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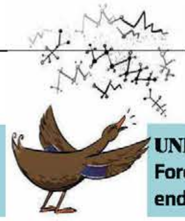

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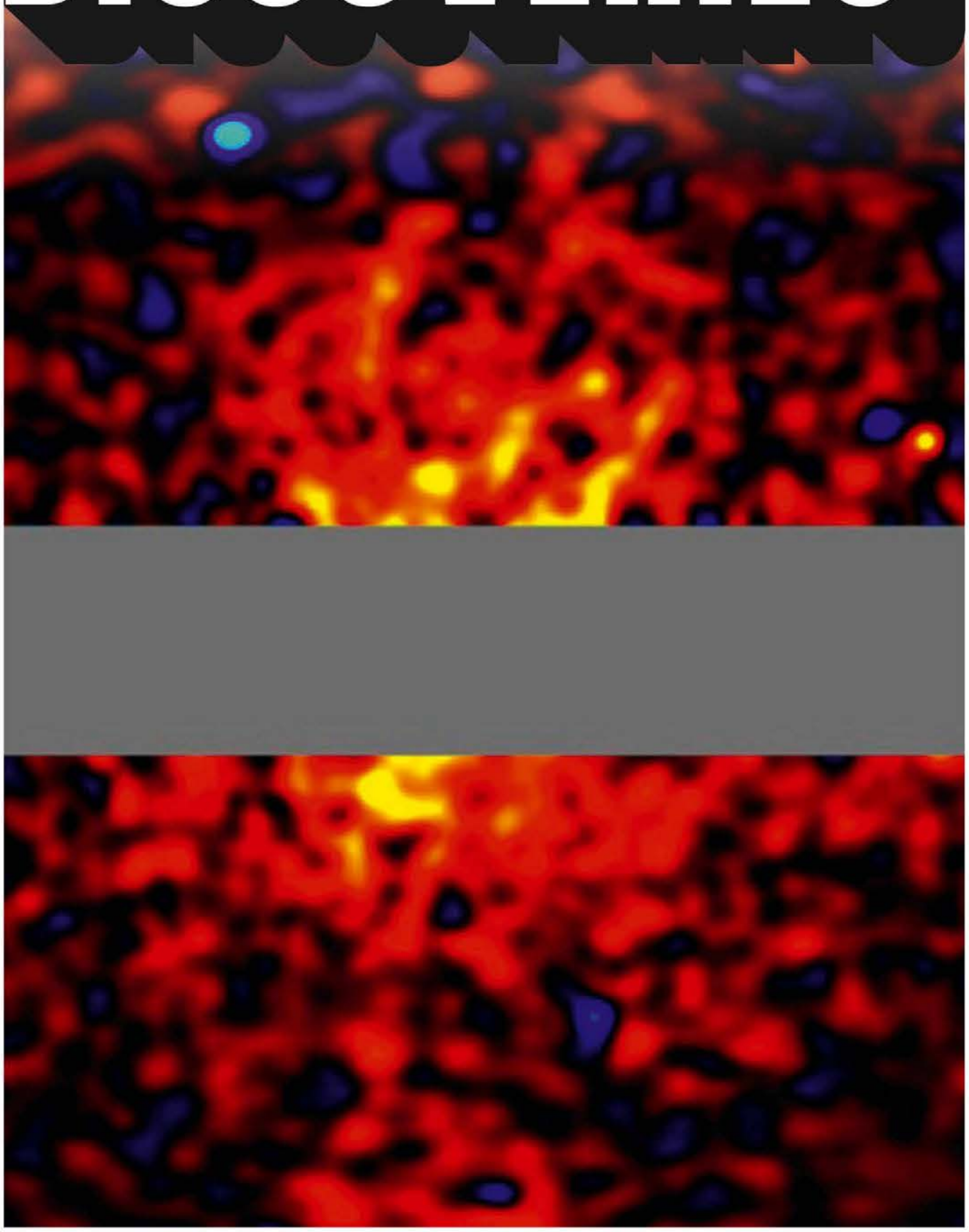

TOMONORI TOTANI/THE UNIVERSITY OF TOKYO, NASA/JPL

SPACE

First signs of dark matter spotted, study claims

A mysterious glow surrounding the Milky Way could be the fingerprints of the Universe's most enigmatic material

For nearly a century, dark matter has remained an enigma. Despite it being around five times more abundant than normal (visible) matter, it can't be seen, touched or detected using any known techniques.

