Getting Curious with Jonathan Van Ness & Don Hampton

JVN: Hey, curious people, I'm Jonathan Van Ness and welcome to Getting Curious. Oh my God, you guys, it is our much awaited, much anticipated Northern lights episode. I wanted to give this to you last year when I went to Finland, but it was too cloudy. But I did learn about Northern lights, but I wanted to learn more about Northern lights, but mostly I really needed to see them IRL. So I went to Fairbanks with my mom and my husband to try to see them again. And you guys, I did! I saw him three times, not to spoiler alert at the very beginning of the episode, but now having seen them, I have like 97,000 more questions: like what's happening on a molecular level, like what are the Northern lights up there? So to talk about that, we're bringing in the gorgeous scientist, Don Hampton. Don Hampton is an associate professor at the Geophysical Institute at the University of Alaska Fairbanks. Don specializes in researching the interface between earth's upper atmosphere and space, then characterizing the energy input of the aurora and studying the effects of auroral energy on the atmosphere. He's giving aurora expert and I'm giving student. Also, you guys, this is just so cute. I had to share on our Airbnb's Ring cam, it picks up the moment that the tow truck brings us back to the house. And our amazing host is like, “The aurora is right above us.” So I literally have the audio of me like yelling to my mom, like ,”Look above us. It's above us.” Um So I, I have that. So I wanted to play that for you guys because it's really such a cute moment. Here it is. [VIDEO STARTS PLAYING] Outside in the Alaskan wilderness. You can hear the snow crunching under my feet and we are watching the Northern lights put on such a show right now. They are right above us, I think and if we've been checking every 30 minutes, it's two in the morning. Um Wow. Ok, I'm gonna go so I can watch this. But um let's get to our expert and learn about what we're seeing. Don, welcome to Getting Curious, how are you?

DON HAMPTON: I'm doing well, how are you?

JVN: Um I am doing pretty good because I got to see the aurora borealis, not once but twice hardcore in the last three days.

DON HAMPTON: Oh, excellent. That’s great!

JVN: Um we are having this conversation from Alaska. I am currently just like right outside of Fairbanks and I got treated to like such a show. Now, my first day in Alaska started with a near death experience, Don because my mom and my husband and I took our rental suburban and we accidentally went up like what seems like a street on GPS. But it is actually more like a hiking trail and we ended up like halfway up Henderson Road, uh, had to get towed out. I literally thought we were going to end up on like an episode of Dateline. It was like negative 30. Um I just wanted to go up to the top of the street to make sure that we could see because I didn't know where the aurora was going to be. But my mom was all like, “No, let's go to this Esther Dome,” and I was like, oh there's directions right here, but it took us on this back way. We literally got stuck in this like deep, deep, deep like the tow truck literally, our car was like 2 ft in the ground from just like the wheels. It was, I was so scared, it was really cold, it was really dark. But then when we come home at like 11:30, the Ring cam picks up the moment when we look up and there is the just fucking Northern lights right directly right above our head. I'm just right. I mean, I looked up and they were giving, they were doing waves, honey. It was giving theta waves. They were, they were giving waves. It was to my naked eye, it looked, it wasn't as green and red as in the pictures. It was more

like, more of like almost the color of like stars with a little bit of green. Um, but then there were different moments on that night and the third night where there, it was full proper green, like even to the naked eye, like it was, I think it must have been strong. So, but anyway, how are you?

DON HAMPTON: I'm doing well and I'm glad to hear you got to see some aurora that's it's always great.

JVN: Um well, because actually, I mean, they just, I was talking about it. It's an in our opening, but we, I've been obsessed my whole life and then my mom and my husband and I went to Finland and didn't fucking see them. Like I took a whole class. I was like researching, I was like, so excited because I wanted to do this episode and they didn't happen. So I just um well, they did happen one night but it was too cloudy and so I could kind of see it on camera but it wasn't giving what it gave in Alaska. Like this gave me what you would think of as the aurora. So, but what was that when, when we look up into the sky and you see those gorgeous northern lights, the aurora borealis, what are we seeing?

DON HAMPTON: So it, it's very similar to what happens in a neon sign. So what happens is you've got the electrons—remember the little light particles that are on the outside of an atom or molecule—-uh there's a whole bunch of free ones that come down our magnetic field lines and bump into our atmosphere, our constituents up in the upper atmosphere, they excite them and, and uh add some energy to those atoms and molecules and then they release that energy as little bits of light. And that's what you're seeing in the aurora. So it's, it's this big sort of electrical discharge that happens and we get to see the light at the end of that show.

JVN: Because I was seeing like, so then like last night or not last night, it was too cloudy, but it was, and I think, was it the night before that? It was, yeah, it was major. Like, I feel like it was even bigger than that first night that we were here. Um So like, it was like, I saw a lot of vertical lines but then I also saw like, that was more like towards the horizon but like in front of me, but then I also saw stuff like, directly like, you know, like right over my head and those were more like, kind of like theta waves or something like, like they were like, you know, like, like it went like this, like, so what, what are like the patterns like, like how come they looked like that?

DON HAMPTON: So, yeah, so the predominantly the, the, the, the base uh sort of pattern of an aurora is sort of this, uh really elongated East/West, uh uh uh arc we call them. So, so they're pretty, you know, very, very, very, very long distances to the east and the west and then the north and south, they're fairly narrow. So what do I mean by that, by, you know, an arc can be 1000 miles long or 1000 kilometers long, either one and, and the thickness in the north south is typically just a few miles, you know, thick and, and that has to do with the sort of the geometry of, of where the particles are coming down to create the aurora. Um and then uh so when it's, when it's pretty quiet, not much is going on, you get these sort of just straight arcs. Now, when you get a lot of those particles coming down, that creates a current and those currents create changes in earth's magnetic field, local magnetic field. And that sort of makes the waves that you see happen. So it's when you get very, very strong aurora that, that sort of just sort of straight East/West arc. Now it starts to bend and fold and do all those really cool things that you got to see. Um and it just has to do with how many particles are coming down at any time.

