Search for Better Vision

Imagine trying to observe the world around you by looking through only a very thin slit in very dark glasses. Because our atmosphere absorbs the energy from all wavelengths except for the radio and visual ones, astronomers were essentially trying to study the universe in just this manner. However, because we are now able to raise our observing platforms above the earth's atmosphere, astronomers are finally able to observe from any of the electromagnetic frequencies.

Wavelength	Typical Observation
Gamma ray	Compact objects in collision (neutrons stars, black holes)
X Ray	Neutron stars, black holes
Ultraviolet (UV)	Hot stars, quasars
Visible	Stars
Infrared (IR)	Red giant stars, galactic nuclei
Far-IR	Protostars, dust, planets
Millimeter	Cold dust, molecular clouds
cm Radio	HI 21-cm line, pulsars

Our ability to routinely place observing platforms in orbit has led to entirely new forms of astronomy dedicated to observing at different wavelengths.

Gamma ray astronomy

Although their existence had long been theorized, gamma rays were not detected until the early 1970s. After launching the SAS-2 (1972) and COS-B (1975) satellites, scientists were finally able to make the first detailed map of the sky at gamma-ray wavelengths.

One of the strongest attractions to gamma ray astronomy stems from its infancy. As late as 1997, scientists still had no idea what caused gamma ray bursts. Observing a gamma ray burst is very much like watching an explosion, only on a different wavelength (part of the electromagnetic spectrum.) When using a gamma ray detector, a burst appears to grow, fade a little, grow to a peak, and then fade. With their gamma ray detectors, astronomers were able to map a few hundred of bursts each year. Unfortunately, with each gamma ray burst lasting only between two milliseconds and a few hundred seconds, scientists could never find the source of the burst. Because they could never find the cause of the gamma ray burst, scientists' best guess was that they occurred randomly. Scientists couldn't even decide whether they came from our galaxy or not.

In 1989, NASA launched the Compton Gamma ray Observatory (CGRO) to better detect gamma ray bursts. Unfortunately, both onboard data-recorders failed in 1992 – early in the CGRO's mission. Making the best of the situation, scientists set up the CGRO to transfer its information through the Tracking and Data Relay Satellite System back to NASA as soon as it was received. This workaround allowed more than 80% of CGRO's data to be recovered.

Realizing that their real-time feed of gamma ray data was an unexpected advantage, scientists (led by Dr. Scott Barthelmy) set up a system to intercept the real time data, compute the direction to the burst, and transmit this immediately to anyone who could use it to make observations. This system, called the "Gamma ray Coordinates Network" (GCN) is both complex and amazingly efficient.

The operation of the GCN can be broken into two stages: collecting data, and distributing it.

Collecting the data

To collect data, the CGN actually draws its information from two sources: the Compton Gamma ray Observatory, and other orbiting spacecraft. Rather than flood the ground stations with huge amounts of data, the CGN keeps high-resolution data onboard (for later transmission) and only transmits low-resolution information in real-time. This real-time data is recorded for 2.048 seconds and then transmitted to a TDRS (Tracking and Data Relay Satellite) for the next 2.048 seconds. As the data is being transmitted, the TDRS gathers another 2.048 seconds of data.

The ROTSE-1 camera array

Distributing the data

The TDRS then sends the data through the NASA White Sands Ground Station in New Mexico to the DOMSAT satellite system. The DOMSAT satellite system then relays the information to its ultimate destination – the Goddard Space Flight Center. This routing of the data takes approximately 1 second.
Once received at the Goddard Space Center, the 2.048 seconds of data is processed in under 0.1 seconds to derive the actual coordinates of the gamma ray burst.

Researchers have the option to be contacted by dedicated phone line, socket (a direct internet connection between two computers), email, dial-on-demand phone line, pager, or cell phone. The fastest method of distribution (the dedicated phone line) adds only an additional 0.3 seconds of processing time.

If the gamma ray burst occurs at the very beginning of the data chunk, a researcher can expect to be notified within about 5.5 seconds of a gamma ray burst. If the gamma ray burst occurs at the end of the data sample, a scientist will learn of the gamma ray burst in a mere 3.45 seconds. Since more than half of the gamma ray bursts are longer than 5.5 seconds, many scientists are able to make follow-up observations while the burst is still occurring.

On January 27, 1999, the ROTSE-1 telephoto camera array in Los Alamos, N.M. took the first ever set of pictures of a gamma-ray explosion in progress. According to Dr. Jerry Fishman, "This discovery signals yet another new era in the study of these fantastic objects. It is now shown that they can be observed from the ground, in different wavelength regions, while the main part of the explosion is in progress."

Post Mortem

On May 24,2000, NASA distributed the following press release:

> NASA's extremely productive and long-lived Compton Gamma-Ray Observatory mission -- which exceeded its mission by four years and completely changed ideas on the most important unsolved puzzles in astrophysics -- has come to end with the failure of one of the satellite's three gyroscopes.
>
> NASA plans to safely direct the satellite back into Earth's atmosphere no earlier than June 1 with the remaining two gyroscopes, which are used to steer the craft. As an extra precaution, Compton engineers are also developing a method to control the satellite without any gyroscopes, for use as backup during the reentry maneuvers in case an anomaly is encountered with the gyroscopes. Compton's four instruments are still in working order.

According to the press release, "NASA, and several other space agencies plan several upcoming missions to continue where Compton left off."