TUMBLE

TRANSCRIPT:
Lesson 6: Henrietta Leavitt and The Resolution to The Great Debate

ME: Imagine for a second that you're inside a really massive building. One that is so big, that not only have you never left it–but you haven't even seen all of its rooms. And then imagine that somebody came along, and asked you to draw a picture of the outside of that building. How would you do it? Where would you even begin?

This problem is a *lot* like the problem that astronomers have: trying to figure out the shape of the universe while we're sitting in the middle of it. To draw a better picture of our universe, astronomers have to rely on clues from light outside the *window* of our own planet.

MUSIC

ME: Hi and welcome to Cataloging the Universe! In this 7 part series, we'll be taking a journey through time and space to try to find our *own* answers to giant questions about the universe. Along the way, we'll have some help from scientists, experts, and our imagination. I'm Marshall, and I'll be your guide on this journey.

This is Lesson 6, Henrietta Leavitt and The Resolution to The Great Debate, where we'll finally find out whether Shapley or Curtis were right.

MUSIC STOPS

ME: When looking into space, as we have learned, there is lots to observe. But seeing a star doesn't mean you understand it. For example, it's hard to figure out the size or distance of the things you find.

If you did the light experiment from the last lesson, you might have noticed something about the way lights look as they get further away from us. You may have made a hypothesis–or an answer–to the question of how lights appear to change as they get further away. The further they are, the dimmer they appear to be, and this happens no matter *how* bright a light might be in the first place. If a very bright object–like a star, for example–is far enough away, it can appear to us to be the *same* brightness as a dim object–like a tiny glow stick or a planet–that is much closer. That's why it can be so hard to figure out the distance of faraway objects if we don't know how bright they really are.

This question of distance was really key …

HS: Yes, yes it was.

ME: Oh, hi there Shapley…. What I was just about to say, this question of distance was really key in The Great Debate from our first lesson, right?

HS: The big problem, you know, was that we didn't know how far away *anything* was.

ME: Uh, yeah.

HS: That's why when I figured out how far away the center of the galaxy was, it was truly revolutionary.

ME: Right, but…

HS: A major deal!

HC: Of course, you're wrong you know.

ME: Shapley, Curtis, it's nice to see you again, but can you *please* stop fighting for just a second and let me talk?

BOTH: Ok

ME: The key point about The Great Debate was this question of how big our galaxy is, how far Earth is from the center, and if spiral nebulae are within that galaxy, or if they're galaxies of their own. We're getting to the answer!

BOTH: Where I'm right!

ME: <sigh> Listen, just take a break guys. The key to finding out which one of you was right really comes down to measuring distance, doesn't it? How do you know how far away something is if you don't know how big it is?

HL: Excuse me, I don't want to interrupt, but I think I might have the answer to that.

ME: Oh, hi! Everybody, this is Henrietta Leavitt.

HL: Oh, hello.

ME: Ms. Leavitt is famous for a breakthrough that helped calculate the distance to stars.

HL: Thank you for that.

ME: You were originally hired as a computer, weren't you?

HL: Yes! But that doesn't mean I'm a robot or machine. My job was to do the calculations and math astronomers needed in order to understand more about what they were seeing. But, as I was doing my arithmetic work, I started to notice something.

ME: What was that?

HL: Well, so I was looking at a certain type of star that changed in brightness over time–so like, the same star was brighter or dimmer, week to week or day to day.

ME: Oh, ok. And why were these flickering stars important??

HL: Well, I was computing those changes, and trying to figure out how fast each of them was changing. And then, that's when I noticed my huge discovery!!

ME: What did you notice?

HL: Well, there are a bunch of these stars whose size we already knew, because we'd figured it out before. And what I found was that the stars' rate of change in brightness was correlated with their size.

ME: What do you mean, "correlated"?

HL: Oh, yeah, right. Good question. "Correlated" means that these things move together–in other words, the bigger the star, the longer it takes to change brightness.

ME: Oh. Ok. <pause> So is this similar to what we've seen with the bright and dim flashlights?

HL: Yes! Exactly! Using the correlation I discovered, we can now measure these stars: are they really big and bright, or are they small, and dim? When you know the size of the star, you can figure out how far away it is!

ME: Oh, wow. That seems like a really big deal!

HS: Yes! Incredibly so!

ME: Oh, hi Dr. Shapley!

HS: Indeed. Ms. Leavitt's findings were absolutely essential to our understanding of the universe.

HL: Oh, gee, thanks!

HC: Well, I'm sorry, but I'm not at all convinced that she's correct, because obviously, *you* aren't…

HS: Wrong! Her findings support *my* model…

ME: Although they didn't agree at first, astronomers everywhere quickly came to Shapley's view that she was absolutely correct about what she'd found.

HS: Ha! We were right all along, Henrietta!

HL: <reaction> Mm-hm.

ME: All thanks to you, Ms. Leavitt!

HL: Happy to help!

ME: And the truth is that Leavitt's findings actually *did* resolve Shapley and Curtis's debate once and for all…

HC & HS: *How?*

ME: Well, as it turned out…

ME: They were both wrong.

HC & HS: *WHAT?!*

ME: A few years after their debate, the astronomer Edwin Hubble, using Henrietta Leavitt's method of calculating distances to a spiral nebula, determined once and for all that spiral nebulae were *actually* outside of our galaxy–that Heber Curtis was actually right about that!

HC: Ha! Told you!

ME: The evidence for Curtis's model was made even stronger a few years later, when Hubble published images of individual stars in spiral nebulae–proving once and for all that spiral nebulae were actually galaxies just like our own, and very, very far away.

HS: Those images shattered my world.

ME: I'm sure it must have been shocking–and not just to you, Dr. Shapley. The fact that spiral nebulae were actually other galaxies meant that the universe had to be bigger… and like a *lot* bigger… than anyone had ever thought before. Where you were proposing that the Milky Way was 30,000 light-years across, these new calculations about the size of the universe meant that other galaxies had to be millions and millions of light years away… maybe even billions.

HC: Or, to put it scientifically, super, duper huge.

ME: Thank you, Dr. Curtis. And while these findings proved that *you* were right about spiral nebulae, it turns out that you were totally wrong about our own galaxy.

HS: Ha! Told you!

ME: Sure, Shapley, sure. As later discoveries showed, our sun is actually quite far from the center of its own galaxy, way out on the edge of one of the arms of our own, spiral-shaped galactic system. And while your estimate, Shapley, for the size of the galaxy was *maybe* a little too large, as it turned out your guess was closer to what we think now than Curtis's.

HS: Well, you can't win 'em all.

HC: Too true, friend. Truce? No more fighting?

HS: Sure. No more fighting.

MUSICAL PAUSE

ME: Thanks to Henrietta Leavitt and Edwin Hubble, Shapley & Curtis's debate was resolved, once and for all. Thanks to all of these scientists, we now know that the universe is much, much vaster than we ever thought it was before–that there are millions and millions, maybe billions and billions of galaxies, just like our own, each of which is huger than the hugest thing you could possibly imagine. Though we know all that, there's still so much that we don't yet understand. Scientists are constantly working to figure out and understand more about the universe, and each question they answer just brings more, and more, and more questions.

Next time, when we use all the skills we've learned so far to try to help scientists today understand more about the millions and millions of galaxies in the universe. I'll see you then, in our last lesson of Cataloging the Universe.