JVN: You said that thing about like the molecules getting excited, like what molecule do, do scientists or because you're a scientist, honey. So do do you guys know, like what those molecules are made of? What are they?

DON HAMPTON: Yeah. So it's, it's predominantly nitrogen, N2. And, you know, and that's, that's 80% of what we breed down here is N2. And up at that altitude where the aurora happens is still there. And then it's atomic oxygen, which is a little bit different because you know what we breathe down here is O2. You know, that's, that's what we need. Uh But of those altitudes, the, the sunlight during the day time has a whole bunch of UV emissions that luckily are blocked by the ozone. So we don't get them down here, but up there, it actually breaks those oxygen molecules into oxygen atoms. So that green that you talked about and, and then sometimes you see pictures the upper atmosphere, there's this really deep red, that's atomic oxygen emissions. And then, and you probably saw those pink or reddish lower borders when it got really active. That's the nitrogen, that's the nitrogen kicking in, then. Now at all altitudes, all those are happening. But, but they change in altitude, they change in density and altitude. So you see different colors of different altitudes, which is pretty cool.

JVN: Does do the Northern lights only happen like above the Arctic circle? Like where do they happen in the world? And like how, and, and how do they happen?

DON HAMPTON: Ok. So uh well, this is a 30 minute segment of the show. No. Um so they, they happen in a, a uh uh a ring around the earth's magnetic pole. So, so you know, those pictures you showed, uh you saw that, that there's very straight lines in the vertical direction and that's because the electrons are charged particles and they follow along magnetic field lines and earth's got a fairly strong magnetic field. Um and, and that's one of the, the uh that's one of the constituents you need to make an aurora on a planet is a strong magnetic field. The other thing you need is a solar wind and that's, that's electrons and protons coming out of the sun, which they do all the time. And then you, you, you, you just have to have and then you have to have an atmosphere—and luckily we have an atmosphere, that's a good thing. Um so what happens is those electrons coming from the sun and the solar wind, they get trapped by Earth's magnetic field, there's a whole host of uh phenomena that happen in Earth's magnetic field and then they get accelerated and they come down at high energy and bump into our atmosphere at the top of the atmosphere. And so, so those are the three things you need. Um so, you know, planets like Mercury uh and, and Mars, the, so Mercury doesn't have an atmosphere and doesn't have much of a, of a uh magnetic field. Mars has a very weak magnetic field, it has a bit of an atmosphere but the, the magnetic field is too weak. And so you don't get those processes that accelerate the particles. Uh Venus has not much of a magnetic field has a very thick atmosphere. So we don't see that. Now, it turns out Jupiter and Saturn have big atmospheres and they've got very, very strong magnetic fields. And yes, there are, there are auroras on, uh there are absolutely Jupiter and Saturn, they've got pictures of Auroras there.

JVN: Like are they the same colors?

DON HAMPTON: No, there'd be different colors because the atmospheres are different. So the, the, the colors that we see are specific to the oxygen and nitrogen. If you go to Jupiter and Saturn, that’s hydrogen and some methane and some other constituents that they have there as well. So they, they're different colors. So they, you have to look at different, uh, uh, you know, different wavelengths or, or with different filters to see those. But…

JVN: If we could live there, what would we see them as?

DON HAMPTON: Uh, uh, uh, you know, you would see you would, I don't know what the colors are actually. II, I haven't been, I haven't been to Jupiter and to see it myself.

JVN: Oh, my God. I wonder if it's like pink, purple. Does it move in the same patterns? Does it have like the same patterns?

DON HAMPTON: It has similar patterns. Yeah. So again, it's, it's, it's, it's in a, it's in an oval around the magnetic field, the magnetic pole of the planet. Uh and so, yeah, so, and uh it happens, it happens very similar to what happens here. There are some differences which is kind of fun. And, and so I've got colleagues here who actually study the magnetosphere out at uh uh uh Jupiter and Saturn and looks at the aurora there and tries to compare why that happens there compared to what happens here on, here on Earth.

JVN: Oh my God, that's so interesting. I can't stand it. Um okay so it's the, is it gravity that's pulling the particles into our atmosphere or it's just happenstance, like it's just like the sun shoots out these electrons and protons and it just so happens that they're like in our way or we're in their way?

DON HAMPTON: Well, yeah. So they, so, you know, we, we've, we've had a pretty strong magnetic field and you, you know, you probably remember seeing pictures, you know, or, yeah, you've seen pictures of magnetic fields, it looks kind of like an apple core, right? You know, if you slice it. Right. Right. And, and so our magnetic field extends, you know, uh uh many times the radius of the Earth way out into space. And so there's a big cross section of that magnetic field that the solar wind sees that it goes by. And so those particles uh get trapped by some of the magnetic uh fields and get sort of swept into the interior of our, our magnetosphere and the magnetosphere is, is what I'm defining as the reason where the Earth's magnetic field dominates, right. And, and so uh when they get trapped in there, like I said, there's a whole bunch of processes, but basically, they kind of get swept to the tail and then from there, they get energized, accelerated down our field lines and come and create the aurora. And so if you think about that, that geometry of that sort of apple core, if, if you've got something several Earth radii out on the tail, if it follows a magnetic field lines, it's gonna come up to the poles. And that's why we see aurora near the poles in that sort of region there. So uh you know, the North pole and the South pole we have aurora there.

