

# THE AMATEUR SCIENTIST

by Shawn Carlson

## Gamma-Ray Bursts Come Home

Sometimes it's better to be lucky than good. On January 23, 1999, a satellite-based instrument called the Burst and Transient Source Experiment (BATSE) detected a bright flash of gamma rays coming from the constellation Boötes. For years, astronomers had caught sight of such gamma-ray bursts several times a week in every part of the sky [see "Gamma-Ray Bursts," by Gerald J. Fishman and Dieter H. Hartmann; *SCIENTIFIC AMERICAN*, July 1997]. But precious little was known about these sources of incredible energy—how do they form and from where do they originate?—because they are so fleeting. They rarely shine longer than a few minutes (some exist for only a tiny fraction of a second), providing little time for astronomers to bring a variety of instruments to bear. Indeed, even though that night's event was quite bright and lasted almost two minutes, BATSE could only localize the source to a disk on the sky about four full moons wide.

Enter Lady Luck. At the moment the burst went off, another satellite called Beppo-SAX just happened to be imaging the same section of sky, using a wide-field

camera for x-rays (radiation of somewhat lower frequency than gamma rays). Within six hours of receiving a detection alert from BATSE via e-mail, scientists had fixed the precise position of a bright x-ray source that was within the BATSE-identified region but that had not been there before.

Astronomers were also able to obtain optical images of the gamma-ray burst. Just 20 seconds after the first alert had sounded, a robotic optical telescope in Los Alamos, N.M., had zeroed in with four wide-field cameras. After other researchers had identified the burst's precise position, the Los Alamos group discovered that its early images had captured a bright (9th magnitude) but rapidly fading star at that exact location.

The next night the mighty Keck II, the 10-meter monster telescope that sits atop the Mauna Kea volcano in Hawaii, swung into action. With its huge light-gathering surface, it measured the ob-

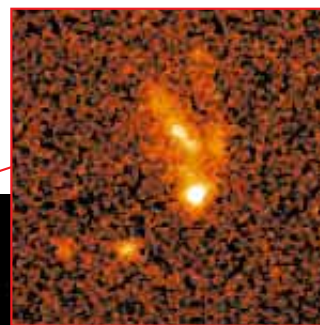
ject's redshift and determined that the gamma-ray burst had originated halfway across the universe.

That's when champagne corks started popping. For something so distant to shine so intensely in our sky, it must be incredibly bright at its source. In fact, whatever produced the gamma rays had, for a while at least, been the brightest object ever identified. Without a doubt, astronomers had made a major discovery. And now they aim to get amateurs in on the fun.

Why amateurs? Because the BATSE team members know that had the Beppo-SAX satellite been looking elsewhere that night, astronomers never would have been able to direct ground-based telescopes to measure the object's magnitude and distance. And even then it took precious hours to fix a position of the rapidly changing object.

A better system would consist of numerous observers looking inside the BATSE-identified region within minutes of the event's detection. With enough

*THE SKY is filled with mysterious events, such as this gamma-ray burst (inset) detected on January 23, 1999. A network of amateur astronomers could help reveal the secrets of such incredibly powerful—but maddeningly brief—blasts of energy.*



JOHNNY JOHNSON/HUBBLE SPACE TELESCOPE/  
SPACE TELESCOPE SCIENCE INSTITUTE (inset)

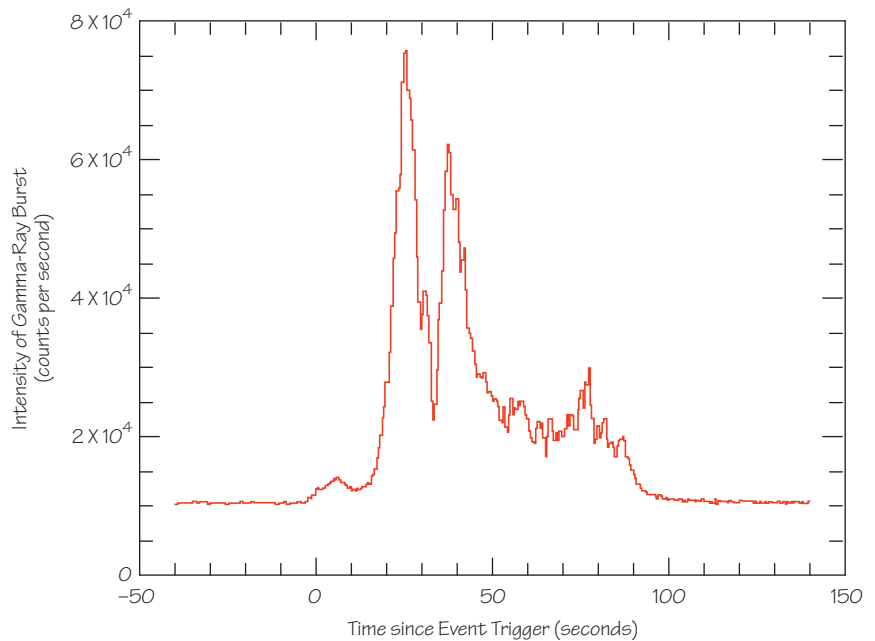
people, chances are that someone would quickly find the new object and report in so that other observations could be set in motion. Thus, the BATSE team has wanted to create an international network of both professionals and amateurs who will be on standby to help when BATSE detects a gamma-ray burst.

