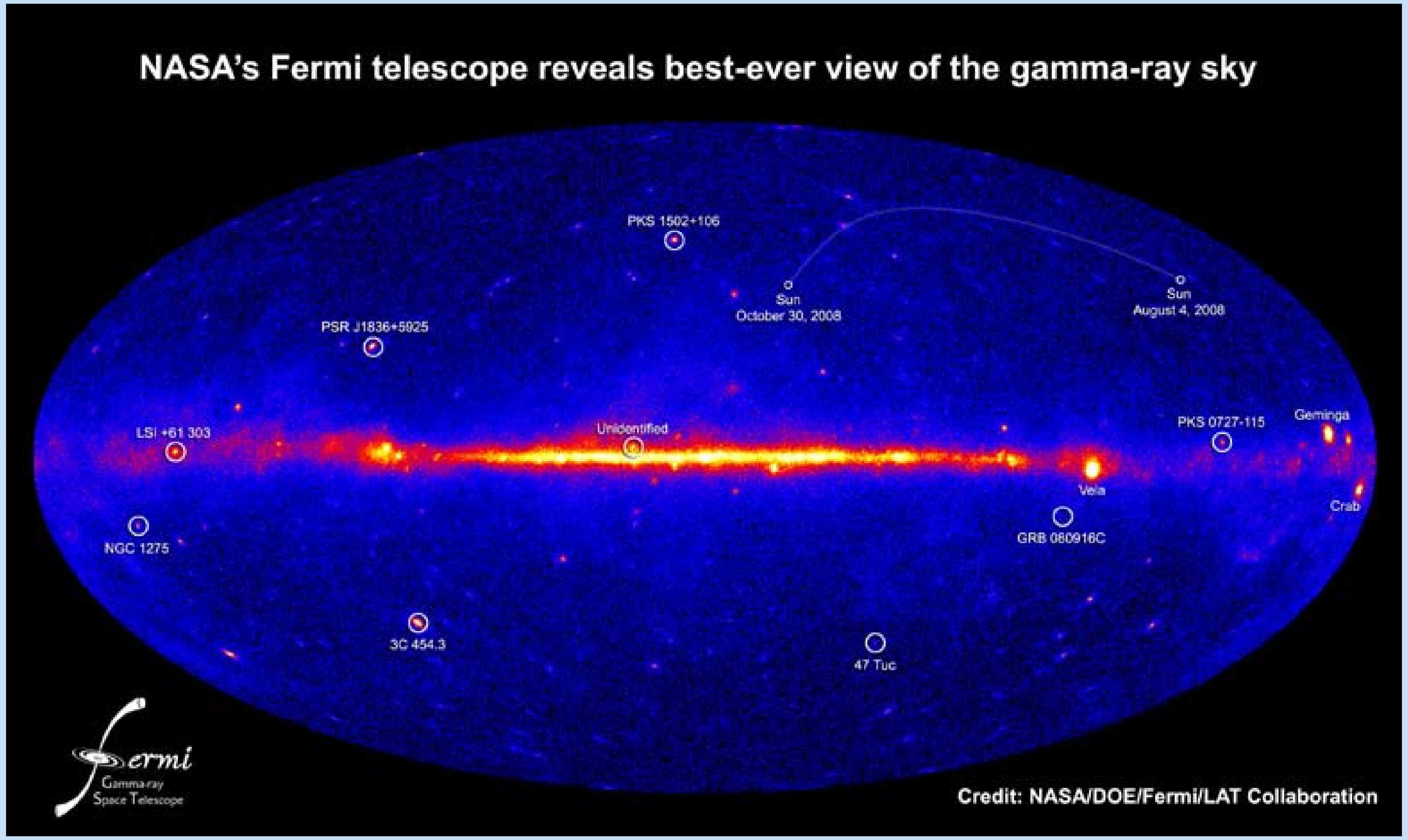

The image above shows a map of the high-energy gamma-ray sky as seen by the Fermi Large Area Telescope in three months of observations. The map is in galactic coordinates, with the plane of the Milky Way galaxy stretching horizontally across the center of the map. Below are descriptions of a few of the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

Five notable sources *within* our galaxy:

The Sun. Now near the minimum of its activity cycle, the Sun would not be a particularly notable source except for one thing: It's the only one that moves across the sky. The Sun's annual motion against the background sky is a reflection of Earth's orbit around the Sun.

