Astronomy Cast Episode 230 for Monday, April 25, 2011: Christiaan Huygens

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: Doing really well…so this is the third live show that we've done, and by live I mean we're doing it as a "Google hang-out." So about once a week, we all connect as a hang-out and eight of our closest friends can watch as we record this show. We typically answer some questions beforehand and stick around and answer questions afterwards, so it's quite a lot of fun, and so if you're listening to this episode and you want to get involved, probably the best way is to get a Google plus account and then add me and/or Pamela as "friends." If you don't have a G-plus account, then I would suggest you email me (probably me not Pamela), frasercain@gmail.com, and say, "give me a Google plus invite please." I will send you the invite, and then also add you to the circle so you can get notified when we do these live recordings, and hopefully, down the road, they'll add more people to the hang-out so we'll have more people to listen.

Pamela: And we are working on figuring out how to do things like share it through Ustream via CamTwist or something like that. We're just not quite there yet, and nor is our bandwidth.

Fraser: Yeah, well this is just so easy, so convenient. We can kind of stick around and chat with people, so you know, if people want us to do more of this, we'll figure out some long-term solution. I like the ones that don't require a lot of effort and expense, which is what this does. OK, alright, so now we finish our trilogy of Saturnian astronomers and missions with a look at the Dutch astronomer and mathematician, Christiaan Huygens. It was Huygens who discovered Titan and figured out what Saturn's rings really are, so it makes sense that a probe landing on the surface of Titan was named after him. Ok, Pamela, so this is great, I mean, so the first episode we did on Cassini, the guy who did some of the best observations of Saturn,

next we did the Cassini mission with the Cassini-Huygens mission, and so I guess part 3 we're actually going to talk about Huygens the astronomer. So where do you want to start?

Pamela: Well, I think the best place to start is by saying that astronomer really doesn't characterize him. Christiaan Huygens was a truly frightening intellect that basically got curious and just did stuff. So, he did advanced mathematics, where the only thing that seemed to limit him -- he's doing a lot of his mathematics work just a few years before Calculus was invented, so he tried to do things like calculate what is the shape of the hanging rope, and he couldn't quite get there because you need Calculus. He did astronomy where he actually built all of his own lenses, and he devised new and better ways to grind and polish lenses. He was a physicist working to try and solve all sorts of interesting mechanics problems. He was also one of the people who worked on designing early clocks, where he didn't build the clocks himself, he hired other people to do that, but he was the person who came up with the idea for the pendulum clock, and thought maybe that would be one of the ways to solve the latitude problem.

Fraser: Now, could we kind of place him sort of in the annals of astronomers? Like who were his contemporaries? Was he sort of after Galileo? Before Hubble?

Pamela: He was after Galileo, sort of contemporary with Newton in terms of both of them were alive at the same time, but they were different ages. Um, he was…protégé may be too strong a word, but Descartes used to take him under his shoulder and watch his mathematical upbringing. So he had these amazing mentors. He worked with Fresnel, so if you've ever driven a motor home or a giant bus with one of those strange, textured things on the back that magnifies -- that's a Fresnel lens, and he worked with Fresnel on a variety of different projects. So he was right there in the heart of the scientific revolution, and was working as hard as he could to keep up, and he built on Newton's formula of f=ma, to figure out…he is the inventor of centripetal force which has led all of us to enjoy XKCD all the more.

Fraser: Right, so he…after Galileo…what about some of the other astronomers of that time, right? Like Copernicus? After Copernicus?

Pamela: He's after Copernicus. He's in those early ages of telescopes, so he and Cassini were contemporary of one another. He was contemporary with

Hooke who was one of those observers of transits, another person into clocks. He was just in those early days where telescopes were new, and people were mostly getting their names known for what they did in physics.

Fraser: Right. And so then where did he get his start? He's Dutch, right? But what was his, sort of, early life?

Pamela: He had the benefit of being the son of a mathematician who was friends with Rene Descartes, so growing up he had all of these amazing people constantly in and out of his life. He was also from a wealthy enough family that he had private tutors until he was sixteen. And he transitioned from private tutoring, which included Descartes looking over his shoulder, to then attending the University of Leiden, and then going on to the College of Orange in Breda. He studied mathematics, he studied Law -- he was your quintessential "Renaissance man" in time and education.

