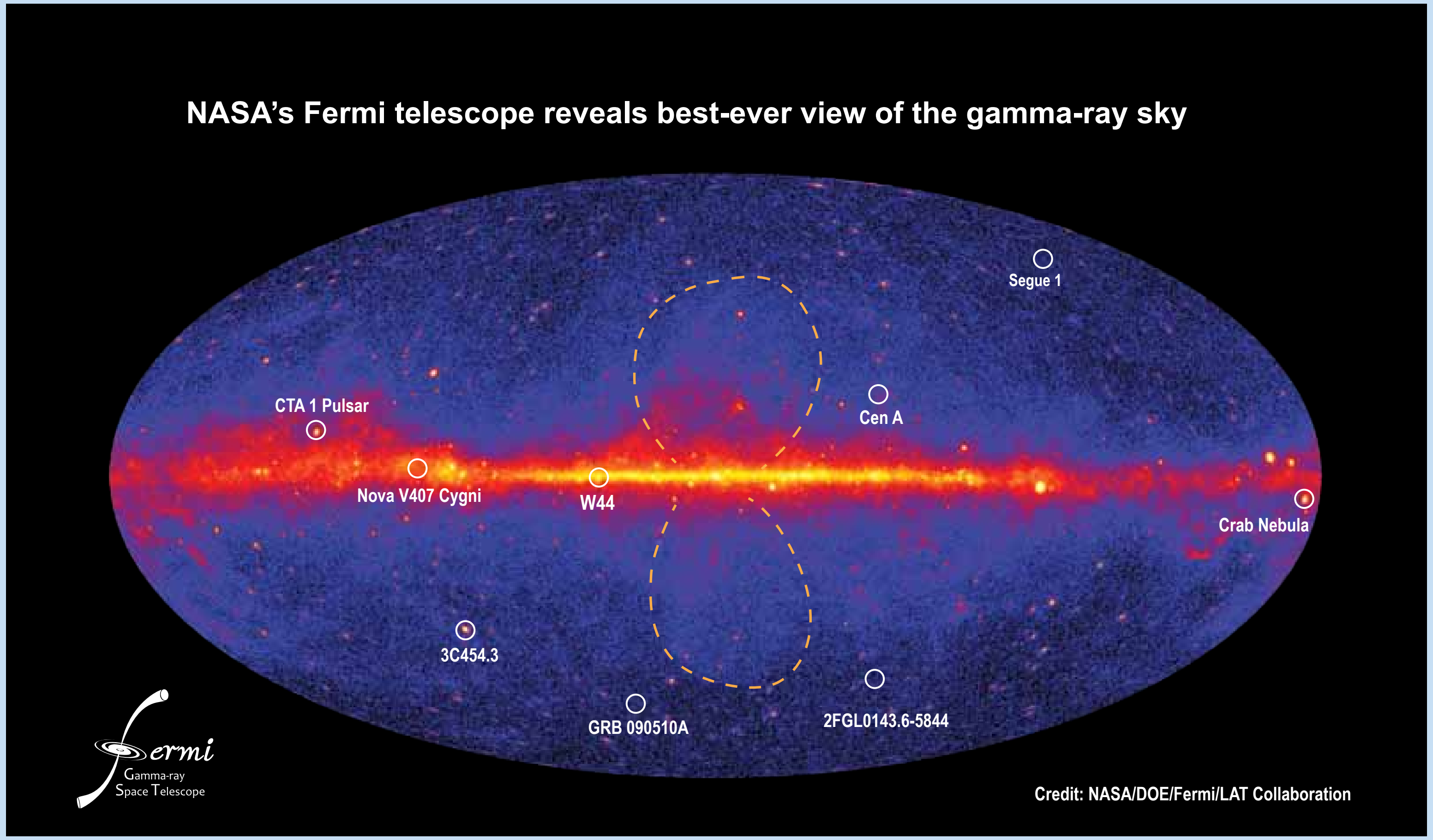

The image above shows a map of the high-energy gamma-ray sky as seen by the Fermi Large Area Telescope in four years of observations. The map is in galactic coordinates, with the plane of the Milky Way galaxy stretching horizontally across the center of the map. Below are descriptions of a few of the notable sources within and beyond the Milky Way.

Five notable sources *within* our galaxy:

Fermi Bubbles (dashed line): These huge, faint structures stretch halfway across the sky above and below the center of the Milky Way. They may be remnants of some powerful activity around the black hole in the Galactic Center.

