Astronomy Cast Episode 207

Lyman Spitzer

Fraser: Astronomy Cast Episode 207 for Monday November 15, 2010, Lyman Spitzer. 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... how is your spare bedroom doing?
Pamela: My spare bedroom is less overwhelmingly filled with things, but a new shipment is coming soon so please order more t-shirts... and we have skinny-people ones, too!
Fraser: Great! So as we mentioned in the last show, we’ve got t-shirts, CDs, posters, all kinds of cool Astronomy Cast related stuff available. You just go to astrogear.org and see what we have on offer... and, yeah, you can buy it and clear out Pamela’s spare bedroom.
Pamela: And I have to congratulate our audience because you guys are overwhelmingly thin! It was the most surreal discovery. Smalls and mediums sold out first and that was awesome and odd...
Fraser: Lots of kids, too... that’s great.
Pamela: Yeah.
Fraser: Alright, well time for another action-packed double episode of Astronomy Cast. This week we focus on Lyman Spitzer, a theoretical physicist and astronomer who worked on star formation and plasma physics, and of course this will lead us into next week’s episode where we talk about the mission that bears his name, the Spitzer Space Telescope. Now when I hear the name Spitzer, I recognize it because of the mission, but when I hear the name Lyman, that also makes me think of something. But I’ve got that wrong, don’t I?
Pamela: Well, yeah... so Lyman... we’ve all heard, if you’ve paid any attention to galaxies, about this Lyman alpha line, except that Lyman alpha line which is a transition.... that $n = 2$ to $n = 1$ transition in the hydrogen atom... that’s named after Theodore Lyman, who’s a Harvard physicist, unlike Lyman Spitzer, who was a Yale physicist, and one should not mix those things up.
Fraser: Ok, so that way if we hear Lyman, it has nothing to do with the Lyman alpha line... until we do a Lyman episode... but... right, so we’ll talk about Spitzer then. Who was Lyman Spitzer?
Pamela: Lyman Spitzer was your quintessential good-guy astronomer. He was brilliant and basically lived one of those textbook this is what every A-type science child is supposed to do. He had the private school high school education, going to the prestigious Phillips Academy in Andover. He comes from the Midwest... this is an Ohio kid from Toledo. He went to this prestigious eastern high school. He went on to study at Yale. He went on at 33 to be Chair at Princeton. Everything he did was fabulous. He was part of discovering how sonars work, he was part of creating basically contained fusion experiments, and well, he’s also the reason that many graduate students get tortured

studying the interstellar media because he sorted out many of the key thermodynamic issues involved in the interstellar media.
Fraser: So when you say the interstellar media, what is that? Is that the stuff that's in between stars?
Pamela: Yeah, basically. We're boring when we name things.
Fraser: Right, but, I mean, it's not giving off any light so how can astronomers find it?
Pamela: Well, it is giving off light, just not in convenient wavelengths. So the interstellar media is literally the stuff between the stars. It's composed of gas, it's composed of dust, and mostly we see it with our eyes as the reason we don't see stars. When you look out at the disk of the Milky Way in the summer sky, you'll see these dark paths through the path of the Milky Way. If you happen to be in the southern hemisphere, one of these dark swaths looks particularly like an emu, which is kinda cool. It's the only dark constellation. These patches of darkness are where the gas and dust are absorbing out and obscuring the visible light from behind. If you look at these patches of sky instead as Lyman predicted... Lyman Spitzer predicted you should... you see ultraviolet emissions from young stars forming, embedded in this gas and dust. You also can observe these clouds in the infrared and you can start to penetrate the dust... looking through it to see what's inside of it and behind it. With millimeter, you can actually see the young stars just as they begin to heat up. Figuring out that this was there... that was what Spitzer did.
Fraser: Right. So instead of it being places where there are no stars because you don't see any stars, Spitzer helped astronomers realize that those are places where there are stars and they're doing very interesting things, like being newly born.
Pamela: Right.
Fraser: And that really leads into one of the major goals of the Spitzer Space Telescope.
Pamela: Which interestingly doesn't work in the wavelengths that Lyman Spitzer was most interested in. But, he actually was the person who said... you know, we need to get above our atmosphere. One of the reasons he said that was that he felt that stars had to be forming in interstellar media where they couldn't be seen, and by looking in the ultraviolet... a wavelength of light that doesn't make it through our earth's atmosphere... by looking at that wavelength, you'd be able to see evidence of these young stars. But to look in that wavelength and see those young stars he predicted, you had to somehow get above our ultraviolet-absorbing atmosphere.
Fraser: And I guess this is the big take-away, right? What key contribution beyond graduate student torture did he contribute to, I'm sure, all the listeners here? He really invented the idea and pioneered the concept of a space telescope, and he was the driving force behind Hubble.
Pamela: Right. And he did this way back in 1946 which was a decade before the first satellite went into space and 12 years before even NASA was a concept. So here he was, driven by a scientific idea, to basically say... we need to do something that right now is only science fiction.
Fraser: So in 1946, way before the first satellite, he wrote a paper and said... we really should put telescopes in space... doesn't matter that we haven't put anything in space... we really should put telescopes in space.
Pamela: Yes, and he was actually responsible for one of the early, early, early space observatories. Back in the early 70s he was part of the Copernicus observatory which was... guess what... an ultraviolet observatory.