JVN: But how is it like where in the Earth? Like how is it that it could be in Texas sometimes or that it's mostly up here? And is there any correlation to like if there's Northern lights in the North, does it also like ha like have to take place somewhere else?

DON HAMPTON: So, so yeah, the the what we call that conjugate yeah. So if there's Northern lights in the North, there are also Northern or Southern lights going on at the same time and they are almost mirror image although there are sometimes some differences but, but essentially they are mirror images and, and that's because the source is out in the magnetic, you know, out in our magnetosphere and, and it, it goes both directions, it goes North and South, you know, at the same time. Um so, and, and the reason uh you know, we get these big storms, that's when there's a lot uh stronger solar wind coming. And so there's a lot more particles that's coming faster. So there's just a lot more energy. So our, our magnetic field is not static. When you get out into space, it, it can be compressed, it can be jostled around and, and when that happens, um the region that's producing this, this acceleration into our upper atmosphere changes. And so you then you see aurora further

South. So very often people like in Minnesota will be able to see aurora, but when you get these really strong storms, yeah, it even extends down into the, you know, the middle United States. And that means people in Texas can look North and see some aurora. So that's, and, and that's, that's why we're excited in the next couple of years because we're at what's called solar max. And we get a lot more of these strong storms from the sun uh that are gonna create these larger storms. And so, uh it's kind of funny in Alaska, we don't really benefit from those strong storms because then all the aurora goes South and, and we're just kinda looking to the, to the South at the aurora.

JVN: Oh, that makes sense!

DON HAMPTON: But we, you know, we, we still get plenty of aurora up here.

JVN: So does where it goes in the world, does that ever or dictate like the color of the aurora? Like, will it like if it happens to go further South or if it's like stronger particles, will it make it appear different?

DON HAMPTON: The, the structures will definitely look different. Uh the, the um we often get uh sort of these very, very tall rays. So instead of just, you know, that curtain looking thing, it even gets a little bit taller. Also, there are a lot more of the lower energy particles. So you get a lot more of that red color on the top. Um that's very hard to see. I,I have a hard time seeing the red on the top. It's, it's not, it's just my eyes are not that sensitive to the red, but sometimes these big solar storms will produce so many low energy particles that it produces though that red at the top that you can see that by, by uh naked eye. Um and then uh um and, and you know, the, the the structures just look different just uh when it gets down there because now the magnetic field is tilted slightly differently as well. So it's not as, it's not as vertical as it’s like here, you more horizontal fields down there. And so you get, you get different structures that way as well. So yeah, it looks much different when you get these very large storms than what you saw the other night here in, uh, sort of Fairbanks.

JVN: What are the other things that, like, all have to happen for like, because we've been watching this, like, um, like, we have this, like, Aurora app and it's all like, you might have a chance in the next hour or whatever. But there's like, and there's like, the whole KP and stuff like what, what are all the things with, like, how do scientists like measure and understand and predict auroras?

DON HAMPTON: So the, the, the main thing, like I said, it's all driven by the solar wind, which is this, this stream of particles that comes out all the time. But, but it, it like any kind of wind, it's kind of gusty. So sometimes it comes nice and, and even other times—uh especially during these solar max periods—there are structures on the sun that kind of hold in some of the solar wind for a while and then it, it lets it out and it comes out in these big bursts so they're faster and much more dense. Um so when that happens, there's just more energy that can go into our magnetosphere and that's when we get these big storms that, that, that people in Texas or at least, certainly in Minnesota that areas are, are being able to watch. Um now the, the, the trickier part is that the solar wind has a magnetic field just like we have a magnetic field because you got charged particles moving around, that's a current and currents create magnetic fields. And it's the orientation of that magnetic field and how it couples with our magnetic field that determines whether that energy is gonna couple better or not. And so the thing that we watch, if, if we want to know for the upcoming few hours, there's a satellite uh out at a, at a region North, not North of us, sorry, up wind of us that sits

there and watches the solar wind come by and it measures that magnetic field orientation. And if that magnetic field orientation has the magnetic field facing South, that turn, that turns out it's going to interact, interact with our magnetic field much better and it couple those particles in and that's when you really start to get the the the the conditions that are going to create good aurora. So yeah, we, we, we understand there, there's this whole, like I said, there's a whole set of processes that go on between the solar wind and our magnetic field that create this dynamo kind of thing that goes on that creates the energy to produce the uh aurora that comes down.

JVN: Is it the same for like everyone? Like would it be, is that the same for like, you know, Finland, Sweden in Greenland or Iceland? Like it just…?

DON HAMPTON: Yeah that's right, that whole oval uh around uh earth's magnetic coal uh will be energized all around. So, so, um, the strongest stuff is usually around midnight uh either local or sort of magnetic ignite we call. Um, but uh anywhere around that oral oval, you, you're likely to see more energetic aurora, if we've got the right conditions in the solar wind.

JVN: Now, it can you ever like think that it's not gonna be that good, but then just like all of a sudden something just happens?

