Astronomy Cast Episode 194

Dwarf Planets

Fraser: Astronomy Cast Episode 194 for Monday June 14, 2010, Dwarf Planets. Welcome to Astronomy Cast, our weekly facts-based journey through the cosmos, where we help you understand not only what we know, but how we know what we know. My name is Fraser Cain, I'm the publisher of Universe Today, and with me is Dr. Pamela Gay, a professor at Southern Illinois University Edwardsville. Hi Pamela, how're you doing?
Pamela: I'm doing well. How are you doing, Fraser?
Fraser: Good! I hear you've been infested with groundhogs.
Pamela: We have a giant (just one) rodent of unusual size eating in our backyard, and it's really, really cute.
Fraser: Awww, it's adorable until they tear your whole yard apart... make it unusable.
Pamela: Yeah, we've already got moles and squirrels and yeah, I'm not worried.
Fraser: Just give it back to nature. Alright, well, in 2006 the International Astronomical Union demoted Pluto out of the planet club. But they also started up a whole new dwarf planet club with Pluto, Eris, and the asteroid Ceres as charter members. Let's find out what it takes to be a dwarf planet and discuss the current membership. Alright, well now the first episode of Astronomy Cast was us talking about why Pluto is no longer a planet. I was hoping we could do an update... you know, Pluto back in the planet club...
Pamela: Nope.
Fraser: Nope.
Pamela: Nope.
Fraser: So then it's really kind of official... let's follow it up, let's set it in stone. Dwarf planets... there have always been dwarf planets... there will always be dwarf planets.
Pamela: Well, there haven't always been dwarf planets, but...
Fraser: We're rewriting the history books now... alright, well let's not talk about the history... so let's provide a shorter version of what happened in 2006.
Pamela: Well, at a meeting of the International Astronomical Union it was decided that they needed to figure out what to do with all of these giant icy bodies in the outer solar system.
Fraser: Right. This was really triggered by the discovery of Eris... which is bigger than Pluto.
Pamela: ...which is bigger than Pluto. Even NASA called it the 10^{th} planet. So there's a lot of people up in arms... "No, there aren't ten planets!" My favorite argument of all is if we start calling all of these icy bodies planets, then there's too many planets for the children to memorize. I'm like... but there's 26 letters in the alphabet, and we make them learn those... there's 50 states in America and we make them learn those...
Fraser: But I can imagine with the success of the icy body finders... the Kuiper Belt object discoverers... there was going to be more and more of these objects, so you would have from 2006 to 2010 there were 10 planets, and then from 2010 to 2015 there were 11 planets.... As the telescopes get bigger... especially, you can imagine what James Webb might be able to turn up... so it's just a matter of time before they find more and more and more... are there 15 planets... 20 planets...

Pamela: That starts to become a matter of what makes a planet a planet. And this is where you start to get to logical arguments. The "well we can't have that many planets 'cause the children can't memorize them," that's not a rational argument, people. But saying, well Ceres in the asteroid belt was considered a planet for 50 years before we started turning up other asteroids and realized oh, it's part of a family of objects... let's call the whole family asteroids. Well, Pluto was the first one found in the Kuiper Belt, and now we're finding all these other chunks of ice, and well it's now the Kuiper Belt. Demoting Pluto is sort of like demoting Ceres, we just realized "oh, it's not really a planet, it's part of this family of specific objects." The analogy I always use is that if aliens were cleaning up our solar system and sorting things into bins, Jupiter, Saturn, Uranus, and Neptune—they'd get thrown in a bin. Then all the rocky stuff would more or less get thrown in bins. And all the icy stuff would more or less get thrown in bins, and who knows what they'd do with Mercury, Venus, Earth, and Mars... but those'd probably get their own stand-alone bin as well. So, yeah... we have all this icy stuff... not really planets... no, not physically planets... but for a certain class of objects—they're all round, they're in hydrostatic equilibrium, and Haumea isn't exactly round because it's spinning wildly... but it could be round if someone stopped it spinning. So now we look at physical characteristics.
Fraser: Right, so in 2006 the IAU decided to do something about Eris, and once and for all... so they came up with their three rules for planets.
Pamela: Right... something has to be in hydrostatic equilibrium, which means the sucker is round.
Fraser: So it has to be a sphere... so something like the Mars moons, Phobos and Deimos, they're not round... they're asteroids... they're, as you call them, spuds. So those, even if they were going around the sun, they would not count.
Pamela: And the way they make an exception for Haumea is they look at it and acknowledge that if it were left alone, the self-gravity of the object would cause it to collapse into a round shape.
Fraser: So that's rule number one, right? It's gotta be round.
Pamela: Rule number two... it needs to be orbiting the sun. So if you have a giant object, orbiting Jupiter, does not count as a planet.
Fraser: And we do... we have Ganymede which is bigger than Mercury. So were it orbiting the sun, it would be a planet.
Pamela: But it's not, so it's a moon.
Fraser: So it's out. But it is in hydrostatic equilibrium... but it doesn't orbit the sun, so it's out.... not a planet. So the third rule... the kicker...
Pamela: The kicker is it needs to have cleared out its own orbit. And this is where a lot of the controversy comes in. If you took Earth and put it out at the distance of Pluto, the huge volume of its orbit... the earth just wouldn't be able to clear that out. So even the earth, in the Kuiper Belt, wouldn't count as a planet. So this is where folks like Alan Stern start looking at the definition we have for a planet and start saying... no guys, we need to rethink this. We need to start classifying things based on the characteristics of the objects. And here's where a lot more controversy comes in... what do you start requiring? And no one really knows. And everyone's just sort of grasping at straws at the moment. But we know that we need to change the definition because the whole "must be orbiting

