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Space

Dark Matter Found? Orbital Experiment Detects Hints

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A $2 billion particle detector attached to the International Space Station has detected the potential signature of dark matter annihilation in the Cosmos, scientists have announced today.

The Alpha Magnetic Spectrometer (AMS) was attached to the space station in May 2011 by space shuttle Endeavour — the second-to last shuttle mission to the orbital outpost. Since then, the AMS has been detecting electrons and positrons (the electron's anti-particle) originating from deep space and assessing their energies. By doing a tally of electrons and positrons, physicists hope the AMS will help to answer one of the most enduring mysteries in science: Does dark matter exist?

And today, it looks like the answer is a cautious, yet exciting, **yes**.

Top 5 Misconceptions About The LHC

Results from the AMS have been highly anticipated, and in a special announcement to be made at 1:30 p.m. EDT (6:30 p.m. GMT) today (April 3) the first results from billions of particle detections will be detailed. The details of the research **have also been revealed by a CERN announcement** ahead of the study being published in the journal Physical Review Letters.

Around 400,000 positron detections have been confirmed in this first batch of data — positrons that are of energies consistent with the signature of dark matter annihilation.

Dark matter is thought to make up 80 percent of all matter in the Universe, the rest is "baryonic matter" — i.e. the stuff we're made of. But the vast majority of matter is locked in an invisible component of matter. As the moniker suggests, dark matter is *dark*; it doesn't interact with electromagnetic radiation. However, dark matter still carries mass that has a gravitational effect on space-time and through indirect means we can detect its gravitational presence.

ANALYSIS: Dark Matter Matters — When You Can't Find It

Theory suggests that Weakly-Interacting Massive Particles (WIMPs) may be a part of non-baryonic matter, bulking up the mass of the Universe. WIMPs are their own anti-particles; when two WIMPs collide, they annihilate and produce positrons and electrons (and energy). But for physicists to confirm WIMP annihilation does occur, the positrons need to have a specific energy signature.

Positrons with energies of 0.5 GeV to 250 GeV have been recorded by the AMS — the largest collection of antimatter particles recorded in space. "The positron fraction increases from 10 GeV to 250 GeV, with the data showing the slope of the increase reducing by an order of magnitude over the range 20-250 GeV," writes the CERN release. This is consistent with the theory that WIMPs are out there, annihilating. And, apparently, these positrons are originating from all directions, bolstering the theory that dark matter permeates the whole Universe.

Other space-based experiments have seen clues of this dark matter signature, such as **the Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics (PAMELA) instrument**. But their measurements of the particle energy spectra have been too "coarse"; the AMS can produce a very refined spectrum of positron energies, allowing scientists an unprecedented high-resolution view of positron energies.

But this is by no means *proof* of WIMPs and a positive identification of dark matter annihilation. Pulsars — rapidly-spinning neutron stars — could also be generating this positron signal, so further work needs to be done.

"As the most precise measurement of the cosmic ray positron flux to date, these results show clearly the power and capabilities of the AMS detector," said Nobel laureate Samuel Ting, of the Massachusetts Institute of Technology (MIT) who leads the international AMS team, **in the CERN announcement**. "Over the coming months, AMS will be able to tell us conclusively whether these positrons are a signal for dark matter, or whether they have some other origin."

ANALYSIS: Dark Matter Found Lurking at Edges of Galaxies

The AMS will remain attached to the space station for the rest of its operational life, so there are many more years of results to be taken and analyzed.

The orbiting particle detector isn't only hunting for dark matter. Another quandary facing modern physics is why the Universe is composed mainly of matter (and not antimatter). Through the careful analysis of electron/positron ratios, it is hoped that some idea as to why the processes immediately after the Big Bang favored matter over antimatter will be gleaned.

While today's AMS dark matter announcement is exciting, it is only the beginning of a long road of scientific discovery as to the origins of the Universe.

Image: The AMS attached to the exterior of the space station. Credit: NASA