asteroid.

Alie: What is that made out of? Like, Mylar? Kapton tape?

Katie: I don't know.

Aside: I'm sorry, I'm a little activated by this. I looked up "asteroid bags" and I was distracted for a few minutes on some galaxy-printed totes and duffels, and I was like, "oh, that's nice." Then I realized that space people call these "capture bags" like it's just no big deal, like they're just used to collect fallen leaves or a dog doodle. But NASA introduced the plan a few years ago and I asked the search engine gods what the bag might be made of, and I found it could be inflatable, could be metal mesh or could just be "high strength material." Sounds like they're figuring that out too. My guess is it's just a very large blue Ikea bag. Tow that fucker in, those things are strong!

Katie: There's another idea which is also really cool where you spray paint half of the object so that it changes the reflectivity, and then that means that the solar wind will push a little bit more on one half than the other in some way and that can change the trajectory. So there are a couple of possibilities.

Alie: [*hopefully*] Those are some good options.

Katie: Yeah but you need a lot of lead time and...

Alie: ...a lot of paint and a really big bag.

Katie: [*amused*] Yeah, yeah.

Alie: Oh my god, I just can't believe that we're kind of sleeping on the job there!

Katie: I mean, a lot of these things are being monitored and there's nothing that we know about that's coming anytime soon as a threat. But we're not fully on top of this in the way that I feel like we should be.

Alie: [p*ained*] Ohhhhh man, good to know! Russel Kelly wants to know: Will the universe expand forever or will it eventually collapse in on itself?

Katie: That is a great question. Based on our current understanding and the data that we have now it looks like it will expand forever, which will lead to something called the heat death, which is the most depressing way for the universe to end. Which is that dark energy – dark energy is whatever is making the universe expand faster and faster - if it's a cosmological constant, which is just a kind of dark energy that was first invented by Einstein but it seems to be the case, then what'll happen is that over time the other galaxies will get farther and farther away. Not Andromeda, the Andromeda galaxy is coming for us now, it's on its way, it's going to collide with the Milky Way in about four billion years... [*sarcastically*] that'll be fine, whatever. But then the more distant galaxies will just get farther and farther away and eventually we won't be able to see any other galaxies outside of our little local group.

Aside: [*disdainfully*] This is like when all your friends grow up and move out to the suburbs, or get rich and go to Santa Monica.

Katie: And then we won't be able to see the cosmic microwave background anymore, the afterglow of the Big Bang. So the universe will just get really, really dark and really empty, and then our little group of galaxies will kind of be combined into one big blob. But eventually all the stars will burn out because they'll run out of fuel, and there's no more gas coming in to make new stars from other galaxies.

So the stars will burn out and then a bunch of things will collapse into black holes and the black holes will evaporate, and the protons will decay, and everything will just kind of like... decay into nothingness and there will be this really empty, cold, dark universe with nothing in it and just this tiny amount of radiation and no ability for any new structures to form, except maybe through some kind of quantum process which is kind of a cool thing. But that's another topic.

Alie: That's so goddamn lonely!

Katie: Yeah, [*sighs*] yeah, it's called the heat death.

Alie: [*playfully*] So what happens when the Andromeda galaxy collides with the Milky Way though?! You glazed right over that! What the hell is that about?

Katie: [*laughs*] That's really cool actually. So the Andromeda galaxy is a spiral galaxy, like our own. It's got about a trillion stars. It's more massive than the Milky Way, and it's got a supermassive black hole, and they're all coming toward us at something like... I think it was like, a hundred kilometers a second. Anyway they're all they're all coming toward us right now and-

Alie: Is it going to smushy-smash?!

Katie: Yeah, it's going to come, and in about four billion years it'll get here and it'll collide with the Milky Way galaxy. The way that galaxies collide is kind of cool. They sort of merge and they make these long trails of stars coming out and it will be this really spectacular light show of like, gas will collide and make new stars, and there'll be this burst of star formation, and the black holes might turn on and start pulling in matter and getting really bright, and stars will be flung out into space and on these long tails -

Aside: This sounds like warehouse space rave, I'm not gonna lie. I'd be down for this.

Katie: - but because there is so much space between stars and galaxies, probably our solar system will not be affected. Probably just the sky will get really interesting. But it will also be four billion years from now so the Sun will be burning out and the Earth will already have its oceans boiled away and life on Earth will be impossible. [*Alie laughs in disbelief*] But if we left something here to take pictures they would be really pretty.

Alie: Mike Melchior wants to know are Uranus [*pronounced "your-anus"*] jokes still funny? It's really "your-an-uss" isn't it?

