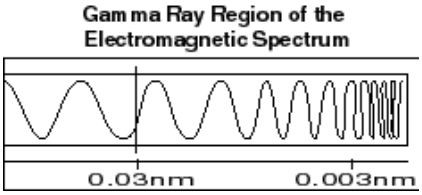
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

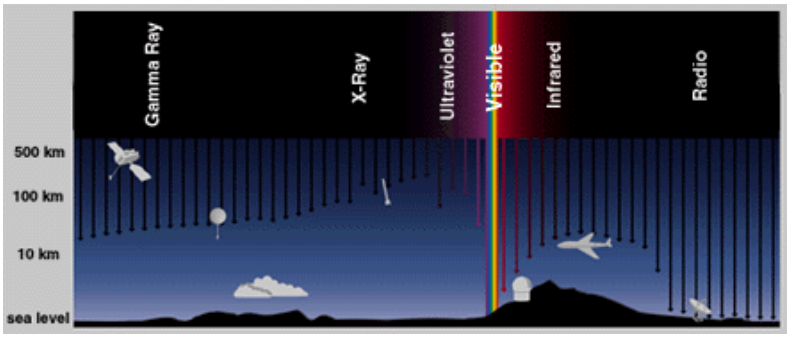
RADIO WAVES | MICROWAVES | INFRARED | VISIBLE LIGHT | ULTRAVIOLET | X-RAYS | GAMMA-RAYS

Gamma-rays



Gamma-rays have the smallest wavelengths and the most energy of any other wave in the electromagnetic spectrum. These waves are generated by radioactive atoms and in nuclear explosions. Gamma-rays can kill living cells, a fact which medicine uses to its advantage, using gamma-rays to kill cancerous cells.

Gamma-rays travel to us across vast distances of the universe, only to be absorbed by the Earth's atmosphere. Different wavelengths of light penetrate the Earth's atmosphere to different depths. Instruments aboard high-altitude balloons and satellites like the Compton Observatory provide our only view of the gamma-ray sky.

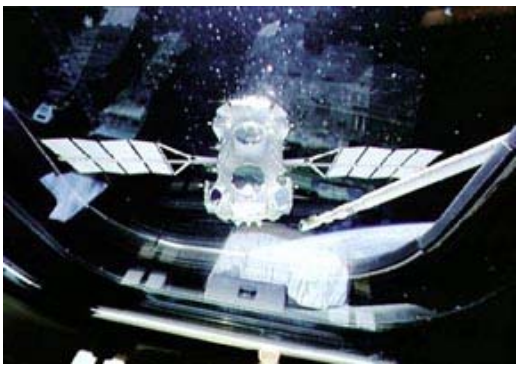


Gamma-rays are the most energetic form of light and are produced by the hottest regions of the universe. They are also produced by such violent events as supernova explosions or the destruction of atoms, and by less dramatic events, such as the decay of radioactive material in space. Things like supernova explosions (the way massive stars die), neutron stars and pulsars, and black holes are all sources of celestial gamma-rays.

How do we "see" using gamma-ray light?

Gamma-ray astronomy did not develop until it was possible to get our detectors above all or most of the atmosphere, using balloons or spacecraft. The first gamma-ray telescope, carried into orbit on the Explorer XI satellite in 1961, picked up fewer than 100 cosmic gamma-ray photons!

Unlike optical light and X-rays, gamma rays cannot be captured and reflected in mirrors. The high-energy photons would pass right through such a device. Gamma-ray telescopes use a process called Compton scattering, where a gamma-ray strikes an electron and loses energy, similar to a cue ball striking an eight ball.

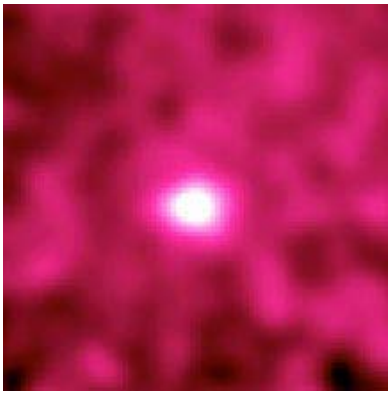


This image shows the CGRO satellite being deployed from the Space Shuttle orbiter. This picture was taken from an orbiter window. The two round protrusions are one of CGRO's instruments, called "EGRET".

What do gamma-rays show us?