Fraser: And so then when did the big astronomy discoveries really kind of kick in?

Pamela: So he was born in 1629, went to university young, got involved on politics side of things before he actually turned to doing science actively. It was in 1657 that he did his first publication, which was in astronomy; it was in probability theory. He was someone who could name-drop anyone. He was encouraged by Blaise Pascal to look at probability and to write the first book ever on probability theory. He then went on in '59 to discover centripetal force – not discover, but to derive the mathematical formulation for "what are the forces on an object that's getting twirled around your head on a string?" He then got distracted by light, and in the late '70s began worked on writing his treaty on light. So he's just bouncing all over the place, but it was his engagement in light and optics that all tied in with what he was doing with astronomy. I think where his name most closely gets tied to the mission is because he was the one who discovered that Titan exists; he's the one that found that happy little moon that kind of got us all started, and the reason he was able to discover it is he was he was using some of the best optics in the world because he figured out more effective ways to grind glass. And he was also the first one to figure out what the rings are, even though everyone argued with him because they couldn't see it because their lenses weren't as good as his.

Fraser: Now, what was the set up? I mean, many of these famous astronomers were all set up at the university or they had some rich patron, and they had some you know, set-up. Did he…where was he working out of?

Pamela: Well, he worked both out of The Hague and then later on he went to France and then was able to return to The Hague later on…

Fraser: But was he backed by some sort of institution, I guess, is what I'm…or was he doing it solo, you know?

Pamela: No, no one did anything solo. In his life, he was mostly tied to different royal societies, so he kind of had royal backing. These were the days when scientists were the pets of kings. Science wasn't a necessity, but it was an amusement, and it's kind of odd to think that you'd have the court jester and the court astronomer side by side, but in some ways you did, so it's because of him. He was first involved in the Royal Society in England, and after seeing their set-up when he was invited to the Royal Society of France, he helped them set up that Royal Society and get that organization going.

Fraser: So then, let's talk about those big discoveries that he made that really relate to the trilogy that we've done so far, which is the discovery of Titan and really his comprehension of what the rings really are. So what were sort of the observations he made leading up to that?

Pamela: So back in the 1650s, he was grinding his own lenses; he was making his own telescopes, and as he's making his observations, documenting day by day the changing alignment of the rings of Saturn…this is one of the most amazing things, is when Galileo looked at Saturn, he saw at one point it looked at one points like Saturn had a pair of handles.

Fraser: Or ears…

Pamela: Yeah, and at another point it looked like the rings had gone away. Well, what happens is over time, the inclination, the angle at which we're able to observe the rings changes, and with his superior optics, Huygens was able to see the angle of the rings change to see that they were rings not attached to the planet and to see this little blob of light that turned out to be the moon Titan orbiting around and around near the rings.

Fraser: And I guess, orbiting sort of on the same plane as the rings, right?

Pamela: Exactly, so this little moon as it's orbiting around the rings, it appeared to be in the same plane, it just appeared to bounce back and forth parallel to the rings and the sky and this led them to understand that this was something orbiting, just as the Galilean moons orbiting Jupiter, this was something orbiting Saturn.

Fraser: So he made those observations, saw Titan on the same plane of the rings, and I guess what really made some observations overtime and just saw that…

Pamela: He saw that the angle of the rings was changing and he was able to figure out that there's a planet with inclined rings, that, as it goes around and around the Sun, just like our poles maintain where they point relative to the stars, we have the North Pole in a constant place, well, Saturn's rings maintain their tilt relative to the stars allowing us to see a constantly changing angle on the rings.

