A Hunt for Flashing Stars

Richard Schwartz, Santa Barbara Astronomy Group

HAVE all the easy astronomical discoveries been made? Or could there be whole new classes of objects within range of modest equipment that, for one reason or another, have been overlooked?

One such category might be celestial objects that emit brief flashes of light. Astronomers only began to take this idea seriously after the accidental discovery of gamma ray bursters in the early 1970's. These are mysterious objects in the depths of space that, on rare occasions, emit sudden, intense pulses of gamma rays. If they flash at such short wavelengths, might they do it in visible light too?

In fact, flares of light have indeed been found at the positions of three gamma ray bursters on old Harvard Observatory sky patrol plates. These events might have been visible to the naked eye.

The nature of gamma ray bursters is one of the outstanding mysteries of astronomy. Hundreds of bursts have been identified by spacecraft and high altitude balloons. They last from a fraction of a second to about 15 minutes in rare cases, are distributed fairly uniformly across the sky, and some may repeat. The spectrum of the gamma rays as well as their intensity varies faster than current instruments can measure.

Many explanations have been suggested, ranging from dust grains entering the solar system at near the speed of light to neutron stars colliding in distant galaxies. The theories now being proposed generally involve neutron stars within our own galaxy. The sources are not concentrated near the plane of the Milky Way, so the neutron stars would either have to be quite close, within a few hundred light-years, or members of the Milky Way's spherical halo of ancient stars, which extends for 100,000 light-years or more.

Whatever gamma ray bursters may be, they are powerful. Even if the closest distance guesses are true, a burster emits energy at 1,000 times the rate of the Sun for the moment it is switched on. If they are farther, they are more powerful still.

A well observed flash of visible light from a burster might provide a key to the mystery. Growing interest in this possibility has led several groups around the world to start building flash detection systems. This is an almost completely new kind of astronomical observation, so it may produce unexpected results.

The most ambitious project is the Explosive Transient Camera – Rapidly Moving Telescope being built by Roland Vanderspek, Bonnard Teegarden, and others at MIT and NASA's Goddard Space Flight Center. This new system, planned for Kitt Peak in Arizona, will monitor the whole sky with arrays of charge-coupled device (CCD) cameras at two locations about a mile apart. The two stations will automatically check each other and, by triangulation, discount nearby objects such as meteors and flashing satellites. Within one second of identifying a flash in deep space, the system will aim a mirror to feed a 7-inch telescope that will analyze any lingering light. "We expect we'll be able to detect a one-second flash at 11th magnitude," says Vanderspek. "The system is going to become operational in stages over the next couple of years."

The author (left) looks on as Russ McNiel (right) and Al Presnell adjust photoelectric flash-detecting equipment on the 12½-inch telescope in McNiel's backyard observatory.

An easier, though more limited, strategy is to monitor the sites of individual gamma ray bursts in case they repeat. Such a project requires modest equipment but large amounts of time, making it appropriate for amateur astronomers.

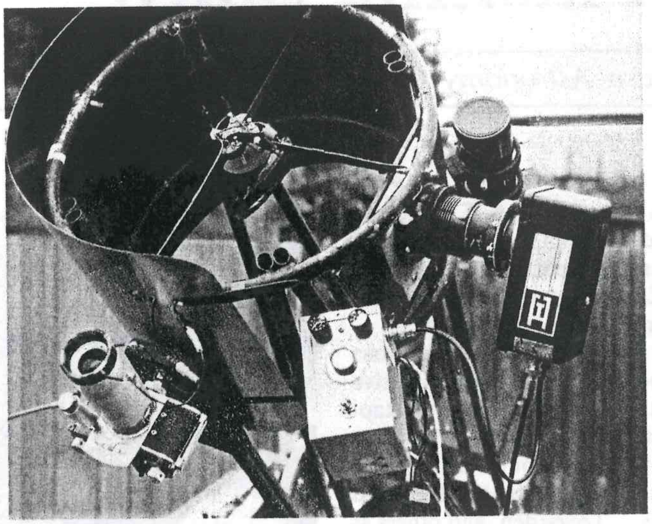
THE SANTA BARBARA PATROL

Excited by the chance of discovery, our team of four amateurs began patrolling for flashes this way last year. Al Presnell, Russ McNiel, Scott Whitney, and I constitute the Santa Barbara Astronomy Group. We each operate 12- to 14-inch telescopes equipped with automated photometer system. We are working closely with Bradley Schaefer at the Goddard Space Flight Center and Mark Jennings and Tumay Tumer at the Institute for Geophysics and Planetary Physics, University of California at Riverside.

