AirSpace Season 6, Ep. 2: Ice Ice Baby

Music in and under

Nick: Welcome to AirSpace from the Smithsonian's National Air and Space Museum. I'm Nick.

Emily: I'm Emily.

Matt: And I'm Matt.

Matt: Last season, we told you all about Venus, Earth's spicy twin. But today we're talking about the fraternal twins of the outer solar system, Uranus and Neptune.

Nick: And just like siblings, Neptune and Uranus always seem to be trying to one up each other in terms of awesomeness. Because of Uranus, we discovered Neptune. Uranus has a lot of moons, but Neptune has a moon that has active plumes. Because of Uranus rings we suspected Neptune's rings. And thanks to the Voyager 2 mission, we were able to get a closer look at both planets

Emily: Even though we've been able to learn quite a bit about these planets. There are still a ton of questions that we can't answer because these planets are so far away, so hard to see and even harder to get to.

Matt: We'll tell you what we do know about these outer solar system siblings today on AirSpace presented by Olay

Music up and out

Matt: So Uranus and Neptune for many, many years, most of human history, we had no idea that these two planets existed. We had seen all of the other planets orbiting around, moving through the sky. It took us forever to figure out where we were in that system and where everything was going. But it wasn't until we actually had the technology of the telescope and modern astronomy that we actually discovered Uranus and Neptune. They are the two most modern planets.

Emily: Modern? 1781 is modern?

Matt: It is! It's it's squarely in the modern era as far as historians are concerned.

Emily: Sure.

Nick: Yeah. I guess that is what brings us to the Dewey days of 1781 in the courtyard of one Mr. William Herschel.
So he, he sees this through his telescope and he thinks he's discovered a comet and he writes to his astronomy buddies and he goes, Look everyone, I discovered a comet and I know it's a comet because when I look at it through my telescope, it's blurry. The stars are just pinpoints of light. But this is resolving differently and it's moving through the sky. So I've discovered a comet. I'm going to call it a comet. And they're like, You mean it's moving like a planet? And you can see it through your telescope and it looks more like a planet than a star. Do you think maybe you've discovered a planet? And he goes, No, it's a comet. Two years. He insists it's a comet. Eventually really, every other astronomer in Europe convinces him it's a planet. And he actually says "By the observation of the most eminent astronomers in Europe, it appears that this new star, which I had the honor of pointing out to them in 1781, is a primary planet of our solar system."

Matt: So he deleted all the earlier tweets and he put the new tweet up, pinned it.

Nick: Precisely. Yeah, yeah, yeah, yeah. They had to, they had to really hassle him into the honor of having found a planet.

Matt: Yeah, yeah. And you know, this is all happening taking place in, in Britain at the time of the American Revolution. Right. So on the other side of the pond, King George, who sang all those wonderful songs in Hamilton, Herschel is dedicating a new planet to him.

Nick: Yeah. So Herschel, who has been hectored into acknowledging that he found a planet, receives a stipend from King George. And when everybody says, 'What are you going to name your new planet Herschel?' He says Georgium Sidis, which is Latin for George's star. His rationale, and I'm not making this up is if we don't name it after King George, how will people remember when it was discovered? That that didn't pass the smell test with the astronomical community. There were some other suggestions but eventually the astronomical community settled on Uranus. Now, that brings us to Neptune. How do we find Neptune? Guys?

Emily: Well, my favorite part about how we discovered Neptune is that we discovered Neptune because we were spending a lot of time looking at Uranus. We talked a lot about how planets kind of wander through the sky at a totally different rate, which is why Herschel at first thought maybe he found a comet, because stars are pretty steady. Right? We know about all the other planets closer to us. They kind of wander across the sky. So checking out Uranus, trying to learn more about Uranus, it was never quite in the right spot. And they were like 'Okay, well, it's never quite in the right spot. Clearly, there's a gravitational force on Uranus that we're not accounting for in our math.' And so everybody was like, well, what could that possibly be? It's probably another planet that we haven't found yet. So they essentially found Neptune because they were pretty excited about how they had found Uranus. And so like, what can we learn about Uranus? Oh, wait, there's Neptune.

