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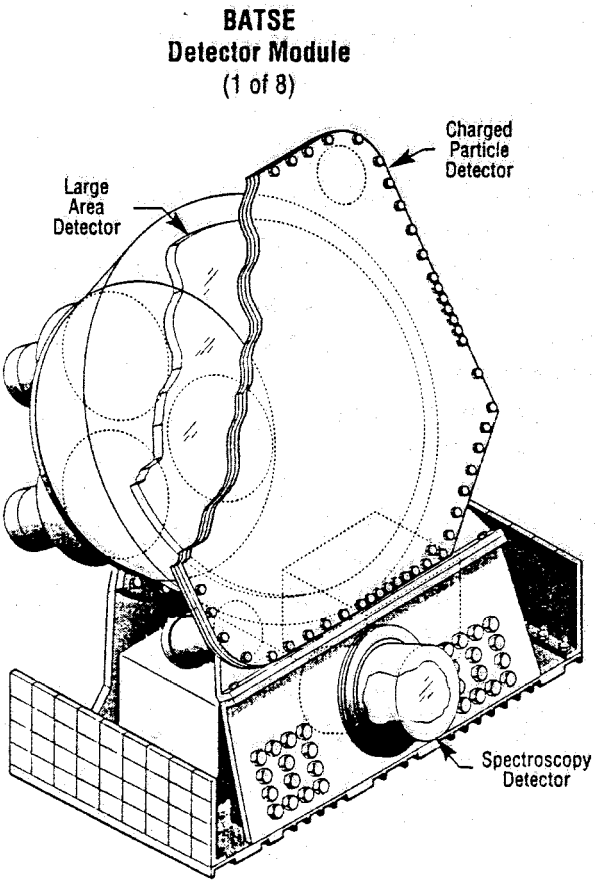
BATSE: The Quest to Understand Gamma Ray Bursts



From the time they first stared curiously at the night sky, human beings have sought answers to the mysteries of the universe. Today scientists continue to search for answers to these mysteries. Their search for knowledge has expanded to include the study of gamma rays, the most energetic form of radiation in the electromagnetic spectrum. The study of gamma rays is especially useful to scientists seeking to answer questions about the forces of change in the universe. Supernovae, black holes, neutron stars, pulsars, and quasars are some of the more interesting sources of gamma rays. In some instances, gamma rays are the only source of information for some of these phenomena.

The Mysterious Gamma-ray Bursts

One of the biggest mysteries in high-energy astrophysics is the origin of gamma-ray bursts. Gamma-ray bursts were discovered in 1973 when the Department of Defense launched detectors to look for nuclear explosions in space. Instead of

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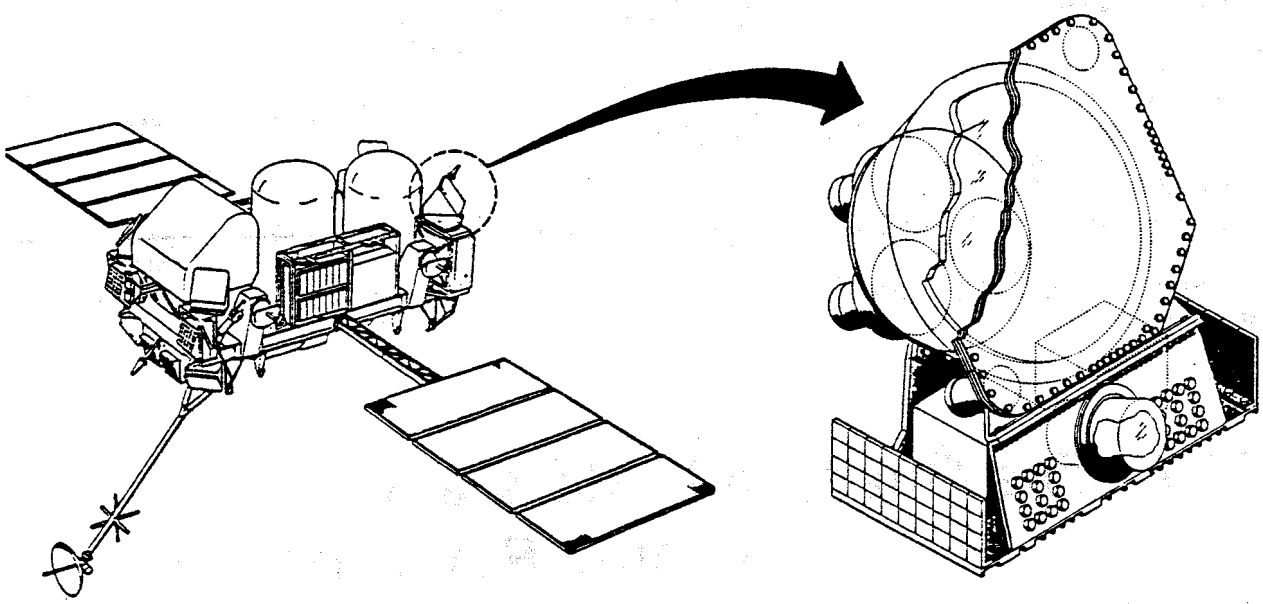
Gamma Ray Observatory