Katie: So actually I don't know which is a better pronunciation. I usually say "your-an-uss" just because I don't want to deal with it, but then it's got the word "urine" in it too, so it doesn't really help... No, they're not particularly funny.

Alie: Okay, good, just checking!

Aside: So I use an AI for transcription for this podcast, and it transcribed to "you're an ass," and I'm sorry but yes, that is funny.

Alie: Meaghan Gerard wants to know, slightly more on a local, practical level, she loves stargazing but even in a small city it's hard to do because of light pollution. So can you recommend any tactics, resources, organizations for helping reduce light pollution? Also she thinks maybe light pollution is bad for us and animals?

Katie: It is, yeah.

Alie: So, good way to stargaze and good way to reduce light pollution?

Katie: So there are national organizations for dark skies. I don't remember the names but if you look them up there are charities that their whole purpose is to try to get better lighting in cities so that more of the light goes down not up, and changing what the lamps are made of and stuff like that. So you can get involved in these campaigns and they're really helpful. I can't remember the name of the organizations right now but there are a few of them out there.

Aside: DarkSky.org has a bunch of information on getting involved in dark sky advocacy and membership in this kind of a dark sky club. So hit that up. I will try to do my part and stop falling asleep with the lights on. I fell asleep with them on again last night, but tonight... tonight's the night. International Dark Sky Association, I'm gonna do my part.

Katie: If you want to go stargazing and your city is too bright you just have to go somewhere else, basically. So when I was living here… when I was growing up in L.A. and Long Beach I was part of the L.A. Astronomical Society and they would have dark sky or star parties where we would drive like, four hours into the mountains and it would be really dark there. So you don't have to get that far out of the city to do good stargazing.

Alie: So getting the fuck out of Dodge. Got it.

Katie: Yeah that's pretty much it. There's a really great film called *The City Dark* which is about light pollution and what it does to us, and what it does to astronomy, and I'd recommend checking that out.

Alie: I fell asleep with the lights on last night... it's not good for your brain.

Katie: It's not good for you, no.

Alie: And now this set of questions comes from the Ologies Podcast Facebook group. They get next crack at questions. Isabelle Lorion wants to know, what do you think the shape of the universe is - hyperbolic? Toroid? What do you think? Did I say "toroid" okay?

Katie: You said "toroid" okay. "Toroidal" is the adjective, but yeah. A torus is a donut shape. That's all she's saying.

Alie: Oh! What? So a toroid cake would be a donut?

Katie: Yes.

Aside: I went my whole life not knowing this, somehow. But also, a torus - apparently - technically would be like an inner tube, hollow, and a solid torus is a donut. But, I wanna say, I was on a dessert show called *Unique Sweets* for like, a lot of seasons. I have to say, a cake donut seems like a solid torus, but if it's a fluffier yeast donut, there's all kinds of air pockets in there and the volume and density seems somewhere between a torus and a solid torus, and I need a physicist to get on this for me, thank you. Okay... back to the shape of the universe.

Katie: So the way she's asking the question, the answer is the universe is probably flat, which just means that there's no large scale curvature to the universe. So I said that matter curves space, so you get these, like, dents in space. On the very large scales space is flat in the sense that it's not large scale curved, it's still probably three dimensional. I mean the space part is three dimensional, and then there's time, that's the fourth dimension.

But it's flat in the sense that if you had two beams of light that were parallel they would stay parallel forever. That seems to be the case at least as far as we can measure. There could be some larger scale curvature that we don't measure because it's just so big, like if you have a ball that's big enough it looks flat like the surface of the Earth looks flat.

But the universe on the whole, as far as we know, appears to be flat. There's no evidence for curvature but it could be curved around on some really large scale.

Alie: Okay! We'll find out before the stars all collapse in on themselves hopefully... maybe?

Katie: [d*oubtfully*] Mmmm, I don't know... [*Alie laughs*]

Alie: Teejay King and Laurie March [phonetic] both had kind of the same question. Is there a reason why some stars appear to twinkle more than others?

Katie: Yeah. Stars appear to twinkle when you're looking through the atmosphere because the atmosphere is bending the light a little bit, just by being a little bit hotter, a little bit wetter or something in different parts. And so when you look through that, sort of, messy air it makes the position of the star move around a little bit from your perspective. And that means that sometimes it will look a little bit brighter and sometimes a little bit dimmer and that makes the twinkling.

So the brighter a star is, sometimes that makes it look less twinkly or more. It depends on what the air is doing. But planets don't twinkle.

Alie: Why not?

