Radio emission from the transient bursting source GCRT J1745-3009: New results

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GCRT J1745-3009 is a transient bursting radio source located ∼1 degree away from Galactic center, discovered by Hyman et al. (2005) at 330 MHz. It is newly detected from 330 MHz GMRT observations in March 2004. The burst lasted for only 2 minutes with spectral index of -13 ± 3. From September 2003 GMRT data, we detect high circularly polarised emission reaching >50%. The emission is most likely coherent (e.g., cyclotron emission), suggesting magnetic field of ∼120 Gauss, expected near stellar surfaces. Non-detection in other wavebands could, however, suggest brown dwarf as a possible source of emission.

1 Summary

GCRT J1745−3009 is one of the small number of transient sources discovered from radio frequency observations and has unique properties (Hyman et al. 2005, 2006, 2007). This source was discovered through detection of "bursts" with approximately 1 Jy peak flux density lasting approximately 10 minutes each and occurring at apparently regular 77 minute intervals. GCRT J1745−3009 was identified from archival 330 MHz (90 cm) observations taken with Very Large Array (VLA) on 2002 September 30. It is located about 1.25° south of the Galactic center and just outside, in projection, of the shell-type supernova remnant (SNR) G359.1−0.5 (Reich & Furst 1984). The environment of the source has been discussed further in Hyman et al. (2006).

Other than a few known exceptions (Melrose 2002) like coherent emission (electron cyclotron or plasma emission) from flare stars and the planets, pulsar radio emission, and molecular line masers, most radio transients are found to be incoherent synchrotron emitters. For incoherent synchrotron emission, the effective brightness temperature is limited to within about 10^{12} K by the inverse Compton catastrophe (Readhead 1994). The properties of GCRT J1745−3009 indicates that its brightness temperature exceeds 10^{12} K by a large factor and that it is a member of a new class of coherent emitters (Hyman et al. 2005).

After the initial 330 MHz detection of GCRT with the VLA, the GCRT J1745−3009 were recovered twice from GMRT 330 MHz observations. The first VLA detection and the subsequent GMRT detection from 2003 September data yielded similar source properties. However, during the second 330 MHz recovery of GCRT J1745−3009 from GMRT data taken in March 2004, a single, much fainter (50 mJy in comparison to 1 Jy in 2002) and shorter (2 minutes in comparison to 10 minutes in 2002 detection) burst is detected in contrast to the burst properties observed in 2002 and 2003. In addition, the burst is found to have a very steep spectrum of -13 ± 3, as expected for a coherent emitter, providing another important clue to understanding the nature of this enigmatic source. Details of the detection made from 2004 observations are given in Hyman et al. (2007).

A subsequent reanalysis of our March 2003 GMRT data led to a factor of three improvement in rms noise, and we find large difference between right and left circularly polarised emission, which varies systematically during its emission detected for over 3 minutes. The maximum magnitude of Stokes V reaches >50% of its total flux density. This is likely for coherent emission (e.g., cyclotron or plasma emission), and the required magnetic field is ∼120 Gauss, expected near stellar surfaces. However, search for this object in all other wavebands have so far yielded a null result. Absence of any X-ray counterpart argues against any accretion driven models, and lack of any optical or infrared counterpart rules out emission from any nearby magnetically dominated star. We consider different sources of emission including that of brown dwarf.

2 References

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