Episode 14: **Ring around the Quasar**

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Travis: Welcome to Slacker Astronomy, a podcast about astronomy and anything else that floats over our heads. Every week we cover a news event from the world of astronomy. And when there is no news, we are happy for the good news.

Pamela: This week we have neither local nor international news – we've got extragalactic news. Quasars are among the most important astronomical discoveries of the 20th century. They are the most distant objects observed, and they are the brightest objects observed. They are so far away and so bright that, even though they are embedded in galaxies, they look like points of light in most images. The glare from these bright galactic cores shines brighter than the entire rest of the galaxy they lurk in.

Travis: Because they are so far away, the light we see from them is very old. The properties of that light has important implications for some of the most profound and important questions of astronomy.

Pamela: Such as how to get funding?

Travis: Well, in a way. The building of some of the largest telescopes in the world was justified in part by quasar research. But I'm talking even more profound questions like how was the Universe created and what will happen to it.

Pamela: The kind of questions that pop into our minds while laying in grass, looking at the stars.

Travis: It beats laying in the gutter, looking at the cars.

Pamela: Really? You can still see Saturn, Taurus, a Nova and even Subaru, which is Japanese for the Pleides.

Travis: Quasars, being so distant, are also difficult to understand.

Pamela: There has been a dominant theory around for quite a while that explains everything we see regarding quasars, except for one thing. That one thing was a glaring weakness that prevented anyone from confidently believing the theory. Finally, with help from the Spitzer space telescope, that weakness has been explained. And there was much rejoicing.

Travis: All it took was a 720 million dollar instrument.

Pamela: Like we said, quasars help justify funding for really big toys!

Travis: Everything we know about quasars come from their light. In particular, the spectrum of their light. Astronomers have observed quasars in just about every wavelength that current technology can manage.

Pamela: One neat thing the spectrum does is map out the composition of the Universe between us and the quasar. The light is so bright, it acts as a sort of core sample of the

Universe. Everything that stands in between the quasar and us appears in the spectrum through absorption lines. These are dark bands in the bright spectrum where atoms and molecules in intervening stuff absorb specific wavelengths of light. In effect, the stuff between the quasar and us casts shadows in the quasar spectrum.

Travis: If we see a bunch of dark bands, we know that there are molecular clouds of gas and dust between us and the quasar. In addition, by looking at where the dust absorption lines are in our spectrum, we also know where between the quasar and us the cloud of stuff is hiding. It ends up being pretty complicated to figure out, but when all is said and done you know a whole lot, about a very tiny sliver of the Universe.

Pamela: Current theory says that quasars are a form of active galactic nuclei, or AGN for short. Basically these are galaxies with very bright centers that contain an actively feeding black hole. Most AGN lived in the early epochs of the Universe, hence why most quasars are seen to be far away.

Travis: Thanks to the ever so slow, 300,000 kilometer per second speed of light, we see distant objects as they appeared in the past. Those quasars that were thriving when the universe was 6 billion years old appear today to be star like objects located 6 billion light years away.

Pamela: One of the big unanswered questions in astronomy is why there are few young quasars nearby.

Travis: Every good astronomy story has to involve a black hole. This is Slacker Law #3.

Pamela: Sure enough, we think quasars, like all AGN, are powered by supermassive black holes at the center of galaxies. These hungry monsters devour matter at a high rate — sometimes as much as a solar mass of material per day.

Travis: Black holes are not fans of the SlimFast or Special K diet ...

Pamela: When the light first leaves a quasar it is smooth, what we call a blackbody spectrum. There are no emission or absorption lines. Blackbody spectrums are very common, and they can be used to determine the temperature of an object. If you make a plot of brightness vs color for you hot, dinner filled, cast iron sauce pan and for a quasar you'll get two plots that are the same shape, but peak at very different colors. Depending on just how hot your dinner may be, the pan will brightest in the infrared or red, while the quasar peaks at very short wavelengths that are bluer then the bluest blue your eyes have every seen. Both these black bodies shapes look like a very smooth, but not quite symmetric grade distribution from freshmen physics. That tail into the low numbers just drags on and on.

