Missing Spiral Arms

Following the demotion of Pluto, it seems that rewriting the nature of the Universe has become part and parcel of an astronomer's job. Well, now scientists working with the Spitzer Space Telescope have removed two arms from the Milky Way Galaxy. Hello, I'm Daniel Brennan.

This Spitzer Space Telescope podcast is part of a series highlighting recent discoveries in infrared astronomy. It's produced by NASA's Spitzer Science Center at the California Institute of Technology in Pasadena. The Spitzer mission is managed by NASA's Jet Propulsion Laboratory.

Lopping off arms may sound like a painful and bloody process, but the reality is that our galaxy may never have had the two missing spiral arms in the first place. The problem is that from our vantage point inside the Milky Way Galaxy, we can't get a bird's-eye view. Like standing on a city street and trying to map the entire city, our view of most of our galaxy is obstructed by gas and dust, and we simply can't shift our perspective.

Astronomers have been attempting to create a detailed map of the Milky Way since the 1950s, at that time using radio observations to look for large regions of star formation. They assumed that a spiral arm would be associated with star formation, because as stars clump closer together in the arm -- like cars caught in a traffic jam -- they compress the interstellar gas and dust, triggering a wave of star birth. These early observations found four major star-forming bands, called Norma, Scutum-Centaurus, Sagittarius, and Perseus. This led to the conclusion that the Milky Way had four spiral arms.

Infrared light is extremely useful for peering through gas and dust, and so in the 1990s astronomers began large-scale infrared observations to get a better understanding of the structure of the Milky Way. Infrared surveys led to the discovery that the Milky Way is not a simple spiral galaxy as had been assumed for decades, but instead has a pronounced central bar, making it a "barred spiral" galaxy instead. But the four spiral arms remained.

However, new results from a team led by Dr. Robert Benjamin of the University of Wisconsin, Whitewater, have unraveled that assumption. Using Spitzer's Infrared Array Camera, Benjamin and his colleagues surveyed the plane of our galaxy across a 130-degree swath of the sky. As part of the GLIMPSE collaboration led by Dr. Edward Churchwell, of the University of Wisconsin, Madison, they created an extensive mosaic combining 800,000 snapshots and including over 110 million stars. By carefully mapping the position and distances of those stars, a new picture emerged. Images from the survey can be downloaded from the Spitzer Space Telescope website at www.spitzer.caltech.edu, and an artist concept of the new structure of the Milky Way can be found there or as the album artwork for this podcast.

Obviously, looking at 110 million stars individually would be an enormous amount of work, even for a grad student. So Benjamin's team developed software that counts the stars, measuring stellar densities. When the team counted stars in the direction of the Scutum-Centaurus Arm, they noticed an increase in their numbers, as would be expected

for a spiral arm. But, when they looked in the direction where they expected to see the Sagittarius and Norma arms, there was no jump in the number of stars. The fourth arm, Perseus, wraps around the outer portion of our galaxy and cannot be seen in the new Spitzer images.

The findings make the case that the Milky Way has only two major spiral arms, rich with stars, a common structure for galaxies with bars. These major arms, the Scutum-Centaurus and Perseus arms, have the greatest densities of both young, bright stars, and older red-giant stars. The two major arms seem to connect up nicely with the near and far ends of the galaxy's central bar, a structure also very typical of barred spiral galaxies.

The Sagittarius and Norma arms now appear to be regions that, by contrast, don't contain a lot of older stars -- they're basically filaments that aren't part of the galaxy's dominant spiral structure as determined by the number of stars. They're filled with gas and dust, as well as pockets of young stars.

Our Sun does not appear to be inside one of the spiral arms. Instead, we're located on the edge of a structure called the Orion Spur of the Sagittarius Arm, between the Perseus Arm and the Scutum-Centaurus Arm. But, since stars continually move in and out of spiral arms as they orbit the galactic center, our Sun has probably spent time in both major arms during the approximately 16 laps it has taken since its formation over 4 billion years ago.

As always, the research continues. But at the present time, there is no indication of what assumptions about the Universe those pesky astronomers plan to dismantle next, having now left us with only one bar and two arms to play with.

For the Spitzer Science Center, I'm Daniel Brennan.

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