Astronomy Cast Episode 222:
The Decadal Survey

Fraser: Welcome to Astronomy Cast Episode 222 for Monday, February 28, 2011: The Decadal Survey. 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 at Edwardsville. Hi Pamela, how are you doing?

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

Fraser: Doing great! Alright, so in episode 198 we explained how space missions are chosen, and we introduced the Decadal Survey. Since the time we recorded that episode, the full Decadal Survey for planetary science has been released. Explain the science goals for planetary geologists over the next 10 years. We thought we'd take an episode and give you an overview of all the science coming your way. Whew! So for those of you who want to read this on their own as we do this episode, or before or after, where can people get their hands on the Decadal Survey?

Pamela: The National Academies of Sciences Press has copies that you can download for free on line of the pre-published version, and all you have to do is be willing to give the National Academy your email address, and that's pretty simple.

Fraser: Right, but they'll need that later when they need to send you your Nobel Prize, so.... Yeah, so you can get it by going to NAP.edu/catalog/13117.html, and you have to give your email address, and you can download the full Decadal Survey, and this is

all of the cool, planetary science that the scientists want to get done over the next ten years, starting in 2013. Now, you were part of this process, right?

Pamela: I was part of the process on the astronomy side. There's actually two different Decadal Surveys. There's the astronomy/astrophysics one, which goes from 2010 – 2020 (and was ironically released in 2011), and then there's the planetary science Decadal Survey, which goes from 2013 to 2022, and being an astronomer who simply likes geo-physics, rather than practices planetary science, I simply watched as an enthralled outsider the planetary sciences Decadal Survey process.

Fraser: Right, and we've already explained the ones that you worked on and looked through, so now we're going to talk about the planetary science ones. I'm not sure… how do you want to approach this? Should we give some highlights? Who were the people behind this? Who came together for this one?

Pamela: Well, just like in the astronomy community, they started by getting together people that they felt were community leaders, and then asked the entire community from graduate students up through the oldest of emeritus faculty to please write white papers and give input as well. So while there was a definite attempt to get the best and brightest of our senior researchers together to lead the process. Every one of them was asked for input, and I think it's worth noting that this process was in some ways distinctly different from the astronomy process. In astronomy, we were asked, "What are the most important things we can do? Dream large. Give us guidance." And there was also the inclusion of education public outreach. How can we better mentor? How can we better teach? And we looked to find the ways in which we could make our community better, both as a community, and as a group of people trying to better understand our universe. And there was really no boundary put on what we could dream. At a certain level,

everyone knew there are financial constraints, there are limits on what NASA and the National Science Foundation can facilitate us being able to achieve, but we dreamed big. On the planetary sciences side, the situation was very different. Planetary science…it's not a bunch of professors like we have in astronomy. It's a bunch of people working – in some cases there are professors, but there are also all the research scientists at places like the Lunar and Planetary Institute, the Southwest Research Institute, Jet Propulsion Labs…at all these research centers, the staff work 100% of their time off of NASA and National Science Foundation funding. This means that they're not getting nine months out of twelve months salary from teaching, and that radically changes what you are able to do because if you're a professor where nine months of your salary comes from teaching, during those nine months, you're still doing research. You're doing it at a reduced rate, but you're still doing research that's getting paid for by your university, and there's lots of astronomers out there, who that nine months salary is enough for, and they'll spend their summer putzing on their personal projects using existing resources to continue doing research. A planetary scientist doesn't have that freedom necessarily. They're writing grants, writing grants, writing grants…and they're only allowed to do what their grants fund them to do. So if you're a planetary scientist funded 100% of your time to study volcanoes on Mars, and you have this wild curiosity about volcanoes on Io, you can't go dedicate the time that you'd like to to study those volcanoes on Io, but a professor – they can. Planetary Scientists, as a result, have a much more pragmatic approach of "What can we do that we'll actually get funded to do?" and that pragmatism is carried on into how they do their Decadal Survey. When they created their model for: "Here's what we want to do," they said, "What can we do within the limits of the projected budgets?" So they worked to find out "What does everyone think NASA's budget will be? What does everyone think NSF's budget will be?" and they

constrained their dreaming to the financial realities that they thought they were going to have.

Fraser: And so what was the process then? They all submitted white papers, and then some group looked through them and tried to find overlap?

