Mapping dark matter from galactic ripples

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(PhysOrg.com) -- Sukanya Chakrabarti, Ph.D., an assistant professor of physics for the Charles E. Schmidt College of Science at Florida Atlantic University, has developed a way to discover and map dark matter in galaxies. Chakrabarti's paper, "A New Probe of the Distribution of Dark Matter in Galaxies," analyzes observed ripples in the outskirts of galaxies to infer the density profile of the dark matter halo. Chakrabarti is presenting her results at this week's meeting of the American Astronomical Society in Austin, Texas.

"Most of the mass in the universe is dark," said Chakrabarti, who specializes in the study of galaxies. "We have known for a long time that galaxies have massive dark halos. But there are very few probes that can be used to figure out how the dark matter is distributed in specific spiral galaxies."

The extended gas disks of galaxies are very fragile and respond easily to gravitational interactions with passing satellites. Chakrabarti discovered that if the density profile of dark matter is varied in the spiral galaxy, it is reflected in the disturbances that form in the outer gas disk when the larger spiral galaxy interacts with a satellite galaxy. The ripples in outer gas disks of spiral galaxies act like a mirror of the potential depth of the dark matter halo in the primary galaxy. Even though the dark matter halo cannot be seen directly, scientists may infer the density profile of dark matter using this method.

Chakrabarti previously developed a mathematical method called "tidal analysis" to find satellite, or dwarf, galaxies by analyzing the ripples in

the hydrogen gas distribution in large spiral galaxies in outer space. This method, called “tidal analysis,” allows us to infer the mass and relative position of satellites from analysis of ripples in outer gas disks without requiring knowledge of their optical light. Many dwarf galaxies are very dim, so it is useful to have a way of finding them that does not rely on their optical light. Earlier, she applied the method to the nearby Whirlpool Galaxy, which has an optically visible satellite to infer the mass and location of its companion and found these values to be observationally corroborated.

Building on her earlier results where she found that the mass and relative position of the Whirlpool Galaxy’s satellite could be derived using “tidal analysis,” she shows here that we can map the dark matter in Whirlpool Galaxy itself.

“The idea is that the ripples in outer gas disks are like a gravitational mirror that let us to see how the dark matter is distributed,” said Chakrabarti.

More information: Meeting paper number 441.13. Preprint: arxiv.org/abs/1112.1416

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