Scientists discover a 'dark' Milky Way: Massive galaxy consists almost entirely of dark matter

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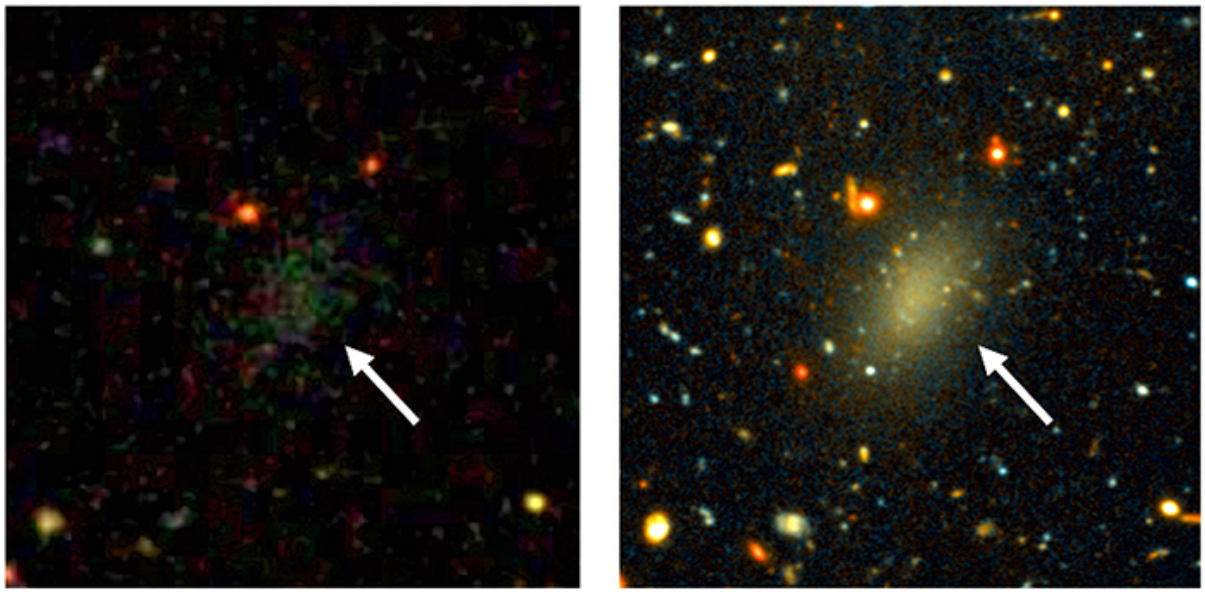

The dark galaxy Dragonfly 44. The image on the left is from the Sloan Digital Sky Survey. Only a faint smudge is visible. The image on the right is a long exposure with the Gemini telescope, revealing a large, elongated object. Dragonfly 44 is very faint for its mass and consists almost entirely of dark matter. Credit: Pieter van Dokkum, Roberto Abraham, Gemini, Sloan Digital Sky Survey

Using the world's most powerful telescopes, an international team of

astronomers has found a massive galaxy that consists almost entirely of dark matter.

The galaxy, Dragonfly 44, is located in the nearby Coma constellation and had been overlooked until last year because of its unusual composition: It is a diffuse "blob" about the size of the Milky Way, but with far fewer stars.

"Very soon after its discovery, we realized this galaxy had to be more than meets the eye. It has so few stars that it would quickly be ripped apart unless something was holding it together," said Yale University astronomer Pieter van Dokkum, lead author of a paper in the *Astrophysical Journal Letters*.

Van Dokkum's team was able to get a good look at Dragonfly 44 thanks to the W.M. Keck Observatory and the Gemini North telescope, both in Hawaii. Astronomers used observations from Keck, taken over six nights, to measure the velocities of stars in the galaxy. They used the 8-meter Gemini North telescope to reveal a halo of spherical clusters of stars around the galaxy's core, similar to the halo that surrounds our Milky Way galaxy.

Star velocities are an indication of the galaxy's mass, the researchers noted. The faster the stars move, the more mass its galaxy will have.

"Amazingly, the stars move at velocities that are far greater than expected for such a dim galaxy. It means that Dragonfly 44 has a huge amount of unseen mass," said co-author Roberto Abraham of the University of Toronto.

Scientists initially spotted Dragonfly 44 with the Dragonfly Telephoto Array, a telescope invented and built by van Dokkum and Abraham.

Dragonfly 44's mass is estimated to be 1 trillion times the mass of the Sun, or 2 tredecillion kilograms (a 2 followed by 42 zeros), which is similar to the mass of the Milky Way. However, only one-hundredth of 1% of that is in the form of stars and "normal" matter. The other 99.99% is in the form of dark matter—a hypothesized material that remains unseen but may make up more than 90% of the universe.

The researchers note that finding a galaxy composed mainly of dark matter is not new; ultra-faint dwarf galaxies have similar compositions. But those galaxies were roughly 10,000 times less massive than Dragonfly 44.

"We have no idea how galaxies like Dragonfly 44 could have formed," said Abraham. "The Gemini data show that a relatively large fraction of the stars is in the form of very compact clusters, and that is probably an important clue. But at the moment we're just guessing."

Van Dokkum, the Sol Goldman Family Professor of Astronomy and Physics at Yale, added: "Ultimately what we really want to learn is what dark matter is. The race is on to find massive dark galaxies that are even closer to us than Dragonfly 44, so we can look for feeble signals that may reveal a dark matter particle."

Additional co-authors are Shany Danieli, Allison Merritt, and Lamiya Mowla of Yale, Jean Brodie of the University of California Observatories, Charlie Conroy of Harvard, Aaron Romanowsky of San Jose State University, and Jielai Zhang of the University of Toronto.

More information: "A High Stellar Velocity Dispersion and ~100 Globular Clusters for the Ultra Diffuse Galaxy Dragonfly 44," Pieter van Dokkum et al., 2016 Sept. 1, *Astrophysical Journal Letters*: iopscience.iop.org/article/10. … 7/2041-8205/828/1/L6 , *Arxiv*: arxiv.org/abs/1606.06291

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