Iconic rings and flares of galaxies created by violent, intergalactic collisions

21 November 2008

The bright pinwheels and broad star sweeps iconic of disk galaxies such as the Milky Way might all be the shrapnel from massive, violent collisions with other galaxies and galaxy-size chunks of dark matter, according to a multi-institutional project involving the University of Pittsburgh. Published in the Nov. 20 edition of The *Astrophysical Journal*, the findings challenge the longstanding theory that the bright extensions and rings surrounding galaxies are the remnants of smaller star clusters that struck a larger, primary galaxy then fragmented.

The study's team consisted of Andrew Zentner, a professor of physics and astronomy in Pitt's School of Arts and Sciences; James Bullock, a physics and astronomy professor at the University of California at Irvine; Stelios Kazantzidis, a postdoctoral researcher at Ohio State University; Andrey Kravtsov, a professor of astronomy and astrophysics at the University of Chicago; and Leonidas Moustakas, a researcher at the NASA Jet Propulsion Laboratory, California Institute of Technology.

The team's computer simulations of galaxy formation suggests that disk galaxies most likely began as flat, centralized star clusters. Smaller galaxies collided with and tore through these disks billions of years ago, casting disk stars outward into the wild extensions present now; the bright center is the original formation. In addition, vast bodies of dark matter—a low-density, high-gravity invisible mass thought to occupy nearly one-quarter of the Universe—swept through these disks and further pulled stars from the main disk.

The researchers' scenario largely applies to the formation of the rings and long flares of stars that surround such galaxies as the Milky Way, Zentner said. But the model also presents a possible solution to how star spirals—the arcs of stars that radiate from the center of some disk galaxies—maintain their shape. Spirals form as a result of any disturbance to the star disk, Zentner said. However, the prolonged disturbance of a galaxy and dark matter expanse passing through a disk explains why the spirals seem to never recede.

"Our model suggests that a violent collision throws stars everywhere and continues moving through the disk, disturbing its structure," Zentner said. "It also has been known for some time that for star spirals to develop and maintain their well-known form, there must be a prolonged disturbance. We show that large masses moving through a galaxy could provide that disturbance."

The team's findings were serendipitous, Zentner explained. They were modeling disk galaxies for an unrelated astrological survey when they inadvertently discovered that stars in the main disk scattered when satellite galaxies—smaller galaxies surrounding larger ones—passed through. They shared their results with colleagues a year ago, and the results have since been replicated, Zentner said.

"One of the major advantages of these results is that we didn't set out to find them," he said. "They happened as we simulated existing galaxies."

Source: University of Pittsburgh