Episode 43: **Throwing Snowballs**

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Written by: *Pamela Gay*
Disembodied Voices: *Travis Searle & Pamela Gay*
Engineering & Production: *Travis Searle*

Pamela: Welcome to Slacker Astronomy; a podcast about astronomy and just about anything else that floats over our heads.

Travis: Every week or so we will bring you a recent news event from the world of astronomy. And when there is nothing to report, we will go outside and make giant dirty snowballs from the snow, ice, dirt, sand and sludge that make up New England sidewalks in winter.

Pamela: While shoveling off my driveway, and my sidewalks, and the snow on my Jeep, and on everything else I was faced with a weird "Only in a city" kind of problem. The snow has to go somewhere, and the yard just isn't big enough to hold all the snow without spilling, so which way can I throw the snow?

Travis: Hey, at least you have a yard! My snow had nowhere to go at all.

Pamela: Well, there's still one direction left.

Travis: And which direction is that?

Pamela: When you can't go anywhere else, you can always go up.

Travis: Hmmmm, snowballs in space. Not a bad idea. We can take all the snow that got dumped on the east coast, compact it all together, and send it into space. … So, some places got 30 inches, some got 3 inches, but if you figure there was an average of 10 inches across New Jersey, Southern New York, Connecticut and Massachusetts, that's … that's…

Pamela: Once you remember Rhode Island, that's about 24 cubic kilometers of snow! Assuming you can figure out how to launch it into space, you'd have a nasty, pollution filled, hunk of ice roughly the size of comet Hyakutake!

Travis: Gives you new respect for Nor'easters!

Pamela: Or less respect for the size of comets…

Travis: Either way, up seems like a good place for snow, but how to we keep something that big from getting in the way of the shuttle and other satellites?

Pamela: We can always do what Jupiter does with snowballs.

Travis: That sounds suspiciously like the lead in for a real news story. So, what does Jupiter do with snowballs?

Pamela: Well, according to press releases put out by Keck Observatory and the University of California at Berkeley, Jupiter seems to be stashing comets in its leading and trailing Lagrange Points.

Travis: Yup, that is definitely the lead in to a news story. I guess there will be no giant snowball creation this week.

Pamela: Oh, I'm sure there will be plenty of snowball making, but it won't be us making them. We have several icy stories to talk about, involving icy objects in our solar systems and others.

Travis: Well, I guess I should take off my jacket and gloves and plan to stay at the mic for a while.
<sound of taking off winter cloths>
So, what were you saying about Jupiter's LaGrange points?

Pamela: Astronomers from the University of California at Berkeley recently used the Keck II Telescope to study an object previously listed as "Asteroid Patroclus."

Travis: This so-called asteroid is in Jupiter's L5 Lagrange point -- a place located 60 degrees around the Sun from Jupiter on its orbital path.

Pamela: Lagrange points are places were the gravity of two objects balance out. There are Lagrange points associated with the Earth and Moon, where the gravitational pull of the Earth and Moon pull with the same strength, and there are also Lagrange points between the Earth and Sun, Saturn and the Sun, and…

Travis: And, yes folks, you guessed it, there are even Lagrange points between Jupiter and the Sun…

Pamela: There are 5 different LaGrange points associated with each pair of objects: 3 on the line connecting the objects, and 1 60 degrees ahead and 1 60 degrees behind the smaller object in it's orbit.

Travis: We have a diagram showing all the Lagrange points in the shownotes for this show.

Pamela: Objects getting too close to these Lagrange points can actually get trapped in these areas of equal tugging. In what looks like a really strange gravitational dance, objects can and do actually orbit these null points.

Travis: And Jupiter's leading and trailing Lagrange points are swarming with spiraling space junk.

Pamela: These trapped objects are called Trojan asteroids.

Travis: In general, the term asteroid refers to rocky and metallic objects that failed to form into planets. These are objects that would sink when put in a lake.

Pamela: And in general the term comet is reserved for objects made primarily of frozen water and gases that are loosely bound together. These are objects that would float when put in a lake.

Travis: So, how exactly does one determine the composition of an object located half a billion miles away?

Pamela: Personally, I generally look the numbers up in google

Travis: But I'm guessing that wasn't a possibility for our friendly neighborhood U-Cal Berkeley Observers.

Pamela: Not exactly – This group, lead by Franck Marchis, had to make many careful observations of the so-called asteroid Patroclus. This object is actually two objects that are each about 70 kilometers across and are located about 680 kilometers apart.

Travis: If you can measure the orbital period of two objects, and you know how far apart the objects are, you can calculate the mass of the system.

Pamela: And if you know the mass of an object and the size of an object, you can figure out the density of an object.

Travis: And if you can figure out the density of an object you can guess what it is made of. You may not be able to tell the exact composition, but you make a calculated guess.

Pamela: Marchis and his team used the Keck telescope and it's extremely hi-resolution Laser Guide Star Adaptive Optics system to make their observations. This system uses a special sodium laser to excite atoms in the atmosphere. These excited atoms form an artificial star that the telescope uses to carefully focus the telescope.

Travis: Anyone who has tried to focus a backyard telescope has probably turned a little knob that moves either an eyepiece or a mirror in and out, thus changing the distance between the optics in the telescope. Still, no matter how well you focus, you probably noticed that stars still appeared to swim a bit and twinkle.