Matt: So ultimately it was in 1846 where this hunt was finally concluded and the French astronomer Urbain Le Verrier and British astronomer John Couch Adams actually discovered Neptune.

Emily: Well we sound like we think we're experts on Uranus and Neptune. We're not really. So we scheduled some time to talk with Dr. Heidi Hammel about Uranus and Neptune.

Dr. Heidi Hammel: My name is Heidi Hammel. I'm vice president for Science at AURA, which is an organization that runs giant telescopes for the U.S. government. And I am a planetary astronomer by trade with a special interest in the planets Uranus and Neptune.

Matt: Uranus and Neptune are classified as ice giants. But if you don't know what astronomers mean by ice giant, it's kind of confusing. We're not talking about ice you skate on or put in your drink.

Heidi: We were trying very hard to communicate that. These are not small gas giants. They are not small Jupiters. They have a fundamentally different internal structure. That's kind of why we latched on to this fridge ice Giants Fran Bagenal always said we should be calling them water giants, not ice giants.

Emily: And oh, man, could you imagine what that would make people's brains?

Heidi: I know, Then then they get so confused, they think it's oceans and, you know, and they're like, oh, so

Emily: and we already have ocean worlds

Heidi: I know, I know. Well, the ocean worlds, of course, came later, so maybe we should have gone with ocean worlds first and then we could have claimed it. But, you know, they aren't quite ocean worlds either, because, again, that gives people this idea of water and and the surface with water. And that isn't what these planets are like. There aren't surfaces that you can land on and on the ice giants. We could never land a spaceship on an ice giant because they have very thick atmospheres and those thick atmospheres transitions somehow into this briny, watery ammonia.

Emily: Mushy? Is mushy a good word?

Heidi: Yeah. You know, we use terms like mush balls. You know, we're out of a realm that we can make direct linkages to earth based phenomena because the pressures and temperatures on these ice giants, especially as you go deep into their interiors, are nothing like what we experience on the surface of the Earth.

Nick: She's uh, Heidi's got a point when I hear Ice Giant, I kind of picture big balls of ice, and that's not the case. They're more like slush puppies.

Emily: Yeah. And this is the whole term ice giant is in kind of I don't want to say it's in constant flux, but it's in flux again, there's people who love it and there's people who hate it.

Nick: Who could hate the ice giants? Truly?

Emily: Well, certainly nobody. It's it's you know, it's all about classifications. And if you've been following Pluto's journey through Planethood, you'll understand that people are really passionate about how we classify the objects in our solar system.

Nick: So slush, Slush giants, we'll call them slush giants for the moment. They're a little bit like the gas giants, but they've got more ice composition. But there's no surface to

speak of just under the atmosphere, like it's you got to go way far down to find a ‘there’ there and that's what they've got in common with the other giants, right?

Emily: Right. I mean, an ice giant. I'd like Heidi's description of the peach,

Heidi: The ice giants are more like a peach where you do have a core. And don't think about the fuzzy part of the peach, but think about how thick the fruit is. You know what I mean? It's kind of a big, thick part of it. It's more like all of the peach, except the pit is like the atmosphere.

Emily: What is important is that the thing that the big planets, Jupiter, Saturn, Uranus, Neptune have in common is that they don't have this solid surface, just as you said, Nick. What makes the ice giants different is that while they don't have ice ice the way my beloved icy satellites do, they have this layer sort of between the rocky hard core and the gaseous atmosphere. That layer in the kind of middle-ish area is sort of a mushy, slushy-ish kind of phase. And you're talking about watery types of elements

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Emily: So there's still a lot that we need to learn about these places, but they're there's stuff we know, right? I mean, these aren't just things that we haven't been studying since they've been discovered. There's there's a lot of things we know. Partly their compositions, right? We know about the water and the ammonia and the methane. They have really pretty similar compositions. My favorite part about Uranus, though, is it rotates on its side. So its North Pole faces the stinking sun, which means all its moons rotate around its equator, which face the sun as opposed to like resting on the dinner plate, which is the rest of the ecliptic plane.

