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Exhibition in Berlin

The ESO exhibition opened at the Zeiss Großplanetarium in (East-) Berlin on November 1, 1991. The City of Berlin was represented by Mr. Arndt, Staatssekretär für Schule, Berufsbildung und Sport and the Mayor of Berlin-Prenzlauer Berg, Dr. Dennert.

This planetarium is one of the world's largest and was inaugurated in 1987 on the occasion of the 750th anniversary of Berlin.

It has the latest Zeiss projector with all possible technical finesses.

Already on the opening day there were lots of visitors and many more are expected during the 3 months' duration of the exhibition.

ESO is particularly pleased to make its exhibition available at an institution which only recently was incorporated into the Federal Republic, at the time of the German re-unification. There is little doubt that it will be of particular interest to the inhabitants of the parts of Berlin surrounding the Planetarium.

Mr. Arndt, Undersecretary of State for Education, Vocational Training and Sports, opens the ESO Exhibition in Berlin.

Looking for Optical Emission from Gamma-Ray Bursters

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1. Gamma-Ray Bursts: a 20-Year-Old Mystery

Discovered some 20 years ago [1] gamma-ray bursts (hereafter GRB) remain mysterious: these transient sources emit only during times ranging from a few milliseconds to several minutes, and they are observed only in the X-ray/Gamma-ray range, from 1 keV to more than 100 MeV. They have no obvious counterparts, either transient or quiescent, in other spectral regions, e.g. optical [2] or in soft X-rays [3] [4]. Furthermore, their light curves, and their energy spectra are extremely diverse: there is no "typical" gamma-ray burst and among the 600 bursts observed until now, not even a general classification has been established. With 3 notable exceptions, none has been observed to repeat. The exceptions are the soft repeaters SGR 1806-20 [5] [6], SGR 1900+14 [7] and the GBS 0526-66 [8] March 5b, 1979 GRB, which is located in the direction of the LMC).

Until recently, there was a general agreement on the galactic neutron star origin of these sources, based on the characteristic time scales of the events (sometimes less than a millisecond) and on the presence of strong magnetic field signatures in their energy spectra. In that case, with more than 600 detections to date (and an actual detection rate of 1 per day), GRBs would have been the most common manifestation of neutron stars in our galaxy. However, recently the situation became quite confused with the announcement by the

BATSE team [9] that the distribution of gamma-ray burst sources is apparently quite isotropic and (from the analysis of their detection rate in a way similar to the logN – logS test) that their experiment sees almost all GRB occurrences. Taken together, these observations exclude a galactic origin and favour a cosmological origin for GRBs although a very local or an extended galactic halo origin seem not to be excluded, and there is some debate on the possible instrumental biases. However, none of these suggestions fit all the observations and this shows the need to obtain independent data on these sources.

2. Localizing the Sources

There are two ways to localize GRB sources. The first one is the so-called triangulation (or time of arrival) method. Using the time delay between the detection of the same event by several instruments, widely separated in space, one can derive the direction of the source. In order to obtain accurate positions, the triangulation method needs at least 2 detectors on interplanetary spacecraft. The current interplanetary network uses the GRB detectors aboard the Pioneer Venus Orbiter (PVO) and the Ulysses mission (which will leave the ecliptic in February 1992) in addition to the instruments on near-Earth platforms (Granat, Ginga, Solar A, Compton GRO, DMSP). This method may reach very good accuracies, 0.25 $arcmin^2$ for GRB 790305b (Gamma-ray bursts are usually designed by the letter GRB followed by the event date, here March 5, 1979, and eventually a letter indicating the order of the event in the day), but for a very small number of strong bursts with a well-defined time structure.

