AstronomyCast Episode 237 for Monday, October 31, 2011:
Spooky Space Sounds

Fraser: Welcome to AstronomyCast, 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. Happy Halloween!

Pamela: Happy Halloween! How are you doing today?

Fraser: Doing really good. We're going to go into a whole pile of trick-or-treating tonight, but uh…or I'm imagining in the future; we're actually not recording this on Halloween, but to get into the setting…but yeah, our kids are at that age now where Halloween is a competitive sport.

Pamela: That is awesome!

Fraser: It's all about speed and endurance and starting time, and uh, yeah....

Pamela: That is very cool. I live in a small town, and we actually do a town Halloween parade, where it's a bunch of, basically, take someone's old hay trailer and build a float on top of it and pull it down the street with a tractor or a pick-up truck -- and it's really endearing, and they throw candy at the kids, not *t*o the kids, *at* the kids.

Fraser: Wow, Halloween's a big deal, then?

Pamela: Oh yeah, totally. We actually have a neighborhood email list to get competitive on who gave away more treats.

Fraser: [laughing] That's awesome! Alright. To help you out with your Halloween party, we've collected together the spooky sounds of the Solar System. Every piece of audio you're about to play might sound like it comes from a terrifying nightmare dimension, but it's really just a natural space phenomenon right here in our own solar system. Alright, Pamela, so this show's going to be a little different in that we're going to play a bunch of audio clips, and then we're going to explain the science that's going on. So why don't we just listen to our first clip?

Pamela: OK.

[audio clip]

Fraser: That was really weird. That kind of sounded like an underwater depth gage, like a submarine sound…so what were we hearing there?

Pamela: So the background hissy static -- that's just the sound of the sky. It's the exact same thing you see when you turn on a television, not a new digital television, you have to find one of the old, regular televisions, and you turn it to someplace where there's no channel. It's that background radio photons that are coming from space, that are coming from electrons trapped in the atmosphere, just the hum of electrons changing energy levels and in the process giving off radio light. Now, that high-pitched UFO noise you heard, that was actually the sound of a meteor reflecting back off of its ion trail, reflecting back sounds from an earth transmitter. Our planet's covered in, well, radio-transmitters; they're giving off your radio signals, they're giving off your television signals, and as a speck of rock comes through our atmosphere, it heats up, it charges the atoms around it as it goes through the atmosphere and it leaves this trail of excited atoms behind it, and that trail of excited atoms acts like a mirror and sends back some of that radio emission, and creates that UFO noise that you hear above the background hiss.

Fraser: And so if they were recording for a whole night, you would be able to hear every meteor that was going across in the sky.

Pamela: And what's kind of awesome is that clip was from the Geminid storm -- and you can actually do this for any meteor storm, you can go out, get a radio receiver that's tuned to the proper station (and there's instructions for how to do this on-line that we'll link to in our show notes), and you can sit there and you can watch the sky for the shooting stars, and at the same time, listen to the noise they make as they reflect back bits of radio signal.

Fraser: And so it's science that regular people could do with a little bit of investment and some time and work. It's not…you don't need a huge radio dish.

Pamela: No, this is the perfect science fair project if you're looking for a science fair project for your kid and you have a Radio Shack nearby. It's really something awesome that everyone who has a kid who likes to tinker should do at least once while their kid is growing up.

Fraser: That really sounds like a UFO. That was great! OK, let's do the next one.

[audio clip]

Fraser: Alright, so that sounded to me like a bit like sirens off in the distance, police sirens off in the distance, a whole bunch of them, or people playing the saw -- you know, that sound, you know, when you play the saw, or a bit like crickets, like cicadas at night. So what was that?

Pamela: That was actually the solar aurora. That was magnetic interactions between our Earth's magnetic field and particles from the Sun that if you could go out and look at them would probably paint the sky in fabulous dancing curtains of green, but auditorily, when you take the radio emissions and you play with them to get them down to where a human can hear them, those particles from the Sun when they hit the Earth's magnetic field, they change velocity and that change in velocity is a change in energy, and that energy has to go somewhere, and that energy goes into creating radio signals, release of photons in the radio frequencies, and we're able to detect those using very special, not-so-cheap-and-easy-to-build-in-your-backyard, using special radio receivers, and what's neat was the person who recorded this, Stephen McGreevy, he actually he went on a trip up to Grassriver Provincial Park in the central western Manitoba area of Canada and this was during normally solar minimum, but there was a really nice light show back in the summer of 1996, and as he looked at the aurora straight overhead, he was able to capture the sound coming from the aurora at the same time.

