NATURE | NEWS

Physicists see potential dark matter from the Sun

X-ray data hinting at axion particles draw interest and cautionary warnings.

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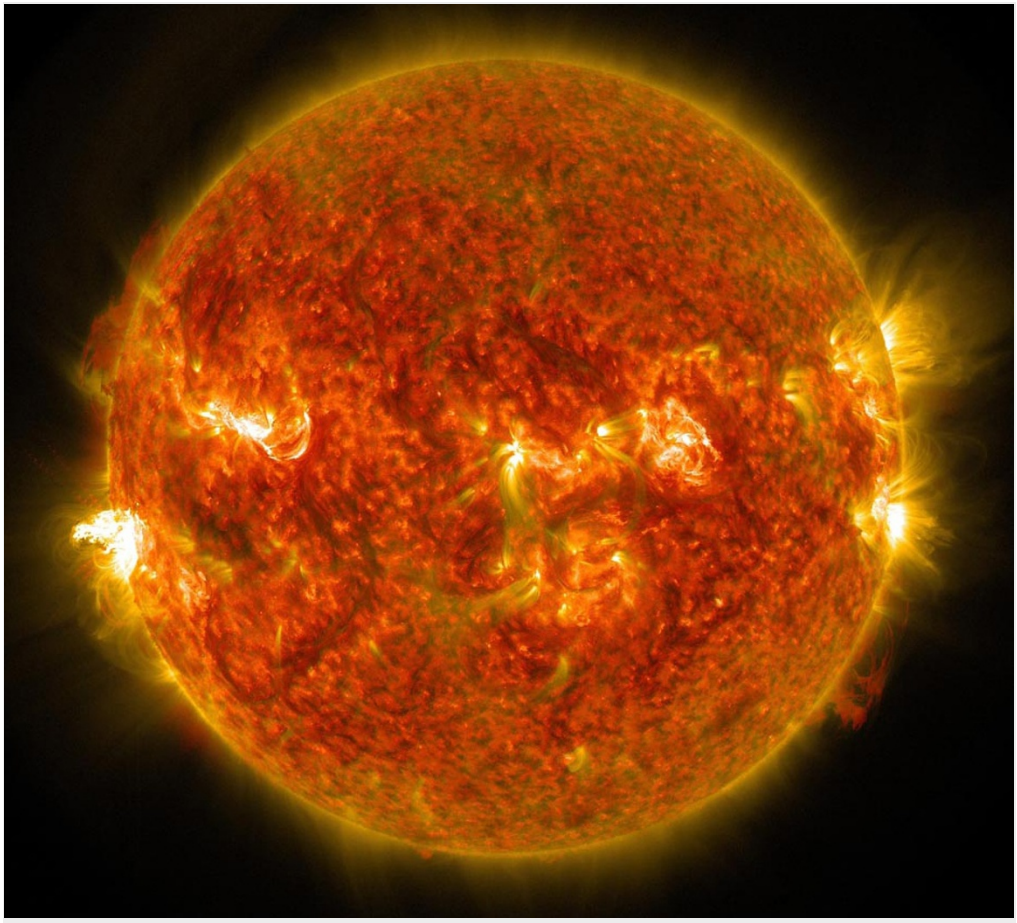
17 October 2014



SDO/NASA

Only independent cross-checks will confirm if the Sun is indeed spewing particles of dark matter.

An analysis of 12 years' worth of telescope data has found a signal that some physicists think could be the first detection of dark matter[1].

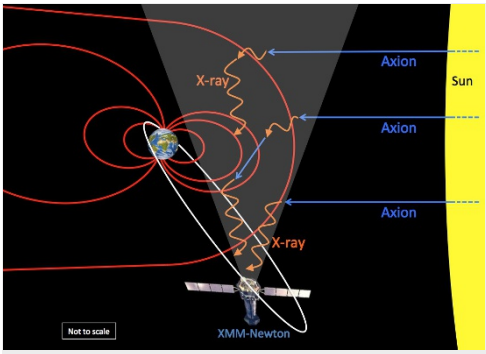
Astronomers have found variations in the stream of X-rays seen by a European Space Agency observatory that matches what would be expected if axions — a hypothetical dark-matter particle — were interacting with Earth's magnetic field.

