Still in the dark about dark matter

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Dark matter, the mysterious stuff thought to make up about 80 percent of matter in the universe, has become even more inscrutable.

Scientists have been trying for decades to better understand and detect the nature of dark matter, which could help them figure out how galaxies first formed.

"We don't know much about dark matter," said Stefan Funk, a particle astrophysicist at Stanford University.

Unlike the visible matter in the universe, dark matter can't be seen and it's exceptionally hard to detect. It moves slowly, carries little energy and interacts very little with the stuff around it. But scientists do know that when a piece of dark matter is destroyed, the resulting burst includes a stream of high-energy particles.

These particles can be made of ordinary matter - protons, neutrons, electrons and their building blocks - and also of their antimatter counterparts. Antimatter was plentiful in the early universe, but it's now exceedingly rare and is created only by strange processes - such as, theoretically, the destruction of dark matter in space or in man-made particle accelerators.

So scientists on the hunt for evidence of dark matter look for positrons - the antimatter analog of electrons - in high-energy bursts of particles known as cosmic rays. If you find a positron, the thinking goes, you know that at some point there probably was dark matter.

Physicists don't know how big dark matter particles can be. But they think that the amount of energy carried by a positron is limited by the mass of its dark matter source.

Scientists figured they could find a cutoff point for the maximum size of a dark matter particle relatively quickly. But recent results from the Russian-European spacecraft known as PAMELA found that the abundance of positrons relative to electrons given off by cosmic rays at energy levels up to 100 gigaelectron volts never fell off - much to the surprise of physicists.

Some scientists questioned the findings. But now Funk and his colleagues at Stanford appear to have confirmed those results in a study that has been submitted to Physical Review Letters.

Researchers on the Stanford team used the Fermi Gamma-ray Space Telescope to look for particles at even higher energy levels. Since the orbiting telescope does not have a magnet on board, researchers used the Earth's magnetic field to separate positrons, which have a positive charge, from electrons, which have a negative charge.

Once again, they found that, even at energy levels as high as 200 gigaelectron volts - twice what PAMELA had been able to search - the share of positrons simply kept rising.

The cutoff point, then, proves elusive - and thus, so does the maximum mass of dark matter particles.

Michael Peskin, a theoretical particle physicist at Stanford who was not involved in the study, said there are two possible explanations. Either the cutoff point exists at a higher energy level than the scientists were able to search, a sign that that dark matter particles are more massive than some models had predicted - or it means that, no matter what energy levels physicists look at, they will not see a cutoff, which could mean that positrons are coming from other sources, like supernovae or pulsars.

In that case, looking for antimatter particles like positrons may not be a reliable way to search for signs of dark matter's presence. To find out, Funk said he may shift his search to positrons at energy levels of up 1,000 gigaelectron volts.

Until scientists settle the question by looking at higher energy ranges, Peskin said, "both of these ideas are still in play."