CTA 1 Pulsar: The first of many pulsars discovered by Fermi LAT scientists using only gamma-ray data was the one in supernova remnant CTA 1. A pulsar is a neutron star whose rapid rotation powers beams of radio, optical, X-ray and gamma radiation. Although 10,000 years old, the CTA 1 pulsar still emits a thousand times more energy than our sun.

Nova V407 Cygni: Fermi LAT scientists were surprised and delighted in March 2010 when gamma rays from a nova were detected for the first time. These stellar eruptions in a binary star system were not expected to be powerful enough to produce gamma rays, the highest-energy form of light.

W44: Fermi's LAT has spatially resolved GeV gamma rays in the supernova remnant W44, the debris left behind by a star that exploded about 20,000 years ago. The features clearly align with structures detectable in X-rays, infrared, and radio. The gamma-ray observations support the idea that high-energy cosmic-ray particles are produced in such supernova remnants.

Crab Nebula: Fermi observations of the Crab Nebula, a 1000-year-old supernova remnant containing a pulsar, revealed gamma-ray flares set off by the most energetic particles ever traced to a specific astronomical object. To account for the days-long flares, scientists say that electrons near the pulsar must be accelerated to energies a thousand trillion (10^{15}) times greater than that of visible light.

Five notable sources *beyond* our galaxy:

3C454.3: : In 2009 and 2010, Fermi's LAT recorded a series of flares from the blazar 3C 454.3. In November 2010, 3C454.3 briefly was the brightest object in the gamma-ray sky. The source is a particle jet powered by the galaxy's supermassive black hole. This blazar is 7 billion light-years away, but is especially bright because its jet is directed toward Earth.

Cen A: Fermi's LAT resolved extended lobes of high-energy gamma rays from a region around the active galaxy Centaurus A. The emission corresponds to million-light-year-wide radio-emitting gas thrown out by the galaxy's supersized black hole. How the energy is conveyed the huge distances out to the gamma-ray lobes remains a puzzle.

Segue 1:
This dwarf spheroidal galaxy, a companion of our own Milky Way Galaxy, is NOT seen in gamma rays. The absence of gamma-ray signals from any such dwarf galaxies is important because they are thought to contain large amounts of dark matter. Fermi observations are ruling out some models of dark matter that predicted gamma-ray detections of these galaxies.

GRB 090510A:
This short gamma-ray burst tested Einstein's idea that all light travels at the same speed. Low-energy and high-energy gamma rays from this burst arrived within one second after traveling 7 billion years, eliminating some theories that challenged Einstein's idea.

2FGL0143.6-5844:
This gamma-ray source is known by its name in the Second Fermi LAT Catalog, because scientists still do not know what it is. Its location far from the plane of the Milky Way suggests that it lies outside our Galaxy. Searches with radio, X-ray, and optical telescopes have not yet found a counterpart to the gamma-ray source. Like almost a third of the gamma-ray sources, it remains a mystery waiting to be solved.

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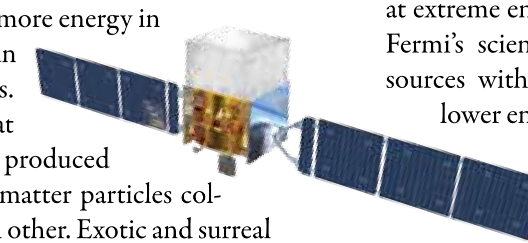
National Aeronautics and Space Administration

NASAfacts

Fermi Gamma-ray Space Telescope

Exploring the Extreme Universe: Under a Gamma-ray Sky

In distant regions of space, supermassive black holes eject streams of gamma-ray producing matter stretching many thousands of light-years. Gamma-ray bursts, the most energetic explosions in the universe, release more energy in a moment than our Sun emits in 10 billion years. Theory suggests that gamma rays are also produced when mysterious dark matter particles collide and annihilate each other. Exotic and surreal though it may seem to some, this is the extreme universe of high-energy astrophysics.



We are now peering into the heart of this cosmic landscape with the Fermi Gamma-ray Space Telescope. An advance in space-science exploration technology, Fermi is probing the nature of the gamma-ray sky and shedding light on some of the most important mysteries of modern astrophysics. Exploring the most extreme environments in the universe, where nature harnesses energies far beyond anything possible on Earth, Fermi is answering long-standing questions across a broad range of topics and is searching for signs of new laws of physics.