Katie: So the reason planets don't twinkle is because the twinkling of a star comes from the fact that from our perspective it's just a single point of light and so it can be moved around and that little point of light can be magnified a little bit, and that makes it look brighter or less. But a planet is a disk of light from our perspective. It’s a really, really small disk but it's a disk of light that's big enough that the little turbulence cells or whatever in the atmosphere only move the light around within the disk mostly, and so it doesn't get significantly brighter or dimmer because the motion of the air is not enough to really change the size and shape of that disk.

Alie: So if it twinkles you've got a star, if it doesn't twinkle you've got a planet, more or less?

Katie: Yeah, more or less. So if you see something pretty bright in the sky and it's not twinkling and other things are, then you're probably seeing a planet, and you're probably seeing Jupiter, Saturn, Mars or Venus.

Alie: That’s so great. If that does happen and it's the first time you've heard this then you should high five Katie on Twitter. Lauren Oakes wants to know, what is the deal with other dimensions? This might not be the right person to ask but I still want to know.

Katie: Okay. So we have three dimensions of space, that's forward/backward, left/right, up and down. We also consider time to be a dimension. So, when you think about things like relativity you have to include time as part of your coordinate grid. That coordinate grid has to have four dimensions, so time's the fourth dimension. And the reason for that is that space and time can affect each other, like moving through space at a higher speed changes the way you move through time. And when you're close to a gravitating object, that changes the way you move through time, and so it has to be part of the same malleable fabric in some mathematical sense.

There could be other dimensions of space that we just can't interact with, we can't see, we can't perceive. And in some cases those other dimensions of space might be kind of wrapped around themselves. Which is a weird concept but it's like if you imagine a string - a string is a three dimensional object. Two of those dimensions are wrapped around really tight. So it only has a little direction you can go in two of the dimensions but you can go a really long way in the other one.

So it might be that in our universe we can go as far as we want in our three dimensions, but the other dimensions are so small that we don't notice them because they're all wrapped up. One of the reasons that those extra dimensions are hypothesized is that it might be that all of our particle interactions and stuff can only happen in this three dimensional space, but gravity can leak out into the other ones a little bit. So if that were happening that would explain why gravity is so weak compared to all the other forces. So that's a hypothesis. So there could be other dimensions that might solve that problem.

Alie: What about multiverses and is there another me with a better life, living in a different dimension?

Katie: So when people say "dimension" in that sense they just mean another universe. "Dimension" doesn't mean "space" anymore, it means something else. So there could be other universes depending on how you define a universe, because you could just define the universe to be everything and then everything is part of the universe by definition.

Alie: There can't be a second everything?

Katie: Yeah, but you can define the universe as just the observable universe, so what's within the distance out to which we can observe anything, which is a set distance. Then we know there's stuff beyond that, so kind of outside our universe. You can think of that as another universe.

Then you could have other universes that are separated by higher dimensions from us, so you could imagine our universe as a flat sheet and there's another flat sheet, so we've just take one dimension down, and they could collide, maybe.

There's a theory for the Big Bang, that these two sheets collide and that makes a Big Bang, and they come apart and then they collide again later on. It's called the Ekpyrotic Model. My thesis advisor was one of the people who came up with that.

Then there are other ways to have other universes, like with the many worlds idea of quantum mechanics which says that every time a quantum event happens basically another universe branches out from ours in a way that somehow makes sense mathematically but it sounds ridiculous when you think about it.

Alie: Is that kind of like an alternate reality?

Katie: Kind of, yeah.

Alie: Is there another me in another universe, in another reality, who brushes her hair more regularly?

Katie: Well, in the many worlds hypothesis I guess technically that would be the case.

Alie: [*laughs*] So if that's a rabbit hole that you want to go into just start Googling!

Katie: Because in many worlds there's another universe where, like, a photon just went through that window or didn't, and that's the only difference. So, every possible thing...

Alie: Raquel Land wants to know is there actual scientific proof that there might be life beyond our planet? Aliens, yes/no?

Katie: Probably.

Alie: Okay.

Aside: So what does Katie haaate about her job? What does she [*whiney*] haaaaate?

Katie: So one is the uncertainty of the academic career ladder. I spent the last eight years as a postdoc, which means I had my PhD and I was doing research but I didn't have a permanent job. And I didn't know where I was going to go next, or how long I would be there, or whether or not I would be able to continue in science, because it was just applying for jobs, and it's a difficult thing to be doing.

All jobs have some uncertainty at some stage but I feel like in academia that uncertainty and that tenuousness last a really long time. And if you get to the stage where you're definitely not going to get an academic job, and you wanted one, then you have spent many years making not very much money, when you could have done something more lucrative and you would have been better off in every way. [*laughs*]

I mean, I enjoyed doing the research. So for me it was like, "well I'll just keep doing science as long as I can, I enjoy it, I'm willing to make that sacrifice". But for a lot of people it's just so disruptive, and it's so difficult that it's a really high anxiety time, and it's really hard, and a lot of people leave because that is just really hard to deal with.