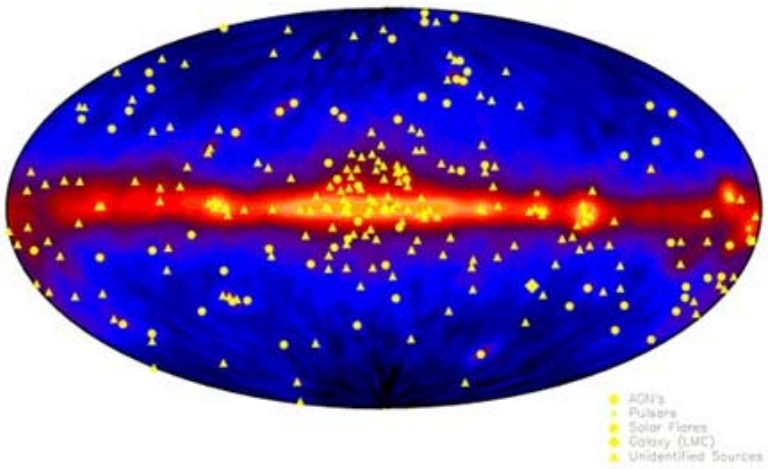
If you could see gamma-rays, the night sky would look strange and unfamiliar.

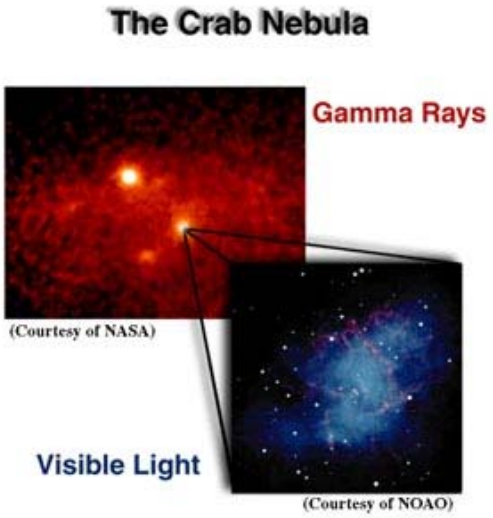
The gamma-ray moon just looks like a round blob - lunar features are not visible. In high-energy gamma rays, the Moon is actually brighter than the quiet Sun. This image was taken by EGRET.



Credit: D.J. Thompson, D.L. Bertsch (NASA/GSFC),
D.J. Morris (UNH), R. Mukherjee (NASA/GSFC/USRA)

The familiar sights of constantly shining stars and galaxies would be replaced by something ever-changing. Your gamma-ray vision would peer into the hearts of solar flares, supernovae, neutron stars, black holes, and active galaxies. Gamma-ray astronomy presents unique opportunities to explore these exotic objects. By exploring the universe at these high energies, scientists can search for new physics, testing theories and performing experiments which are not possible in earth-bound laboratories.

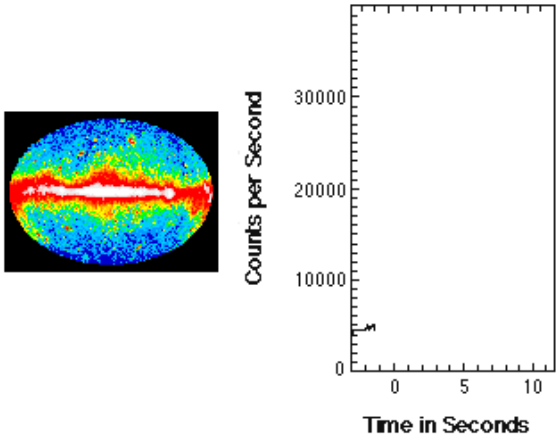




If you could see gamma-rays, these two spinning neutron stars or pulsars would be among the brightest objects in the sky. This computer processed image shows the Crab Nebula pulsar (below and right of center) and the Geminga pulsar (above and left of center) in the "light" of gamma-rays.

The Crab nebula, shown also in the visible light image, was created by a supernova that brightened the night sky in 1054 A.D. In 1967, astronomers detected the remnant core of that star; a rapidly rotating, magnetic pulsar flashing every 0.33 second in radio waves.

Perhaps the most spectacular discovery in gamma-ray astronomy came in the late 1960s and early 1970s. Detectors on board the Vela satellite series, originally military satellites, began to record bursts of gamma-rays -- not from Earth, but from deep space!



Today, these gamma-ray bursts, which happen at least once a day, are seen to last for fractions of a second to minutes, popping off like cosmic flashbulbs from unexpected directions, flickering, and then fading after briefly dominating the gamma-ray sky.

Gamma-ray bursts can release more energy in 10 seconds than the Sun will emit in its entire 10 billion-year lifetime! So far, it appears that all of the bursts we have observed have come from outside the Milky Way Galaxy. Scientists believe that a gamma-ray burst will occur once every few million years here in the Milky Way, and in fact may occur once every several hundred million years within a few thousand light-years of Earth.

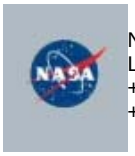
Studied for over 25 years now with instruments on board a variety of satellites and space probes, including Soviet Venera spacecraft and the Pioneer Venus Orbiter, the sources of these enigmatic high-energy flashes remain a mystery.

By solving the mystery of gamma-ray bursts, scientists hope to gain further knowledge of the origins of the Universe, the rate at which the Universe is expanding, and the size of the

Universe.

[NEXT LONGEST WAVELENGTH]

RETURN TO THE ELECTROMAGNETIC SPECTRUM



NASA Official: Sharron Sample
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