Episode 35: **Stellar Skeletons**

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Travis: Welcome to show number thirty-five of Slacker Astronomy; a podcast about astronomy and just about anything else that floats over our heads.

Pamela: Each week we bring you a recent news event from the world of astronomy. And when there is nothing new to report in astronomy we will track the rising stars of the toy industry.

Travis: This year's hottest new toy, as far as Slacker Astronomy is concerned, is the iDog, which can party hard to podcasts, and unlike Pamela's dog, it will never pee on your shoes.

Pamela: Um, Travis, my dog and I think there is actually news to discuss this week, even if it would be more fun to discuss teaching Furbey 2005 to use a planetsphere.

Travis: Can Furbey and iDog do the podcast for us while we shop for astronomical almanacs?

Pamela: I don't think our audience understands Furbish, so I think shopping is gonna have to wait. Supernovae are calling your name.

Travis: Drats… Furby, you're getting signed up for ESL classes tomorrow! So, what's up in the world of Supernovae?

Pamela: We have three hot new stories to report. The first and fastest focuses on the Crab Nebula.

Travis: The crab nebula is a giant shell of glowing material in the constellation of Taurus the bull. It can be seen with a modest telescope from a dark location in the Northern Hemisphere's Fall and Winter.

Pamela: The Crab Nebula was formed when a star exploded as a supernova. This explosion was visible here on Earth in 1054 and was recorded by the Chinese and Japanese, and possibly by the Native American's of the American Southwest, although interpretations of symbols vary.

Travis: During the explosion, the core of the star collapsed and started rotating very rapidly, forming a pulsar.

Pamela: At the same time, shockwaves and material from the outer layers of the star accelerated away from where the star used to be.

Travis: Today, the pulsar continues to sit and spin like a small child who's eaten too many sugar cookies, and the material from the outer layers of the star glows brightly as a supernova remnant.

Pamela: During October of 1999 and January of 2000 the Hubble Space Telescope took 24 images of the Crab Nebula using the Wide Field and Planetary Camera 2. These images were assembled together to form a spectacularly detailed image of the nebula that reveals fine structure and composition.

Travis: In the image available on our website, bright blue filaments of neutral oxygen mix with the greens of glowing ionized sulfur, and the entire nebula is infused with the red of doubly-ionized oxygen.

Pamela: At this time, the folks at the Space Telescope Science Institute have just released the pretty image, and they aren't revealing details on the new science associated with the image, but when the science comes, we'll be here to share. For now though, take a look at the image and tell us what it reminds you of.

Travis: Personally, I don't see a crab, I see one of those weird medical diagrams where all they show you is the veins and arteries.

Pamela: Been watching the Discovery Channel again Travis?

Travis: It was that or "The Biggest Loser" and going into the holiday gluttony season, I just don't feel like being inspired to diet.

Pamela: I'll raise an eggnog to that.

<clunk>

Travis: So check out the image of the Crab Nebula at www.slackerastronomy.org and let us know what you see. We've also included a finding chart, courtesy of the Hubble Folks, for those of you wishing to take a backyard view of the system.

Pamela: Our second story involves that moment when a supernova stops being a supernova and starts being a supernova remnant.

Travis: Like many things in astronomy, we understand the extremes, but we're not quite sure how to explain the boundaries.

Pamela: For instance: What's the cutoff between a planet and brown dwarf star? How far from a red super giant's core does its atmosphere end and the nebula of blown off material begin? Where do you draw the line between a giant star cluster and a dwarf galaxy?

Travis: <pause> Yeah, astronomers are good at defining undefined boundaries.

Pamela: So, when you look at the crab nebula, you see a cloud of glowing material that is defined as a supernova remnant.

Travis: And when you look at Supernova 1987a, you are looking at an 18-year old supernova.

Pamela: Until recently some astronomers had assumed that the original explosion gradually faded away, and a supernova remnant formed as the shock waves from the supernova explosion hit the surrounding interstellar medium, causing it to light up.

Travis: The interstellar medium is the collection of free roaming dust and gas that permeates all of space between the stars.

Pamela: Like the dust in your house, it is thick in some places and almost non-existent in others, and it is always catching the light that is trying to pass through it.

Travis: Astronomers led by Dr. Stefan Immler of NASA's Goddard Space Flight Center, have looked for supernova – supernova remnant transition in the 35-year old supernova

1970g.

Pamela: Supernova 1970g is the oldest supernova visible to X-ray telescopes. Immler and his team took new images of this supernova with the Chandra X-ray observatory, and combined this new data with X-ray images taken with the European-led ROSAT and XMM-Newton observatories.

Travis: They used these images to study the x-ray emitting glowing material around the supernova. They discovered the X-rays originate from material blown off the supernova's progenitor star – the star that eventually blew up as a supernova.

Pamela: This implies that the progenitor star can provide all the material necessary to form a supernova remnant – no high-density interstellar medium is required.

Travis: In fact, in an Astrophysical Journal paper co-authored by Dr. Kip Kuntz, also of Goddard, it was shown that the Cassiopeia A supernova remnant also is made up of material from the progenitor star and not from the surrounding interstellar medium.

