Astronomy Cast Episode 227 for Monday, April 4, 2011:

The Big Dipper

Fraser: 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 are you doing?

Pamela: I'm doing well. How are you doing, Fraser?

Fraser: Good, a little under the weather. We were going to record yesterday, and I was just totally out of it, but it was like a one-day cold, I'm not sure, but I'm feeling miles better, so...

Pamela: Oh, I'm so glad. It seems like this is the summer when everyone is getting sick.

Fraser: Well, the worst thing is when both parents are sick, you know, so me and my wife are sick and the kids are like, "why are you guys so lame?"

Pamela: It's bad when your own kids say you're lame.

Fraser: Exactly! "Come on, we want to do something." "…uhhh…watch TV…leave us alone." So we'll be a lot better tomorrow, and definitely a lot better today. So…alright, well, we wanted to spend a few shows talking about some of the most recognizable constellations in the night sky. We've chatted about Orion, and now we're going to talk about the Big Dipper, also known as Ursae Majoris, or the Great Bear: apologies to our Southern Hemisphere listeners. Alright, Pamela, so do you know where the Big Dipper is?

Pamela: I actually do.

Fraser: Yeah, me too. If you live in the Northern Hemisphere if you've ever looked in the sky, you've got to know where The Big Dipper is, but you

know it's one of those constellations – same with Orion – it is, on the surface, really recognizable, easy to find, and yet, as we're about to get into, it's got inner vagueness.

Pamela: Yes.

Fraser: So then can you give a little bit of history, or like, where should we start on this one?

Pamela: Well, I think the place to start is: there's probably already people out there going, "The Big Dipper is not a constellation."

Fraser: It's an asterism -- there! Ha! There! Gotcha! Yes, but it is part of Ursae Majoris, so…

Pamela: And the thing is many cultures, the main stars, the seven stars that we see as The Big Dipper are what are the constellation in just not Greek constellation sets, so if you were to instead look at this in Chinese or Japanese or Korean, it would be The Seven Stars, and that's fine. It's actually, in eastern Asian tradition, it's The Northern Dipper, so our Big Dipper is a constellation if you just "switch your longitude" of looking up.

Fraser: What? What?

Pamela: Well, so, I've been watching TV, there's "switch your latitude" commercials -- I'm saying, "switch your longitude." Go to eastern Asia. It was a bad joke; it was a really bad joke.

Fraser: I don't have cable. I don't watch commercials. So right, but the, I mean, the shape again, I mean, you know you look at -- like I'm trying to think -- Gemini, Virgo, you know, Sagittarius…when you look at Sagittarius and someone says you know whatever it's supposed to be…it's a teapot.

Pamela: Yeah, it's a teapot.

Fraser: Right? You know, Gemini -- you can kind of understand it's like two lines, side by side; Leo there's a backwards question mark, ok, maybe that's a lion…

Pamela: But really, you're guessing when you see all of those things, and…Big Dipper, yeah!

Fraser: No question -- that is a dipper!

Pamela: Ladle, you could call it a ladle if you wanted to.

Fraser: Yeah, ladle, pot -- absolutely what it is describing…

Pamela: And the other thing that it gets named as which -- I think we live in the wrong culture to see it, but in Europe it gets referred to as the plow. And that if you actually think of the old-time, hand-pushed, make-your-life-suck plows -- it really looks like one of those.

Fraser: So then, what sort of history-wise, where did this…where did it come from? How did it become what we call Ursa Major and The Big Dipper?

Pamela: So there you start getting into pre-history. This is one of those problems with Astronomy is people have been looking up since before they knew how to write things down, and a lot of the constellations and all the different cultures date back to pre-history and it's kind of hard to figure out where they originally came from. With Greek mythology, Ursa Major is just one of the "bears" in the sky, and it's related to Orion the Hunter in some places, and it's cropped up in various ancient books, but you can't actually say who was the first person to sit down and say what it was, but if you look in Homer's *Iliad,* it's in there as The Bear, which men also called the Wain, and Wain has also in some places gotten tied to Charlemagne, and Charles's Wain, so that's one that just crops up all over Europe in slightly different ways, but I can't tell you exactly who the first person it was to actually figure it out.

Fraser: And the Ursa Major, the Great Bear in the Greek definitions of the constellations, it has other, as you said, it's The Plow in Europe, but different civilizations have given it different constellations, different mythology.

Pamela: Exactly. Exactly. Now where this one crops up, in some ways it's more interesting than talking about Ursa Major, is this is a constellation that has a star that if you look at it and you have really keen eyes and you're in

really still skies, you'll start to pick out it has a little buddy. This is Mizar in the handle of The Big Dipper. So when you're looking at the Big Dipper, you have the bowl, and then moving away from the bowl, you have the three stars that make up the handle, and the middle star of those three if you have really keen eyesight, you'll see there's a little buddy hanging out next to the really bright star, and that little buddy is Alcor, and this was an eye test to get into the elite military for a while, so while it's hard to track down exactly where the constellation came from, I find it fascinating that this may have been one of the very first eye tests around.