The gamma rays Fermi now sees from the Sun actually come from high-speed particles colliding with the Sun's gas and light. The Sun is only a gamma-ray source when there's a solar flare. During the next few years, as solar activity increases, scientists expect the Sun to produce growing numbers of high-energy flares, and no other instrument will be able to observe them in the LAT's energy range.

LSI +61 303. This is a high-mass X-ray binary located 6,500 light-years away in Cassiopeia. This unusual system contains a hot B-type star and a neutron star and produces radio outbursts that recur every 26.5 days. Astronomers cannot yet account for the energy that powers these emissions.

PSR J1836+5925. This is a pulsar — a type of spinning neutron star that emits beams of radiation — located in the constellation Draco. It's one of the new breed of pulsars discovered by Fermi that pulse only in gamma rays.

47 Tucanae. Also known as NGC 104, this is a sphere of ancient stars called a globular cluster. It lies 15,000 light-years away in the southern constellation Tucana.

Unidentified. More than 30 of the brightest gamma-ray sources Fermi sees have no obvious counterparts at other wavelengths. This one, designated 0FGL J1813.5-1248, was not seen by previous missions, and Fermi's LAT sees it as variable. The source lies near the plane of the Milky Way in the constellation Serpens Cauda. As a result, it's likely within our galaxy -- but right now, astronomers don't know much more than that.

Five notable sources *beyond* our galaxy:

NGC 1275. Also known as Perseus A, this galaxy at the heart of the Perseus Galaxy Cluster is known for its intense radio emissions. It lies 233 million light-years away.

3C 454.3. This is a type of active galaxy called a "blazar." Like many active galaxies, a blazar emits oppositely directed jets of particles traveling near the speed of light as matter falls into a central supermassive black hole. For blazars, the galaxy happens to be oriented so that one jet is aimed right at us. Over the time period represented in this image, 3C 454.3 was the brightest blazar in the gamma-ray sky. It flares and fades, but for Fermi it's never out of sight. The galaxy lies 7.2 billion light-years away in the constellation Pegasus.

PKS 1502+106. This blazar is located 10.1 billion light-years away in the constellation Boötes. It appeared suddenly, briefly outshone 3C 454.3, and then faded away.

PKS 0727-115. This object's location in the plane of the Milky Way would lead one to expect that it's a member of our galaxy, but it isn't. Astronomers believe this source is a type of active galaxy called a quasar. It's located 9.6 billion light-years away in the constellation Puppis.

GRB 080916C. The first gamma-ray burst to be seen in high-resolution by Fermi's LAT is one for the record books. The blast had the greatest total energy, the fastest motions and the highest-energy initial emissions recorded to date. For a few moments, it was the brightest source in the universe.

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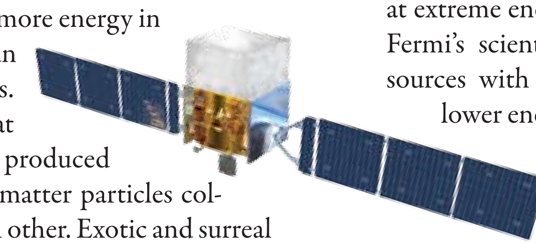
NASAfacts

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.