Pamela: According to Immler:

Travis: <quote voice> "We have to rethink this notion that a shock wave from the supernova crashes into the interstellar medium to create a supernova remnant. The luminous supernova remnants that we see can be created without the need of a dense interstellar medium. In fact, our study showed that all supernovae detected in X-rays over the past 25 years live in a low-density environment."

Pamela: So, one set of good observations raises a whole lot more questions.

Travis: And every new question provides our show another day's life. As long as astronomers are coming up with new stuff, we'll be coming up with new shows.

Pamela: But today's show still isn't over – we have one more bit of supernovae news to share.

Travis: You astronomers sure don't know when to let a supernova lay, do you?

Pamela: If we did, how would we know the universe is accelerating apart?

Travis: Accelerating apart? That just can't be good.

Pamela: It's not really good or bad it just is.

Travis: So when you say the universe is accelerating apart, what exactly do you mean?

Pamela: Well, it all started with Einstein…

Travis: Not Eve? I thought it all started with Adam and Eve…

Pamela: Um… Okay, the story on the acceleration of the universe all starts with Einstein.

Travis: Okay, that I'll buy. So once upon a time, at a desk far far away, Einstein…

Pamela: Einstein wrote out the equations for the evolution of the universe. After much mathematical mayhem he found himself face to face with an equation that implied the universe is expanding.

Travis: The problem is, in 1917 Einstein lived in a society that believed the universe was static – neither expanding nor contracting – and just sitting there being a universe.

Pamela: So, like all good mathematicians, he added a constant that made his equations work. He named this constant Lambda and used it to balance the universe so that it just sat there at a constant size.

Travis: And a few years later, when Hubble measured the actual expansion of the universe, Einstein renamed Lambda his greatest mistake.

Pamela: And he was wrong.

Travis: Yes, that's why it was his greatest mistake.

Pamela: No, he was wrong when he called Lambda a mistake.

Travis: But how was it a mistake – the universe is expanding.

Pamela: Exactly.

Travis: But Lambda was used to explain that the universe ISN'T expanding.

Pamela: It all depends on what value you give lambda. You see, when the universe came thundering into form with the Big Bang, it had an expansion velocity. Gravity has been working against that velocity though, and you'd expect that gravity would over time be slowing the rate at which the universe is expanding. At the same time, Einstein's Lambda can we used to describe some force that is pushing the universe apart, balancing out or even overcoming gravity's deceleration.

Travis: And, using suepernovae, a many-membered international team of astronomers demonstrated that the universe is expanding faster now than it was in the past.

Pamela: Supernovae were the key because they are standard candles. Just like you can tell how far away a car is by looking at how bright its headlights appear; astronomers can measure the distance to supernova by looking at how bright they appear.

Travis: By measuring the brightness and thus the distance to many many supernovae as well as the rate at which the galaxies appear to be moving away, we can plot out the expansion rate of the universe as a function of time. Supernovae at a large distance are seen far in the past and nearby supernovae demonstrate what the universe is currently doing.

Pamela: If by current you mean what the universe has been doing in the past billion years or so.

Travis: So, when astronomers plot distance versus recession speed, they are also plotting time versus expansion rate.

Pamela: And the latest plots show that Einstein's idea that Lambda was some constant energy term seems to fit what is being seen better than anything else.

Travis: Lot's of theories exist trying to describe Lambda as some form of dark energy that changed form over time, but the observers working on this study just don't see that.

Pamela: According to Ray Carlberg, of the department of astronomy and astrophysics at the University of Toronto.

Travis: <quote voice> "Our particular observation is at odds with a number of theoretical ideas about the nature of dark energy. They generally predict that it should change its form as the universe expands, and as far as we can see, it doesn't."

Pamela: So, we live in a universe that, for reasons unknown, is accelerating apart and is thus providing many future doctoral dissertations for theoretically minded graduate students.

Travis: And, when the universe has accelerated apart to the point that everything is cold and distant, we can burn those doctoral dissertations to keep warm.

Pamela: Um, well, errr… I think humanity will be good and consumed by the Sun or by ourselves by then, so let's not worry about staying warm in the future, and just wish everyone out there listening a warm and happy holiday season now.

Travis: Merry Christmas, Happy Hanukkah, Best Kwanza Wishes, and may the Pasta be with you.

Pamela: At the end of today's show you're going to hear our first official slacker commercial. Aaron, Travis and I are hoping to travel more so that we can bring you more interviews and better content, and so we can help get other astronomers doing high quality podcasts. To make this happen, we had to find someone to help fill our cash box with money for airfares. You guys have been donating enough to pay for bandwidth and recording equipment, and now Oceanside Photo and Telescope is going to help us take that equipment on the road.

Travis: We hope you all will take the time to click through to OPT's website at www.optcorp.com the next time you visit us at Slacker Astronomy. We asked them to be our sponsor because they are a company we believe in, and we hope you'll take a look at their site when you look to add to your astronomy toy box.

Pamela: As always, more info on the science behind this show is available in the show notes on our web site. You can also post comments and questions there too. Visit us at slackerastronomy.org.

Travis: Thanks for listening. For Pamela and Aaron, this is Travis Searle.

Pamela: Clear Skies and Clear Bandwidth. This has been Slacker Astronomy, a volunteer collaboration for you, for fun, for the voices in our heads.