

## Dark matter on the move

January 3 2019



Star formation in tiny dwarf galaxies can slowly "heat up" the dark matter, pushing it outwards. The left image shows the hydrogen gas density of a simulated dwarf galaxy, viewed from above. The right image shows the same for a real dwarf galaxy, IC 1613. In the simulation, repeated gas inflow and outflow causes the gravitational field strength at the centre of the dwarf to fluctuate. The dark matter responds to this by migrating out from the centre of the galaxy, an effect known as 'dark matter heating'. Credit: J. Read et al.

Scientists have found evidence that dark matter can be heated up and moved around, as a result of star formation in galaxies. The findings provide the first observational evidence for the effect known as 'dark



matter heating', and give new clues as to what makes up dark matter. The research is published today in the journal *Monthly Notices of the Royal Astronomical Society*.

In the new work, scientists from the University of Surrey, Carnegie Mellon University and ETH Zürich set out to hunt for evidence for <u>dark</u> <u>matter</u> at the centres of nearby dwarf <u>galaxies</u>. Dwarf galaxies are small, faint galaxies that are typically found orbiting larger galaxies like our own Milky Way. They may hold clues that could help us to better understand the nature of dark <u>matter</u>.

Dark matter is thought to make up most of the mass of the universe. However since it doesn't interact with light in the same way as normal matter, it can only be observed through its gravitational effects. The key to studying it may however lie in how stars are formed in these galaxies.

When stars form, <u>strong winds</u> can push gas and dust away from the heart of the galaxy. As a result, the galaxy's centre has less mass, which affects how much gravity is felt by the remaining dark matter. With less <u>gravitational attraction</u>, the dark matter gains energy and migrates away from the centre, an effect called 'dark matter heating'.

The team of astrophysicists measured the amount of dark matter at the centres of 16 dwarf galaxies with very different star formation histories. They found that galaxies that stopped forming stars long ago had higher dark matter densities at their centres than those that are still forming stars today. This supports the theory that the older galaxies had less dark matter heating.

Professor Justin Read, lead author of the study and Head of the Department of Physics at the University of Surrey, said: "We found a truly remarkable relationship between the amount of dark matter at the centres of these tiny dwarfs, and the amount of star formation they have



experienced over their lives. The dark matter at the centres of the starforming dwarfs appears to have been 'heated up' and pushed out."

The findings provide a new constraint on dark matter models: dark matter must be able to form <u>dwarf galaxies</u> that exhibit a range of central densities, and those densities must relate to the amount of star formation.

Professor Matthew Walker, a co-author from Carnegie Mellon University, added: "This study may be the "smoking gun" evidence that takes us a step closer to understanding what dark matter is. Our finding that it can be heated up and moved around helps to motivate searches for a dark matter particle."

The team hope to expand on this work by measuring the central dark matter density in a larger sample of dwarfs, pushing to even fainter galaxies, and testing a wider range of dark matter models.

**More information:** J I Read et al, Dark matter heats up in dwarf galaxies, *Monthly Notices of the Royal Astronomical Society* (2018). DOI: 10.1093/mnras/sty3404

Provided by University of Surrey

Citation: Dark matter on the move (2019, January 3) retrieved 2 May 2024 from <u>https://phys.org/news/2019-01-dark.html</u>

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