the sun" part kinda means that things orbiting Eta *?* and 51 Peg and all these other stars out there, they technically aren't planets.
Fraser: But you can just change it to "orbiting their star."
Pamela: Right, but still that's a change in definition. So while we're rewriting the definition, let's start to consider what other things do we need to put into the definition to make planets incontrovertibly planets.
Fraser: Right. What if they orbit a pulsar, right? What if they orbit two stars in some strange way... anyway, yeah I can see that it might get more complicated. Ok, we've got the three rules... it's gotta be a ball, it's got to go around the sun, and it's got to have cleared out its orbit. What are the current dwarf planets?
Pamela: Currently, there's five known dwarf planets.... five acknowledged dwarf planets. We have Ceres hanging out in the asteroid belt, and then of course there's Pluto and its demoted self in the Kuiper Belt. We have Haumea and Make-make, and then there's Eris. These are five very, very different objects, and there's two more that a lot of people group in, but we don't know enough about them. There's Quaoar, which is utterly unpronounceable, and Sedna; and we just don't know if these objects are in hydrostatic equilibrium, so we need better data to figure these two out. But, they probably are.
Fraser: And these objects are actually quite different... especially Ceres compared to the Kuiper Belt objects. So let's take a look at Ceres first.
Pamela: Ceres... it's a rock. It's nearby; it formed right along the frost line of the solar system. It's on the inside of the frost line; so when it formed, it actually formed without any volatiles. It looks like a moon. It looks a lot like our own moon. It has craters, it has variations in color on the surface; but it's hanging out in the asteroid belt, leering over all the potatoes in its sphericalness.
Fraser: Right. Ceres is the largest object in the asteroid belt by far... it's got a third of the mass... but it hasn't cleared out the space around it.
Pamela: No... no. And it's not actually that big once you start comparing it to some of the other dwarf planets. It's radius is 487-ish km. along the equator. It's 455 along the pole. It's a lot bigger than all the other asteroids, but it's not the biggest thing out there.
Fraser: And the cool thing is that NASA's Dawn spacecraft is going to be getting to Ceres in 2015 after it explores Vesta next year.
Pamela: Right. So this means that we're going to have two more dwarf planets getting explored in the not too distant future. And we also have New Horizons, so apparently we're focused on sunrises and sunsets and horizons with these missions. We have New Horizons going out to visit Pluto...
Fraser: Also in 2015...
Pamela: Yes.
Fraser: That's going to be a big year.
Pamela: And they're looking for another target for New Horizons to go to after Pluto, so hopefully we're going to be able to get two icy bodies for the cost of one satellite.
Fraser: So then we talked about Pluto [Ceres?-ed.], so we can kind of jump out then to take a look at Pluto... which is very different from Ceres.
Pamela: So Pluto... it's a system... it has moons... it's surface is pretty much solid ice. This is an icy body... it's atmosphere comes and goes. When it's closest to the sun, it has a very, very diffuse atmosphere. Then that atmosphere snows out when it's at its most distant, and then its a nice atmosphere-less icy blob. One thing that I heard Mario Livio