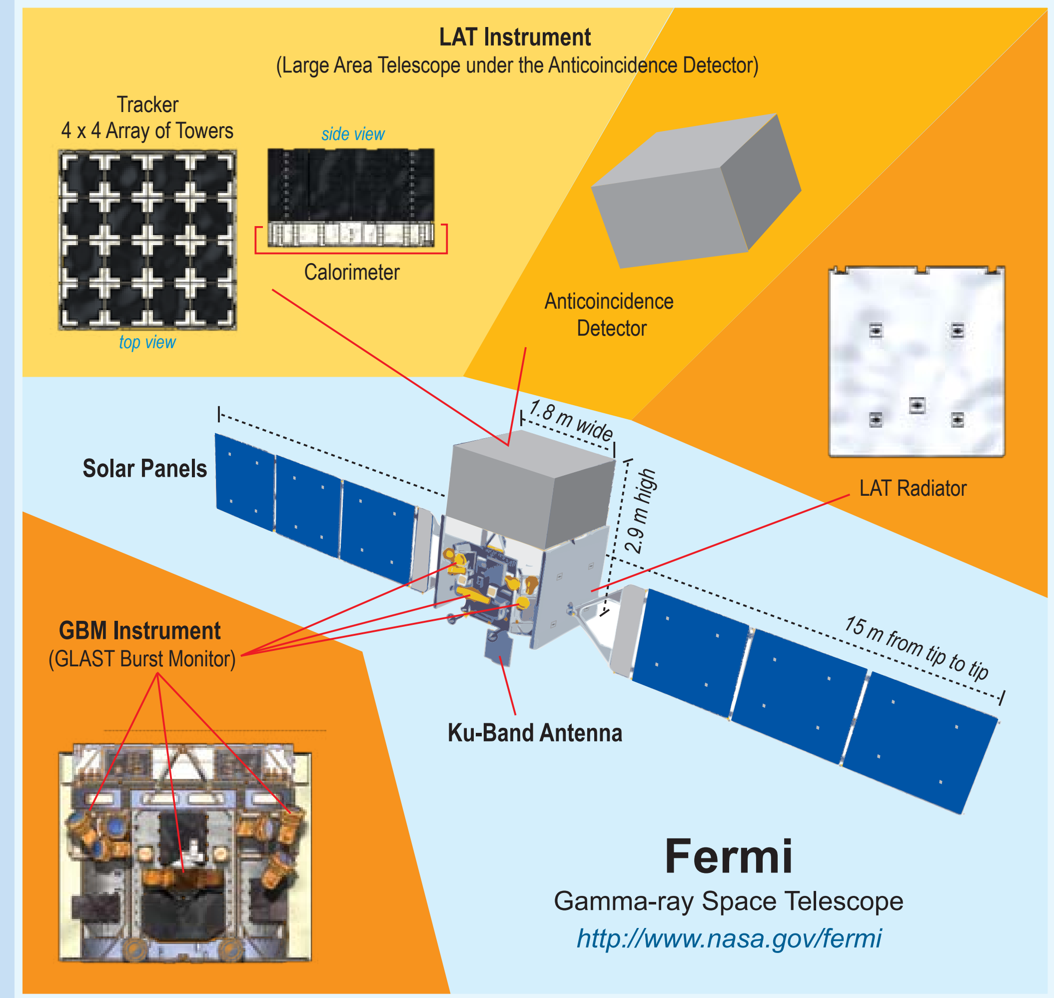
Large Area Telescope (LAT)

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

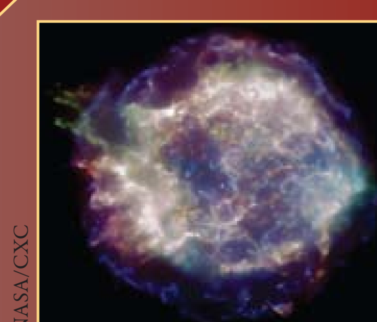
Active Galaxies and Blazars: An active galaxy is a galaxy with an accreting super-massive central black hole. These black holes produce high-energy radiation from the swirling disks of matter falling into them. Some of these black holes also eject streams of matter thousands of light-years at very nearly 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.