Heidi: The main difference, of course, is that Uranus is knocked over on its side. It rotates with this rotation axis tilted 98 degrees from perpendicular to the plane of the solar system.

Emily: It's important to understand, while its North Pole is facing the sun, it's still rotating on its axis. Right. We rotate on an axis, right? That axis goes from the North Pole to the South Pole. And so we rotate on that axis. Well, so does Uranus. Except for Uranus’ axis is perpendicular to that, right? So its North Pole is facing the sun and it's

spinning around its North Pole, which makes it… it's such a wonky thing and it makes it really, really special.

Matt: Yeah. And one of the other kind of trippy things about these two planets is that even though they're very similar in what, you know, they're composition, what they're made of. And even though Neptune is further from the sun than Uranus. Neptune is actually a hotter planet. Like it defies, you know, your sort of common sense.

Heidi: We know that Neptune has a great deal of internal warmth that is emanating from it, you know, three times as much heat as you would expect from a ball of gas at its distance. So, you know, a lot of internal heat coming out. Uranus, on the other hand, seems to have none. Now, is that intrinsic to these two planets or is related to their evolutionary history? We don't know the answer to that.

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Nick: So we've talked about the planets themselves. Emily, are there moons around Uranus and Neptune?

Emily: Yes. If you've been a long time listener of aerospace, you will know how I feel about Neptune's moon Triton. And Triton is special because it was born out near Pluto. So it's part of the Kuiper Belt. It's originally a Kuiper Belt object. It was captured by Neptune. And what makes Triton special is it's an icy moon. Obviously, it's an icy moon because I'm talking about it. So we think it has a liquid water ocean in its subsurface and it's geologically active. Voyager 2 flew by Triton and discovered plumes. I could go on, but what makes Neptune's System of Moons really different is that it has one large big moon that wasn't born around Neptune and a bunch of other little siblings that kind of are weirdly shaped. Uranus's moon system is totally different in that it's five large moons and then some other smaller orbits around it. And each one of these five moons are really unique. They're very special. They were or are geologically active. They're really exciting. And if you remember us talking about Uranus being tipped over on its side and rotating sideways all of those moons are still orbiting around Uranus' equator. So all those moons are orbiting kind of in a weird plane. And so whatever tilted Uranus over, tilted the whole system over. Or the system became that way because Uranus got tilted over. We don't know.

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Heidi: Uranus has a beautiful ring system. Unlike Saturn's rings, though, which are quite broad and and very filled in for the most part. Uranus rings are more like hula hoops.

Nick: So Saturn's got rings. Neptune and Uranus do, too, it turns out. And if we needed a telescope to discover those planets, hooooe boy, the telescope that we needed to discover the rings.

Matt: Yeah, to find Uranus' rings and to make a lot of other important observations. They took a large cargo airplane back in the seventies, retrofitted it with a high powered telescope and other observational equipment on board, and flew it high in the atmosphere so there was less interference, and scientists could see things further away more clearly. One of the things they did discover was those rings which are so faint, right, that you really do have to get out past most of the atmosphere in order to see them.

Emily: I love the story of the discovery of Uranus rings because it shows kind of this accumulation of observations once you know that you should be paying more attention to a particular point in space. So when Uranus rings were discovered in 1977, it was really exciting because there was going to be a follow up from the Voyager spacecraft flying by Uranus in 1986 to both take more observations, but also validate the observations that led to the discovery of Uranus rings. And when Voyager confirmed that there was rings and even found more rings, as we've continued to explore the ice giants, we've continued to devote newer technologies and newer resources to look back at these places and say, okay, did we get them all? And so even when Hubble was available, which was after Voyager 2, Hubble found more rings around Uranus because it was like, okay, well where there's a handful, maybe there's even more. And now that we have these better technologies, what else can we see?

