What Will GLAST Tell Us?

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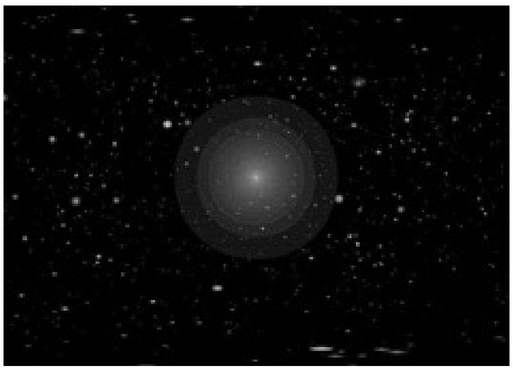

A simulated image of gamma-ray sources from dark matter annihilations in a model galaxy. Image courtesy of James E. Taylor and Arif Babul

The identity of dark matter—the mysterious stuff that makes up a quarter of the universe—continues to elude scientists, even decades after they first inferred its existence. The leading candidate that might explain the fundamental make-up of dark matter is a hypothetical particle called the weakly interacting massive particle (WIMP). Soon, with the Gamma-Ray Large Area Telescope (GLAST) built in part at SLAC and scheduled for launch in August of 2007, scientists may finally find clear evidence that dark matter is indeed made of WIMPs.

Gamma-rays—the most energetic form of light—originate from a multitude of mysterious sources, like black holes or exploding stars. But current theory suggests they can also come from WIMPs. Scientists believe WIMPs can interact with themselves, annihilating each other and releasing a flurry of secondary particles as well as gamma-rays. Using GLAST, scientists hope to find these high-energy signatures of dark matter in our galaxy. If they succeed, this discovery would help solve one of astronomy's grandest puzzles.

"With GLAST, we hope to actually see individual dark matter annihilations," said Michael Peskin, professor of theoretical physics at SLAC. Ted Baltz, a Kavli Institute for Particle Astrophysics and Cosmology (KIPAC) researcher who also works on the GLAST project, added, "GLAST has the real possibility of making a fundamental contribution to understanding what galaxies are made of."

Even though it is much more weakly interacting than ordinary matter, dark matter is not spread out evenly through space and should form clumps in galaxies. If dark matter is in fact composed of WIMPS, this clumping would improve the chances of these particles meeting and annihilating, producing steady streams of gamma rays detectable by GLAST.

The trick will be distinguishing gamma rays generated by dark matter events from those generated by numerous other sources in the universe. To differentiate between the two, researchers have established a set of four guidelines. Theory predicts that WIMP annihilations will create gamma rays of particular wavelengths, distinct from those generated by other sources like black holes or exploding stars.

Dark matter annihilations should produce gamma rays exclusively, ruling out interactions that involve other kinds of radiation. These signals should appear to GLAST not as point sources, but as large patches in the sky—some nearly twice as big as the full moon. Finally, these streams of gamma rays would be continuous, a marked difference from the fleeting explosions of gamma-ray bursts that last only a few milliseconds to several minutes. If scientists find a signal with all these characteristics, chances are good that they have found a source of WIMP annihilation.

Along with numerous other dark-matter experiments, such as searches for WIMP collisions in underground detectors and attempts to manufacture WIMPs at the Large Hadron Collider (LHC) at CERN, many scientists believe the existence of WIMPS could be confirmed within the next few years.

"I think there's a lot of hope in this business," Baltz said. "If GLAST doesn't see anything, and the LHC doesn't see anything, a lot of people will be surprised. But, we've been wrong before."

Source: Stanford Linear Accelerator Center, by Marcus Woo

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