Our four telescopes are equipped with a flash detecting system of our own design. On each, a photometer provides an "active field of view" 13 arc minutes wide. Its signal is electronically analyzed for any slight but sudden increase in the field's total light. A 6th-magnitude point flash would be noticed easily.

Such an event triggers a one-minute camera exposure with a 135-mm telephoto lens riding piggyback on the telescope. It also tells a computer to store the photometer data from one second before the trigger to two minutes after, and sounds an alarm for the observer on duty.

Every clear night two of us set up operations at our homes, which are 5 to 8 miles apart. A session begins by aiming the telescopes at one of six well known positions of gamma ray bursters supplied to us from NASA. The position uncertainties, or error boxes, are typically only 2 to 4 arc minutes on a side and fit well within our fields of view. We have taken much care to determine the location of each error box with respect to dim field stars. Once the telescope is aimed the photometer is turned on, a trigger level is set, and the computer takes over the work. The observer just has to recheck the telescope's position every 45 minutes or so and stay within earshot of the alarm, which in my case is relayed inside the house.



An automatic discovery system for visible gamma-ray bursters. At the eye end of Russ McNiel's homemade 12½-inch reflector is a photoelectric photometer (gray box with "E"). Its signal goes through a buffer-preamplifier (silver box on telescope) to a "comparator trigger instrument" (top left box with knobs in the right-hand photograph) that reacts to any slight, sudden brightening in the telescope's view. Such an event triggers the camera on the telescope and alerts a computer (middle shelf) that stores the digitized light curve. The other components in the right-hand picture are power supplies for the equipment and for dew inhibitors on the telescope optics and camera, and a shortwave radio for time signals.

The alarm tends to go off only once for every 20 or 30 hours of observation. Usually a local cause is obvious — an airplane crossing the field or a fog bank rolling in. If no such cause is evident, we follow a set procedure. First the observer telephones his partner. If the other person had a simultaneous event (the computer records time to the second) then a flash in deep space may have occurred. So far, out of 200 hours logged since our systems were upgraded to their present sensitivity, no event has been recorded at two sites.

If this were to happen, we would phone astronomers working with us at the Flagstaff Station of the U. S. Naval Observatory, who can immediately take deep photographs. They might catch any faint "afterglow" from a burster, which could provide crucial information. The time and position would also be sent to gamma ray burster teams at the Goddard Space Flight Center and Los Alamos National Laboratory to check whether spacecraft recorded a burst at the same time.

We do not know when or if we can expect to discover an optical flasher, only that it would be a great event if it happens. Theories of gamma ray bursters range widely in their predictions about how often flashes might recur. Yet regardless of the outcome, our project has already been very rewarding.

We would like to expand our group to include trained observers at other locations. Gamma ray astronomers are urging us to form a national network in order to watch more points in the sky and operate on more nights. We can furnish electronic schematics and other aid. Serious amateurs who wish to participate can write to Richard Schwartz, 1530 Miramar Lane, Santa Barbara, Calif. 93108, or call 805-969-0837.

Perseus Flasher Update

Two years ago, a group of Canadian meteor observers near Toronto reported seeing several flashes as bright as zero magnitude in northern Aries several weeks apart. In March, 1985, two members of the group, Bill Katz and Joe Adair, captured one such event on film. It turned out to be just over the border in Perseus (*S&T:* July, 1985, page 54).

Since then there have been no more photographs or other confirmation that flashes happen at the same point on the sky, and astronomers remain skeptical of the whole affair. In the last year *Sky & Telescope* has received a number of reports, including three photographs, of isolated flashes at places all over the sky. Other observers wrote to say they have seen satellites produce a single bright flash but otherwise remain nearly invisible. One photograph shows a nearly starlike flare on a barely detectable satellite trail.

Katz and 14 colleagues write about their work in the August 1, 1986, *Astrophysical Journal Letters.* In 95 hours of observing, they state, eight flashes brighter than 2nd magnitude were seen at positions consistent with the one photographed. This implies an average of a bright flash every 12 hours.

On the other hand, Stanley E. Browne at the U. S. Naval Observatory took 30 hours of photographs of the site with the 61-inch reflector in Flagstaff, Arizona, on nights when the seeing was too poor for the telescope's normal work. He told *Sky & Telescope* that any flash as faint as 9th or 10th magnitude probably would have been detected. None were.

ALAN MacROBERT