DON HAMPTON: Oh, yeah, yeah. Yeah. So, so you can remember, you know that that satellites just one point, you know that we're measuring that solar wind, it's a good indication of what's happening. But, but you know, the solar wind has more structure than that. So there can be an area over here that has the right magnetic field and we just didn't see it in there. So, yeah, there's sometimes we're out there watching and think, oh, nothing's gonna happen. But sure enough, uh the, the, the aurora kind of kicks in. It's pretty funny, before we had that satellite, we, we just have to sort of guess what, you know, we knew that maybe there was a, a storm coming. Uh we'd sit out at our, one of our sites called Poker Flat. And to get out there, you have to drive over this pass called Cleary Summit. And, and we, we had this long standing uh uh phenomenon we call the Cleary Summit effect where you sit out there for three or four hours, nothing happens, you start to drive home, you get to Cleary Summit and all of a sudden the sky opens up and it's like, well, I wish I was still at Poker Flat taking measurements of this.

JVN: But could you still take measurements at the summit or no?

DON HAMPTON: Well no, I mean, the instruments were out there and this was before we had, you know, internet out there and, and do things locally and the nice thing now is most of my cameras are just, you know, they're automatic, they're just running all the time and I don't have to be out there, but I still like to go out and watch the aurora when I can.

JVN: Who is like, do we…because, I mean, there's like, aurora scientists in Alaska, Finland, sweet. Like everyone's got like, geophysicists like aurora, like experts who, like, do we know who's like the most active, like who gets the most auroras per night like, and do we know?

DON HAMPTON: Uh so, um, it depends on latitude because the, the, the, the activity is sort of the, this distribution of activity most of the time it's like just sort of average activity. And so, you know, Fairbanks does pretty well if, if we've got sort of KP 2 or 3, we're gonna see aurora here. But that's the same thing. If, if you go to Yellow Knife in, in Canada, they're gonna see the same thing. If you go even Eastern in Canada, you can see the same thing.

Uh, then it just becomes what the weather is like, right? So if, if you pick the right latitude, uh, you just got to worry about the weather and the nice thing, you know, Fairbanks in the fall, we get a fair amount more clouds. But in the spring, like now we tend to be less cloudy, although, like, you know, the next couple of days it looks like it's gonna be a little cloudy and some snow, you know, just weather, weather patterns happening. Um, but, you know, I, I think as long as you're in the right part of the auroral oval, in terms of latitude; North, South, you're gonna, you're gonna see if it's clear, you're likely to see some aurora every night.

JVN: So, what's the right latitude again?

DON HAMPTON: So it's about 65 degrees where we are. Um, and now that's magnetic latitude and that changes a little bit, uh, as you go East and West. So in Canada it actually drops a little bit further South. So, like 62 degrees North in Canada, you're likely to see aurora quite a bit. Uh, and when you get over to Europe, it's about the same, the interesting thing everybody thinks. Oh, Russia's got a whole bunch of stuff to the North. But, uh, it turns out the way the magnetic field is oriented. They're kind of, it's kind of tilted away from Russia. So you've gotta, you gotta have sort of more active stuff to see stuff in Northern Russia.

JVN: Oh. So, really, it's like Canada, U.S., uh, Greenland…

DON HAMPTON: Iceland, Iceland is pretty common.

JVN: Iceland and then Finland, Sweden, Norway.

DON HAMPTON: Northern Scandinavia is kind of the place to see it on a regular basis, you know, from night to night. Now, these big storms, that's, that's when people get very excited because then people in Minnesota and, and New York State or Vermont or whatever can start to see the aurora and then there are really, really big storms, uou know, people in Kansas and Texas are seeing aurora.

JVN: Now because I've been because of my little app, like, I can see like the cameras that are like kind of in like the auroral like latitude that you were just saying, why is it, it sometimes like, it'll just be going off in Sweden or whatever. But then like by the time it gets here, even if it's clear, it just like misses, like, is it just something about like the way that like the magnetic, the magnetic um or our, our magnetosphere just like miss the lines, like when it's like making its way so then you just don't see it?

DON HAMPTON: Well so, so I didn't mention earlier, but the magnetosphere is clear of this teardrop shape, right? You know, so the front side, it's like when you put, you put a rock in a stream, you get that sort of bowel shock in the front and you get that stuff behind there. So the, the best aurora happens when the magnetic field lines you're on are back in that tail of that teardrop. And so, so yeah, the, the local, very active aurora can be fairly localized. And so it, it may happen in Sweden and we're sitting here with, you know, not much going on. Uh and by the time we rotate around to that, that same orientation, maybe the solar wind has changed and has, has died down. So, so there's, there's both a uh you know, a geographic aspect of it, but there's also a temporal aspect. So you have to be, it's kind of the right place at the right time thing, you know. So, you know, it's very frustrating when you see, you know, Finland's getting great aurora and then it dies down and we don't get much. It's kind of frustrating.

JVN: But what was, what was it like to like, what was it the like KP or whatever, like, um not last night, but the night before and then like on, because it was like, what did I get here? It was like Thursday night and then I think Sunday night were the two really big nights.

DON HAMPTON: Uh So, yeah. Yeah. Well, actually, yeah, Saturday night I think was the, was the big night because I was, I was at Poker flat doing another campaign and I thought, well, it's clear it would be nice if we could see aurora, but we got done at midnight, I went home and then I looked the next day at 3:00 in the morning, it just went crazy

JVN: Because we were up that late, like, we were late, like, because we were waking up, like, every 30 minutes to check.

DON HAMPTON: Right. And that, and that was a KP 6 or KP 7, I think it was. Yeah. Yeah, that was, that was, that was a big storm and, and, and you did see differences there. If you look at the movies again, there's a lot of that red emission in there and there was really tall rays and that's pretty common for these big storms, especially in Alaska. So

JVN: So we saw a really big one?

