LETTER TO THE EDITOR

Based on a paper presented at the 88th Annual Meeting of the AAVSO, October 29, 1999

"The AAVSO Gamma-Ray Burst Network Project"

The AAVSO has been invited to participate in an exciting program to search for and monitor the optical counterparts and afterglows of gamma-ray bursts (GRBs). To this end, the AAVSO has set up a gamma-ray burst network working group co-chaired by Gerald J. Fishman, who is in charge of the BATSE (Burst and Transient Source Experiment) instrument aboard the Compton Gamma-ray Observatory Satellite and is stationed at the NASA Marshall Space Flight Center in Huntsville, Alabama. The other co-chair is the present writer, who is a CCD observer and member of the AAVSO Council.

Gamma-ray bursts are the most energetic objects known in the universe and are the subject of intense astronomical research. Gamma-ray bursts are discovered at approximately one per day and noted to appear randomly in the sky. The energy levels have varied widely. Once a gamma-ray burst is detected, it is followed in rapid succession by x-rays, then often by an optical counterpart, the afterglow. Most of the optical afterglows are rather faint, having been detected in the magnitude 16–21 range. Only one so far has reached magnitude 9 during a brief burst early in 1999, however, this subsequently faded rapidly within 10 minutes to magnitude 14. In general, the decay of afterglows is very rapid, and the afterglow generally lasts 12–24 hours. Therefore, the monitoring has to be performed as soon as the information regarding its localization is obtained. Gamma-rays from space were first discovered as early as 1967. The U. S. Air Force, worried that either the USSR or China would explode nuclear weapons in space as a means of avoiding detection during testing, deployed satellites (Vela spacecraft) in earth orbit to detect any such clandestine nuclear explosions. The government even worried about the possibility of clandestine explosions occurring on the far side of the moon, and therefore placed satellites in long orbits to rule out this possibility. These spacecraft quickly determined that random bursts of gamma-rays were, in fact, occurring. After some initially tense worries of the source of these gamma-ray bursts, it was finally determined that these gamma-ray emissions were occurring from deep space and not from human activity. They had some very unusual properties and diverse light curves. They also had a wide range of durations, ranging from milliseconds to as long as one thousand seconds. The bursts may appear as a brief spike or as a broad and diffuse emission. No periodicities were noted with this. The energy range of these bursts was enormous, ranging from 1 KEV all the way up to 18 GEV. Eventually, this knowledge was de-classified and NASA took over the function of determining the origin of gamma-ray bursts. In April of 1996, the BEPPO SAX satellite was launched to search for gamma-ray bursts. On February 28, 1997, a strong 80-second burst occurred. Approximately 8 hours later, an X-ray satellite found the first afterglow. An optical afterglow was found by the William Hershell telescope in the Canary Islands. This faint optical glow was later determined by the New Technology Telescope eight days later to be imbedded within a faint extended object presumed now to be a galaxy. Gamma-ray bursts are now thought to occur at cosmological distances in the 8–12 billion light year range, therefore, the search for gamma-ray bursts in essence is a sampling of energetic events that are occurring at the edge of the known universe and back in time to the early universe.

At present, BEPPO SAX is the only gamma-ray burst instrument capable of providing immediate GRB localizations, but only to within a few degrees. We are currently awaiting the launch of the MIT-led HETE-11 spacecraft, which will be able to provide immediate arcminute localization of these gamma-ray bursts. With this rapid and precise localization will come the ability to search for the optical afterglow. For this to occur, we need a rapid response team with worldwide distribution because of the short nature and rapid fading of these afterglows. With the increasing number of amateur observers with charge-coupled devices (CCD) that can reach very faint magnitudes, searching for and monitoring the afterglow can now be done by amateur astronomers worldwide. This will increase the possibility of finding these optical counterparts of the gamma-ray bursts themselves. The AAVSO Gamma-Ray Burst Working Group and AAVSO Director Janet Mattei will devise a plan for extremely rapid notification of members of the gamma-ray burst network. The most feasible plan would be to notify observers immediately upon detection of a gamma-ray burst using a pager system to allow time for rapid setup and detection of these optical afterglows. All are welcome to participate. What is suggested is a minimum of a 12-inch aperture telescope, coupled with a CCD camera and the ability for rapid response upon notification.

There are numerous theories of the origin of gamma-ray bursts. Over one hundred, in fact, have been proposed, the most notable of which are colliding neutron stars, hypernovae, or early formation of black holes. It will be exciting to be involved in the early research of a whole new field of endeavor, and to help solve the mystery of these gamma-ray bursts. In addition, these are the ultimate variable objects with energies of enormous size, with very brief transients that literally fade before your eyes. We invite all AAVSO observers worldwide who have the ability to detect magnitudes 16-21 with a CCD camera to join in the hunt for the most energetic and enigmatic objects in the universe.

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[*Ed. note: One year after the presentation of this proposal, the AAVSO Gamma-Ray Burst Network is in the process of being activated. GRO was terminated in June 2000. HETE-II was successfully launched in early October and should begin reporting observations by the end of November. The AAVSO will notify over 50 network members via pager and e-mail and will also provide finder charts on the AAVSO web site. All of this will be automated to occur minutes after a gamma-ray burst is detected in space. Three AAVSO members have already detected gamma-ray burst afterglows—either on their own or as part of a testing program of the AAVSO network. Those observers interested in participating should fill out the form on the AAVSO website (http://www.aavso.org/committees/ccdreg.stm).*]