A NEW KIND OF GAMMA RAY BURST?

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One of the most recently detected (Cline et al., 1980) Gamma Ray Bursts (GRB) appears to have very unusual properties.

We recall here briefly the main features of the time history and of the spectral data, as given by Cline (1979). The time history has a very fast initial rise, less than 200 μsec , a smooth, large but very short initial peak, with a maximum intensity of several x 10^{-3}ergs cm^{-2} sec^{-1} and a 150 msec duration, followed by an oscillating decay phase, with at least 22 compound 8 second pulses. The spectrum of the initial phase of the event corresponds to a steep power law with possibly a line at 420 keV. The total spectrum of the decay phase is even steeper and shows no lines (Mazets and Golenetskii,1979). The location of the event (Evans et al., 1980) corresponds to N49, a supernova remnant in the Large Magellanic Cloud, which gives a total (isotropic) emission of $\approx 10^{45}$erg, one half of it in the initial spike, the rest in the decay phase. Three later events, apparently with no special properties, are attributed to the same source (Mazets and Golenetskii, 1979), with increasing delays (0.6, 29 and 50 days) and decreasing peak intensities (3%, 1% and 0.5% of the first event), because their locations are all consistent with the much smaller March 5 error box.

We wish to discuss here whether this event should be assigned to a new class of GRB as suggested by Cline (1979), on the base of its observed properties. Let us compare these properties with those of other bursts:

a) short rise time and duration of the initial peak: for at least 2 more events it cannot be excluded that they had the same properties. They are events 69-3 and 72-5 in Strong et al. (1974);
b) structureless initial spike: the event of March 22, 76 (Cline et al., 1979) had only one simple shape peak, albeith with much larger duration and slow rise;
c) slow decay phase, with a ≈ 50 sec time constant: the July 8, 77 event (Cline et al., 1979) probably had an even larger time constant;
d) pulsations in the decay phase: they would not have been detected by the early GRB detectors, but event 69-3 had a "weak continuing flux" (Strong et al., 1974);
e) steep power law spectra: also observed in other events, even if more

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typically in their final stages (i.e.: Mazets and Golenetskii, 1979);

f) evidence of a line at ≈ 420 keV: also present for example in the November 19, 1978 event (Teegarden and Cline, 1980; Mazets and Golenetskii, 1979);

g) repeated bursts and association with a known object: except possibly for Cyg X-1 (Strong, 1975), this is the only instance of burst repetition and identification of a GRB source with a known celestial object, and it is based on a small (1'x2') error box;

h) peak flux at the earth: this is indeed at least one order of magnitude larger than for any other event detected.

For the energy output at the source, a somewhat longer comment is necessary. It has been suggested, both on the base of the log N-log S curve (Fishman, 1979) and of limitations to the energy density required at the source (Schmidt, 1978; Cavallo and Rees, 1978), that GRB are of Galactic origin. If, at the same time, we accept N49 as the source of the March 5 event, then both its peak intensity and its total energy output are several orders of magnitude (10^5-10^6) larger than those of the other bursts. This fact alone puts it in class by itself. On the other hand, the identification of the source with N49, means that at least one burst mechanism does not obey those restrictions to the energy density and weakens the case for the Galactic origin of the other events. Such a mechanism has been suggested by Ramaty et al. (1980a and 1980b).

We conclude that, while many of the properties of the March 5 event have been seen in at least one more event, they certainly have not been observed together in any other GRB. Although we must be cautious in considering this event as unique, because of instrumental limitations in early detections, we should at least separate GRB into "slow" and "fast" (March 5 type) events, assigning tentatively to the latter class also the two events 69-3 and 72-5. The suggestion is not entirely new: in fact it was noticed very early that some bursts were unusually short (Strong et al., 1974). Future GRB monitors should be flexible enough to detect both kinds.

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