Travis: The smoothness in the black body curve means any absorption lines we see must come from material outside of the quasar. The dominant current theory states that a torras of material surrounds the center of a quasar. A torus is a geeky way of saying it is shaped like a donut.

(clip: Homer: Mmmmmm donut. and/or clip about theory of donut shaped universe from hawking episode)

Pamela: Quasars are pointed all over the place. Sometimes their poles point perpendicular to us and we see a jet of material shooting across the sky. Sometimes the quasars point right at us and *all* we see is the end of the jet, because its light drowns out everything else. These are called blazars.

Travis: We have heard a rumor that a drink called the blazar exists somewhere in the midwest. Super kudos to anyone who can send us any information on it!

Pamela: Of course, quasars can also be pointed at all the angles in between. When they are pointed such that the torus is between the quasar core and us, then a specific kind of silicate dust in the torus blocks some of the light. This creates absorption lines that are clearly located the same place as the quasar. These lines are the reason we why we know these toruses exist.

Travis: However, if we are looking right down through the top or bottom of the quasar then we don't see the torus. We see into the hole of the donut, unobstructed by the dust. So the absorption lines should be gone.

Pamela: And sure enough, that is what astronomers find. But something is missing.

Travis: The light the torus absorbs to create absorption lines gets re-radiated in all directions and at a new wavelength. We know what this wavelength should be and we have looked for it in the spectrum of quasars that are pointed at us.

But we just don't see it.

Pamela: Check that, we *didn't* see it. Until now.

Travis: Using the Spitzer Space Telescope two groups of astronomers claim to have finally found the missing emission lines. Astronomer Lei Hao of Cornell University — one of the universities that helped build the Spitzer Space Telescope — has published a paper describing the detection of two types of dust from the torus, thus confirming current quasar theory.

Pamela: Cornell issued a press release on June 6, 2005 detailing her discovery. In Slacker Astronomy's humble opinion, it was one of the best press releases we've read in a long time. It was well written, detailed and without much of the hokey forced quotations usually found.

Travis: You mean like the hokey forced jokes we usually have?

Pamela: Ouch! I guess you have a point. Anyway, we highly recommend you read the press release, which is linked in our show notes at slackerastronomy.org. This release got some coverage on the web and that is how it came to our attention.

Travis: But in our research of the story we found a *second* group of astronomers who claimed to have discovered the same thing at the same time using the same telescope.

Pamela: The *same* discovery, *same* time and *same* telescope?

Travis: That's right. But in two different journals. One in North America, and one in Europe.

Pamela: We suspect a major case of professionally rivalry is underfoot.

Travis: Hao's paper was published in ApJ Letters. That is the quick publication arm of the Astrophysical Journal, published in the United States. If you have a paper with timely results that need to be quickly published, you go there.

Pamela: The other paper was published by R. Siebenmorgen of the European Southern Observatory in A&A Letters. Yep, you guessed it. That is the quick publication arm of Astronomy and Astrophysics, a *European* astronomical journal!

Travis: Both groups were clearly eager to get the word out. From the abstracts, the only clear difference between the papers we could find is that Hao detected dust emission at two wavelengths, while Siebenmorgen detected one. What this means, we can't say. No one at Slacker Astronomy are experts in...

Pamela: — anything.

Travis: True, but we are especially not experts in quasars and infrared spectra. So we cannot judge the quality of the papers. All we can say is kudos to both groups for solving a mysterious puzzle that has confused astronomers for over 20 years.

Pamela: It's nice to know quasars are still quasars.

Travis: Like we said, no news is good news...

Pamela: And that is the end of the news. You have been listening to yet another edition of Slacker Astronomy. Send us feedback to info@slackerastronomy.org.

For Travis and our trusty author Aaron Price, this is Pamela Gay.

Travis: Clear skies and clear bandwidth, you've been listening to Slacker Astronomy, a three-person collaboration for you, for fun, for the voices in our heads.