Pamela: This swimming / twinkling problem is due to our atmosphere, which is in constant motion.

Travis: To correct for the atmosphere, telescopes like Keck II actually flex one of the telescope's mirrors to compensate for the atmosphere's motion. Bright stars, including artificial stars, are used to figure out what the atmosphere is doing, and how to correct things.

Pamela: Basically, if a star looks like a teardrop, the mirror is flexed to make the star look round. These corrections are done many hundred times per second and allow astronomers to make more tightly focused images than would be otherwise possible with our atmosphere.

Travis: Using Keck II with it's adaptive optics, Marchis and his team measured the orbital motions and thus the densities of Patroclus and its companion and determined these two objects have densities less than water, and appear to be similar in composition to comets.

Pamela: Kuiper Belt objects - the icy bodies out near Neptune - also have comet-like composition, and it's thought that some of the comets are actually Kuiper Belt objects that were gravitationally flung into the inner solar system.

Travis: A recent article in the journal Nature by French theoretician Alessandro Morbidelli suggested that icy comets would have been captured into Jupiter's Lagrange points during the epoch of heavy bombardment in the early years of the solar system. We actually reported on this in an earlier episode. Kudos to

the listener who can write in about which it was.

Pamela: It's always nice to report on things that turn out to be true.

Travis: It is a goal. Even Slacker's need goals. We don't need to attain them, but we should have them.

Pamela: If we attain our goals, will we need to rename our show?

Travis: Nah, we can just claim it was luck rather than effort.

Pamela: Okay, I'm willing go to with that.

Travis: So, through hard work, Marchis and his team provided evidence for Morbidelli and his colleagues' theories and demonstrated that the Trojan Asteroids just might need a new name that reflects their icy reality.

Pamela: And if the Trojan Asteroids need a few new friends, we're willing to ship off our New England snow and send it their way.

Travis: Patroclus wasn't the only icy body in the astronomy news, and I think this Trojan Icy Object will have no shortage of extrasolar friends.

Pamela: Another team of U-Cal Berkeley astronomers, lead by Paul Kalas, used the Hubble Space telescope to find rings of icy bodies around two other suns.

Travis: This brings to 9 the number of stars known to have icy, dusty belts. Our solar system's Kuiper Belt is a normal part of a solar system, and objects like our Trojan Ice Balls may be common

Pamela: Until now, the Kuiper-like belts found around other stars were all in systems that were very young – only tens of millions to 200 million years old. At this tender age, debris disks aren't yet fully formed and stable.

Travis: The new belts are in systems more than 300 million years old, and have reached a stable adulthood orbiting stars very similar to our Sun.

Pamela: While the first extrasolar planets, and extrasolar asteroid belts and debris disks were all very different from our own, we are slowly beginning to find things that look more like what we're used to seeing here at home.

Travis: In addition to the discovery of these new Icy Belts, scientists also found an ice planet.

Pamela: Located 20,000 light years away, this newly discovered world orbits a red star smaller than our sun. The planet is 5 times the mass of the Earth and orbits its home star roughly every 10 years.

Travis: If you lived on this Icy Planet, you'd experience daytime temperatures that averaged a whopping 220 degrees below zero as you slowly froze beneath the a faint red Sun.

Pamela: Faced with a choice of dieing a melting death on one of the hot Jupiter's found orbiting way to close to their Sun's for comfort, or dieing a slow frozen death on an Ice Planet, I'll take an ice planet any day.

Travis: This new world is currently named OGLE-2005-BLG-390Lb, but we at Slacker Astronomy would like to suggest that a more interesting name for this world might be Hoth. It's a cold planet, it could be a base for the rebel alliance, and it would certainly freeze any Jedi Knight lost on its surface after dark.

Pamela: But since no one ever listens to our suggestions, expect to get hear the name OGLE-2005-BLG-390Lb being talked about wherever extrasolar-planet geeks go to gossip.

Travis: This ice planet, which *I* still think should be called Hoth, was discovered in a new way – It's light became detectectable when it was gravitationally lensed by a foreground object.

Pamela: Gravity can bend light in the same way that lenses bend light, but the geometry has to be just right, with a nearby mass being exactly along the line of sight of a far away mass.

Travis: When the masses line up just right, light that would normally fly off toward some other part of space is bent toward observers here on Earth. This extra light makes the object appear much brighter than normal, and brighter, in astronomy, means more easily seen.

Pamela: This is the third planet found with this technique, and by far the smallest.

Travis: And with several different teams viewing the heavens for microlensing events, this is surely not the last planet to be found with this technique.

Pamela: So, for this week, with ice on the ground, ice near Jupiter, and ice seemingly everywhere else, we leave you with these warm words:

Travis: It is better to be hit with a comet's worth of snow, then with a comet. Happy shoveling out all you East Coast listeners, and stay cool, stay warm, or stay whatever temperature your hearts desire.

Pamela: So long and thanks for all the ice, you Keck and Hubble and other telescope wielding astronomers. Clear Skies and Clear Bandwidth. On behalf of Travis and Aaron, this is Pamela Gay.

Travis: This has been Slacker Astronomy, a three-person collaboration for you, for fun, for the voices in our heads.

(oceanside clip)