Dark matter is the name given to the substance thought to make up some 85% of all the matter in the Universe. It is 'dark' because although its presence can be inferred from the pull it exerts on stars in the Universe, it has evaded all attempts so far to detect it convincingly.

If confirmed, the axion finding would be a huge discovery. The study leader, astronomer George Fraser of the University of Leicester, UK, died just two days after he and his co-authors submitted the paper for publication. The study was Fraser's "most astonishing swan song", wrote Andy Lawrence, an astronomer at the Institute for Astronomy in Edinburgh, UK, in his blog the e-Astronomer.

But although the paper has been accepted by *Monthly Notices of the Royal Astronomical Society* and is to be published on 20 October, the surviving authors are not popping champagne corks just yet. "We found an unusual result that we can't explain by any conventional method, and this axion theory does explain it," says co-author Andy Read, an astronomer at Leicester. "But it is just a hypothesis, and most hypotheses don't make it," he adds.

Axions were originally proposed to explain an anomaly in a different area of physics — the theory of the strong nuclear force, one of the four fundamental forces of nature. These uncharged, very light particles would be created in the Sun's core and would barely interact with ordinary matter, which would allow them to zip through thousands of kilometres of solar plasma and escape into outer space. But the axions would interact with magnetic fields such as the one that surrounds Earth, and turn into X-ray photons. Those photons are the particles the researchers say they may have seen.



University of Leicester

'Axions' (blue) from the Sun could convert into X-ray photons (orange) in the Earth's magnetic field (red). (Click to enlarge.)

The team found that as the European probe, the X-ray Multi Mirror satellite (XMM-Newton), passed through the strong magnetic field on the Sun-side of Earth, it saw a slightly more intense X-ray signal than when it was on the far side of Earth. Discounting known sources of X-rays, the background signal should be the same wherever the spacecraft is, says Read.

In their 67-page paper, the researchers did their best to rule out more mundane phenomena — such as interaction between the solar wind and Earth's magnetic field — as the cause of the excess, Read says, before invoking axions as a source.

One unusual aspect of this analysis is that it shows XMM-Newton picking up the X-ray photons, even though it is not looking straight into the Sun but at a right angle to it. But the authors say that the axions could be scattered in such a way that the corresponding photon end up in the telescope.

The authors also show that hints of a similar signal can be found in data produced by NASA's Chandra X-Ray Observatory, although a formal corroboration will take more data and years of analysis.

But not everyone is convinced by the axion interpretation. Astronomer Peter Coles of the University of Sussex, UK, called the evidence "circumstantial" in a post on his blog, In the Dark. "It's tantalising, but if you want to ask me where I'd put my money I'm afraid I'd probably go for messy local plasma physics rather than anything more fundamental," he wrote.

Igor Garcia Irastorza, who works on the CERN Axion Solar Telescope (CAST), based at the CERN physics laboratory near Geneva, Switzerland, agrees that the signal is intriguing. But the kind of axion that would fit such a signal would clash with other astrophysical observations, he says. And, he says, the particles' properties would have to be different than what has been theorized for decades.

Corroborating the Leicester findings will take cross-checks from other axion experiments that work in completely different ways to the telescopes, adds Konstantin Zioutas, who leads the CAST experiment.

Mike Watson, who is an astronomer also at the University of Leicester but was not involved in the study, says that Fraser was an "exceptional scientist" and the mastermind behind the work. "The interpretation is quite appealing, and on the human side of this is that we would all like it to be right, as it would be a great tribute to George. But that's not how you do science."

Nature | doi:10.1038/nature.2014.16174

References

1. Fraser, G. W. *et al*. Preprint at http://arxiv.org/abs/1403.2436 (2014).