DON HAMPTON: You did! You did!

JVN: Oh my God. Uh I mean, do you think it's gonna be big tonight? And maybe it won't be so cloudy?

DON HAMPTON: Uh, unfortunately it looks like it's gonna be cloudy. But let me take a look at the solar wind is, is moderate tonight right now, but it could change. Uh Let me take a look at the…

JVN: It's just so cloudy because I've really been like, I've been like all over that. I've been all over that forecast like every hour just giving consistent clouds.

DON HAMPTON: I'm sorry about that.

JVN: It wasn't cloudy last night for like two hours, but I just couldn't stay awake because my body was like, girl, like, I've just been like waking up every 30 minutes. Like, all night for the last, like, four nights trying to see…

DON HAMPTON: That takes a toll for sure.

JVN: I mean, you know, it is hard. It's like, I'm like, I'm tired. What does the aurora tell us about the earth's atmosphere? Like, what does it tell us?

DON HAMPTON: It doesn't help much with what happens down here, you know, in terms of global warming, that sort of thing. It, it's really, it's really a region of uh research we call space weather. Um and that's becoming more important because, you know, there are more satellites up all the time. I mean, you know, I have a starlink at home and so there are thousands of starlink satellites up there and they're affected by what we call space weather. Um your, your GPS signal can be affected by space weather. If you want to talk to a, uh you know, a geosynchronous satellite, you've gotta, you've gotta go through this region in our upper atmosphere called the ionosphere. And so uh aurora is part of the space weather and, and what it does is it changes the density of charged particles in our upper atmosphere. You know, we, we live in, we live in a really special place we're in between this, you know, solid rocky earth. We've got this nice atmosphere and most of the atmosphere where we live and

do most of our daily lives is uh no charge particles. I mean, they're all tied up, you know, in atoms and molecules and so they're sort of all around neutral. As soon as you get above about 100 kilometers, about 60 miles up, everything beyond that is what's called a plasma, which means it's got a significant number of charged particles. Um and, and you know, 99.99% of the universe is this plasma. So, so aurora is a way to a cheap way to study plasma because we can observe it sort of for free with a nice camera on the ground. And it also makes sense now because we've got satellites we need to talk to, um, if we have aurora that actually heats up the atmosphere and makes it a little bit thicker up there. And even, even where the satellites are going, there's just a tiny bit of atmosphere and, and now satellites are moving pretty fast and if you want to avoid having two satellites bump into each other, you need to know where they're gonna be on the next orbit and that change in that atmosphere can change that timing a bit. You know, and, and they're moving at eight kilometers per second, you know, you know, six or seven miles per second, that's not miles per hour, that's miles per second. And so if you change that timing by even like a quarter of a second, that's a couple of miles difference, right. And so that can make a big difference in whether you're going to have a near miss with another satellite or not. So, so what we're doing now in terms of aurora is not just understanding what's going on. It's like, ok, this aurora is part of this big energy input from the space weather. How does that affect our modern technology? You know, and, and uh you know, we, we're trying to avoid uh cases where there might be some catastrophic consequences.

JVN: Is there any like new instruments that are like helping you um you guys understand auras or like predict them more or something like what's like the buzz in aurora research.

DON HAMPTON: Well, you know, so the the it's, it's sort of been this, this constant improvement in the imaging technology. So I, I do mostly optical stuff and, and, you know, I started back in ‘87 doing this stuff and the difference, the difference between ‘87 and now is just, it's just amazing and that's, that's largely been driven by this sort of uh commercial, I'm sorry, consumer grade uh uh advances, you know, the cameras you can get like your iPhone. I mean, you took a picture of the aurora with your iPhone, right? If I wanted to take a color picture of the aurora back in 1987 this was like a $200,000 camera. Yeah. Yeah, I mean, because just the technology back then was not as mature. So it's really changed. So, so, and, and, and that's the cool thing is, is the cameras you can buy off the shelf that, you know, a Nikon or a Sony or something like that. And, and people are taking pictures of the aurora have actually found new and interesting things that, uh, we had not noticed just because we're not, you know, we weren't keeping up with the technology to be able to see what was going on with the aurora. So this phenomenon, people are calling Steve and then there's some other new things that are going on uh were found by, uh uh am I mean, photographers, they're amateurs.

JVN: What’s Steve?

DON HAMPTON: So it's a, it's a region sort of South of the aurora. Well, at least in the Northern hemisphere, it's, it's more towards the equator. Uh and it's this funny, it's this interesting glow. It's, it's sort of this, uh people call it mauve. It's, it's sort of a purplish pinkish glow. Uh it turns out it's not precipitation like we, you know, I'm sorry, electrons coming down and, and we call that precipitation. It's actually just very, very high uh temperature electrons bumping into the atmosphere there. And it actually creates not specific colors but sort of a broadband, uh you know, uh uh uh uh broad set of colors that you can see uh with the

cameras that we're looking at. And, and that's something people knew that that uh phenomenon was going on. But people had not been able to see it optically until these uh photographers kept finding it and saying, hey, what's this? And we were going, well, we're not quite sure yet, but now we, I think we understand that somewhat better.

JVN: And that's called Steve?

DON HAMPTON: Yeah. So, so the, the people who, um, did it were big fans of, did you ever see *Over The Hedge*? No, the, the car, it's a car. It was a cartoon and they actually made a movie out of it too. It's about these animals who, you know, they're living in the woods and, and they wake up when, when, you know, after hibernating all winter and there's this hedge. Um, and then there's a, there's a, um development on the other side with all these houses. And so the animals are confused by what this hedge is and they say, well, it looks friendly, let's call it Steve. So the, the photographers like this, this uh cartoon and they said, well, let's, let's call this thing Steve because it looks friendly. But we, we, we actually have an acronym for it now, it's a, we call it an bacronym where we, we, we took the letters and, and change it so strong thermal…uh what is strong, strong thermal emission velocity enhancement is what we call it. So Steve.