The other approach uses the anisotrophy of the detector response to the signal direction of incidence, with several detectors (8 for the Burst and Transient Experiment – hereafter BATSE – onboard the Compton Gamma-ray Observatory – CGRO) localized symmetrically on the same spacecraft. In this "response anisotrophy" method, the accuracy reached is not as good, 1 to 5 degrees for BATSE on CGRO, but almost all bursts detected may be localized (about 150 during the first 6 months of the CGRO mission). The WATCH experiment, onboard the Granat satellite, uses a third method, with a rotating collimator grid, and provides localizations with an intermediate accuracy, typically 0.3 deg. for strong events. Except for a handful of error boxes which were well enough localized with the triangulation method, the error boxes are far too large to search for quiescent counterparts at any wavelength.

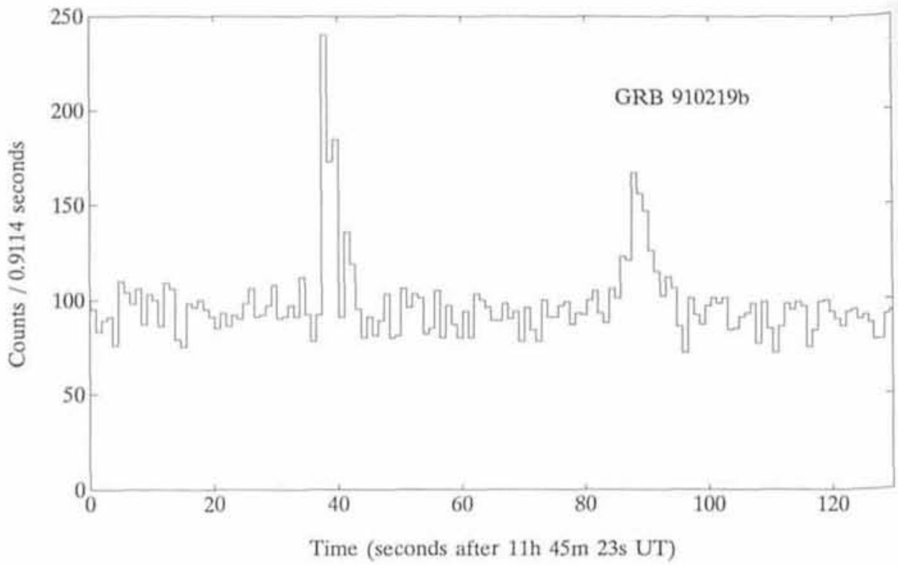

Figure 1: *Light curve of GRB 910219b as seen by the WATCH instrument in the 15 – 180 keV energy range with a time resolution of 0.9114 second.*

3. Do GRB Emit Visible Light?

Based on work on archival plates [10] [11] [12] there were claims that optical transients were observed in or near some gamma-ray burst error boxes. The reality of these events is not yet established and is the subject of a very hot debate [13] [14] [15]. However, GRB sources may well appear to be emitters at optical wavelengths, either as the result of the reprocessing of the gamma rays in an accretion disk or in the photosphere of a binary companion, or because of the thermal decay of the neutron star surface after the burst, which depends on the amount and on the depth of the energy release.

The goal of our project is to find this emission, or to set constraints on it. The WATCH, BATSE, and COMPTEL teams may provide rough localization within 12 to 14 hours after the burst. Shortly after, we expose a plate at the ESO Schmidt telescope. This plate may then be compared with the ESO, Palomar or UK sky surveys. If a new object is found, then follow-up studies may be triggered at larger telescopes. Later, when a more precise localization is eventually derived using the triangulation method, a more careful study of the GRB area may be done.

The discovery of an optical transient GRB counterpart may answer several questions about these elusive objects, such as their distance (galactic vs. cosmological), their membership to a binary system, the energy process. . . . A detection would provide us also with a localization suitable for a real deep search for a quiescent counterpart, and may result in a breakthrough in our understanding of these enigmatic sources. Even repeated non-detection would set stringent constraints on the amount of energy emitted at optical wavelengths during and after the burst, on the thermal decay time of the source and on its nature. This would also be an important point in the debate on the reality of optical flashes, their astrophysical origin, and their association with the GRB phenomenon. Whatever is the outcome of our project, we hope that it will improve significantly the knowledge of gamma-ray burst sources.

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