Nick: And as happens with this particular family of planets, because we found rings around Uranus, the suspicion was maybe Neptune has rings too. But it wasn't until Voyager 2 that we knew that there were rings around Neptune as well.

Heidi: Neptune like Uranus, has rings that are more like hula hoops, except that the hula hoops are not uniform in density. There's clumps in the hula hoop where it's very thick and then other places where it's very thin. And so we call those thick places arcs, ring arcs.

Emily: Think of, think of Neptune's clumpy hula hoop rings as like instead of a hula hoop drawn with a solid line. Think of it as a hula hoop drawn with a dashed line. So Neptune's rings are called arcs because there's these clumpy sections along the hula hoop that make these arcs. And then there's these places where, like, you kind of can't see any ring. And this is why Voyager 2 had to confirm the presence of the rings, because some people using Earth based telescopes would sort of look at Neptune and be like, 'Yeah, there's totally a ring there. I can totally see a ring there. You can see a ring there. Right?' And then somebody would go back and try and confirm the observation, and they'd be like, 'There's no ring there. I don't see a ring. There's no ring there.' And it was because of these ring arcs. So because you had so many positive and negative detections coming from Earth based telescopes, you had to make that confirmation with Voyager 2 so lucky Voyager 2 was on its way.

Matt: And even though there haven't been any additional missions to these ice giants since Voyager 2, you know, there have been a lot of discoveries made anyway with newer space technologies, including, you know, orbiting telescopes and even improved ground based telescopes.

Emily: Well, and now we have a big new shiny space telescope. Heidi and other scientists are really excited about the kinds of data that we're going to get back from the JWST, the new big, great honeycomb shaped space telescope that's going to not only tell us about the universe we live in, but they're also going to be able to tell us about things closer to home. But nothing's going to beat a space robot in orbit around a planet. We all know how much I love the Cassini mission. And it had a very incredible lifetime in the Saturn system. And it's only those kinds of spacecraft that can do the kind of science that Heidi and others really want to get done so we can really, truly understand these planets, not just from a quick little fly-by.

Heidi: We want an atmospheric probe. We want an orbiter to truly answer all those questions. And that's hard to do. But, you know, I'm willing to do the work, you know, just let let us loose. There's a lot a lot of young people, who want to do it, not only for the planets, but for the moons and the rings and magnetic fields. That's what I love about that kind of a mission and orbiter mission. It's got something for everyone in the planetary science community.

Emily: We need these really big system orbiters that are going to drop probes in through these atmospheres and look at the interiors of these planets, because each one of these

planets has its own little system and a lot of the science, a lot of the open questions we have just are never going to get answered until we send a robot out there.

Matt: Right. Like the Kepler Space Telescope has shown us that not only do we have these ice giants in our own solar system, but out there in the galaxy, right, there are other ice giants around, other stars and in fact, you know, they're actually along with the gas giants, very common planet types out there, you know. Maybe even more common than the Earth, like planets that we think of as being, you know, the best planets.

Emily: So far, as far away as Uranus and Neptune are and as hard as they are to study, those exoplanets are even harder to study. So it makes sense that we really need to devote some time and resources to understanding the gas giants in our own solar system, because there are a heck of a lot closer than those exoplanet

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Matt: Heidi had actually been studying Uranus since before that. She was already one of the world's experts on Uranus.

Emily: So Heidi was pretty much studying these cool ice giants before they were cool

**Silence*

**Nick laughs quietly*

Emily: Somebody better laugh, laugh into the microphone, into the microphone.

**Matt laughs*

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