

## Episode 8: No Metals Present

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- Pamela: Welcome to show number 8 of Slacker Astronomy; a podcast about astronomy and just about anything else that floats over our heads.
- Travis: Every week or so we will bring you a summary of a recent news event from the world of astronomy. And during slow news weeks, I may sneak in some music from my Band [insert band name here].
- Pamela: I always knew you used to be star!
- Travis: [Real modest] A star? No, I wouldn't go that far. I mean we have groupies and get the occasional fan email, and everything... but I don't think I really am a star ... [pause – now in grumpy voice] Wait a second – you just said “Used to be a star didn't you.”
- Pamela: Yup – You used to be a star.
- Travis: [Defensive.] Not used to be. Am. We are stars...
- Pamela: Nope – not anymore
- Travis: But people come to our shows!
- Pamela: Oh Travis, it's okay. I know that in your secret little fantasy world you are a rock and roll legend, but in real life you have been a former star since the day you were conceived. So was I. In fact, so was my dog.
- Travis: [acts like Pamela is on drugs] Um, Pamela... Your dog is not, was never, and never will be a star. Your dog pees on people's shoes. That does not garner stardom for anyone.
- Pamela: My dog was a star. Not a celebrity or anything. But, the carbon that makes up her skin and the iron in her blood, and even the calcium in her bones all used to be part of a star.
- Travis: A star – you mean me, you, and your dog all used to be a star like the Sun is a star?
- Pamela: Yup – See, today's show is all about stars, and how stars are responsible for creating pretty much all of the atoms in our universe that are heavier than Hydrogen and Helium.
- Travis: When the universe first formed, it underwent a brief period of nuclear fusion when the temperatures and densities of what was then all of space weren't too different from what you find inside of stars. When these nuclear reactions were over, the universe was 25% Helium had trace amounts of Lithium and Beryllium, and everything else was Hydrogen.

Pamela: All these non-Hydrogen, Helium, Lithium, and Beryllium atoms were formed in just 3 minutes. To get to the next easily formed atom, Carbon, the universe would have to wait until stars had formed.

Travis: Forming Carbon is a rather challenging act of stellar alchemy that requires something called the “Triple-Alpha Process.” This reaction involves three helium, and requires just the right temperatures and densities to occur. It is a very slow reaction too, and those first, helium producing, three minutes just weren’t long enough to create to Carbon.

Pamela: The first stars entered the scene several hundred million years after the Big Bang. These early stars, like early humans, just didn’t look and act like what we’re used to seeing today.

Travis: Early stars had bushy eyebrows and big heads?

Pamela: There were no cro-magnan man eyebrows, but the stars were bloated. Early stars formed from clouds of gas that just couldn’t get cool. These hot clouds formed really large hot stars – Many of which were 100s of times the size of the Sun.

Travis: Weren’t you telling me that all large stars explode?

Pamela: Violently

Travis: So all the stars that formed in early universe exploded?

Pamela: Very violently

Travis: That just doesn’t seem like a good thing. I can hear the new’s anchors now: “And tonight at ten, Stone Phillips reports on the new fad among stars: exploding. Stars everywhere seem to be following this self-destructing trend. Tune in to find out which stars are likely to be next, and what you can do to be prepared.”

Pamela: With no heavy elements, there were no planets and there could be no life. Who were the explosions going to bother? In fact, its because these stars all exploded that the universe was able to start building up the Carbon and other elements that Earth required when it started forming a few billion years later.

Travis: The second generation of stars formed out of a mixture of the stuff flung into space during these explosions and stuff from the Big Bang. Some of these stars are still around, and astronomers are slowly but surely finding some of these elusive stellar elders.

Pamela: While really large stars burn through their nuclear fuel quickly and then explode, small stars just sort of putze along, giving off a little bit of light while very slowly burning through their fuel. The large stars are the cosmic Hummers, tearing apart everything that gets in their way, while the small stars are more like a Prius. No, they won’t go 160 down the highway, but they can get you from Boston to New York with 4 gallons of gas.

Travis: 4 gallons, \$2 a gallon – That’s 8 bucks! You mean, if I get a Prius, I don’t have to take the \$5 China Town bus to afford to go to New York City?

Pamela: Um, well, if you can afford the \$21,000 to get a prius.

Travis: You know, that China Town Bus is the best thing ever created...

Pamela: But returning to stars...

Travis: Oh yeah – I used to be a star!

Pamela: So, the little stars burn through their fuel very slowly, and some of those second generation of stars are still out there, and still slowly burning.

Travis: An international group of astronomers using the Japanese Subaru Observatory recently found the second of two of the most metal poor stars ever seen. This star, with the ever so creative name HE 1327-2326, has 250,000 times LESS iron than our Sun. It is the first unevolved star to be found with such a low amount of iron.