Fraser: That's pretty amazing and it's interesting that it happened during the solar minimum so I wonder if someone's going to be doing that now that we're nearing the solar maximum.

Pamela: Well, what gets me is so you can have solar flares at any time, but the type of sound that you get from them captured in the radio signals – that traces out how the particles are interacting with our magnetic field, and if you have a whole lot more particles coming from a really big flare, like the flares we're starting to get right now that are causing auroras visible as far south as Arizona, they're going to be even more spectacular to listen to, and I look forward to seeing those posted on the internet -- they're just not there yet.

Fraser: OK, so let's move on to the next one, and it's kind of related…

[audio clip]

Fraser: That's a haunted house.

Pamela: That's totally haunted house. This is the one [missing audio] sent me. It's totally haunted house!

Fraser: It is amazing! Alright, now we're getting into it. I mean, that was a haunted house sound. That was really scary! What is that?

Pamela: That's Saturn!

Fraser: What part of Saturn?

Pamela: It's an aurora on Saturn. It's basically the big brother to the previous sound clip that we listened to. So the Cassini spacecraft is approaching Saturn; it was able to listen in on the Sun's, well, solar storms wreaking havoc, or at least wreaking beautiful noise on Saturn's magnetic fields. So as waves of particles went in and moved up and down the field lines, their changes in velocity and other interactions were able to produce these changing pitch radio frequencies and the change in pitch, that actually corresponds to the different energy levels, where as you're hearing higher pitched notes, those are higher energy, higher frequency photons, and as you hear the lower pitches…so you're essentially sliding up and down the energy spectrum. Think of it as particles sliding down the magnetic field and gaining and losing speed depending on which direction their whipping along the field lines.

Fraser: Right, and it's…I mean there was something in common with the Earth aurora, but it definitely sounded otherworldly. Is it just like the instruments that were used to measure the two different aurora?

Pamela: It is a matter of: this is a much better instrument. It has much better frequency coverage, which is where you get the sliding up and down, so if you imagine a difference between a slide whistle that is two inches long and a slide whistle that is twenty inches long that allows you to detect different things. It's a difference in, well, you're not getting all the background hiss that you get from being within the Earth's atmosphere. And then it was just they managed to take a much longer time and they cheated. In that particular audio clip they seriously cheated. Every 73 seconds of audio corresponds to 27 minutes, so they sped things up a little bit, which helps as well.

Fraser: Right. That's what I was wondering is: was that over a long period of time? OK, so let's move on to the next one, and just give people a hint: this is also on Saturn, but something different.

[audio clip]

Fraser: That sounded like hail hitting like a tin roof, but a little more muffled, or like you're walking on chunks of ice, or walking on snow, like icy snow.

Pamela: Or, so I don't know if you've had this where you are, but here in southern Illinois, and back growing up in Boston, we'd sometimes get these snowstorms that would cover the roof and everything else in 5, 6, 10 inches of snow, and then we'd get an ice storm afterwards, so you end up with this layer of ice on the top of the snow, and the sound of the ice balls hitting the snow sounded a lot like this as well.

Fraser: I mean, we never get anything like that, but… So what is it then?

Pamela: That is lightning on Saturn.

Fraser: Are all those pops like lightning strikes?

Pamela: That's lightning bursts. Yeah, so you have, basically, you're catching all of the lightning strikes across a large section of the planet. You hear all of these little tiny pops that are all different frequencies, and they're occurring over time (again this is one that's sped up 20 seconds in this case is 2 hours, so you can imagine each of those little blips is lightning that occurred over two hours). But this was a massive lightning storm, and we can also detect the Earth's lightning, but it doesn't sound like much when you add in the Earth's noise that we also receive, so this was just much more amazing. And we don't really think of Saturn as having lightning storms -- it's not like we see lightning bolts when we look at pretty, astronomical images of Saturn, but this is a stormy planet that has lightning going off all the time, and we can detect it from its radio signals.