So that's the main thing. And then the other thing is it's really easy to have a lot of self-doubt and you have to be very self-driven and it's hard to know if you're doing a good job. [*laughs*] Academia can be very competitive and you don't get a lot of positive feedback. And so it can be hard to keep doing what you're doing and know that you're doing it well, or know how to do it well, all of that stuff can be difficult.

Alie: Which is great that you're a science communicator as well because you get a lot of feedback from the public, I imagine?

Katie: Yeah, that does help a lot. Like if I'm sitting in my office banging my head against something that I feel like, "I really should know this thing, I really should understand it and this should come more easily," and I feel like I'm a total failure and I don't know anything. And then I go talk to a room full of school kids and suddenly, like, "I'm an expert!" [*laughs*] Then I feel like I know a lot of things and that helps a lot. So for me it's made a big difference, and just keeping me from getting too depressed about not understanding the universe as well as I wanted to.

Alie: What about your favorite thing about the job, or cosmology, or physics, or...?

Katie: My favorite thing is that I get to ponder the deep questions of reality as my job, you know? [*laughs*] I was at a conference a couple of weeks ago and most of the topics in this conference were not stuff I work on. It was really deep questions about the nature of reality and whether or not spacetime is really a thing, and how particles really work and all of that. It's not the area I work in so there's a lot I didn't understand about it, but I could grasp some of it and I felt so privileged to be able to be in that room and to think about these things, and to have some grasp of these huge concepts. And that was part of my work, you know?

Every time that happens it's an amazing feeling that I get to do these mental exercises, and learn about the fundamental properties of the universe, and that's my job. I mean, writing the papers and teaching and all of that stuff is also my job so there's a lot of other aspects to it but just learning about the universe is a big part of my job and I love that.

Alie: [*awestruck*] That's so baller.

Katie: Yeah.

Alie: All right, thank you for letting me talk to you for so long. I'm so sorry, this is the longest interview I've ever done 'cos there was too many questions! Okay, let's go to the movie.

Katie: Okay, bye! [*laughs*]

So, we barely made it to the movie, which was a very forgettable mystery romp about a train stuck in the snow, but stellar mustaches, and I will remain forever shooketh by this conversation. I'm glad we took as long as we did.

To follow Dr. Mack, you can find her on Twitter or Facebook as AstroKatie or on Instagram at AcademicNomad.

This podcast is at Ologies on Twitter and Instagram, and I'm @alieward on both. For t-shirts and totes and mugs and to support the podcast while also covering your nude body, go to OlogiesMerch.com. And of course, if you like the podcast and wanna support, just tell a friend, or make a post about it, or rate it on iTunes. That's huuuge.

This week's secret is that I record all this narration in my closet because the sound is pretty good, there's all these clothes to dampen it. But the real nugget here is that have a real laundry situation and about half of my body is currently sitting on a pile of towels, which I'll get to this weekend after I obtain some soap. So yeah, I'm podcasting from a laundry nest, like a cozy little woodland rodent. [*high pitched, croaky, mouse-like voice*] Talkin' atcha through a machine.

Big, huge thanks to Steven Ray Morris, Patron Saint of Podcasts, for editing this episode, and to Shannon Feltus and Boni Dutch for all their help with merch, and Hannah and Erin for running the Ologies Podcast Facebook group. And the theme song was composed and performed by Nick Thorburn - a.k.a. Nick Diamonds - of the band Islands. He's great, check out his music.

Next week: a little episode on carbohydrates. Comes out the day after Christmas! So what the hell are they, why do we like them, and why do our cells wear them like hats? Because they do! A glycobiologist [*deliberately for comic effect*] spills the starch beans.

Until then, ask smart people all the dumb questions you want. The universe is big, and regret is maybe the scariest thing there is.

Okay, berbye!

[*Outro Music*]

Transcribed by Kris Noble, your friend who now thinks waaaaay too much about vacuum decay and the bubble of death

Some links that may be helpful:

Spaghettification

Spike in paper submissions

ArXiv.org

Great Red Spot

LIGO

Kip Thorne

Quantum Theory Cannot Hurt You

NASA JPL

Many Worlds

Stars circling black holes

How big is the Milky Way?

Pale Blue Dot

More Pale Blue Dot recording

String Theory in a Nutshell

General Relativity

Peter Higgs interview

Higgs Boson particle

Large Hadron Collider

Large HARDON Collider

For comments and inquires on this or other transcripts, please contact OlogiteEmily@gmail.com