say once that I'm never going to forget is you can't call Pluto a planet because if you gave it... and I'm paraphrasing... you gave it the orbit of a comet, it would grow a tail in the inner solar system and that's not the way a planet should behave.
Fraser: That's just not civilized.
Pamela: No, not at all. So, it probably has a rocky core... It is denser than water... but it has this icy outer layer, and yeah, if you brought it close to the sun, the sucker would grow a tail. It's density is only 2×10^3 g/m^3. That's twice the density of water, so it's still not that rocky of a rocky body.
Fraser: And Pluto has a moon that's a significant portion of its own mass. In fact, the two objects, Charon and Pluto, they orbit a common center of mass. And so for a while there, there was a possibility that Charon would be considered a dwarf planet all on its own.
Pamela: Right. That was part of the argument actually... what do we start calling all of these things? They were throwing everything in... if it's round, we're going to call it a planet. So all of these smaller bodies were also getting considered, and Charon, they kicked out. And, this is where they start looking at secondary parameters. They start looking at the densities, they start looking at the... well, is it round because it hasn't been beaten up that much, or is it round because this is its default shape due to gravity. With Charon, if you beat it up enough, it would stay in a deformed state.
Fraser: Oh, ok... so it just hasn't been beaten up enough and so it's got a fairly circular shape.
Pamela: Right.
Fraser: Ok, and then the next object out is Haumea.
Pamela: Right, and this one is just interesting in so many different ways. So first of all, it's not round, as near as we can tell. Now we don't have any perfect images of it. Instead, what we look at is how does it's brightness vary over time. It's thought, based on watching light curves as it rotates, that it's probably much longer on one axis than the other, and this implies fairly fast rotation. Now, at the same time, because we don't have any direct images, it could also be just another one of these strange objects that has two extremely different albedos. We've seen this on some of the moons out there. But it's thought, no, this is actually something that simply has very different dimensions in the two axes... almost a factor of 2 difference. So looking at it, we make this guess at the shape, we make this guess at its rotation period, and as near as we can tell it's a fast-rotating oblong object, and it probably just got the tar knocked out of it in a collision early on in our solar system's past. Now this was the second giant object found out in the Kuiper Belt. It also had a fairly controversial beginning. The people who are normally acknowledged for finding it are Michael Brown and his team. But if you actually look at the official notice for it, it's kind of confusing because it's acknowledged as having been discovered at Sierra Nevada Observatory in Spain, but then it's given the name that was submitted by Michael Brown's team. If you read back about what happened, Michael Brown had been observing it, along with the rest of his team, and as they were pulling together all of their data, they nicknamed it Santa Claus, and they observed it multiple times... they were holding back with it and some other objects to have a really big release. They'd written an abstract that was submitted to a conference, and somehow a Spanish team got wind of it. They looked at the conference abstract... they did some Googling... they found the observing logs, which give you a sense of where on the sky the telescopes

were pointed. Apparently Michael Brown and his team didn't know their observing logs were public. So the Spanish team, knowing an object had been discovered, knowing the rough area on the sky where it had been discovered, went back through some archival images... back to 2003 archival images... found the object in the archival images. They did follow-up observations based on the positions of Michael Brown's team's observing logs... rediscovered the object using the predictions and then sent in their results to the Minor Planet Center. Now this put the Minor Planet Center in a horrible position because... well, initially, Michael Brown sees a discovery of one of his objects, kind of does the "oh, no, other people are looking at the same things I am..." rushes Eris, which is bigger than Pluto and really important to him, to publication. And this was like on a Friday afternoon, and a bunch of us looking at the press releases were like, "Wait, huh? Press release Friday afternoon? This makes no sense, there's some story behind this." And Michael Brown... he took the high road... he congratulated the Spanish team. He admitted... Yeah, some folks looked at my observing logs and that's why I rushed Eris to publication... really sorry to step on your thunder. But the Spanish team didn't acknowledge that they were the ones who looked at his observing logs, and he figured that out later. He ended up lodging a complaint, and so the announcement and the naming of this object really got held up in the politics of trying to figure out who do we give credit to. They ended up giving credit to both teams by naming the observatory from the one team and using the name from the other team. It was David Rabinowitz who came up with the name. It's the matron goddess of the island of Hawaii where Mauna Kea Observatory is, where their team was observing it. But it was just a political mess. As near as anyone can tell, having public data logs is a really bad idea when you're discovering objects. The Spanish team read the observing log, realized that no one had published the discovery yet, and stole it.

Fraser: ...is the allegation.

Pamela: Is the allegation.