Fraser: And it's a great, easy thing to observe with a small telescope or even binoculars, you can see... Now is it actually like a binary star, or double star?

Pamela: Now when you say double star, that's just two stars that appear close together. These aren't stars that are orbiting one another or anything like that, but it does qualify as a widely-spaced double star. Now, the thing is these stars, if you keep looking at them better, they then split themselves apart again, making this a quadruple system because each of them are independently binary systems.

Fraser: And each independently are actually binaries, so they've got the stars orbiting each other.

Pamela: Right, so you have two stars that aren't orbiting one another that are actually not two stars -- that are actually four stars that appear as two stars until you get enough magnification and they split themselves.

Fraser: What does it take to see that? What kind of telescope?

Pamela: So, while they are both double systems, you can't actually split both of them. It's one of those unfortunate things where Alcor – it really… it's a spectroscopic binary, so if you look at it with a big telescope attached to a spectrograph, watch it over time, you see the lines dancing apart from the two different stars, but with your standard backyard system, you're not going to split it into two different stars. Mizar, on the other hand, all you really need is clear skies and a really good eyepiece on even a small backyard telescope, so I'd say pull out your handy dandy friendly 70 mm refractor and a 4 mm eyepiece, if your sky supports it, and you should be able to split those.

Fraser: Alright. So we've already picked out one of the stars, but there's a bunch more very interesting stars in the constellation, so do you want to start with any of them?

Pamela: So if you start looking at Ursae Majoris, and you look at Alpha Ursae Majoris, this is the star in the upper right-hand corner of the pot if you have the handle shooting off to the left, so imagine it as a nice friendly ladle, someone's holding and keeping stuff in with the handle to the left, pot to the right.

Fraser: Top front of the plow…

Pamela: Yes, exactly. So that is one of the brightest stars, but we're used to thinking of constellations as politely being: alpha's the brightest, beta's the next, gamma's the next, but with this particular constellation, they actually labeled things right to left and sort of didn't worry about what was the brightest or not, so if you want to keep track of which is which, you start at the upper right-hand star and go around in a clockwise direction and you get alpha, beta, gamma, delta as you go around. Now, when you're at the bottom of the pot, there's a couple of really cool [missing audio] objects right next to Merak, the beta star, the bottom right-hand, the part that digs into the dirt of the plow, or the bottom right-hand side of the dipper -- you have M108 and M97 just sitting there being stunningly beautiful in the field.o

Fraser: So yeah there's a bunch of stars, they're not individually as spectacular as the stars in Orion. In Orion you have Betelgeuse and Rigel and it's a party, but in The Big Dipper, Ursa Major, really it's about the objects that are clustered around the constellation itself . Many of the most famous Messier objects -- ones that you all recognize looking at pictures from Hubble -- are all located in this one constellation.

Pamela: And in fact the Hubble deep field is located near this particular object, so this is just like beautiful, glorious stuff all piled up in one place, just pick your telescope and you can decide how glorious you want it to be.

Fraser: So let's run down the list…so what can we find in this constellation?

Pamela: OK, so looking at the base of the pot you have M97 and 109, and M97…unless you have a lot of magnification, doesn't look all that glorious:

it's the Owl Nebula. I've tried observing it with a 30-inch and got an unimpressive blob of light on my CCD, but it's still kind of cool, you can see color with a camera on a moderately-sized telescope and you can actually see with that moderate-sized telescope that it is a circular blob that has two eyeballs on it.

Fraser: Right and this is why it's called the Owl Nebula. It looks like great big eyeballs -- with your imagination and the Hubble Space Telescope.

Pamela: Or if you just integrate, and integrate, and integrate, and take a very long exposure…I didn't do that.

Fraser: So what is it though?

Pamela: It's a planetary nebula. It's a star not too different from our Sun that at some point in its past puffed off its outer atmosphere, and that outer atmosphere is sitting there quite happily glowing in pretty colors.

Fraser: What's causing these "owl eyes" in it, though?

Pamela: This is actually one of the reasons for building the Hubble Space Telescope is planetary nebulae are just plain confusing. We don't know why they all look so amazingly different, and they have all of these different apparent structures, so something at some point interfered with the light getting to those parts of the nebula.

Fraser: But, I mean, you've got some of these situations like the Helix Nebula, and you've got these asymmetric outflows coming out of the stars – it's spinning, right? And so you could have this situation where inside it's just parts that are like darker material being sprayed out, or parts of it that are being cleared out?