BATSE
Detector Module
(1 of 8)



Gamma Ray Bursts

Detectors launched in the 1970s first recorded flashes of gamma rays, called "bursts." About 100 strong bursts occur each year along with hundreds of weaker bursts. But gamma-ray bursts are difficult to study. They are unpredictable and last only a short time. BATSE is expected to allow scientists to identify and perhaps determine the origins of gamma-ray bursts.

human-induced explosions, the detectors recorded extreme flashes of gamma rays, called "bursts," coming from different parts of the sky.

Gamma-ray bursts have been difficult to study because they are unpredictable, of short duration, and occur at random. A burst seen in 1979, if it came from the Large Magellanic Cloud, as some astronomers believe, released more energy in gamma rays in one-tenth of a second than the total energy the sun will emit over the next one thousand years.

Development of BATSE and GRO

To observe gamma rays and gamma-ray bursts, special instruments must be sent above Earth's obstructing atmosphere. NASA's Gamma-Ray Observatory (GRO), with its Burst and Transient Source Experiment (BATSE), is expected to allow scientists to identify and perhaps determine the origins of the numerous gamma-ray bursts that occur each year.

BATSE, one of four instruments on board the GRO, was developed under the direction of principal investigator Dr. Gerald Fishman at the Marshall Space Flight Center in Huntsville, Alabama. Data collected by BATSE will be forwarded to the team at Marshall for interpretation.

The Gamma Ray Observatory will be placed in space at an altitude of approximately 280 miles (450 kilometers).

GRO is mission STS-37, flown aboard Space Shuttle Atlantis.

The other GRO instruments are the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL), and the Energetic Gamma Ray Experiment Telescope (EGRET).

The BATSE Objective

BATSE's primary objective will be to conduct detailed investigations of gamma-ray bursts, a previously elusive feat due to the extreme brevity and random appearance of bursts. About 100 strong bursts occur each year along with hundreds of weaker bursts, but their sources remain a mystery primarily because of the random nature of the events.

Eight detectors on the instrument will enable BATSE to continuously search a large segment of the sky and thus serve as GRO's wide-field monitor. When BATSE detects a high flux of gamma rays, it will send a signal to the other GRO instruments to begin simultaneous observations, gathering data across a wide energy range for later comparisons.

In addition, BATSE will conduct studies of pulsars, solar flares, and monitor the intensity of other strong gamma-ray sources.

Other Sources of Gamma-rays

Supernova
The explosion of a large star. Supernova explosions create heavy elements, some of which are radioactive and produce gamma rays.

Quasars
Astronomers are not certain what quasars actualy are nor how they can be so luminous. They emit strong radio waves and one quasar, 3C 273, has been identified as a gamma-ray emitter.

Pulsars
Rotating neutron stars are called pulsars. Periodic gamma-ray emissions have been discovered from two radio pulsars and hints from others.

Black Hole
Believed to be the result of a collapsed star - an object so dense and gravitationally strong that even light cannot escape it. Its region radiates gamma-ray photons.

How BATSE Works

BATSE consists of eight, 195-pound detectors mounted around the periphery of the observatory. This placement allows BATSE to "see" all of the sky at once - except where the view is blocked by Earth. The other GRO instruments observe a smaller area of the sky.

When a gamma ray reaches a detector it is absorbed by a single sodium iodide crystal 50.8 centimeters (20 in.) in diameter and 1.27 centimeters (0.5 in.) thick. The crystal then emits a flash of visible light, which in turn is transformed into electronic impulses. The impulses are transmitted to BATSE's central data system for storage and later transmission to scientists on Earth.

The GRO is currently planned as a two-year mission, but could be extended for several additional years.

The BATSE Potential for Scientific Understanding

Many times more sensitive than previous gamma-ray burst detectors, BATSE will be capable of measuring variation of bursts, both in time and in spectral distribution. The instrument's high degree of sensitivity will detect bursts some 10 times fainter than any ever before studied. The instrument's sensitivity also will enable scientists to pinpoint the locations of bursts to an accuracy of just a few degrees. Scientists believe that BATSE's ability to detect both dim and bright bursts will enable it to record hundreds of gamma-ray bursts each year.

GRO is the first NASA spacecraft equipped with complementary sophisticated instruments designed specifically to study a broad range of gamma-ray energies. With BATSE aboard to monitor large portions of the sky, astrophysicists will finally have the opportunity and means to gain a better understanding of the elusive sources of gamma-ray bursts, an understanding unattainable from previous instruments.

BATSE was developed by the Marshall Space Flight Center for the Office of Space Science and Applications.