Fraser: Right. We have no proof either way. So next is... so you're saying it's Makemake, or not?

Pamela: I think it's Makemake... it rhymes with bake...

Fraser: Right. Makemake.

Pamela: Right, it's not a fish dish... I keep trying to turn it into one...

Fraser: Mmmmm. This one was discovered by Michael Brown and team.

Pamela: Yes. This one was announced back in 2005. It's the third largest known dwarf planet... it's a big ol' object. It's on a really weird orbit... it comes in as close as 38 ½ AU and goes out as far as 54 AU, so it's really elongated. It's a rock... well, actually it's a block of ice.

Fraser: It's a block of ice... it's a snowball.

Pamela: It's a block of ice. Yeah, it's not the most exciting of them...

Fraser: Yeah, there's not a lot that's very interesting... so let's just move on.... to Eris.

Pamela: Well, Eris... this is where we get into the big controversy... For almost a year it got referred to as the 10^{th} planet, even by NASA.

Fraser: Or Xena...

Pamela: Or Xena... that was the other one that was particularly cool... it's code name was Xena and it has a moon, so it's code name for the moon was Gabrielle. I think everyone was really hopeful that silliness would prevail, but...

Fraser: But it didn't.
Pamela: No!
Fraser: Although the name that they came up with was pretty great.
Pamela: The name that they came up with was pretty great. It was almost kind of sad, though, because Michael Brown's daughter was born at the same time, and her name was Lillith. Rumor has it that he wanted to name it after his daughter, but that wasn't allowed. So the dwarf planet's name is Eris. It's moon's name is Dysnomia, and we were lucky to be able to find it when we did. This is again an object that has an extremely elongated orbit, comes in to about 38 AU and then goes out to 98 AU, and it's not visible out there. It's orbital period is actually 557 years. Brown and company... Brown and Trujillo and Rabinowitz... they were lucky to catch it when they did... 'cause it's on its way in right now, it's on some of its closest approach, and we get to observe it, and then it goes away for awhile.
Fraser: So it gets as close as 37 AU and as far away as 97 AU... that's a big difference between its closest point and its most distant point.
Pamela: Yeah.
Fraser: And it's got a moon, and it's bigger than Pluto.
Pamela: And it's a lot bigger than Pluto... that's cool. It's dense, it's big, and it's on a really weird orbit... this is one of those objects that leads people to really start trying to figure out what could cause these weird things. But there are weirder objects lurking out there still awaiting final classification.
Fraser: And so with the five dwarf planets, and 2 or 3 provisional ones... the two Sedna and Quaoar are pretty close. Maybe with better observations, seeing their orbits for longer, maybe discovering a moon... that'll make a big difference.
Pamela: Right.
Fraser: But it really is just a matter of time before more of these large Kuiper Belt objects are turned up.
Pamela: And that's what's so amazing is so, for instance, Quaoar... it's a rock. It's a known rock. There's a great post over on Emily Lakdawalla's blog... The Planetary Society Blog... titled "Quaoar: A Rock in the Kuiper Belt" where she pulls a bunch of these images where they were looking to see its moon and trying to figure out its mass. It's moon is named Weywot, which is just fun to say. So they're out there, they're trying to figure these things out, and as they look at them... Quarhar... we don't know where this rock in the Kuiper Belt came from, and that leads to a lot of questions about dynamics. We look at Sedna that has this really weird orbital radius of 509 AU, this is another object we were lucky to catch when we did.
Fraser: That's five times further away from the sun than Eris.
Pamela: Right.
Fraser: And more like ten times further away than Pluto, but happens to be at the closest point of this really elliptical orbit.
Pamela: And so we look at these things and start wondering well what gravitationally could cause something like this... and there's some folks working on planetary orbits who figured out, well, there could easily be an Earth-sized object, a Neptune-sized object, a Jupiter-sized object, out thousands of AU from the sun just waiting to be found. And of course there's the eternal search for Nemesis, a small dwarf star that's orbiting our sun,

waiting to be discovered. So there could be more things that we'd recognize as planets waiting to be discovered, just not reflecting a whole lot of light.
Fraser: So it's really just a matter of time... so we'll be updating this show, somehow, as we go... In ten years when we have episode 500 of Astronomy Cast... we'll have probably more dwarf planets by then. Especially with the launch of the James Webb Telescope, so stay tuned. Alright, well thanks a lot, Pamela!
Pamela: Sounds great, Fraser. Talk to you later.