Pamela: Right, so it was a many-step process where there were committees put together, panels put together, for instance, an inner planets panel. Mars gets its entire own planet panel because we know Mars is important. There were people dedicated to the giant planets, to satellites, and each of these panels got together, accepted white papers… They actually traveled and they did town hall meetings all across the United States and they actively sought input from the community. They then looked at all of this information and looked for guiding themes. They then judged the guiding themes based on "What has the greatest potential to generate science, to generate new technology, and to be completable within the constraints of the budget?" And it's based on that "How do we get the best science? How do we get the best future technology? And how do we do it all without going into the red?" that led to the results that we now have in the Decadal Survey for Planetary Science.

Fraser: And so in theory, now that this plan has been provided, how will that turn into missions?

Pamela: This is a guiding document, and so suggestions are made. For instance, they proposed which flagship missions should be built, and what typically happens, what's happened in the past is NASA and the Congress and National Science Foundation have all looked at the results of the Decadal Survey (this is basically a wish list from the entire community) and said, "OK, you've provided us guidance. We're now going to write proposals, not proposals…we're now going to write calls for proposals, and ask

you to propose exactly how we're going to carry through on each of these different ideas." So in some cases it was quite specific. In both the Astronomy and Planetary Science Decadal Surveys, both came forward and said, "We need to fund the Large Synoptic Survey Telescope." This is a very large telescope that's being built in South America that will every three nights image the entire sky that's viewable. That's a very specific recommendation.

Fraser: Right, but you can imagine how it has dual purpose, right?

Pamela: Exactly, so this many-purpose mission that's just going to bury everyone in data, it was specifically named. Now, there's other cases where within the survey it said, "we suggest that you fund one of the following…we suggest you fund three of the following…" so for instance, one of the things that they did…there's a NASA program called New Frontiers. These are medium-sized missions. They do a new call for these every few years, and they put together a list of five different concepts that they think it's important to design missions around. And they said that during the New Frontiers Mission 4 call for mission proposals that the ones that are funded and the exact number that can be funded (that's going to depend on how the missions are designed) should come from five specific concepts. There should perhaps be one that does a comet surface return mission. This is where you send a spacecraft out and you actually take part of a comet and you bring it back! So that's just kind of cool, and highly complicated and really awesome in a lot of different ways. There was an idea put forth that another necessary-to-pick-from idea is to go to the lunar south pole Aitkin basin, grab a rock and bring it back…so this is another sample return mission. There was a proposal put forward that maybe one of these missions should be another Saturn probe, that maybe we should go to the Trojan asteroids and do rendezvous missions, like Dawn is doing with the nearby asteroid belt, and there was a Venus In-Situ Explorer explorer proposed. So there are five different candidates and they won't all be chosen.

There will probably be two of them chosen – it all depends on the funding situation. And they said that in the next call, take whatever you didn't fund from those and add to those an Io observer to go observe the volcanoes of Io, and a lunar geophysical network: this is the idea of building seismic stations like the ones we have across the planet earth -- instead, scatter them across the moon.

Fraser: You're already starting to give some of the highlights, so how many missions have been proposed overall?

Pamela: The problem is they were very narrow in how they dreamed, but they recognized in writing this that they were going to make certain guiding principles that basically said, "in the best case, this is what you should do," but there isn't a best case, so altogether they're recommending that you should put some emphasis on small missions. No matter what, do not get rid of the small missions. And they put no science guidance on these, other than to consider things like a Mars trace gas orbiter, so for the most part they said, "let's take this program -- it's highly successful. We're not going to give you a whole lot of guidance, but you've got to keep funding this." They said, "OK, medium missions are necessary. We're going to give you the following funding caps that are different than the old ones, and here are the guiding principles, but we're not going to tell you exactly how many." The committee did recommend (and here I'm going to read it) that NASA select two new Mars Frontier missions in the decade 2012 – 2022. These are referred to as Mars Frontiers mission 4 and mission 5. So they're saying, "of the first list I've read, pick one, and from the second list I've read, pick one." So that's kind of depressing, but everyone hopes that if something happens, that they'll be able to add, so there's ideas for "if a third mission is selected, one of these should be the following…" Now you have to be flexible because some of the things are so expensive and so risky that it may be worth making the decision instead of building,

for instance, a mission to go explore Jupiter in detail, instead of building a mission to go and return rocks from the surface of Mars, let's not have a large mission. And that would be heartbreaking for many individuals, but at the cost of one large mission… These are multi-billion dollar projects, where the Mars return mission was de-scoped -- it was made smaller -- and it's 2.5 billion dollars!

Fraser: Can you imagine…for some rocks from Mars? Yeah…

Pamela: And the medium-sized missions are capped at 1.5 billion. So you can get two smaller missions for the price of getting rocks from Mars.

