

## Fermi Mission Science

Gamma rays are the most energetic form of electromagnetic radiation, typically a million or more times more energetic than visible light. They are produced by some of the Universe's most powerful and exotic phenomena including flares on the Sun, pulses from rapidly spinning neutron stars and super-massive black holes at the centers of galaxies. In these sources and many others, the exact mechanisms that produce the gamma rays are not known, in part, because the enormous energies of gamma rays inhibit our ability to study them. The fact that gamma rays in Fermi's energy band are absorbed in our atmosphere and never reach the Earth's surface means we must send instruments above the atmosphere in order to detect these gamma rays from the extreme Universe.

## On the Shoulders of Giants...

In an effort to better understand celestial gamma rays, an international group of scientists, engineers and technicians has built a next-generation space telescope that is detecting gamma rays with unprecedented sensitivity. The Fermi Gamma-ray Space Telescope, is the successor to the Compton Gamma-Ray Observatory (CGRO) that orbited the Earth during the 1990s. CGRO studied gamma rays from many types of celestial objects, including monstrous black holes at the cores of distant galaxies ("active galaxies"), spinning collapsed stars that emit pulses of gamma-ray light ("pulsars"), and tremendous blasts of gamma radiation known as gamma-ray bursts (GRBs.) Fermi is studying these known gamma-ray sources in detail and will also discover thousands of new gamma-ray sources in its five-year nominal mission.

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 and partners in France, Germany, Italy, Japan, Sweden, and the U.S.

National Aeronautics and Space Administration  
Sonoma State University, NASA E/PO  
1801 E Cotati Avenue  
Rohnert Park, CA 94928  
Fermi.sonoma.edu

<http://www.nasa.gov>

Front: Fermi silhouetted against the simulated gamma-ray sky in the region of the galactic anti-center. The bright source above the line of gamma-emission from the Milky Way is "Geminga" - a gamma-ray pulsar. The brighter source below the Milky Way is the Crab pulsar, and the fainter source is the quasar PKS0528+134.

## The Main Mission Objectives for Fermi are to:

- Explore the most extreme environments in the Universe, where nature harnesses energies far beyond anything possible on Earth.
- Search for signs of new laws of physics and what composes the mysterious Dark Matter.
- Explain how black holes accelerate immense jets of material to nearly light speed.
- Help crack the mysteries of the stupendously powerful explosions known as gamma-ray bursts.
- Answer long-standing questions across a broad range of topics, including solar flares, pulsars and the origin of cosmic rays.

## Fermi Instrumentation and Spacecraft:

There are two science instruments on board Fermi:

1. **Large Area Telescope (LAT):** The LAT has a very wide field-of-view and is able to determine the energy of an incoming gamma ray as well as the direction in the sky from which it came, both to unprecedented accuracy.
2. **Gamma-ray Burst Monitor (GBM):** The GBM views the entire sky not occulted by Earth to detect GRBs a few times per week and extends the energy range for GRB observations by many orders of magnitude.

The LAT and the 12 detectors that make up the GBM are mounted on a spacecraft bus which provides power to the instruments through solar panels, includes momentum wheels and star trackers to point and steer the spacecraft, and provides antennae and on-board computing for data communications and data storage.

Data from the Fermi spacecraft are transmitted via NASA's Tracking and Data Relay Satellite System to Earth, where they are processed at the Instrument Science Operations Centers at Stanford University and the National Space Science and Technology Center in Huntsville, Alabama, and made available to scientists worldwide. The mission is managed and operated by NASA/Goddard Space Flight Center, which also staffs the Fermi Science Support Center.

Fermi is harnessing the power of thousands of professional and amateur astronomers around the world by rapidly notifying them of GRBs and powerful flares from active galaxies that it detects. The astronomers can then choose to employ other telescopes using the full electromagnetic spectrum to observe the sources of the gamma rays.

Fermi is seeing the high-energy gamma-ray universe like never before. Centuries of astronomy have taught us that viewing the Universe with higher resolution and greater sensitivity produces amazing surprises. Fermi will provide answers to questions that have puzzled scientists for decades, but even more important, it will reveal things we had not expected, and it will raise questions we did not previously think to ask.

## Pulsar Activity

You will need:

- 2 light emitting diodes (LEDs)
- 1 watch battery
- Cellophane (Scotch) tape
- Modeling clay or aluminum foil
- Toothpick, skewer, or string (optional)

- 1.) Using cellophane tape, attach the two LEDs to the battery so that they face in opposite directions. Make sure that one lead of LED is touching the positive side of the battery and the other lead is touching the negative side; Fig. 1.