Fermi Mission Profile

Fermi is the first imaging gamma-ray observatory to survey the entire sky every day and with high sensitivity. Orbiting Earth every 95 minutes, Fermi is giving scientists a unique opportunity to learn about the ever-changing universe at extreme energies. With improved resolution, Fermi's scientists are identifying the celestial sources with objects that are recognizable at lower energies, such as distant quasars, pulsars, or supernova remnants. A network of ground-based and space-based telescopes are working together with Fermi as it opens the high-energy universe for exploration. Fermi is a flexible observatory for investigating a wide range of extreme astrophysical phenomena.

General Spacecraft Information:

Lifetime	5-10 years
Height	2.9 m (9.2 feet)
Width	1.8 m (4.6 feet) across spacecraft bus
Mass	4,303 kg (9,487 lbs)
Download Link	40 megabits/second
Power	1,500 watts
Launch	June 11, 2008

Gamma-ray Origins?

At the core of Fermi's mission is finding out what gives birth to the diverse spectrum of gamma rays. There are many intriguing possibilities, including blazars, gamma-ray bursts, and pulsars.

Gamma rays permeate the cosmos. They are emitted from objects as nearby as our own Sun and Milky Way galaxy to those as far away as tremendous explosions in the early universe. Fermi, NASA's new gamma-ray observatory, is opening a wide window on the extreme universe. With a huge leap in all key capabilities, Fermi is enabling scientists to answer deep and perplexing questions related to supermassive black-hole systems, gamma-ray bursts, pulsars, and the origins of cosmic rays. Fermi is also uncovering new sources of gamma rays and enabling searches for signals of new physics.

NASA's Fermi mission is an astrophysics and particle physics partnership, developed in collaboration with the U.S. Department of Energy, along with important contributions from academic institutions, laboratories, and partners in France, Germany, Italy, Japan, Sweden, and the United States.

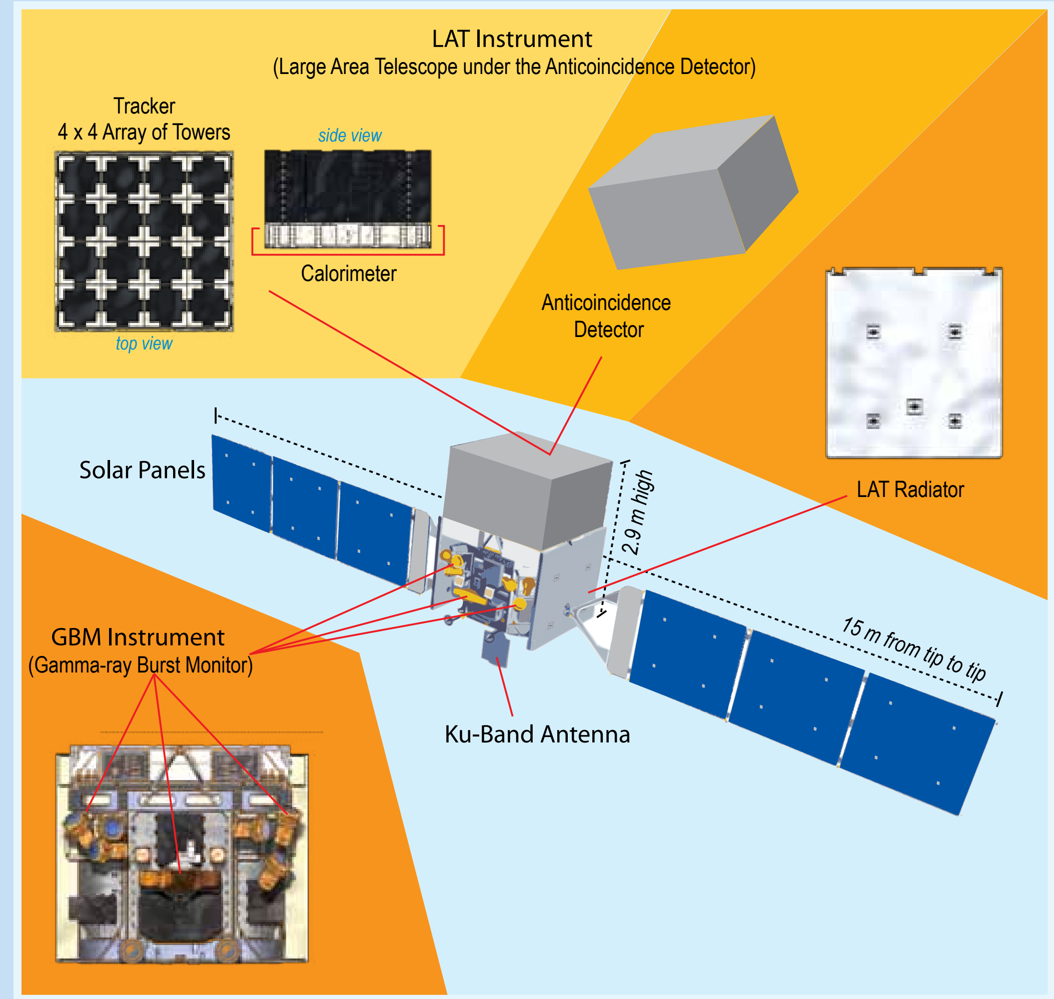
Large Area Telescope (LAT)

