Top Space Station Research Results Countdown: Three, Dark Matter is Still Out There

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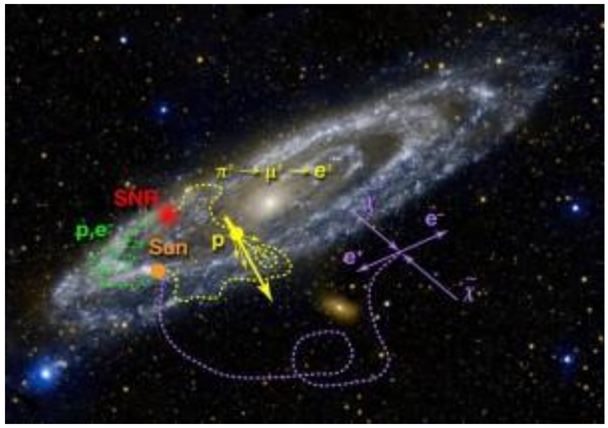
In today's A Lab Aloft entry, International Space Station Program Scientist Julie Robinson, Ph.D., continues her countdown to the top ten research results from the space station, recently presented at the International Astronautical Conference in Beijing, China. Be sure to check back for daily postings of the entire listing.

Number three on my countdown of the top ten International Space Station research results acknowledges that dark matter is still out there—and the space station is helping to find it. I want to start this entry out by apologizing to any astrophysicists reading this, as I am a biologist. But for all of those who are not astrophysicists, perhaps a biologist's interpretation is a good one. Today I am focusing on the first results from the Alpha Magnetic Spectrometer (AMS) aboard the space station.

AMS is the most sophisticated magnet for making measurements of galactic cosmic rays that has ever existed. The state-of-the-art particle physics detector collects particles arriving from deep space, measures their energies, and most importantly the direction they are coming from. Particle physicists have dark matter as the best existing theory and keep trying to find evidence to either disprove it or get more information to validate it. Findings point to a new phenomena that has researchers across the globe working to solve the cosmic puzzle of the origins of the universe through the pursuit of antimatter and dark matter.

One of the important sets of particles that the instrument is looking at are positrons. The first paper, published this year in *Physical Review Letters*, looked at positrons up to 300 giga electron volts (GeVs)—visible light has an energy of between 2 and 3 eV, by way of comparison. This is the same range studied with two other instruments, PAMELA and Fermi. But AMS has far greater accuracy than observations from these instruments. What the AMS results show is that there are far too many high energy positrons than can be explained from any established natural phenomenon. Those positrons appear to be coming not just from the center or the outside of the universe, but from every which direction.



The flux of high-energy particles near Earth (cosmic rays) can come from many sources. “Primary” particles (green) come from the original cosmic-ray source (typically, a supernova remnant). “Secondaries” (yellow) come from these particles colliding with interstellar gas and producing pions and muons, which decay into electrons and positrons. A third, interesting possibility is that electrons and positrons (purple) are created by the annihilation of dark matter particles, denoted by $\tilde{\chi}$ in the figure, in the Milky Way and its halo. Note that for illustrative purposes the background image used here is of Andromeda, a typical spiral galaxy, roughly similar to ours. (GALEX, JPL-Caltech, NASA; Drawing: APS/Alan Stonebraker)

The way Nobel Prize Laureate, Samuel Ting, Ph.D., summarized the findings in his paper was to say that these observations showed the existence of “new phenomena, whether from particle physics or from an astrophysical origin.” But of course what it really means, is that the data is consistent with what you would see if dark matter were being annihilated and producing positrons.

Ting and his hundreds of colleagues have published additional papers on other particles at meetings during the summer. What’s really exciting, though, is the next set of data that Ting will publish. For example, the instrument is measuring positrons up to to 1 Tera electron volt (TeV). The 300 GeV measurement matches all the other data, but as a good statistical sample builds and there is enough data on particle events to publish 300 GeV to the 1 TeV, all of that information will be completely new to science.

Big questions are out there. Even though we see events becoming rarer at high energies, will we continue to see an increased proportion of those? And at what energy levels and frequencies? All of that data becomes really important for answer the questions about the nature of dark matter and dark energy as we seek to unravel the mysteries of our universe.

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