Fraser: Alright, let's move on to another one and this one is still -- like we're following a theme -- it's lightning, but it's somewhere else. Listen.

[audio clip]

Fraser: I'm hearing a video game. It's sounds very familiar. I think I've played that game.

Pamela: Either that, or like a bad 1980s sci-fi battle scene.

Fraser: Yeah, exactly! Perfect. So, I said it was lightning. So where is this?

Pamela: This is here on Earth, but we're listening to something else now. We're not listening to the individual bleeps of lightning like we were on Saturn. These are what's called whistlers, and what ends up happening is when you have the lightning go off, it can produce ionized gas, and that ionized gas as it gets caught up and travels along field lines, produces this whistling noise. So again, lightning, but you're hearing a different aspect of the lightning, and this is just one clip of many that we could have chosen from. You get them that they sound sometimes like an entire arcade of video games because you get different ones going off at different frequencies all layered on top of each other. So here is ionized gas that is created by lightning and produces radio signals as it travels along magnetic field lines.

Fraser: But it's the same phenomenon -- that's really neat! Alright, let's move on to another one.

[audio clip]

Fraser: Right, so that one sounded similar to the haunted house sound, but then there was like this crash halfway through.

Pamela: Right, so it's sort of like you're going along, they're trying to creep you out, they're trying to creep you out, and then they *attack you with everything all at once*! In this case, it's the Cassini spacecraft again traveling through space, listening to radio waves, listening to radio waves, everything's fine, suddenly hits the edge of Saturn's magnetic field, and that place with the solar wind hits the edge of the magnetic field. This is the bow shock region around Saturn and everything goes nuts at that particular place. One way to think of this is it's almost like the sonic boom that's created when you start traveling faster than the speed of sound, and it booms through. This is the radio in the magnetic field equivalent of that, so you have supersonic solar wind suddenly gets decelerated rather rapidly and creates this pulse of radio emissions across the entire frequency band.

Fraser: It's the same instrument that captured the sounds of the aurora, which is why it sounds familiar, but it's capturing a different phenomenon at this point. I mean, we've all seen those pictures of a bow shock. Usually we see it around the Earth; we see these illustrations of it. It almost looks like there's a comet around the Earth, where on one side of the Earth, it's rounded -- and this is our magnetic field, and then on the other side of the Earth, the one that's away from the Sun, it's stretched out into this big, long tail because that's the side that's not being impacted by the charged particles from the Sun, and that's the thing that's protecting us, and I guess protecting Saturn, and this is that moment where Cassini crossed into that force field around Saturn, right?

Pamela: And it wasn't the fact that Cassini crossed it so much that caused the sound, as Cassini was able to hear all the solar particles that were traveling along with it have the "Holy expletive!" moment of changing velocity, and this is something that we keep kind of saying as though everyone understands it, but all of these noises come from some sort of a particle: an electron, a proton, an atomic nuclei that doesn't have as many electrons attached to it as it should. It comes from one of these charged particles traveling through space and interacting with a magnetic field in a way that changes what direction it's moving in, it changes what speed it's traveling at, and all of these different changes represent a change in the energy of the particle. And when you change the energy of a particle, that energy that it lost has to go somewhere, and where it's losing the energy is into creating radio light, and so if you think of it in terms of: if you get something going really fast, it has to take energy from somewhere – that's the gasoline, and then when you slow it down really fast, slam on the brakes, the tires get really, really hot from all of that energy that had been the motion of the car getting expelled against, well, the asphalt as the tires try and screech to a slow-down, so what becomes hot tires, when it's a slowing down particle, becomes radio energy instead.

Fraser: Right, or to use another analogy, right, if you're not wearing your seatbelt and you run into something and you come smashing out the front window, you're the radio emissions being given off by the car, which is the particle, so…alright well, the next one then is similar, but a different spacecraft.

Pamela: Yep.

[audio clip]

Fraser: That one was a little more subtle. What were we hearing there?

