Milky Way struck 100 million years ago, still rings like a bell

An international team of astronomers have discovered evidence that our Milky Way had an encounter with a small galaxy or massive dark matter structure perhaps as recently as 100 million years ago, and as a result of that encounter it is still ringing like a bell.

The discovery is based on observations of 300,000 nearby Milky Way stars by the Sloan Digital Sky Survey (SDSS). Stars in the disk of the Milky Way move up and down at a speed of about 20-30 kilometers per second while orbiting the center of the galaxy at a brisk 220 kilometers per second. The positions and motions of these nearby stars weren't quite as regular as previously thought, according to the study results.

"We clearly observe unexpected differences in the Milky Way's stellar distribution above and below the Galaxy's mid-plane having the appearance of a vertical wave – something that nobody has seen before," says Queen's University physicist Larry Widrow, lead researcher on the project.

The researchers have not been able to identify the celestial object that passed through the Milky Way. It could have been one of the small satellite galaxies that move around the center of our galaxy, or an invisible structure such as a dark matter halo. It might not have been a single isolated event in the past, and it may even be ongoing.

The researchers discovered a small but statistically significant difference in the distribution of stars north and south of the Milky Way's midplane when analyzing SDSS data. For more than a year, they explored various explanations of this north-south asymmetry but were unable to solve the mystery. So they began exploring whether the data was telling them something about recent events in the Galaxy's history.

Scientists know of more than 20 visible satellite galaxies that circle the center of the Milky Way, with masses ranging from one million to one billion solar masses. There may also be invisible satellites made of dark matter. There is six times as much dark matter in the universe as ordinary, visible matter. Astronomers' computer simulations have found that this invisible matter formed hundreds of massive structures that move around our Milky Way.

These dark matter satellites, because of their abundance, are more likely than the visible satellite galaxies to cut through the Milky Way's mid-plane and cause vertical waves.

Computer simulations indicate that over the next 100 million years or so, our galaxy

will "stop ringing". The north-south asymmetry will disappear and the vertical motions of stars in the solar neighborhood will revert back to their equilibrium orbits unless we get hit again.

Collaborators on the project include Brian Yanny and Scott Dodelson (US Department of Energy's Fermilab), Susan Gardner, (University of Kentucky) and Hsin-Yu Chen (University of Chicago).

The results have been published in The *Astrophysical Journal Letters*.

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