The Milky Way Galaxy is Warped

Our Milky Way Galaxy has recently been determined to be a barred spiral galaxy. Now a new attribute can be associated with its description -- The Milky Way Galaxy is warped and is believed to look much like galaxy ESO 510-13 shown in this image. This particular galaxy, located in the southern constellation Hydra, is about half the size of the Milky Way (100,000 light years across) and is about 150 million light years away. (Image Credit: NASA/ Space Telescope Science Institute/ AURA/ C. Conselice University of Wisconsin)

UMass and Berkeley astrophysicists believe that the Milky Way's satellite galaxies - the Large and Small Magellanic Clouds - are interacting with dark matter in the Milky Way to create a mysterious warp in our galactic disk that has puzzled astronomers for half a century.

The warp, seen most clearly in the thin disk of hydrogen gas permeating the galaxy, extends across the entire 200,000-light year diameter of the Milky Way, with the sun and earth sitting somewhere near the crease. Leo Blitz of the University of California, Berkeley, and his colleagues, Evan Levine and Carl Heiles, have charted this warp and analyzed it in detail for the first time, based on a new galactic map of hydrogen gas emissions.

They found that the atomic gas layer is vibrating like a drum, and that the vibration consists almost entirely of three notes, or modes.

Astronomers previously dismissed the Magellanic Clouds as a probable cause of the galactic warp because the galaxies' combined masses are only 2 percent that of the disk. This mass was thought too small to influence a massive disk equivalent to about 200 billion suns during the clouds' 1.5 billion-year orbit of the galaxy.

Nevertheless, theorist Martin D. Weinberg of the University of Massachusetts teamed up with Blitz to create a computer model that takes into account the Milky Way's dark matter is 20 times more massive than all visible matter in the galaxy combined. The motion of the clouds through the dark matter creates a wake that enhances their gravitational influence on the disk. When this dark matter is included, the Magellanic Clouds, in their orbit around the Milky Way, very closely reproduce the type of warp observed in the galaxy.

"The model not only produces this warp in the Milky Way, but during the rotation cycle of the Magellanic Clouds around the galaxy, it looks like the Milky Way is flapping in the breeze," said Blitz.

"People have been trying to look at what creates this warp for a very long time," Weinberg said. "Our simulation is still not a perfect fit, but it has a lot of the character of the actual data."

The interaction of the Magellanic Clouds with the dark matter in the galaxy to produce an warp in the hydrogen gas layer is reminiscent of the paradox that led to the discovery of dark matter some 35 years ago. As astronomers built better and better telescopes able to measure the velocities of stars and gas in the outer regions of our galaxy, they discovered these stars moving far faster than would be expected from the observed number and mass of stars in the entire Milky Way. Only by invoking a then-heretical notion, that 80 percent of the galaxy's mass was too dark to see, could astronomers reconcile the velocities

with known theories of physics.

Though no one knows the true identity of this dark matter - the current consensus is that it is exotic matter rather than normal stars too dim to see - astronomers are now taking it into account in their simulations of cosmic dynamics, whether to explain the lensing effect galaxies and galaxy clusters have on the light from background galaxies, or to describe the evolution of galaxy clusters in the early universe.

Because many galaxies have warped disks, similar dynamics might explain them as well. Either way, the researchers say their work suggests that warps provide a way to verify the existence of the dark matter.

"We found something very surprising, that we could describe the warp by three modes of vibration, or three notes, and only three," Blitz said, noting that this rather simple mathematical description of the warp had escaped the notice of astronomers since the warp's discovery in 1957.

"We were actually trying to analyze a more complex 'scalloping' structure of the disk, and this simple, elegant vibrational structure just popped out," Levine added.

The current warp in the gas disk is a combination of these three vibrational modes, leaving one-half of the galactic disk sticking up above the plane of stars and gas, while the other half dips below the disk before rising upward again farther outward from the center of the galaxy.

Blitz, Levine and Heiles are continuing their search for anomalies in the structure of the Milky Way's disk. Weinberg hopes to use the UC Berkeley group's data and analysis to determine the shape of the dark matter halo of the Milky Way.

For More Information:

http://www.umass.edu/newsoffice/newsreleases/articles/27490.php

http://www.berkeley.edu/news/media/releases/2006/01/09_warp.shtml