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Letter to the Editor

An Upper Limit to Microwave Pulse Emission at the Onset of a Supernova

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Summary. This paper reports an upper limit at 10 GHz of 4×10^{43} erg in a 40 MHz bandwidth for the microwave pulse emission at the onset of an optically observed supernova.

Key words: supernova — perseus cluster of galaxies — radio pulse search

A supernova has recently been discovered by Lovas (1975) in the Perseus Cluster of Galaxies at the location $\alpha = 03^h\,16^m.4$, $\delta = +41°\,27'$ (1950.0). The network of tracking 10 GHz radiometers in use to search for prompt emission from supernovae (Delaney *et al.*, 1974) has been directed towards $\alpha = 03^h\,16^m.1$, $\delta = +41°\,18'$ since July 1974. This position had been chosen on the basis of supernova statistics together with other factors (Palumbo, 1975) as being the most favourable for our experiment. The supernova therefore occurred almost at the maxima of our $\sim 2°.5$ beams ($-3dB$).

This supernova was first observed on 1975 March 1, and subsequent observations (Kirshner, 1975) suggest that it was discovered near its optical maximum. It occurred in a member of the cluster and is of Type I. From the work of Pskovskii (1971) and Barbon *et al.* (1974) it appears that the onset of a Type I supernova may occur up to 40 days before the maximum optical brightness. In order to allow for large uncertainties in this estimate we searched our data for pulses during the 75 days prior to the time of the initial optical observation. During this period of interest, 1974 December 15–1975 March 1, some observing time was lost, but the overall 2-station coverage amounted to 94.5%, while the 3-fold coverage was 63.4%. The chart records for the period were carefully scanned for pulses occurring within 10 min of each other at different stations above a threshold of twice the "peak-to-peak" noise level, i.e. approximately 10σ. The events selected by this procedure were then examined for coincidence with a resolving time of 20 s. Taking account of the absence of pulses at other stations, as well as the effects of local interference, the search failed to reveal any coincident pulse exceeding a threshold of 7×10^{-22} J m^{-2} Hz^{-1} for events shorter than the 0.5 s integration time. For a pulse longer than our integration time the corresponding threshold is more correctly expressed as 14×10^{-22} W m^{-2} Hz^{-1}. Thus the microwave radiation emitted by the supernova on a timescale less than our integration time, and within a 40 MHz band around 10 GHz, must be $< 4 \times 10^{43}$ erg. We assume the supernova was in the cluster (Kirshner, 1975), i.e. at a distance of 110 Mpc (taking $H_0 = 50$ km s^{-1} Mpc^{-1}). This limit also assumes isotropic emission.

The theories of the onset phase of supernovae are far from complete but timescales of the order of seconds or less are expected in various models (cf. Shklovsky, 1968). It should be noted that our limit at 10 GHz is greater

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than the maximum energy predicted by Colgate (1975). The spectrum of the pulse which he described is such that the energy per unit bandwidth is less by a factor of ~350 at 10 GHz than at 200 MHz, the frequency around which maximum emission occurs. However, our previous VHF experiments (Charman *et al.*, 1970; Lawless, 1971; Meikle, 1973; Drever *et al.*, 1973) set limits three orders of magnitude below the maximum energy given by Colgate (1975) in the VHF region.

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Note Added in Proof. Recently, the explosion of another supernova in the Perseus Cluster has been reported (IAU Circular 2825). A preliminary search of our data failed to find a coincident microwave pulse during the 90 days preceding 1975 August 11, the date on which the event was first reported. Further details of this event will be published elsewhere.

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