Pamela: Those were what are called electron plasma oscillations, which is a fancy way of saying there's a whole lot of charged particles out there, and as those charged particles from outside of our Solar System hit the termination shock of the solar particles pushing against them, they end up getting driven into oscillations, and the Voyager spacecraft, as it's trying to leave the Solar System, has had this weird experience of the solar termination shock. Where it ends depends on how active the Sun is, so it goes back and forth like where the shoreline is on a beach. As you're walking along, sometimes your feet are dry, sometimes your feet are wet. Well, sometimes Voyager for a while was within the termination shock and sometimes it was beyond, and as it was traveling along, it got to pick up all of these little electronic plasma oscillations along the edge of that, well, termination shock to our Solar System.

Fraser: And so the termination shock is sweeping past Voyager and then coming back in.

Pamela: And beyond the termination shock is where there's a region of electron plasma that is oscillating, and those little blips of noise that you hear -- those are the plasma oscillations. Now, the reason it doesn't sound quite so sexy as the other ones is -- it's Voyager.

Fraser: Right, it's a very old spacecraft, very far away, not able to send a lot of data, not a lot of power…

Pamela: [laughing] Right.

Fraser: You can barely hear it…yeah.

Pamela: Yeah, so it's several hours worth of data…collapses down into like six seconds of audio, and the frequency range that we were listening to was a lot less than some of the other clips.

Fraser: So, when Cassini…well, Cassini will never get a chance to leave the termination shock, but if it could it would sound different. We would hear a more high fidelity version of this.

Pamela: So hopefully someday we will get to send an instrument with the fidelity of Cassini out there, but it's not in the budget right now.

Fraser: So, let's do our last piece of audio.

[audio clip]

Fraser: I heard a saw going, you know, going through metal really far away, or some bird, some exotic bird in the middle of a rainforest making its sad call, but what are we hearing?

Pamela: What I heard actually was a 1980s synthesizer pretending to either be a piccolo, or a bird and failing miserably in the process. The reality is we were listening energetic electrons at Jupiter caught up in its magnetic fields. Jupiter is one of the most complex magnetic fields in the Solar System in terms of…well, it has a nice, normal magnetic field that has moons embedded in the side of it, and those moons spew up particles that get caught in the magnetic fields, and some of them have their own magnetic fields and, well, to the hapless electrons out there, they can what are called cyclotron emissions as they move through the magnetic fields and spiral rapidly around and around the field lines, and in the process they give off radio emission that sounds rather like you wish you were wearing earplugs.

Fraser: Well, this is Jupiter's equivalent of a particle accelerator.

Pamela: Exactly, and it's one of the biggest particle accelerators in the Solar System. It's just not useful for doing, well, Higgs Boson-type science.

Fraser: Yeah, um, the power would be there, we just can't control it. Right. So that was great. Now, that's actually only about half of the spooky sounds that are out there. We just covered the ones that we have in the Solar System, so maybe next year, we'll cover the spooky sounds around the whole universe because there's pulsars…

Pamela: Blazars, and quasars …

Fraser: Quasars and all kinds of great stuff, so I hope you enjoyed this, and I would love to hear if anybody wants to turn this into a haunted house background sound. People could play it in their homes, "What's that weird sound?" The sounds of space…

Pamela: And we have to give kudos to the University of Iowa for putting these up on their website. This show was made much easier to put together thanks to the hard-work of the folks there just archiving these noises and making them not sound horrible to the human ear.

Fraser: And I know you kind of curated this one with your friends on Twitter, so thanks to everybody on Twitter who responded to you and pointed you towards cool, spooky space sounds.

Pamela: So one final announcement before we disappear. I was asked by Andy Shaner at the Lunar and Planetary Institute down in Houston, TX if I could let all of you know about a project called "My Moon." They're actually trying to provide jobs to people 18-25 who are interested in the Moon, and are interested in helping them out with the Moon, and if you want to find out more, we'll be tweeting about it and we'll post a link up on the website, or you can just Google "my moon street team" and find out how you can be a part of, well, helping everyone know more about the Solar System.

Fraser: Sounds really great. OK, well, thanks a lot Pamela! We'll talk to you next week, and Happy Halloween!

Pamela: Happy Halloween!