Modern Magellans: New grant uses the power of the masses to map dark matter in the galaxy

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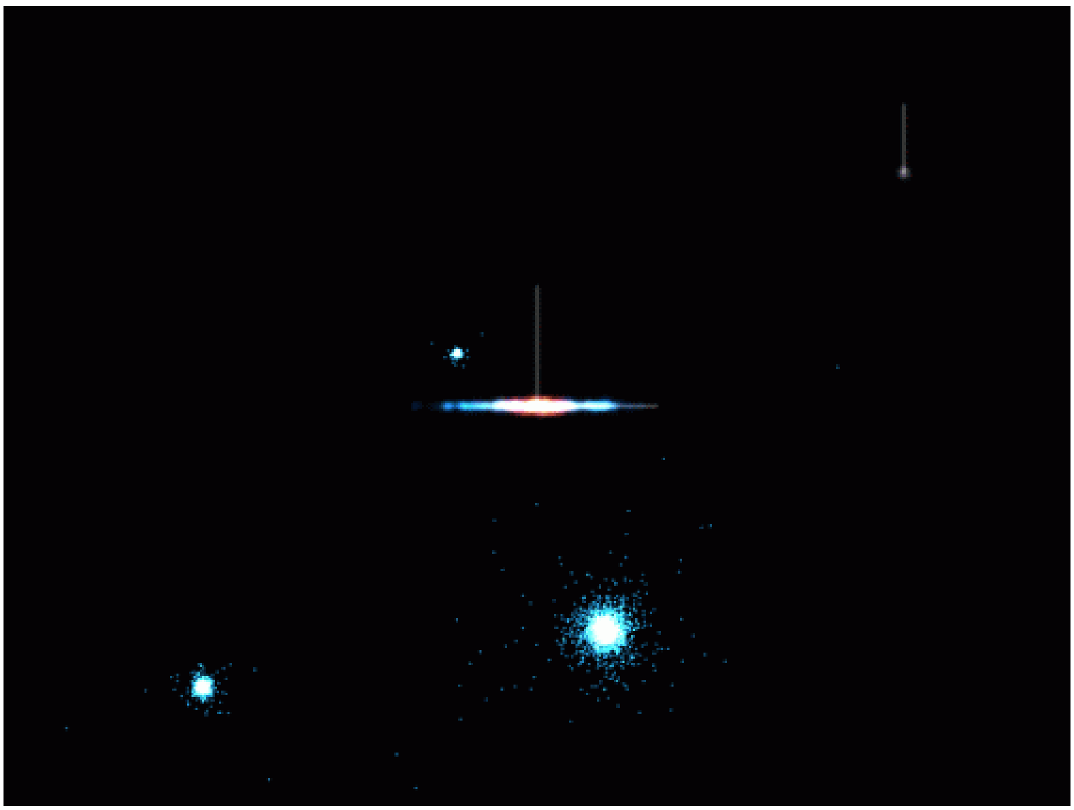

The simulation was developed with MilkyWay@Home and shows the formation of several stellar streams (Sagittarius, Orphan, and GD-1) around the Milky Way. The animation represents four billion years in the Milky Way, ending at the present day. Credit: Rensselaer/Benjamin A. Willett

Rensselaer Polytechnic Institute astronomer Heidi Newberg is using a new grant from the National Science Foundation (NSF) to begin mapping the distribution of dark matter in our galaxy. The more than $382,000 grant will utilize the massive computing power of the international MilkyWay@Home project to help uncover the whereabouts of the elusive dark matter and provide another piece in the puzzle to map the Milky Way.

Any third grader can tell you the order of the planets from the sun, but astronomers know surprisingly little about exactly how and where the mass in our galaxy is distributed across the cosmos. One large conundrum with the effort to map the Milky Way is that much of the known mass of the galaxy is completely unaccounted for. Add up the planets, sun, stars, moons, asteroids, and other known mass and only a fraction of the mass is accounted for. Many scientists purport that the difference is made up by the presence of dark matter, which is undetectable to all modern telescopic technology. But Newberg thinks that with MilkyWay@Home, the computer may be able to accomplish what no telescope has done before – show astronomers where dark matter is likely to reside in the galaxy.

Led by researchers at Rensselaer, the MilkyWay@Home project is among the fastest distributed computing programs ever in operation. At its peak, it has run at a combined computing power of over 2 petaflops donated by a total of 93,206 people in 195 countries and counting. That is more countries than the United Nations. The combined computing power of all these personal computers, which rivals the most powerful supercomputers in the world, is being used by researchers like Newberg to uncover some important and basic things about our galaxy.

"MilkyWay@Home is allowing us to consider bigger thinking when it comes to understanding the galaxy," said Newberg, who is professor of physics, applied physics, and astronomy at Rensselaer. "With this grant we will combine my previous research mapping tidal debris streams with the power of MilkyWay@Home to simulate the creation of these streams and begin, very importantly, to start to constrain the properties of dark matter."

Tidal debris streams, also called stellar streams, are the scattered remains of dwarf galaxies that have been ripped apart after coming too close to a larger galaxy such as the Milky Way. Several of these glowing streams currently orbit the Milky Way as part of what is aptly called the galactic halo.

Given the gross amount of dark matter thought to be present in the galaxy, the collision of dwarf galaxy and massive Milky Way that created tidal debris streams would have included the strong involvement of dark matter. This makes study of tidal debris stream formation a good window into understanding how and where dark matter comes into play in the galaxy, according to Newberg. Know how the debris stream was formed, she said, and astronomers would start to understand where dark matter may reside.

Newberg's previous research has successfully mapped the position and distribution of stars in several stellar streams, including the Sagittarius stream, the Orphan Stream, GD-1, and the Cetus Polar Stream, using data from the Sloan Digital Sky Survey (SDSS). With this new funding, she will use MilkyWay@Home to simulate how exactly the stars in those streams got to where they currently reside in the sky.

To simulate stream creation, she will use MilkyWay@Home to model what happens when a dwarf galaxy meets up with the Milky Way and is ripped apart and spread around the galaxy like an intergalactic paint splatter. To confirm the model, she will match it to the known distribution of stars in the streams mapped by her previous work with SDSS. The first step in this process will be to constrain the properties of an initial dwarf galaxy that would be input into the MilkyWay@Home system.

"We are currently running some simulations on MilkyWay@Home right now on a single dwarf galaxy," Newberg said. "This is a small part of the problem, but an important step in the effort to map the overall distribution of mass in the galaxy."

The NSF grant is expected to total $382,513 over three years.

Provided by Rensselaer Polytechnic Institute