Fraser: I mean, we see the pictures now, we see the pictures from Hubble, we see the pictures from Cassini, and it's obvious -- you look at it and you go, you know, those are clearly a big ring, you know, you might not know what it is but at least the shape of what that is, is very obvious to us. But you can just imagine the leap that they would have to make, especially, you know, with how terrible the objects were back then you could just barely make out that, I mean like in my telescope, when I look at Saturn, if the ring plane is really at its big angle, I can just barely see the gap on either side and you know I'm looking you know with a fairly…I'm sure a telescope that's many times better than anything they ever had. So I just can't imagine you know if you look back…you remember when we played around with the Galileo scope, at the AAS? You could just make out theses little moons poking out of the side of Jupiter and some bands, and that was kind of it, so it just amazes me that they would make this cognitive leap. It really had to be someone sitting there, you know, Huygens sitting there looking at what he was seeing in the telescope and going, "What am I looking at?" and running through the ideas in his mind. It's astonishing that they came to that realization so early on. You know, later on it would have been obvious, but in the beginning – yeah, just amazing!

Pamela: And one of the things that the poor guy ran into was he reported his discovery of Titan and he reported his ring theory and everyone's like, "No, sorry dude, we just don't believe you." And he had to wait for other people to build comparable telescopes before people started to believe him, and this was one of his frustrations, and it was actually he was able to figure out that other people did not have telescopes as good as his by who denied his ring theory.

Fraser: That's awesome!

Pamela: It was just one of those things where it took a while for people to believe him and to confirm his results because he was just too good at what he did.

Fraser: Wow! OK, so he made this announcement, you know, as you said, involved in various royal societies, I guess that was the way that news sort of percolated out. What did he work on after that?

Pamela: Well, so he was writing books, he was working on actually clocks next, and if you think about it, you're trying to understand orbital periods, you're trying to understand all these different kinematic problems. He was referred to as a mechanicist in some instances, and to understand all of these things you really need good timekeeping, and these were in the days where we didn't have good clocks, and being someone that thought in terms of force, thought in terms of energy, he figured out, "Oh! Pendulum clock!" and this was back in the days when people still, even in the field of science, had the idea that if you pull a pendulum back even further, it will take it longer to get from the high point on one side and let it swing to the high point on the other than if you only pull it back a little, and it turns out that that's just not how it works. And so he was able to figure out how to relate all these things with the periods of different pendulums. And that was kind of cool!

Fraser: So, pendulum research?

Pamela: Pendulum research.

Fraser: What else?

Pamela: I'm probably far more excited about that than other people.

Fraser: Than Titan? Discovery of Titan and Saturn's rings?

Pamela: Well, no Titan was way, way cooler.

Fraser: I didn't know you were such a big pendulum clock fan.

Pamela: No, I'm not. No, I'm not

Fraser: No, it's an interesting physics challenge. No, I know. I take the kids, we go to the park, I take the kids, and I ask them not to pump the swings, but I will hold them up to my face with their feet straight out, right? And then I let them go and I'll show them how I will won't move my face as they swing back because it's impossible for them to kick me in the face.

Pamela: You totally trust your children.

Fraser: As soon as they pump, I move my face out of the way because I see that this is about to backfire.

Pamela: [laughing] You know they're out to get you.

Fraser: But just in general, but no, no, no…but there's this amazing clock in Vancouver, in the HSBC building -- it's beautiful! Huge pendulum clock, like the pendulum itself is, I don't know, you know, 10 meters tall, 15 meters tall, and probably 2 meters on the side. It's quite amazing, this huge pendulum that swings back and forth, and you can kind of see it working in the same way, so anyway, pendulums, uh, what do you know? I love pendulums too. Alright, let's move on. Right.

Pamela: [laughing] So yes, he did pendulums, which was kind of totally awesome. He went on…so if you think about it all of this kind of built he's like, "OK, I'm doing astronomy, I'm going to figure out how to make better lenses…OK, need better timekeeping to do better astronomy, so let's figure out how to build a pendulum clock, along the way try and solve the longitude problem," and then he…

Fraser: [laughing] Sorry to interrupt you again…that is crazy, you know?! "I need better timekeeping; I have to invent a whole new kind of clock."

Pamela: Right, right!

Fraser: "I need to figure out where I am on the Earth; I need to invent a whole new way of discovering where I am on the Earth." You can see he really had the forces of, you know, arrayed against him because they just like oh you know its just like us. "Great, I need to invent a microphone, OK, great, now I need to invent the internet, to get some information I need." I can just see, you know, [laughing], its crazy!

