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ISS Particle Detector Findings Could Shed New Light On Origins Of Dark Matter

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The Alpha Magnetic Spectrometer attached to the International Space Station. Credit: NASA

Chuck Bednar for redOrbit.com – Your Universe Online

Thanks to a particle detector module mounted to the exterior of the International Space Station (ISS), researchers from the MIT Laboratory for Nuclear Science and their colleagues have collected new measurements which could help scientists learn more about the origin and characteristics of dark matter.

The unit, known as the Alpha Magnetic Spectrometer (AMS), captures incoming cosmic rays from throughout the galaxy. Out of about 41 billion instances of cosmic particles entering the detector, they were able to identify 10 million electrons and positrons, which are stable antiparticles of electrons that can exist in small numbers within the cosmic ray flux. These positrons provide hints about the origin of dark matter, the MIT researchers said.

Previous experiments have observed an excess of the particles, which suggests they could not originate from the cosmic rays but from a new and different source, they added. Last year, scientists using the AMS were able to accurately measure the onset of

this excess for the first time, and those findings could ultimately help reveal new information about the dark matter whose collisions could be responsible for creating those positrons.

The team reported the ratio of the number of positrons to the combined number of both positrons and electrons (also known as the observed positron fraction) within a wider energy range than before. From this data they found that the positron fraction increases quickly at low energies, then slows down and ultimately levels off at higher energies. This is said to be the first experimental observation of the positron fraction maximum (243 to 307 gigaelectronvolts).

[Listen to the Podcast: The Future Of Dark Matter Research – With Guest Dr. Matthew Walker]

"The AMS results announced today are tremendously provocative, and will drive scientists around the world to continue pursuing one of the biggest mysteries in the cosmos: dark matter," NASA chief scientist Ellen Stofan said in a statement. "The clear and definitive data from AMS represent the caliber of scientific discovery enabled by our unique laboratory in space, the International Space Station. Today we are one step closer to answering the fundamental questions about how our universe works, and we look forward to many more exciting twists in this developing story."

"The new AMS results show unambiguously that a new source of positrons is active in the galaxy," added Paolo Zuccon, an assistant professor of physics at MIT. "We do not know yet if these positrons are coming from dark matter collisions, or from astrophysical sources such as pulsars. But measurements are underway by AMS that may discriminate between the two hypotheses."

The research was funded by the US Department of Energy, and the findings were published Thursday in the journal *Physical Review Letters* in two separate studies – "Electron and Positron Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the International Space Station" and "High Statistics Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5–500 GeV with the Alpha Magnetic Spectrometer on the International Space Station."

According to the MIT researchers, almost 85 percent of the universe is made up of dark matter, which is essentially invisible to modern telescopes because it does not emit or reflect light. Astronomers have been limited to observing its effects in the form of unusual gravitational forces that appear to bind together galaxy clusters that otherwise would have come apart, leading them to develop the theory about the existence of this unseen source of gravitational mass.

The AMS project was designed to try and identify the source of this dark matter by collecting a constant flux of cosmic rays. Those rays are believed to include leftover material from collisions between dark matter particles, which release a specific amount of energy dependent upon the mass of the mass of the original particles. When those particles are annihilated, they create particles that eventually become electrons, protons, antiprotons, and positrons.

[Listen to the Podcast: Hunting For Cosmic Rays – With Special Guest Dr. Stephan Funk]

"As the visible matter in the universe consists of protons and electrons, the researchers reasoned that the contribution of these same particles from dark matter collisions would be negligible" the MIT researchers explained. "However, positrons and antiprotons are much rarer in the universe; any detection of these particles above the very small expected background would likely come from a new source."

The onset, maximum position, offset and other features of this excess will help scientists figure out if positrons arise from pulsars and other astrophysical sources, or from dark matter. After continuously collecting data since 2011, the AMS team analyzed 41 billion incoming particles, and identified 10 million positrons and electrons with energies ranging from 0.5 to 500 gigaelectronvolts (GeV) – a wider energy range than they had previously measured.

“The researchers studied the positron fraction versus energy, and found an excess of positrons starting at lower energies (8 GeV), suggesting a source for the particles other than the cosmic rays themselves,” MIT said. The positron fraction slowed, then peaked at 275 GeV, which indicates that the data could be compatible with a dark matter source of positrons. The research could indicate that dark matter is a new kind of particle.

“The new phenomena could be evidence for the long-sought dark matter in the universe, or it could be due to some other equally exciting new science,” said Barry Barish, a professor emeritus of physics and high-energy physics at the California Institute of Technology who was not involved in the experiments. “In either case, the observation in itself is what is exciting; the scientific explanation will come with further experimentation.”

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