Fraser: So based on your experience so far, you know, in how this works, and how the funding works, what do you think this will realistically turn into? Because when I think back over the last ten years, I mean, there were dozens of missions launched. I mean, there were tons: there was New Horizons, and Messenger, and you know…there were a lot of missions. There was the Lunar Orbiter…so what do you think this will realistically turn into over the next decade?

Pamela: I think the steady stream of small missions, things like Dawn, that no one quite imagined and someone had a really excellent idea and proposed it -- that steady stream of really excellent small missions -- those are going to keep happening. And those are the ones that the Decadal Survey says, "Keep doing this. We're not going to give you a whole lot of guidance, but this is important."

Fraser: But these missions haven't really been planned out yet.

Pamela: Right, now when it comes to the giant missions that we've gotten used to…these are the things like the Curiosity Mars Lander, the Mars Laboratory that's going to be taking off later this

year – those giant flagship missions have consistently been outlined in the Decadal Surveys, and if we're able to get those giant missions…those are the exact ones we're looking at right now on the Decadal Survey. The community is very good at sticking to its wishes. The biggest question mark is always Congress. The thing that I think I will remember as one of the best and most falsely foreshadowing the future events I ever saw was in 2003 at the Lunar and Planetary Sciences conference down in Houston. It was a very strange meeting because this was the same week that we went to war with Iraq, so that was kind of casting a bad aura over the meeting, especially with Johnson Space Center there -- we had military aircraft flying overhead, but in the shadow of all of that weirdness, there was NASA administrator whose name has been lost to me over time who stood in front of us, and she was a very dynamic speaker. And she said you gave us your survey, and here are the missions that we have funded that will answer every single one of your scientific requests. And she went down the list and she said "here's your goal, here's your mission; here's your goal, here's your mission." Now unfortunately, subsequently, many of those were canceled due to the fact that our economy isn't very good right now, and so that moment of glorious "you came together as a community, you came together around ideas and here's how we're going to answer you" -- that was awesome. Today the message is different. Today the message we're getting is "as a community, if we want to see our dreams come to a reality, we have to be proactive in dealing with Congress." It's no longer enough anymore to simply do amazing science that inspires. Now you have to do amazing science that inspires and personally *be* inspiring, personally go out there and talk to your congressman, talk to your legislators and say, "this is important." One of the things that gets lost a lot is when you discuss cutting funding to science, you're cutting jobs, and the jobs that get lost first are the people that haven't been employed yet: the future funding for students, the future funding for post-doctoral researchers, the future funding for people who are currently

working on their degrees and need to have early degree research scientist jobs to step into later. Those are the positions that get lost first, and every time we cut funding to a mission, all the jobs associated with that mission go away, and we need to communicate this better so that people understand funding science is funding what we know, is funding the people that tell us what we know, it's funding the engineers that build the spacecraft and while there is a lot of money that gets tied into launch vehicles, and a lot of money that gets tied into the electronics… At the end of the day, it's all human beings that put that together.

Fraser: So, let's get some real highlights because I think you've dropped a bunch of mission ideas across this podcast so far, but I think, can you give a succinct list of the big missions that might happen?

Pamela: So the list of large potential flagship missions includes a Mars Trace Gas Orbiter. This is a mission that would occur jointly with a European space agency and would do what it says it's going to do. It would go and it would measure the composition of Mars' atmosphere.

Fraser: Right, they're looking for life through the methane emissions, among other things, to try and conclusively…OK, cool.

Pamela: So there's that. That's going to go forward. Sorry, these are overview, it's not just the flagship. They're recommending that there should be two New Frontiers missions, two New Frontiers missions…so these are the "pick one…pick one that includes going and exploring Io, going back to Jupiter." These are the wonderful medium-size missions that get us out into the outer solar systems.

Fraser: What's an example of a mission we've already got? New Horizons?

Pamela: Yeah, New Horizons is a good example.

Fraser: So did they actually list out the mission ideas?

Pamela: There are mission concepts, but the way this works is once the funding gets allocated of "yes, we're going to go do this," they put out a call for proposals and that's when the teams get built. You have to put the funding in front of the people funded.

Fraser: Right, so you may get 20 or 30 proposals for these Frontier missions, and then in the end, two will probably be selected, maybe a third.

Pamela: Yeah, and it will be along the lines of "here are the five concepts that are recommended by the Decadal Survey. Go write proposals related to these five concepts," and each one of those concepts will probably get just a handful of proposals. So you're looking at maybe 20 proposals for all five ideas. And then from those, they will select one of those proposals to get funded in each of the two calls for proposals.