Pamela: So, you went from there to, well, light -- he's thinking a lot about light because that's what you do when you're working with telescopes and getting annoyed with the telescopes, and these were in the days when we still hadn't come to terms with the fact that light is both a particle and a wave. That just…that was something that took quantum mechanics first to get past, so people were still having this argument, and he came up with a wave theory of light that was able to very successfully explain how it was that light got focused through lenses, how it was that light got passed through different media, and then when he got together with Fresnel and they figured out how diffraction played into all of this…was so they were able to explain how light passed around the edges of objects. They basically defined the first several weeks of what we learned in optics courses in modern physics. And so that was how he spent a lot of the 1670s was working on solving problems with light and polarization and diffraction and all of these other amazing things.

Fraser: Right again, back to being able to build a better telescope.

Pamela: Exactly.

Fraser: Right.

Pamela: And, in the middle he was one of the people who observed the 1661 transit of Mercury across the Sun. He did that from London. Mercury does this fairly often so it wasn't nearly as exciting as Venus, but nonetheless, it was…

Fraser: Yeah, the transits of Venus…

Pamela: Yeah, he was also someone that was involved in building community, and he had the misfortune of being alive during the Eighty-Year

War, and seeing the Napoleonic Wars, and this periodically prevented him from being able to go home. If you're in France, and France is in the process of trying to conquer Holland, you're not necessarily welcome home, but wherever he went he worked to pull together the scientists to help build collaborations. He was constantly publishing and publishing in collaboration, and publishing things like probability that weren't his own work, so while he's responsible for making these great discoveries, he's also responsible for being one of the communicators during the scientific revolution that brought together different ideas to different people, and that's a completely different way to be a major influence. Or this is something we talked about with Planck, who a couple centuries later was dealing with similar things as well.

Fraser: But again, it funny, that's the same to me as needing to discover how optics works, and then you get a sense of "Oh, I see, collaboration is our problem now, so I need to fix that, I need to help everyone kind of connect together." So it seems like it's a real vein running through his personality, where he clearly identified the gap and didn't care what it was, he was going to figure it out and solve it and fix it, so then everyone could benefit from it. What an amazing guy! Now, there's one thing that I kind of know, is that he had some theories about extraterrestrials.

Pamela: Yeah, he was actually a very strong believer that there is life out there in the Solar System, and in a book published after his death, he discussed his belief system. He figured that the other planets must be pretty close to what we experience here on Earth. He thought about things like, "Well, what is essential for life?" and back then, water -- that was one of those primary things. He figured there is sunlight. He thought about things like well, what temperatures are alright. He thought about things like the thermodynamics: "Well, Jupiter's probably too cold, maybe Venus…maybe Venus is too hot." He's one of the ones who looked to Mars and saw as you can see in most amateur telescopes that the surface of Mars isn't all one color, and that led him to think, "Well, maybe the dark, maybe that's vegetation." And that's a notion that actually many people help up until we started sending things to Mars, and going "Oh, shoot! Not alive."

Fraser: Yeah, we're only sixty years away from that theory being widely held by many people.

Pamela: It was a good theory, it was just wrong. Wrong happens.

Fraser: Well, had he lived a little longer, I can just imagine him inventing rockets and, you know, all kinds of stuff.

Pamela: So he's someone that lived a fairly long life, and he just spent his entire life thinking and collaborating and doing and bringing the community together, and the thing about someone like him, is there were specialists -- there were people who only did physics, who only did astronomy, who only did mathematics, who only did timekeeping, but he was someone who did everything, and who knew everyone, who lived a long life and was thus able to bring together all sorts of different people to discuss ideas and build a real scientific community.

Fraser: So, where did he die?

Pamela: He ended up dying at home in The Hague, and was buried there in Grote Kerk, so nominally, you can go on a pilgrimage to see the place of his death.

Fraser: Alright, well thanks a lot, Pamela -- that was great! I really appreciate that, and I think from what I remember last time, we were going to go on to Galileo and the Galilean missions, so we will sort of pick that up next week. Thanks again, and thanks to everyone who listened in live as we did this as a Google chat. Sorry for the technical hiccups. I'm sure Google's working on it. Talk to you later, Pamela.

Pamela: Talk to you later. Bye-bye.