Amateur involvement is not as far-fetched as it may sound. Thousands of hobbyists own research-quality telescopes. But even instruments with mirrors as small as 25 centimeters could participate. (Such devices could either be bought for about \$700 or fashioned, albeit with considerable time and effort, for less than \$100.) And these days many amateur telescopes are equipped with sensitive charge-coupled-device (CCD) cameras that can capture an electronic image of a star field. A personal computer could then process this information in real time to identify new objects. Some of the more expensive telescopes are even automated: they can receive instructions via the Internet and take images anywhere in the sky—without an observer even having to be there. Clearly, the amateur community is ready to be a vital partner in uncovering the secrets of these strange sources of gamma-ray energy.

The network is being developed and overseen by the American Association of Variable Star Observers, located in Cambridge, Mass. Founded in 1911, the AAVSO is the oldest institution in the U.S. dedicated to helping amateurs make astronomical measurements of scientific importance.

The AAVSO organizes and compiles data on thousands of variable stars. To date, it has logged more than nine million measurements of star brightness. Janet Mattei, the executive director and a dear friend of mine, is a person with boundless energy, political savvy and a passion for advancing amateur astronomy. If anyone can keep this network going, it's Janet. And the observing team is being led by Gerald J. Fishman, the principal investigator on the BATSE project, and Mario Motta, a cardiologist and avid amateur astronomer from Lynnfield, Mass.

To join the team, log on to the AAVSO's Web site ([www.aavso.org](http://www.aavso.org)) and fill out the on-line application, including information about your telescope's size, field of view, and location. In addition,



JOHNNY JOHNSON; SOURCE: NASA

**INTENSE BUT EPHEMERAL** energy is a characteristic of gamma-ray bursts, making it difficult to pinpoint their exact locations. The event that was detected on January 23, 1999, lasted less than two minutes.

just before embarking on a long night of astronomical adventure, you need to notify the AAVSO by sending an e-mail to [aavso@aavso.org](mailto:aavso@aavso.org). Then, whenever BATSE detects a gamma-ray burst and obtains data on the center and width of the target region, a computer at the AAVSO will automatically send this information via e-mail to everyone who has logged on for that night.

But what about people who don't happen to be observing when an event is detected but who could fire up their backyard telescopes on a moment's notice? The AAVSO intends to reach them by pager, with the coordinates of the gamma-ray burst contained in a text message. So even sleeping astronomers can be alerted to the opportunity to make scientific history.

Of course, BATSE's determination of the location of an event will always suffer a large uncertainty. But if even 10 observers are on-line and scrutinize the identified area with wide-field imaging CCDs, it seems likely that many of the optical companions of a gamma-ray burst will be captured within minutes of receiving the alert. Participants can then e-mail their results to the AAVSO so that everyone on the network can see the information in real time.

Obviously, there's a better way to do all this. The ideal system would use the information in the AAVSO database to

assign a particular spot within the BATSE-identified region to each on-line observer, thus maximizing coverage of the section of the sky that contains the gamma-ray burst and thereby increasing the likelihood that someone will find it. Also, the simplest way to locate the optical companions of a gamma-ray burst on a CCD image is to run a program that identifies all the stars on the image and then compares them against stars in an electronic catalogue, like the one NASA compiled to provide guide stars for the Hubble Space Telescope.

But it will take a top-notch programmer to write the computer code that can do all this. Unfortunately, being a non-profit organization, the AAVSO doesn't have the budget to hire such a person. So if you're a computer expert and would like to volunteer your talents to make a major contribution to science, please contact Janet Mattei at 617-354-0484. It's a fantastic opportunity for you to make a lasting contribution to unraveling one of the greatest mysteries in astronomy.

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*For more information about this and other projects, visit the Society for Amateur Scientists's Web site at [earth.the-sphere.com/sas/WebX.cgi](http://earth.the-sphere.com/sas/WebX.cgi). You may also write the society at 4735 Clairemont Square PMB 179, San Diego, CA 92117, or call them at 619-239-8807.*