JVN: And so that's basically like not the particles like kind of streaking down, interacting with ours. It's just like them, just kind of like running into it, bumping into it and it's like more static?

DON HAMPTON: Right. Just, just because the the electric field in that region and the charged particles uh really heat up the atmosphere in that region.

JVN: So where's the Steve zone?

DON HAMPTON: So it's, it tends to be a few degrees South of sorry, a few degrees equator. So we assume there's some in the Southern hemisphere as well uh of of the region where you're seeing the precipitation creating the aurora. Now, it doesn't happen all the time. It only happens in certain, in certain conditions but uh during solar max, like now we're seeing it fairly, fairly commonly. So…

JVN: Ok, so '87 was like a really good year if I do say so myself like that was, yeah, I was introduced into the wild. What was like your most like, like what were like your biggest auroras that you've ever seen? Like, have you ever like measured the biggest one that you saw? And like how intense was it? Like how it was like the most rare one you ever saw? Like, what would like did you ever get like stuck in a trail in Fairbanks? And you're like, fuck, I need to get towed out and I'm scared.

DON HAMPTON: I've certainly gotten stuck in Fairbanks. Uh so I was, I was doing some measurements in 1989 and there was a very, very large KP 9 storm in 1989 and that was, it was so, and that was, I think one of the previous times people in Texas have been able to see Aurora. There was certainly people in Kansas. Um but it also turns out again, I was talking about space weather. When you get these large storms, you get large currents in this ionosphere that can induce large currents in power lines and, and pipelines. And it turns out uh one of the uh uh uh um what do you call them transformers in the Quebec power grid, uh had so much current going through it from this aurora that it actually burned out, it failed. And that sort of triggered this whole sort of cascade of failures in the Quebec power system.

And so the Quebec power system was out for like six or eight hours until they could get it back online. And that was due directly to an auroral event.

JVN: But then they were able to really see it and the light pollution didn't get in the way. So, like all of Quebec was treated to like a stunning like…

DON HAMPTON: That was, that was, that was a good part, you know…

JVN: Montreal was just like, wow, these are like our food spoiled, but it's fine because these auroras.

DON HAMPTON: Exactly. And, and it was also very important because it saved my master's thesis. So that, that was important too.

JVN: What did it look like? Did you see that one?

DON HAMPTON: Yeah. Yeah, I've got pictures again, like, like what you saw it was these very, very tall rays and Alaska, you know, we were kind of on the Northern edge of it but, but it was just, it was just more grandiose and, and bigger than kind of the, the more subs storms that we, we tend to see in Alaska. So, yeah, it was impressive.

JVN: What colors was it giving you?

DON HAMPTON: Again, it was, it was a lot of that red, that deep red that you can see and it was bright, that deep red was bright enough that you could actually see it. But then, you know what saved my master's thesis. I could also see some oxygen iron emissions which you don't normally see, or are not very bright. And I was trying to measure those and it was very bright in that and I was able to see them. So yeah, so every everything that you, you know is there but maybe not see all the time all of a sudden really started to show up.

JVN: What about the purple color? Have you ever seen the purple color with your naked eye?

DON HAMPTON: So the, the, the pink Laura border or the purple Laura border is there quite often. And then if you get uh sunlight on the upper atmosphere while the aurora is happening, you'll get to see that sort of purple uh uh upper atmosphere and that's sort of this nitrogen emission that's being excited by the sun, but also enhanced by the aurora as well.

JVN: So the purple is more of like sunrise or sunset auroras?

DON HAMPTON: You tend to see that when the sun is shining on, yeah. So it tends to be near twilight either, either in the evening or…

JVN: Have you ever, what about, um, if, what if it's like, daytime but it's like KP 75. Like, could you ever see one, like, when, like, in the daylight?

DON HAMPTON: So, it turns out it's very, very hard. If you have a very, very special instrument that can measure just, just the wavelength of the aurora, you might be able to see it with that instrument. Uh there are some emissions out in the infrared beyond where our eye can see. So you wouldn't be able to see it. But we're, we're working on a project now to look at some near infrared emissions. And we think with a balloon up above maybe 30 kilometers, you know, 20 miles up or so with uh this camera, we might be able to see some auroral emissions during the daytime. So when the sun is actually up or certainly during uh

heavy twilight. So, so there are ways of doing it. Uh but, but unfortunately even just KP 75 it's unlikely to see it from the ground.

JVN: What about like um like a like does a full moon, our scientists that, that taught us in Finland said that a full, like you can still see them, even when there's a full moon, it's like a wives tale that you can't see it when there's a full moon.

DON HAMPTON: You can see them. So the issue is if there's, if there's some thin clouds or whatever, then the full moon will, will bright, you know, make those very bright and it's harder to see them. But you know, some, some of the prettiest pictures you see of aurora, uh uh make use of the full moon because you got the full moon illuminating the snow in front of you, but you get the aurora in the sky. So no, you, the the the full moon does not keep keep you from seeing aurora and auroras happen all year long. So we've got radars that can actually measure the ionization in the upper atmosphere in this ionospheric region. And we can see that aurora is happening and, and the ground magnetometer can see that the magnetic perturbations from the aurora. So we know they're happening. We just can't, I just can't take a picture of them because the sky is just too bright from the ground.