Pamela: Strangely though, this star does have a lot of Carbon. It's this carbon that has scientists thinking that this star came from the second generation of stars. It is possible that when the first generation of stars exploded, their iron rich cores collapsed into black holes while their carbon rich outer layers got flung out into space and recycled into a new generation of stars.

Travis: It's also possible that HE 1327-2326 is a low mass member of that first generation of stars, and the carbon that we see on it has actually fallen onto it over time. Think of HE 1327-2326 as a potentially dirty star that had it's pristine, carbon free exterior polluted as it traveled through the disk of our galaxy.

Pamela: Sounds like someone left it out in the open in Gary, Indiana.

Travis: No one ever claimed carbon pollutants were unique to Earth.

Pamela: Trying to understand how stars like HE 1327-2326 came into existence is sort of like understanding what goes into a casserole. If your Aunt Matilda shows up with something consisting of chicken, potatoes, green beans, squash and creamy mushroom soup that is coated in potato chips, you know she had those things available when she was cooking. If one day she shows up and the squash isn't in the casserole, you know you should ask if some critter got her squash from the garden this year.

Travis: <sounding a bit green> Your family's not from around here, are they?

Pamela: You don't like good middle of the country casserole cooking?

Travis: Ummm <being politically correct> So how does this relate to stars?

Pamela: When the squash isn't in Aunt Mattie's casserole, I know something prevented her from putting it in. With her, it's usually the squash vine bores. If I find a star that has a lot of carbon in it, but not a lot of iron, I know something prevented the iron from getting in. Supernova can release both iron and carbon into space.

Travis: When astronomers noted that HE 1327-2326 had carbon but not iron they were able to place some constraints on what the universe has been and is made

of. Either we've got a lot of carbon hanging around waiting to leap into the atmospheres of unsuspecting old stars, or the early supernova that released the carbon didn't also release the iron.

Pamela: When stars more than 120 times larger than the Sun explode, they completely explode, and their ain't nothing left but a large pretty cloud of stuff like carbon, and iron, and even gold and silver.

Travis: So you're saying that jewelry is nothing more than ashes from supernova explosions?

Pamela: It's all about the spin, Travis – That pretty bling you give your girl friend is made of star dust, not soot or fall out.

Travis: And if the exploding star belongs to that first generation of stars and it is small, say just 100 times the mass of the Sun, most of the iron and heavier atoms falls back to form a black hole, leaving just the carbon to go out and make stars.

Pamela: So our little HE 1327-2326 may be telling us that the largest of the first generation of stars weren't generally larger than 120 times the size of the sun.

Travis: All that from just one star... It must have taken generations of stars to build up enough materials to make the planet Earth. Lots and lots of supernova went into the formation of the copper deposits in Arizona and the gold in them there hills of California.

Pamela: There are some scientists who think that our little Earth may have formed about as early as any planet could possibly have formed.

Travis: So, there are probably no little gray men out there who have been exploring space for a billion years?

Pamela: Probably not. Maybe little gray dudes a few 1000 years more advanced... but, there's a lot of statistics to think about... But that's a topic for a future Monolithic Monolog. I think its time to finish up this podcast.

Travis: This episode, and in fact for this entire month, we're going to do something we've never done before and don't plan to do again for at least one more year. We're going to ask all of you, our gentle listeners, to click over to Podcast Alley and tell the world you like us.

Pamela: It is our goal to soar, for one month at least, in their ratings.

Travis: Now it may sound like we're on an ego trip, but we're actually doing this for a logical, or at least a financial, reason. We're in the process of trying to find money to support our podcasting habits. Buying equipment, buying bandwidth, and just getting properly caffeinated to record all costs money. In order to get funding, we have to convince potential funders that someone is listening. This is where Podcast Alley comes in.

Pamela: We also encourage you to send us letters, write comments on our message board, and otherwise scream to world, "I AM HUMAN. I AM LISTENING. I AM NOT A NET BOT." We liked the 4 comments on our last show, but 40

would have been much more exciting to potential sugar daddies.

Travis: So please, if each and every one of you could sometime this month drop us a message and go to Podcast Alley and vote for us, it would really help. Our email address is [info@slackerastronomy.org](mailto:info@slackerastronomy.org)

Pamela: And we'd really like to thank those of you who have donated money to us through paypal. Aaron and Pamela have their Griffin Lapel Mics, and we'll be buying our first iRiver in the next couple days we think! We are in the process of scheduling interviews with a bunch of astronomers, and this equipment will really help us sound a little more pleasant.

Travis: So long, and thanks for all the fish, err, um, for all the support. So long and thanks for all the support. We love you former stars; each and every one of you.

Pamela: On behalf of Aaron and Travis, this is Pamela Gay.

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