An Upper Limit on Flux Density of Radio Bursts at 327 MHz from MXB 1730-335

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Abstract

The rapid X-ray burster MXB 1730-335 was observed with the Ooty Radio Telescope on 13 and 14 August 1979. During the period of our observations the X-ray burster was active. No radio bursts were recorded and the upper limit on the radio flux density from the burster at 327 MHz is estimated to be about 1 Jansky.

Microwave bursts from the rapid X-ray burster MXB 1730-335 have been reported by Calla et al. (1979, 1980a, b). These observations which were made at 4.1 GHz have not been confirmed by any other group. In fact, no other radio observations have been reported so far. Since this X-ray rapid burster produces bursts also at infrared wavelengths (Kulkarni et al. 1979, Jones et al. 1980), confirmation of the existence of radio bursts would be of considerable interest for understanding the emission mechanism. We, therefore, observed the source for about 10 1/2 hours with the Ooty radio telescope and we find no evidence for bursts at 327 MHz even though during the time of our observation the burster was active at X-ray wavelengths and is reported to have produced at least two X-ray bursts (Inoue et al. 1980).

The Ooty radio telescope, which operates at 327 MHz, has 12 simultaneous beams which are separated by 3 sec δ minutes in declination. The beam width is 3.6 sec δ minutes in declination and 2 degrees in right ascension. The Ooty telescope is particularly well suited for studying burst phenomena since, because of the 12 beams, we can easily distinguish between genuine bursts in the source and local interference. A genuine burst appears positive only on the beam pointing at the source and on the nearby beams it shows a characteristic side lobe pattern. Local interference, however, appears on all beams and shows no characteristic side lobe pattern. Since we are able to identify interference, we can put fairly stringent upper limits on the radio flux density from any burst.

The X-ray burster was observed with the Ooty radio telescope on 13 August 1979 between 1400 and 1950 hours UT and 14 August 1979 between 1340 and 1933 hours UT. The observing procedure was to point the 6th beam of the telescope at the burster and track the source from east to west while recording the output of all the 12 beams on chart recorders. While the outputs of all the beams were recorded with a time constant of 1 sec, the output of the 6th beam was in addition recorded with a time constant of 0.1 sec, which made it sensitive to very short duration bursts. After editing out the obvious interference, the 10 1/2 hours of data showed no evidence of any radio burst. From the data recorded with a time constant of 1 sec, we put an upper limit (5 times the r. m. s. noise) on the peak radio flux density from the burster at 1 Jansky (1 Jy $= 10^{-26}$ $\mathrm{Wm^{-2}\ Hz^{-1}}$).

During the period of our observations, the X-ray burster as recorded by satellites, was quite active. Inoue et al. (1980) have published 20 minutes of record of X-ray bursts on 14 August 1979 which overlaps with our observations. At the times of the first two X-ray bursts (at 1727 UT and 1732 UT) our radio records are very clean and stable and they show no trace of a burst. At 1738 UT., however, the radio observations were interrupted for about 25 minutes for calibration and so there were no observations at the time of the third burst, at 1742 UT. All the three X-ray bursts have trapezoidal profiles characteristic of the new mode of X-ray bursts reported by Inoue et al. Thus, our observations clearly show that the flat topped trapezoidal bursts from MXB 1730-335 are not accompanied by radio emission at 327 MHz with flux density greater than 1 Jy.

While there are no reported observations at 4.1 GHz which coincide in time with ours, Calla et al. (1980a) have observed trapezoidal bursts at 4.1 GHz on August 20, 1979 which is 5 days after our observations. If we assume that the properties of the burst do not change appreciably over 5 days, we can deduce some radio characteristics of the X-ray burster. Unfortunately, since Calla et al. give the flux density of the bursts in units that depend on the parameters of their system, we have to make a few assumptions about their system to determine the flux density of the burster. If we assume that their antenna aperture efficiency is 60% and their system temperature is 130° K as reported in Calla et al. (1979), their reported peak amplitude of 0.25 dB for the burst on August 20 works out to be 225 Jy. However, in Calla et al. (1980b) the system temperature is reported to be 180° K which would imply that the peak flux density of the burst is 310 Jy. We will assume that the mean value of $\sim$ 270 Jy is a typical value for the flux density from the bursts. This, combined with our upper limit of 1 Jy at 327 MHz, implies that the spectral index α (defined as flux $\propto$ [frequency]$^{+\alpha}$) is greater than 2.2, which rules out any thermal model for the burster. If we assume that the size of the radio emitting region is approximately given by $c\tau$, where τ is the rise time of the radio bursts, the brightness temperature (T_B) of source is given by

$$T_B = \frac{10^{21}}{\nu^2_{GHz}\ \tau^2_{sec}} \left(\frac{S}{100 Jy}\right) \left(\frac{D}{10\ kpc}\right)^2 K$$

where D is the distance to the burster. For the burst seen by Calla et al. the reported value of τ lies between 5 and 100s and S=270 Jy and we see that for any reasonable distance for the burster, the brightness temperature of the radio bursts is so high that it rules out any incoherent radiation process. However, speculation on the nature of the emission mechanism based on only these two observations is premature. Though Calla et al. have seen radio bursts on a number of occasions, there have been no other reports of positive detection of microwave bursts from MXB 1730-335, despite the reported microwave bursts being so strong as to make it one of the brightest sources in the sky. The existence of microwave bursts from MXB 1730-335 can be regarded as fully established only if the observations of Calla et al. are confirmed by independent groups or if evidence is presented to show that the microwave bursts are synchronised with the X-ray or infrared bursts.

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