Fraser: So then, beyond his work on the telescope, what other types of research was he involved in?
Pamela: Well, to basically step backwards, after he was done working on his PhD, World War II broke out... I'm not sure what else you say about WWII other than it happened... and like so many scientists, he got enlisted during the war to work on projects other than his central research which was stars and stellar atmospheres. The work that he did was to join a team that was studying sound underneath water. In the process, the team that he was part of developed the first sonars. The sonar technologies that are responsible for the bing, bing, bing noise in every submarine movie you've ever watched... he's part of the reason that technology exists. That's just kinda cool and off-topic. To see someone who's career could span across so many different fields is really quite amazing.
Fraser: That is pretty interesting... you could imagine working in astronomy and then being able to come into a completely different field... I wonder if there are similarities about light propagating through the interstellar media and sound propagating through water?
Pamela: Not so much...
Fraser: Oh...
Pamela: It is all wave physics, but the things that you have to worry about in the two different technologies—not so much the same. But he was someone who was extremely diverse in his ability to work. So he went from studying sound under water and developing sonar during WWII to... after the war he went back and joined the faculty at Yale and was there briefly. He also was a postdoctoral fellow at Harvard for a bit. He was recruited when he was 33 to go and become Chair of Princeton's Astrophysical Sciences department, and that, in and of itself, is pretty amazing and says something about how well-regarded he was as both a scientist and a leader. Most PhDs nowadays at age 33 are happy if they almost have tenure. To be faculty chair at such a prestigious institution at such a young age is amazing.
Fraser: Right, and that really is a testimony to his abilities... as you said he's sort of this classic textbook perfect astronomer in how he and how his career progressed right from the beginning right to the end. Alright, so he's at Princeton... he's the Chair. He kind of whipped them up into a real major research group, didn't he?
Pamela: Well, the first thing he did was he brought in a co-conspirator, a dear friend Martin Schwarzschild of the Schwarzschild radius that anyone who's looked at black holes has had to try to figure out how to spell, which is sometimes harder than doing the mathematics, I think. The two of them together basically started defining new areas of research including working on plasma physics. This is where we see Lyman Spitzer jumping fields again where he wanted to work on fusion and try to figure out how do you recreate the conditions in the inside of a star in the laboratory so you can understand experimentally what's going on.
Fraser: And harness it as a source of energy...
Pamela: Right...
Fraser: 30 years away...
Pamela: Always 30 years away!
Fraser: No, I mean he started in the 1950s, right, he started in the early 50s working on turning fusion into a clean and renewable source of energy... we talked about that in the Fusion episode. And here we are, 60 years later, and it's still 30 years off.

Pamela: Right...
Fraser: But maybe we'd be further off...
Pamela: Exactly. So back in 1951, Spitzer founded the Princeton Plasma Physics laboratory. It was originally called Project Matterhorn and of course had government funding, but he was working to try to find effective ways to contain plasma and came up with some really neat and literally twisted magnetic fields to do the containment for him, so that he could get various particle drifts to cancel out as particles circled in what was essentially a twisted figure 8. It's a fascinating design and shows a lot of interesting thought. His design was given the clever name of a stellarator because he was working to recreate the insides of a star. He was generating basically fusion systems back when in many ways we were still trying to understand fusion. It was only in the beginning of the 1900s that we even knew that fusion was what powered stars, and here he is trying to recreate it in the 50s in the laboratory.
Fraser: And it turned out a lot more difficult than anybody had ever expected but...
Pamela: Well, doing it in a way that generates energy...
Fraser: Yeah... yeah... but to even do it at all is quite amazing.
Pamela: Yes.
Fraser: Right. Ok... so, that was in the 1950s... but, you know, as we talked about earlier, he really started to move into helping get space telescopes off the ground.
Pamela: Right, so in the background of all of this is the constant dialog of... we need a space telescope... we need a space telescope... we need a space telescope. This was in some ways his mantra. While he's busy doing everything else... working on his plasma physics, being departmental director, being laboratory director for the Princeton Plasma Physics Lab... while doing all of this he was also this constant space telescope cheerleader. From 1960 to 1962 he also took on the presidency of the American Astronomical Society which is the premier professional organization for astronomers here in the United States. Premier... I think it's the only professional research organization in the United States for astronomers. He took over the society's presidency, and this was part of his platform from which he said... look, here, we need to build a space telescope... look, we need to build a space telescope. This was in a point in time when we had a space program which was in its early days and was looking to be able to do this. It was no longer science fiction, and in 1962, he got to start designing an observatory to orbit the earth. This was the successful Copernicus satellite. This was a long-lived observatory... it orbited from 1972 to 1981, and it proved his theories. It showed that yes, there are stars out there emitting ultraviolet light deep in these cloudy dusty blobs of interstellar medium.
Fraser: And it also proved his theory that yes, the future of astronomy is in space-based telescopes.
Pamela: Yes. But even before that little space observatory got to launch in 1965, there was a committee put together to start discussing... ok, so Spitzer's been talking about this idea for a long time. What would it take to build a large space telescope? Early on they dreamed big... they were thinking of building perhaps a 3-meter observatory. But as they initially started these plans, before we had that first observatory launched, this was a highly political thing to discuss. Funding is very limited in the sciences. People basically fight it out tooth and nail on a daily basis trying to get funding for their research, for their observatory, for their institution, for everything.