Fraser: Got it. OK. Yeah.

Pamela: So the big flagship that's currently getting recommended over and above the rest is a project called MAX-C. This is the first part in a mission to go and grab rocks from Mars and bring them back. This is a bit scary of a mission in my opinion -- very exciting scientifically, technologically very terrifying because this is where we need two spacecraft to land side by side, and as I mentioned in our last episode, we know how to land things in rather large landing ellipses; side by side is a challenge we still need to figure out, but one thing they're recommending is in the increase in the amount of funding that goes to research and development of new technologies. So they're recognizing through

the Decadal Survey that in order to keep moving forward, to keep doing new and interesting things, to build toward our dream of exploring under the waters of Europa, exploring the outer solar systems, the lava caves on Mars, and all these interesting scientific ideas, we have to develop technology.

Fraser: So, Mars Sample Return Mission…

Pamela: Right.

Fraser: OK.

Pamela: The next one, you know, you can say this two ways and one of them sounds much worse than the other: it's a Uranus Probe. [laughing]

Fraser: [laughing] We didn't laugh, children; we didn't laugh. There's nothing funny about that -- purely scientific. OK, a probe to the planet Uranus. Understood. Again, to study the planet, its moons…OK?

Pamela: This is going to be another mission along the lines of Galileo, Cassini, where you go out, you have an orbiter that orbits and orbits and orbits and drops something through the atmosphere.

Fraser: Yeah, to think we've only seen that planet once, briefly. All the images we have were taken by Voyager as it moved past… OK, more!

Pamela: So beyond this there's a recommendation that, you know, if the budget picture gets nice, if we have more funding than was anticipated – let's go orbit Enceladus. Let's go see the geysers up close and personal for a good period of time to understand exactly what's going on with this little moon.

Fraser: That would be amazing! OK…

Pamela: The alternative to that (because even when you dream big, you recognize you're only likely to get one wish come true)…the alternative is a Venus climate mission to go study that insane, acidic, gas, greenhouse effect planet, and so that's another interesting mission laid on the table.

Fraser: But an orbiter…

Pamela: An orbiter, yes.

Fraser: OK, I choose the Enceladus one, please. So anything else?

Pamela: Beyond that it starts getting into the "big picture" ideas. This is where they want to increase the amount of funding that's going to research and technology to make sure there's better ground-based technology, so this is where funding for the Arecibo radio dish was brought up, the idea that we need to build the Large Synoptic Survey Telescope. So we need to keep having good, ground-based support for all missions that go forward as well.

Fraser: So, I mean it sounds very loose, you know, like it doesn't sound very tight in the actual, specific missions. So what's going to happen next?

Pamela: Well, this is a multi-year plan – ten years, so while there isn't a "we have a mission, it's name is such and such, it's going to have the following five instruments on it…" while we don't know that, we know "here are guiding principles. Today we recommend these three things, pick one of the three." And as we go through the next three decades as the funding comes in we'll know, yes, going to Uranus is the right thing to do, going to Europa, which is still on the table, but is not one of the higher ranked ones, we know that is still on the table…so there's guiding principles. Each year

as the funding comes out, NASA will determine what calls for proposals it can put forward. I believe, based on all of the discussion I've heard, that we're going to consistently have calls for small missions, and that medium-sized missions -- there will be two calls for those in the next ten years.

Fraser: Now, can you give me an example of a small mission? Would that be something like Gravity Probe B?

Pamela: It's planetary, so this is where we're really looking at Dawn, at Stardust…

Fraser: At Dawn, at Stardust – OK, yeah, those are amazing missions, too.

Pamela: Exactly.

Fraser: Any word of the Terrestrial Planet Finder? Did you see anything in there?

Pamela: No, but that's in the Astronomy side, so this is where you end up with a fascinating "if it's inside the Oort Cloud, it's planetary, if it's outside the Oort Cloud -- which means extra-solar planets and the rest of the universe – that's astrophysics."

Fraser: Maybe there's still some hope there, no, there wasn't anything in the astrophysics either

Pamela: No, it's dead.

Fraser: Alright, well thanks a lot, Pamela. So over the next ten years, you can reference this podcast as we see what reality came from the fantasy.

Pamela: And if you want to see it become a reality, take the time out to let your congressman know and help be a part of the process.

Fraser: OK. Take care!

Pamela: Thank you. I'll talk to you later.

Fraser: Bye.

Pamela: Bye-bye.