The Large Area Telescope, the observatory's primary instrument, is seeing an enormous 20 percent of the sky at any given time and is detecting the arrival time and direction of gamma rays broadly ranging from 20 MeV (20 million electron volts) to 300 GeV (300 billion electron volts). The LAT's field-of-view is four times that of its predecessor instrument, the Energetic Gamma-ray Experiment Telescope (EGRET), which operated on board the Compton Gamma-ray Observatory (CGRO) from 1991-2000. The sensitivity of the LAT is 30 or more times that of EGRET, depending on energy.

Gamma-ray Burst Monitor (GBM)

Gamma-ray bursts (GRBs) are elusive and short-lived. Although they are among the most energetic explosions in the universe, it is challenging to catch them even with a telescope having a field of view as large as the LAT's. The Fermi Gamma-ray Burst Monitor solves this problem by providing all-sky coverage with an array of 12 low- and 2 medium-energy gamma-ray detectors pointing in different directions from the spacecraft. These detectors are tracking the direction and time histories of GRBs and other rapidly flaring gamma-ray sources. The Gamma-ray Burst Monitor is detecting approximately 200 GRBs each year, as well as solar flares, and other short-lived, high-energy cosmic events.

Anatomy of a Space Telescope



Gamma-ray Mysteries

Dark Matter - The origin of dark matter, which makes up as much as 80 percent of the mass of the universe, remains a mystery. If dark matter is made up of hypothetical particles called WIMPs (Weakly Interacting Massive Particles), as many scientists theorize, then interactions of these WIMPs may produce gamma rays detectable by Fermi's Large Area Telescope. If so, Fermi could provide scientists with data that shed critical new light on the mystery of dark matter.

Unidentified Sources - It is likely there are many more types of gamma-ray sources among those presently unidentified and those to be discovered by Fermi. The superior angular resolution of Fermi's Large Area Telescope is helping to unveil the nature of these mystery sources, providing new understanding of the origin of their gamma rays and possible new laws of physics.


Aurore Simonnet, SSU

Active Galaxies and Blazars: An active galaxy is a galaxy with an accreting super-massive central black hole. These black holes produce high-energy radiation from the swirling disks of matter falling into them. Some of these black holes also eject streams of matter thousands of light-years at very nearly the speed of light. Blazars are thought to be active galaxies whose jets happen to be pointing toward us, and we see gamma rays associated with the jets.


Dana Berry/NASA

Gamma-ray Bursts: Gamma-ray bursts are among the most energetic explosions in the universe. Recent observations have linked the origins of GRBs to the death throes of very massive stars, or to collisions between two black holes and/or neutron stars – both events will lead to the birth of a new black hole. Fermi is providing new insights into these mysterious and exotic events by studying their gamma rays over a huge range of energies.


Casey Reed/Penn State

Pulsars: When the core of a massive star undergoes gravitational collapse, it forms a very dense object known as a neutron star. These objects have densities on the order of 10^{18} kg/m^3. (Imagine condensing Mount Everest down to the size of a sugar cube.) With magnetic fields trillions of times that of Earth, these objects work like high-energy particle accelerators, expelling jets of gamma rays which rotate through our line of sight, producing pulsations that we can observe. Other neutron stars – the so-called magnetars – may possess even stronger magnetic fields. Magnetar starquakes can unleash tremendous flares of gamma rays.


NASA/CXC

Cosmic Rays and Supernova Remnants: Cosmic rays are subatomic particles that are accelerated to very near the speed of light by mechanisms that are still a mystery. One theory suggests that these particles are accelerated by the shock waves of supernovae. The LAT is searching for the telltale gamma-ray signature of this acceleration.