Fraser: And you can imagine for the human space program was gobbling up all of the available funds at this time. This was right in the middle of the Apollo missions when they were talking about this.
Pamela: Luckily, human space flight has typically been pretty non-destructive to the science budgets, but when you start building a science telescope, well, that's the science funding. There's a lot of concern that space-based observatories and ground-based observatories would be competing for the same pocket of funding. By redirecting funds, these already-functioning, easy to work with, known entities of ground-based telescopes might begin to lose their funding. It takes time to get a good space telescope put into orbit.
Fraser: But he was successful and got... I mean, there was a series of telescopes, right?
Pamela: Yes... and so there's been all of the orbiting observatories that have been launched, orbiting astronomy observatories... a whole series of them by NASA... and his early pleas, his early bargaining, his early passionate arguments for why scientifically we need to go into orbit with our observatories, were listened to. This led to in 1975 NASA and the European Space Agency together began development of the Large Space Telescope. This is after his Copernicus observatory, so he got to follow on the foot tails of that success with a position leading the design for what would be needed for the new what would later become Hubble Space Telescope.
Fraser: Even the relationship of Hubble is still the same. When we get the press releases for Hubble, they come from NASA and the European Space Agency. So, they both still have a role. That relationship that he helped negotiate did see through all the way to the development and launch of the telescope.
Pamela: One of the things that really impresses me about Spitzer is here's this guy that was just your standard American researcher... sounds like a domesticated cat... but he did the solid research... paper after paper after paper with research award after research award after research award. He was a brilliant theorist who could also work to build the experimental apparatus. You don't get that very often. In the same human head that could hold all of that engineering and mathematical and everything else experience and knowledge was also a personality that allowed him to convince his colleagues to take a risk and to also convince Congress. Spitzer had to go before Congress to get them to approve the funding for that space telescope.
Fraser: Yeah, I know what you mean. It really is this rare combination of personality where you've got the technical, engineering, science mind set, but then you've also got this leadership and vision to be able to carry out some of the bigger projects and really get some of this really incredible technology developed and created. That provides new tools back to the researchers. It's living in both today... what you can get done with what you've got... but also really dreaming big and helping get it done.
Pamela: He stayed with the Hubble Space Telescope project all the way through to its launch and in fact all the way up through to his death in 1997. He was still going into campus, working full days at Princeton University at the age of 82. He was continuing to work on reducing data from the Hubble Space Telescope, continuing to work on doing new research all the way up until he died. The thing that amazed me the most, preparing for this show, was every single account I found of his life, every single bio, no matter how brief, mentioned that on the day he died he worked a full day and he talked about science from the Hubble Space Telescope with his colleagues. He died unexpectedly and

suddenly at home, and I think in this constantly repeated refrain is the... this was the perfect capstone to the life of someone who just wanted to work with the space telescope.
Fraser: And I know that he was also active in mountain climbing, and again...
Pamela: You almost want to hate him!
Fraser: I know... I know!
Pamela: He's an athlete, he's charismatic...
Fraser: It's just like Hubble again... you've got this athlete who was great at science. Yeah, and so once again, he had a certain amount of vision. He was helping his alpine club conquer mountains quickly and rapidly with more challenging ascents than anyone had ever done.
Pamela: Right... he actually went after grant funding to develop ultra-light hiking gear so that people could make the first ascent to various mountains or to find new paths. Everything he did was cutting-edge... even mountain climbing. He died and they named a space telescope after him.
Fraser: Right. So, NASA decided to create the Spitzer Space Telescope. What was the original name?
Pamela: It was SIRTF.
Fraser: SIRTF... right... right... right. So... to name a space telescope after him to commemorate all of his work in really pioneering the whole concept of space telescopes. I think that's what we're going to be talking about next week.
Pamela: And just to give a preview... what is awesome about this is while Lyman Spitzer spent his whole life dreaming of space telescopes, his research was focused on the higher energy side of things... the ultraviolet, defining the interstellar media, looking at the pressure lack-of-gradient across the interstellar media... showing that hot stuff and cold stuff are in pressure equilibrium. All of this work with the interstellar media... while he was working on the high-energy side, Spitzer the telescope works on the interstellar media, too. It just looks at the cold side. And they are, as we know from Lyman Spitzer's work, in pressure equilibrium with one another.
Fraser: And so that's where we'll pick things up next week.
Pamela: Sounds good. And saying that out loud was far less interesting than it was in my head.
Fraser: Well, we'll jazz it up next week.
Pamela: Sounds good...
Fraser: Equilibrium... keep that in mind.
Pamela: Ok.
Fraser: Alright... take care... bye.
Pamela: Bye-bye.