

## Episode 25: Downsizing

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

Pamela: 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, we'll bring you the latest gossip on Hollywood stars.

Travis: They tend to be much more interesting on the short term anyways. And their explosions can rival that of most any supernova. Just ask the hotel clerk who's dealt with Russel Crow.

Pamela: And like so many Hollywood Stars...

Travis: <cough> Nicole Richie <cough> Jessica Simpson <cough>

Pamela: ... the galaxies in this week's show are downsizing their figures.

Travis: Astronomers led by Yale University's Jenica Nelan studied 4000 elliptical and lenticular galaxies using the 3.5-meter WIYN telescope at Kitt Peak National Observatory in Arizona and the 5-meter Blanco Telescope at Cerro Tololo Inter-American Observatory, east of La Serena, Chile.

Pamela: Galaxies come in 4 basic forms. Often considered the prettiest, are the spiral galaxies like our own Milky Way Galaxy and the nearby Andromeda Galaxy. In spiral galaxies the majority of the stars are in a coherently rotating disk with structure that looks like arms or in some cases many pieces of arms. Spiral galaxies also have a central spheroid, called a bulge, of stars. The bulge ranges in size from dominating the disk to being basically non-existent.

Travis: Elliptical Galaxies, like M87 in the Virgo Cluster, are spherical. Their stars often orbit in many different directions, shaping the elliptical galaxies into celestial cigars or somewhat boxy structures. It's thought that elliptical galaxies are built up through the merger of many smaller systems – and when I say smaller, I mean that two galaxies like our Milky Way and Andromeda can merge to form a larger elliptical galaxy.

Pamela: Intermediate in shape between the spiral galaxies and the elliptical galaxies are lenticular galaxies. These systems have a disc but no discernible arms. Like with spirals, the bulge in lenticular galaxies varies in size.

Travis: And then of course there are the weirdo galaxies, scientifically called irregular galaxies, which have no easily classified structure. This category contains merging galaxies, tiny systems that are distorted and all sorts of weird and unusual looking systems.

Pamela: As two galaxies merge, they can go from spiral to irregular to elliptical over the course of billions of years.

Travis: And over the course of enough billions of years, a reasonable sized elliptical galaxy can grow huge as it consumes more and more galaxies.

Pamela: Galaxies are not good to one another. Whenever two galaxies get together violence ensues.

Travis: Sometimes it's simple harassment, where one galaxy will commit a drive by gravitational beating. As one large galaxy rushes past a spiral, its gravitational pull can convert a spiral into a lenticular. Sometimes, the stress of just being embedded in a galaxy cluster will cause a spiral to lose its arms and become a lenticular!

Pamela: It's a dog eat dog world in the high-density environment of galaxy clusters. Giant galaxies will cannibalize smaller galaxies, leaving almost no evidence behind.

Travis: Of course, violence isn't confined to high-density clusters. Our own Milky Way is in the process of eating the Sagittarius Dwarf Spheroidal Galaxy and a casual extragalactic observer would probably never notice.

Pamela: And when titans collide, such as the two galaxies in the Antennae ...

Travis: ... picture available in the show notes ...

Pamela: fireworks announce the birth of an elliptical galaxy and the death of the spirals.

Travis: When Nelan and her team observed their 4000 elliptical and lenticular galaxies they were studying, among other things, the star formation histories of the galaxies.

Pamela: When galaxies interact, whether it be in clusters or in isolations, the interactions can remove all the dust and gas from the galaxies causing star formation to cease.

Travis: You can see this in the colors of galaxies. Blue stars don't live for very long, but while they are alive they are extremely bright and their light can dominate the light from the stars around them. Galaxies with active star formation, like spiral galaxies, appear blue, and galaxies without active star formation, like elliptical galaxies, appear red.

Pamela: Now the catch is, while giant short-lived stars are always bluer than smaller long-lived stars, just how blue those giant stars will be varies with composition. Stars that have a lot of complex atoms like carbon, silicon and iron are redder than stars that are primarily hydrogen and helium.

Travis: So when we look at giant elliptical galaxies and see they are very red and we look at smaller elliptical galaxies and see that they aren't as red, we don't know if it's because they have less or no star formation or if it is because the stars they are forming are rich in heavy atoms.

Pamela: By carefully looking at the atomic absorption and emission lines in the galaxies' spectra the astronomers could distinguish between these two scenarios.

Travis: Theory told them that all elliptical galaxies are made through the merger of other galaxies, so the large ellipticals should consist of stars that are the same age as the stars in smaller elliptical galaxies.

Pamela: But sometimes theory is wrong.

Travis: And this was one of these times.

Pamela: What they found is that giant elliptical galaxies consist almost entirely of ancient stars. There is very little recent star formation and little evidence for the consumption of young galaxies. The stellar populations of these giant ellipticals formed as much as 13 billion years ago.

Travis: Recall, our universe is just 13.7 billion years old.

Pamela: Small elliptical galaxies, on the other hand, are made of younger stars, some only 4 billion years old.

Travis: According to Nelan:

Pamela: "Our analysis shows that there is a clear relationship between mass and age in these red galaxies, meaning that the stars in the biggest, oldest galaxies that we studied formed early in the history of the Universe. On average, the smaller galaxies have one-tenth the mass of the larger ones, and are only about half their age."

Travis: End quote.

Pamela: This relationship implies that in the past all the star formation was reserved for the big galaxies while in our modern universe all the action appears in the small galaxies.

Travis: In essence, the universe is downsizing, moving away from the giant galaxies and focusing its energies on the smaller systems.

Pamela: This work also implies that as astronomers study galaxies further and further into the past they will find fewer and fewer red elliptical galaxies.

Travis: Which, as we've reported in past shows, is exactly what they are seeing.

Pamela: It's always nice when the implications of one study match the observations of another study.

Travis: And before we bring up any more ugly little details that don't match theory, we're going to try and tie up this show. ... You may have noticed that this show is a bit shorter than normal. Well, for one thing Pamela and Aaron, our two noble writers, are both currently busy traveling to conferences, and once again they have left me behind.

Pamela: While madly preparing to leave, Aaron and I chewed out several scripts and Travis and I struggled to find a bit of time to record. And in the midst of all of

this, and making all of our business seem meaningless, was hurricane Katrina.

Travis: Writing comedy about astronomy isn't easy when all you want to do is reach out and help our brothers and sisters in the Deep South.

Pamela: On our website is a links to a couple of support organizations that we respect. Please, if you have some extra to share, consider sharing it with these folks who have so little.

Travis: Thanks again for listening. On behalf of 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.