But a new analysis of 15 years of data from NASA's Fermi Gamma-ray Space Telescope claims to have picked up a signal indicating its presence.

The analysis reports the detection of a mysterious halo-like glow of gamma rays around the Milky Way, which peak sharply at energies that closely match the kind of signal expected from a particular type of hypothetical dark matter particle.

Such particles, known as weakly interacting massive particles (WIMPs), could produce the gamma rays by colliding with each other in a process known as annihilation.

It's not a detection of dark matter itself, but akin to finding the fingerprints it has left behind.

"If this is correct, to the extent of my knowledge, it would mark the first time humanity has 'seen' dark matter," said

LEFT NASA's Fermi Gamma-ray Space Telescope observes gamma rays, the most energetic form of light and one that's beyond the visual range of the human eye

LEFT A gamma-ray intensity map of the Milky Way halo. The grey bar corresponds to the galactic plane, which was excluded from the new analysis to avoid strong radiation

Prof Tomonori Totani, an astronomer and author of the study.

Speaking to *BBC Science Focus*, he added: "When I first spotted what seemed like a signal, I was sceptical. But when I took the time to check it meticulously and felt confident it was correct, I got goosebumps."

A CLOSE MATCH

Totani's study, published in the *Journal of Cosmology and Astroparticle Physics*, examined 15 years of data from the Fermi telescope, honing in on the region above and below the main disc of the Milky Way known as the galactic halo.

"If this is correct, it would mark the first time humanity has 'seen' dark matter"

"We detected gamma rays with a photon energy of 20 gigaelectronvolts (or 20 billion electronvolts – an extremely large amount of energy) extending in a halo-like structure toward the centre of the Milky Way galaxy," Totani said. "The gamma-ray emission component closely matches the shape expected from the dark matter halo."

A gigaelectronvolt, or GeV, is a unit physicists use to measure the energy of subatomic particles – roughly a billion times the energy picked up by a single electron when it moves across a one-volt battery. The possible dark matter signal detected by Totani rises steeply from a few GeV, peaks sharply at roughly 20 GeV, and falls again. This curve matches predictions for WIMPs that have masses about 500 times that of a proton.

In Totani's view, the data form a strong indication of dark matter annihilation. "This signifies a major development in astronomy and physics," he said.

But Jan Conrad, a professor of astroparticle physics at Stockholm University in Sweden and an independent expert in gamma ray searches for dark matter, urges caution.

"It's notoriously difficult to make these claims with Fermi data," he told *BBC Science Focus*. Indeed, this isn't the first time astronomers have seen something like this. As far back as 2009 – just a year after the Fermi telescope launched – scientists spotted an unexplained excess of gamma rays coming from the galactic centre.

For years, this finding has remained one of the strongest hints of dark matter. And yet, Conrad said, after 16 years the scientific community still isn't settled on whether the signal is or isn't dark matter.

Even today, he noted, researchers who have tried for over a decade to disprove the galactic centre excess haven't been able to show conclusively that it must be astrophysical (from non-dark matter sources). But they also can't prove that it's dark matter. It remains unresolved.

The new signal in the halo is far less studied, Conrad said, and will likely require years of further research to verify. Both the new halo excess and the long-debated galactic centre signal share a fundamental problem: noise.

In these regions, gamma rays that might be from dark matter annihilation could also originate from many other sources, many of which aren't fully understood. That makes drawing firm conclusions exceptionally hard.

"Because the backgrounds of astrophysical sources are so uncertain, it makes it very difficult to make strong claims," Conrad said.

NEXT STEPS

Despite their differing confidence levels, both Totani and Conrad point to the same next step: dwarf galaxies.

These small, faint galaxies orbiting the Milky Way are believed to be extremely rich in dark matter, yet their astrophysical gamma-ray backgrounds are minimal. That makes them one of the cleanest possible laboratories for testing dark matter annihilation.

"If you see a similar excess in dwarf galaxies, that would be a strong hint," Conrad said. "Dwarf galaxies are much cleaner so there could be a confirmation there."

Totani agreed: "If the result of this study is correct, it wouldn't be surprising to detect gamma rays from dwarf galaxies as well."