JVN: Do you know what, like the furthest South aurora of all time time is or like do scientists like have a or not, I guess for the South because like, obviously there's like there's Southern lights but like the most middle, like the most equator centric one?

DON HAMPTON: Close to the equator. I don't know, I, you know, I think, I think the ‘89 and the two, there's one in 2003 and some of the recent ones, I don't know. Uh uh to be honest, I have not looked to see, you know, how far South people were seeing that. Now there in, in 1859 way back when, before we had cameras looking at the aurora, there was a very, very large solar storm, it was called the Carrington event. And, and this, this is sort of one of these space weather events. So back then, you know, they didn't have big power lines, the the big long linear structure with cables we had were telegraph lines and people were being shocked by uh the currents being run through those telegraph lines. So probably then there were probably, I think there were some reports of Texas seeing aurora down there and maybe even further South, I'd have to go back and look. But uh that one was a very, very large event and we're, you know, we haven't experienced one, maybe that large in quite a while now. So we're kind of, we're kind of wondering when that's gonna happen again?

JVN: So like, is there a lot of people who kind of were like me, it's like giving *Twister* but like, aurora is like, they just wanna be like storm chasers but aurora chasers like and does everyone get stuck on Henderson Pass? Like or was I the first in the like um like, like what's like the aurora chasing community like in Fairbanks? Like, is there one?

DON HAMPTON: Oh, yeah, there's, there's quite a strong one. Yeah. And, and, and uh so I know that they're there because, you know, I run a camera at Poker Flat. Uh, and, and, uh, when that camera goes down all of a sudden I start getting emails and saying, why isn't the camera running? So, yeah, they, they use the cameras, they use whatever resources they have. And it's great because they, they are, they are well tuned into what the solar wind is doing and what they can expect from, you know, from NOAA sites and stuff like that what's gonna go on. They also know what the weather patterns are and know where are the best places to go. So, yeah, so there are, there are amateur, uh, aurora chasers. Uh, they take, you know, and some of them are out there to take pictures, some of them out there just to gawk at the aurora. And then there are companies now that, uh, that actually do tours for

aurora. So you come up and you stay with them and they put you in a van and they drive you out, uh, to where they know you're gonna be, have the best view of aurora. So they'll either watch the weather and drive further North or further East or further West. Um, and, and based on what they know the aurora is gonna be doing, try to get you in the best place to watch the aurora. Yeah. So it's, it's, it's, it's quite, it's quite a, quite a, a vibrant community up here.

JVN: I wonder if we should try to hire one for tonight.

DON HAMPTON: You can try. Yeah, I mean…

JVN: I want to see them one more time before we leave.

DON HAMPTON: They may be booked unfortunately. So they get booked out, you know. So, you know, it used to be that in the winter time, you know, our tourism just kind of closed up in Fairbanks. But now the aurora tourism is almost as vibrant as the summer tourism.

JVN: And I'm definitely not venturing out alone again. I'm never, we are never relying on GPS.

DON HAMPTON: No, no, no, no. They don't always know what the conditions of the roads are, that's for sure.

JVN: So, like how does that like aurora chasing like does, does everyone just like have like walkie talkies or something if it's like bad service? Like, do you guys just have to show up for each other if someone gets stuck or something? Like, does that happen? Like, is it dangerous or was that just us because it was our first night?

DON HAMPTON: I think it's a lot of social media and, and uh, you know, knowing people and so texting. So as long as you stay within cell range, which is, which is kind of right around Fairbanks and along the highways you can do okay. Um, so, um, yeah, I think, you know, pe people watch out for each other and, and have a good network as far as I know.

JVN: If someone's planning a trip to Fairbanks, like to try to see them, like, because we kind of stayed, like, outside the city a little bit, like, but not, like, forever away, just like a little bit away. Like, if you were, like, right in the heart of Fairbanks, like, do you still see it or is it harder with like, that level of light pollution or…?

DON HAMPTON: So, there are a couple of places in town. Uh, so we have one place called Creamer's Field. It's a, it's actually a wildlife refuge. And then, and then to the North of that, there's a big area where they do a lot of dog mushing. So that whole area has got a lot fewer lights. And so if you can go there, uh, in town, you know, and that's, that's a 5, 10 minute drive from anywhere in Fairbanks, that's good. Uh, you can drive East to West of town and find places as well. But no, even in town, if it's very, very bright aurora, you'll be able to see it. Now if, if you're, if you're just waiting for it and you get these very sort of what we call quiet arcs, it's, it's harder to see those, uh, before it gets really active. So, so it, you know, it, it is better if you can have really, really dark skies if possible. But if you, if you don't feel like venturing too far out, you can go and places in Fairbanks and see the aurora.

JVN: So like Nasa's uh aurorasaurus, right?

DON HAMPTON: Aurorasaurus, yup.

JVN: Is NASA like your guys' like biggest thing like when like for people who are like, because, because you're like, wait, let me see because you're um you are literally a wait because, because, because what was like, how did like, what is your like, you study like geophysics, geophysics?

DON HAMPTON: I mean, we're, we're, we're, most of us are physicists and, and we, we uh um we do what's called space physics, which is concerned with this plasma I talked about earlier. Um And, and uh yeah, I mean, space physics is, is kind of similar to astrophysics. It's just, we're not maybe not as high energy and we're just kind of localized to the earth. Yeah. So we're, we're, we're, we're geophysicists but we're space physicists is sort of specialized thing. And, yeah, so, and so, yeah, and, and you know, we need, we need funding for research and a lot of it comes from NASA, a lot of it comes from National Science Foundation NSF as well. So those are our kind of uh big groups that we work with closely and we work with other scientists to get funded by them or actually are at NASA or NSF as well.

