

# Thunderstorms produce antimatter, scientists find

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Courtesy of NASA  
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**Scientists using NASA's Fermi Gamma-ray Space Telescope have detected beams of antimatter, a rare and bizarre mirror-image form of ordinary matter, above thunderstorms on Earth.**

The phenomenon has never been seen before, researchers say. Antimatter is practically nonexistent on Earth, where it can be found only as a result of certain exotic processes which create, then quickly destroy it.

"These signals are the first direct evidence that thunderstorms make antimatter particle beams," said Michael Briggs, a member of Fermi's Gamma-ray Burst Monitor team at the University of Alabama in Huntsville. He presented the findings Monday, during a news briefing at the American Astronomical Society meeting in Seattle.

Most of the particles that are the basic, subatomic building blocks of matter have an "antimatter" counterpart: a particle that is exactly alike, except that it has an opposite electrical charge. Charge comes in two forms, positive and negative, which attract each other. The antimatter particles detected in the new experiments are positrons, tiny carriers of positive charge. They are antimatter counterparts to electrons, the basic charge carriers within atoms, which have negative charge and are responsible for the currents in ordinary electrical circuits.

When an antimatter particle meets with its matter counterpart, they destroy each other in a flash of energy. Antimatter particles in the universe appear to be far outnumbered by ordinary matter particles, though scientists are unsure why.

Nonetheless, certain physical processes can create antimatter. In the case of thunderstorms, scientists think the antimatter particles were formed in a terrestrial gamma-ray flash, a brief burst produced inside thunderstorms and shown to be associated with lightning. It is estimated that about 500 of these flashes occur daily worldwide, but most go undetected.

The Fermi instrument is designed to monitor gamma rays, the highest-energy form of light. When antimatter striking Fermi collides with a particle of normal matter, both particles immediately are annihilated and transformed into gamma rays. Fermi's Gamma-ray Burst Monitor instrument has detected gamma rays with energies of 511,000 electron volts, a signal indicating an electron has met its antimatter counterpart, a positron.

The research team has identified 130 terrestrial gamma-ray flashes since Fermi's launch in 2008.

"In orbit for less than three years, the Fermi mission has proven to be an amazing tool to probe the universe. Now we learn that it can discover mysteries much, much closer to home," said Ilana Harrus, Fermi program scientist at NASA Headquarters in Washington.

The spacecraft was located immediately above a thunderstorm for most of the observed flashes, but in four cases, storms were far from Fermi. In one case, the storm was even over the horizon, thus not directly detectable by Fermi, scientists said. "Even though Fermi

couldn't see the storm, the spacecraft nevertheless was magnetically connected to it," said Joseph Dwyer at the Florida Institute of Technology in Melbourne, Fla. "The [flash] produced high-speed electrons and positrons, which then rode up Earth's magnetic field to strike the spacecraft."

Scientists long have suspected that the flashes arise from the strong electric fields near the tops of thunderstorms. Under the right conditions, they say, the field becomes strong enough that it drives an upward avalanche of electrons. Reaching speeds nearly as fast as light, the high energy electrons give off gamma rays when they're deflected by air molecules. Normally, these gamma rays are detected as a terrestrial gamma-ray flash.

But the cascading electrons produce so many gamma rays that they blast electrons and positrons clear out of the atmosphere, scientists said. This happens when the gamma-ray energy transforms into a pair of particles: an electron and a positron. It's these particles that reach Fermi's orbit.

Scientists now think that all terrestrial gamma-ray flashes emit electron-positron beams. A paper on the findings has been accepted for publication in the journal *Geophysical Research Letters*. "We still have to figure out what is special about these storms and the precise role lightning plays," said Steven Cummer at Duke University.