Pamela: It's impossible to come up with a nice, clean explanation for this one because it has this beautiful symmetric shell all the way around, then it basically looks like an hourglass that has a dark bit to the left and to the right, but then that shell around it, so it's unclear what would cause it to not have a stripe all the way across the front. Why is it filled in in the center, but not filled in where the two eyeballs are? So this is where you end up with asymmetries that are just very, very hard to make sense of.

Fraser: Hm…OK, so that's M97, the Owl Nebula, and that's a rough one, so don't expect that you're going to see the owl eyes in your backyard telescope…but, look to Hubble for that one.

Pamela: So M108 is almost on top of it. They are very nearby in the sky and this is another one that isn't going to look fabulously glorious in your average backyard telescope. It's about nine arc minutes by 2 arc minutes, so it's big but not that big and it's going to appear pretty much as a fuzzy stripe across your field of view.

Fraser: Right. I mean it's a spiral galaxy that we're seeing edge-on.

Pamela: And it has amazing dust lanes, and you can actually see the dust lanes if you're using a 12-inch telescope with good magnification in a dark site.

Fraser: Right. So it's a really fantastic point of view from us to be able to see a galaxy that's relatively close and see those dust lanes that normally we don't see them when we see the galaxy face-on. Now we can really see that structure because we're seeing it from the side, but again from a backyard telescope point of view, it's not the greatest view.

Pamela: Right. So then now we have to jump over to the next star over, so now we're at the bottom left-hand star, the Gamma Ursae Majoris and right next to it -- again, thoroughly boring star, but right next to it is M109, which is a face-on spiral galaxy. Again, pretty small, pretty faint -- this one's about 11th magnitude, so you're going to need a fairly large telescope to be able to see it, but if you can see it. It's about 7 ½ by about 5 arc minutes in size and it has these glorious well-defined arms, and a bar across the center, so it's not all that different from what our own galaxy might look like, so when you look at M109 and you think, "Hey, that's what we look like to aliens..."

Fraser: Right, because the recent evidence is that the Milky Way seems to have these two spiral arms with this big bar in the middle. So it really is…I mean, a lot of the images that we see of what the Milky Way looks like is probably not what the Milky Way looks like.

Pamela: Right.

Fraser: It's only in the last couple of years that they've really started to probe what our own galaxy looks like, and it's more like this, and not those mini-armed galaxies.

Pamela: Yeah, that's just one of those things that really…we keep wanting to look just like Andromeda, and we're not. Andromeda is our big sister, and we're a little bit smaller in we're structured a little bit differently just like siblings don't always look the same. Now, as you keep going around the "drinking gourd," as it's talked about in African American history, you have to go up the arm and then if you can imagine an equilateral triangle with the two end stars of the handle, so Mizar, that great double-double we talked about, and Alkaid, the last star in the handle – imagine them as the base of an equilateral triangle, and at that top point, that invisible to the eye point of that equilateral triangle, that's where the Pinball Galaxy, M101, is located, and this is one of the most amazing things to image with a backyard telescope. It's not that faint – it's about 8th magnitude and it's absolutely huge! It's almost a ½ degree by ½ degree in size, and just sit on it for a few minute and all of these structures, all of these dust lanes…they start slowly coming out second by second by second in your CCD images, and it's one of the most spectacular things to look at in the sky.

Fraser: Yeah, now without a CCD can you…I mean, it's just a fuzzy bit, right?

Pamela: Actually, without a CCD it's…in a telescope you can see it, but none of these things that I've been talking about are visible without binoculars or a telescope.

Fraser: No, but I mean like even with a backyard telescope, but without a CCD, right?

Pamela: Oh, without that?

Fraser: So just when you're looking at it with your eyes, you're kind of just seeing a fuzzy bit.

Pamela: One of the things you run into is because it's so big, it doesn't have a lot of surface brightness out in its arms, so when you look at it by eye through a telescope, all you're going to see is the fuzzy core. And that's

OK; Andromeda's the exact same way -- all you see is the fuzzy core until you start exposing with your CCD or your camera.

Fraser: And what's going on in this galaxy? I mean, I know it's a pretty famous image, even the ones taken by Hubble.

Pamela: It's just a standard run-of-the-mill-but-close-nearby-large-and-stunningly-beautiful spiral galaxy, so it has star formation, it has open clusters, it has globular clusters around it, but you're not going to see those with your backyard telescope. It's just everything a textbook says a spiral galaxy should be, and I think that's one of the things that's so interesting about it is it has those well-defined arms like you want to see in a grand design spiral. They're not as prefect as you'd see in some of the barred spirals, but they're still nice, well-defined arms. It's tightly wound, you can see the blue color if you take a CCD exposure…it's just textbook.

Fraser: And it's big galaxy; it's about twice as large as the Milky Way. Alright, so let's move on…there's pair of galaxies, right?