JVN: Yes, NASA. OK. So what, so what's the deal with the Aurorasaurus ? Is that like a dictionary for aurora or something?

DON HAMPTON: No. So uh the Aurorasaurus was another citizen science uh um uh uh initiative uh come up with a, with a colleague of ours named Liz McDonald. Um her original thing was uh to sort of uh um comb through Twitter tweets from Twitter um to look for cases where it says, oh, we're seeing aurora right now, right? And so, and so they had, they had uh uh filters to look at all the tweets that were coming in and say aurora, aurora, aurora. And now a lot of times, you know, that was like Aurora, Colorado or Aurora um you know, uh Illinois, but sometimes it really was, hey, I'm watching the aurora right now. So you could go on to Aurorasaurus and look through tweets and say was this person actually see the aurora and that way the idea was to be able to sort of map out where the aurora was happening. And they were able to compare that to some of the models that uh NOAA puts together to predict where they might see the aurora at the time. And then also just kind of get the statistics of where it's going on and, and then what they do is they also come up with a, a prediction based on all those tweets and what people are reporting uh saying, hey, you know, uh Fairbanks, you might be able to see the aurora soon and they'll send out a little email to you and, and that's a good uh that's a good, you know, uh prompt for somebody maybe to go outside and look.

JVN: Oh, my God. Thanks Aurorasaurus. So, um, because, I mean, you've been studying this for a little while. So, what, what mysteries still remain like what do you want to learn? What do you think? Um, like, yeah, like what, what mysteries still remain?

DON HAMPTON: Well, so, you know, like I said, we're finding sort of new things like this Steve thing was kind of new. Um and, and there are a couple of other things that come up recently, the sort of sort of flashes we see sometimes of, of uh um of a sort of brighter aurora that we see. Um the, I think, I think the big thing we're trying to understand is is we still don't know exactly uh when that, like these subs storms are really triggered, right? You know, that there, there's something happening out in the magnetosphere and it's a big magnetosphere and we've got, you know, NASA satellites going through, but they gotta be in the right place at the right time. So we're still trying to figure out exactly when that happens, you know, and again, that's, that's sort of just you just general knowledge, you wanna understand that. But also from a space weather prediction center, you know, uh um uh standpoint, you want to be

able to predict maybe when that's gonna happen and, and understanding that better would be able to do that. So we've kind of gone from, you know, what is the, you know, what is creating the aurora what, blah, blah, blah, to understanding how it's affecting the upper atmosphere and how it affects modern society as well. So, yeah, it's, it's fun.

JVN: Well, you go, you guys follow, Don's work in the meantime. Are you, do you talk about this stuff on X? You like, do you share about your stuff on um, like, like from the, from not that past, but the flats like that place where you have your camera running, where can people follow?

DON HAMPTON: Yeah, Poker Flat has a, has a uh I think they have a Twitter stream and a, and a Facebook. Uh uh The Geophysical does that and when something new comes out, they definitely want to tout it. Um You know, we've, we've, we've got, uh and we've got several young researchers coming in now who are doing some interesting things with machine learning and that sort of thing. So, yeah, it's, it's a pretty exciting time. Uh you know, and like I said, this, just this explosion in, in new and modern technology is making things uh uh very exciting.

JVN: Don Hampton, thank you so much for coming on Getting Curious and teaching us about our gorgeous Northern lights.

DON HAMPTON: Absolutely! I'm happy to do it.

JVN: Thank you so much. Did we learn what northern lights are? Honey yes, they are literally like electrical discharge in the atmosphere. It's giving neon sign of the atmosphere. Uh also Southern lights are a thing. And also I saw a gigantic like KP 6 or 7 storm that was major like I am Helen Hunt, this is *Twister*. I am an aurora chaser. Oh my God. Um also I did learn about like all of the variables about what you need in order to see the to see auroral activity like the magnetic field of like our magnetic field and the magnetic field of the solar wind has to be aligned in order for you to actually get to see it. Um And I also thought it was like that the aurora, like that teardrop shape that he was talking about, like if you get the aurora app, uh you'll be able to see like where it is each night. But that part I thought was really interesting and that it's like if you're within that longitude of those countries, like you're probably gonna get to see it, weather permitting. Um but then still, it's like they are going to be subsets of places where it's going to be bigger or less big. Um and things can just happen that could prevent you from being able to see it. So it is like The Elusive Chanteuse of like natural phenomenon.

Um and also like what's like on the frontier of like aurora is like uh like what causes those sub storms. So here's what I'm really curious about. Now, first of all, Alaska has really got me, you guys, it's a gorgeous place. It's, it's even, I don't know what I was expecting, but it's just so incredibly stunning. I can't get over it. So all things like Native Alaskan culture um and then also like Alaskan history um like I just, I wanna learn all about that and also like those conjugate points like for the Northern and the Southern points. Oh my God. And also our eyeballs. How do we perceive color? Uh so interesting. II, I can't even get over it. Um OK. Northern lights. I feel complete. I feel gorgeous. And thank you so much for listening to Getting Curious. Thanks for supporting our show. What natural phenomenon are you guys curious about? Let us know and thanks for listening and we love you so much. We'll see you next time on Getting Curious. You've been listening to Getting Curious with me, Jonathan Van Ness. You can learn more about this week's guest and their area of expertise and the

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