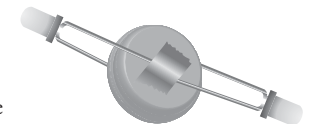


Fig. 1

- 2.) Using either the modeling clay or aluminum foil make a round ball that encases the battery while exposing the LEDs. Note: If you are going to use aluminum foil, please make sure that the battery and the LED leads are completely encased by tape otherwise the LEDs will not light up; Fig.2.



Fig. 2

- 3.) Insert the toothpick or skewer into the ball, or hang the ball from a string. Spinning the ball then gives you an idea of how a pulsar creates the pulses that we see.; Fig.3.

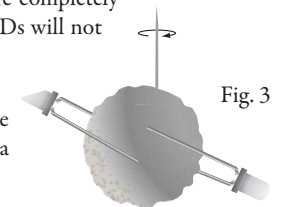
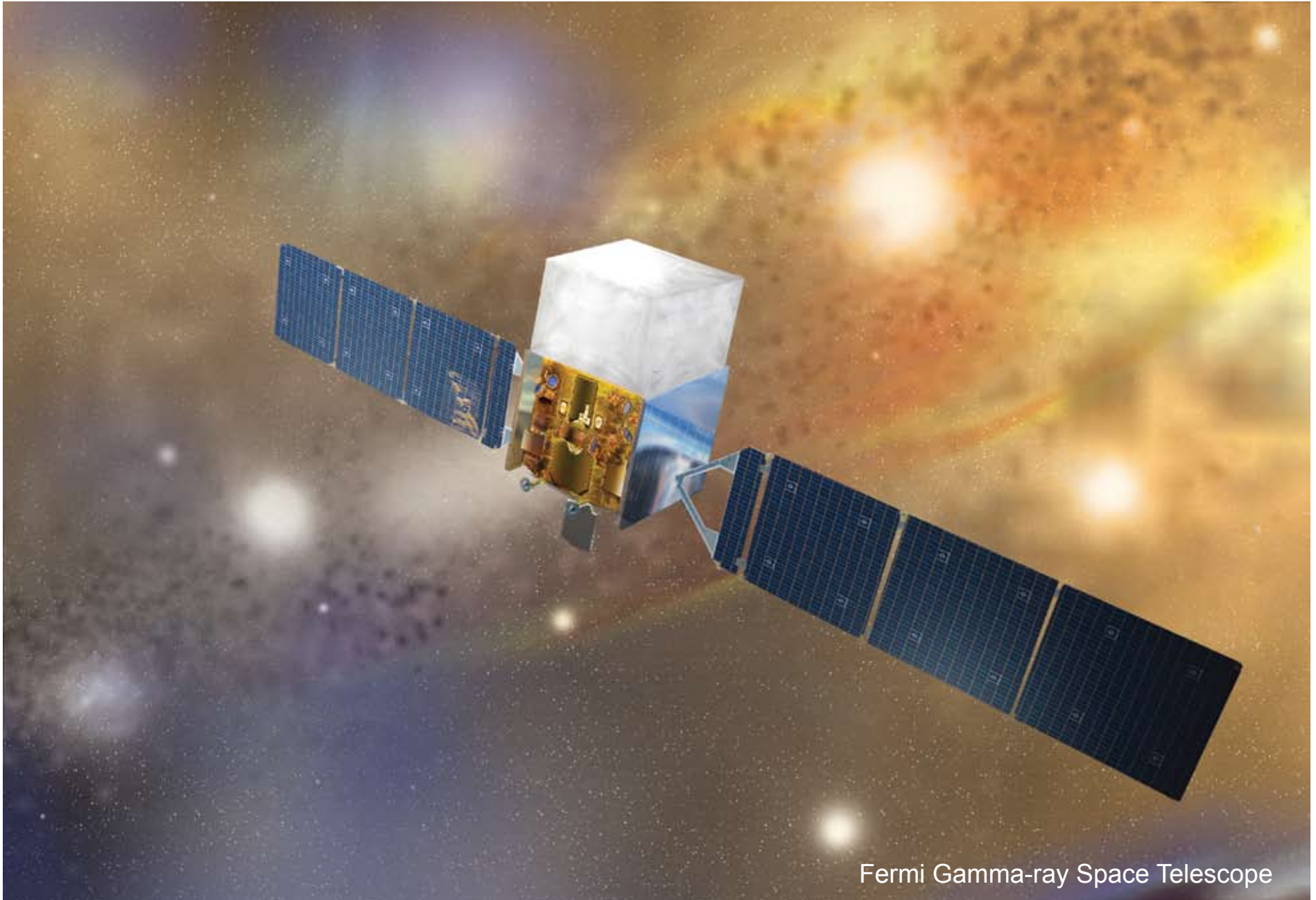
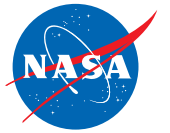


Fig. 3



Fermi Gamma-ray Space Telescope