Pamela: Right. So as you start moving away from The Dipper, you can use it to navigate to all sorts of different things in different directions, and nearby are M81 and 82, which M81 is a nearby spiral galaxy, and it's one of the nearby active, mean, eating, black hole-containing galaxies, so to find it on the sky what you want to do is go off the end of the pot and if you go straight up -- again we have the handle to the left, the bowl to the right. If you go straight up you're going to hit Draco, and if you go up hit Draco and go to the right, that's where you're going to find this pair: M81 and M82. Now, M82 – this is one that's famous for all of these stunning Hubble images that show it as a colliding system, where you see basically what looks like a plus sign of nasty material in a certain way. It's what's called a star-bursting system, so when you look at it in the Hubble images, what you see is a fairly normal looking disk, but then it looks like there's some sort of Phoenix springing from the top and the bottom of the image in the Hubble images. The material is actually quite red coming off the top and the bottom of the system. This is a fairly bright system, again, it's magnitude 8.4, it's moderate-sized 11 arc minutes by 4 arc minutes, and you can actually see that it has kind of a "dead bug" appearance…looks like a galaxy got squished on your eyepiece when you look at it through a large telescope on a dark, dark site. So find your friend who has a 20-inch Obsession and a

really good eyepiece set, and this is one that you can actually start to see the crazy structure of.

Fraser: I don't have one of those friends.

Pamela: Well, you need to go to more star parties.

Fraser: I guess, but uh, yeah, I mean, I think …so what's going on with M82 then? I mean, it's an active star-bursting galaxy, but what's going on inside of it?

Pamela: Well, this is a system that, as near as we can tell, it's probably gone through some sort of a recent collision and that's what we're witnessing is a starburst that was driven through something triggering the wild star formation…and tidal forces were involved distorting everything. It and M81 are close enough that they do affect one another, so it's gone through at least one tidal encounter with M81, and this caused material to get funneled into the galaxy's core. So here you have two systems nearby, they both have active galactic nuclei in their centers, the one of them came out much the worse for wear from the…it wasn't a head-on collision, it was what's called "galaxy harassment" when things get a little too close to one another and gravitationally muck one another up. M82 just came out much the worse for wear than M81.

Fraser: Yeah, I mean when you get a galaxy in this kind of situation. I know M82 has got like ten times the star formation as the Milky Way, so you know new stars are being formed at a furious rate.

Pamela: And the things is this is the type of system that when all of that wild star formation that's currently going on comes to a stop, this is the type of system that without gas left behind, could fade into being a red spiral – one of those things that we're now learning exist, but aren't like anything you read about in textbooks.

Fraser: I think that one of The Big Dipper's best uses is as like your "on ramp" to finding your constellations.

Pamela: That's entirely true.

You know, like, from The Big Dipper, you could find your way to so many other constellations, and I think one of the most important things for it is finding the North Star, so why don't we kind of wrap this up with using The Big Dipper to find the North Star.

Pamela: Well, and even if you can't find the North Star, finding The Big Dipper and following it by itself will take you north for most parts of the planet, or most parts of the Northern Hemisphere at least. In African American slave songs, they talked about following the drinking gourd to find your way north to find your way to freedom. And if you want to actually find, and you have dark skies…you can't find the north star in every city…if you want to find the North Star, you take the alpha and beta star, the sides of the gourd away from the handle, the sides of the ladle away from the handle and you follow them from the bottom of the saucepan up toward the top of the saucepan, and then go five times that distance and five times that distance will land you on a very faint, little, tiny -- in this vastness of the sky -- unassuming star that just happens to be located very, very close to the rotational axis of the celestial sphere.

Fraser: Right. So you start at the bottom corner, draw a line to the top corner, keep going about five times and you'll be hitting the North Star, and then as I said it's this ladder, right, because then you can see The Little Dipper sort of folding backwards off of the North Star and you know it's more of a stretch to see it as The Little Dipper, but it's there, and then from there you can see Cassiopeia and Perseus and all these things are all there, so it's just fantastic.

Pamela: And there's other things if you've ever gone to a planetarium show in the Northern Hemisphere, most of them at some point will say "arc to Arcturus," and "spike to Spica," and this is because you can follow the arc of The Big Dipper's handle and arc off of it to this amazingly bright red star, and that's Arcturus in the constellation Bootes… and then you can do a straight line off of that to "spike to Spica" which is Alpha Virginis, and so you can start to find yourself more and more constellations just by using this as a starting point, and one of my favorite in terms of that would just be funny if it was actually happening is there's "leak to Leo," which is if you imagine it as a slotted spoon that holds no soup, if you tried to hold soup, the soup would fall on the head of Leo the Lion.

Fraser: There you go. Alright, well that's great, Pamela. Thank you very much, and we'll talk to you next time.

Pamela: Sounds good. I'll talk to you later.