NATURE | NEWS

Survey finds no hint of dark matter near Solar System

Result poses a cosmic dilemma but critics prescribe caution.

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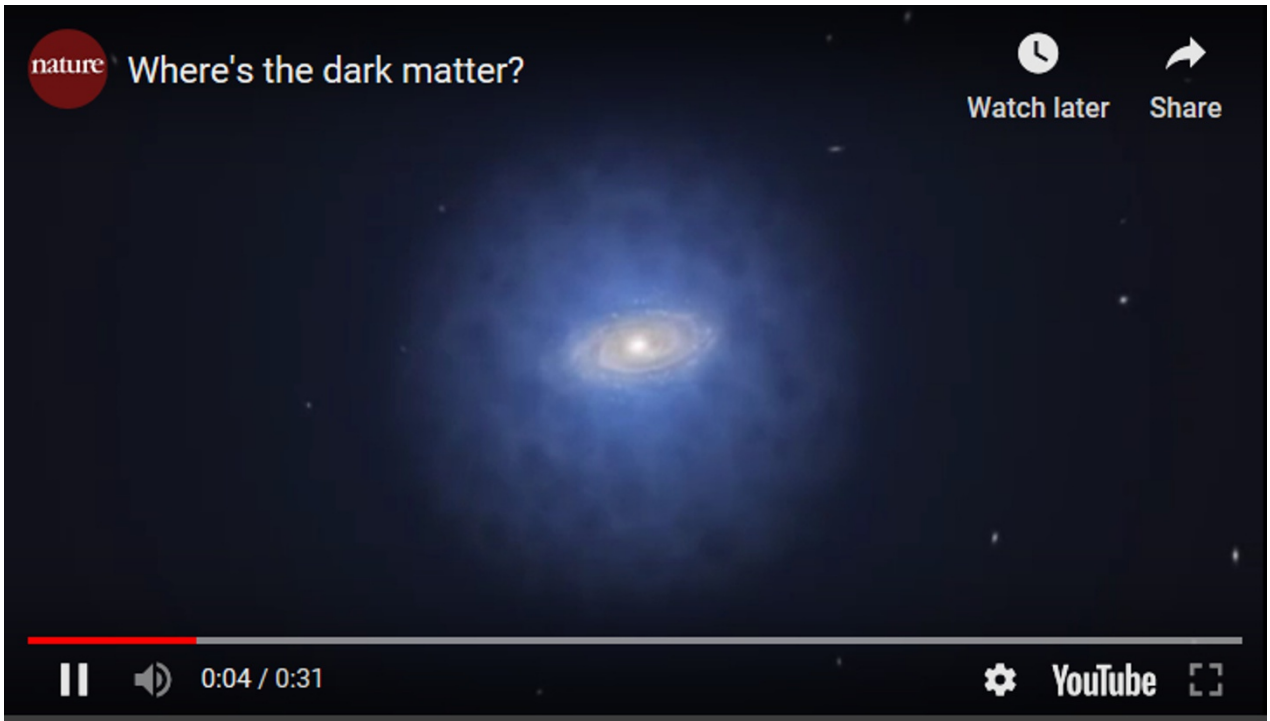

Through a glass, darkly

A survey of the space around the Solar System has found only one-tenth the amount of predicted dark matter, shown here as a blue haze around the spiral Milky Way.

In the largest survey of its kind to date, astronomers scouring the space around the Solar System for signs of dark matter — the hypothetical material believed to account for more than 80% of the mass in the Universe — have come up empty-handed.

If confirmed, the surprising result would upend a long-established consensus, researchers not involved in the study say. For decades, cosmic theories have relied on dark matter — which exerts gravitational pull but emits no light — to be the hidden scaffolding that explains how structure arose in the Universe, how galaxies formed and how the rapidly spinning Milky Way manages to keep from flying apart. Without dark matter, theorists say, the visible material in the Universe, such as stars and gas, would not have the heft to do the job alone.

“If the results stand up, it’s going to be very difficult to make them compatible with the conventional view of dark matter,” says Scott Tremaine, an astrophysicist at the Institute for Advanced Study in Princeton, New Jersey, who was not involved in the study.

In their survey, Christian Moni Bidin of the University of Concepcion in Chile and his colleagues used the European Southern Observatory’s 2.2-metre telescope in La Silla and three other telescopes to weigh, in effect, an extended volume of space centred around the Sun. Although this area cannot be measured directly, the total mass within the volume can be inferred by its influence on the motions of stars that are passing through.

The researchers measured the velocity of more than 400 stars within 4,000 parsecs (13,000 light years) of the Sun in a limited volume — a 15-degree cone — below the flattened disk of the Milky Way Galaxy, and then used those observations to extrapolate the velocities of stars on the other side of the disk, above the plane. This volume is approximately four times greater than that surveyed by other teams in previous studies.

The researchers found that at most, only about one-tenth the amount of dark matter predicted by models could exist in the volume of space they examined, Moni Bidin says.

Only if dark matter has a highly unlikely arrangement — squeezed into a shape like that of an upright rugby ball rather than a round soccer ball — could the team's results be consistent with the dark matter that other researchers have, since the 1970s, said must exist to account for the rapid rotation of the outskirts of the Milky Way.

Moni Bidin adds that the myriad experiments designed to directly detect dark-matter particles "are doomed to fail" if the density of the invisible material is as low as he and his colleagues have found.

Agreeing to disagree

But Tremaine and others say that they won't be convinced unless other teams, making their own observations, arrive at the same unsettling conclusion.

"I wouldn't throw out nearby dark matter quite yet," says Chris Flynn, an astronomer at the Swinburne University of Technology in Melbourne, Australia, who reviewed the paper, which has been accepted by the *Astrophysical Journal*. "The measurement being made is very challenging, and there are a number of ways for it to miss the dark matter even if is there." Despite his qualms, Flynn says that he "agreed to disagree" with the authors of the study and approved the paper for publication.

Heidi Newberg, an astronomer at the Rensselaer Polytechnic Institute in Troy, New York, notes that the difficult measurement is dominated by the matter near the plane of the Milky Way, which, unlike the rest of the Galaxy, is expected to be made up mainly of normal matter. That makes it more difficult to tease out whatever dark-matter component may exist in the region.

She cautions that some of the general assumptions that underlie the result, although standard, are nevertheless only approximations. "In my opinion, many of them will turn out not to be true in detail," she says.

As an example, Newberg notes that the researchers assumed that the group of stars they examined were smoothly distributed above and below the plane of the Milky Way. But if the distribution turns out to be lumpier, as is the case for stars in the outer parts of the galaxy, then the resulting calculations of dark matter density could be incorrect.

Flynn agrees that there are a number of ways that the method employed by Moni Bidin and his co-authors "could get it wrong."

Moni Bidin says he's not sure whether dark matter exists or not. But he says that his team's survey is the most comprehensive of its type ever done, and the puzzling results must be reckoned with. "We don't have a good comprehension of what is going on," he says.

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