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*Published in:*  
The astronomer's telegram

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*Citation for published version (APA):*  
Tetarenko, A., Sivakoff, G. R., Bahramian, A., Heinke, C. O., Miller-Jones, J. C. A., Maccarone, T., ... Wijnands, R. (2016). VLA observations indicate GRS 1736-297 is either a black hole X-ray binary or accreting millisecond pulsar. *The astronomer's telegram*, 8744, [8744].

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## VLA observations indicate GRS 1736-297 is either a black hole X-ray binary or accreting millisecond pulsar

ATel #8744; *A. Tetarenko, G. R. Sivakoff, A. Bahramian, C. O. Heinke (UAlberta), J. C. A. Miller-Jones (Curtin), T. Maccarone (Texas Tech), N. Degenaar (Cambridge), R. Wijnands (Amsterdam)*

on 26 Feb 2016; 23:44 UT

Distributed as an Instant Email Notice Transients

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Subjects: Radio, X-ray, Request for Observations, Black Hole, Neutron Star, Transient

Following the detection of a new outburst from the transient X-ray binary GRS 1736-297 (ATels #8698, #8704), we requested Director's Discretionary Time radio observations with the VLA to classify the source via its radio emission and more precisely localize its position. The VLA was on source, (in the C configuration) targeting the Swift X-ray position, between 11:13 UT to 11:41 UT on 2016 February 26 (MJD=57434.4771) with a total exposure time of 23 min. The data were taken using two 2048-MHz basebands centred at 9 and 11 GHz. We note that the source was at low elevations (~12-15 degrees), elongating the radio beam.

We clearly detected a radio source that was consistent with an unresolved point source down to the beam size of 9.2x2.3 arcseconds (at a position angle of -36 deg) at 10 GHz. Fitting the data to a point source model in the image plane, we derive a preliminary flux density of 282 +/- 6 microJy/beam across 8-12 GHz. The luminosity of the radio source ( $L_R = v L_\nu$ ) is 2.2e29 (d/8 kpc)<sup>2</sup> at 10 GHz, where d is the unknown distance to the source. Since GRS 1736-297 is 1.5 degrees away from the Galactic centre, the distance is likely close to 8 kpc.

The source was detected individually in both the lower 9 GHz baseband (271 +/- 10 microJy/beam) and the upper 11 GHz baseband (318 +/- 12 microJy/beam). We measure a spectral index (defined by  $S_\nu \propto \nu^\alpha$ ) of  $\alpha = 0.78 +/- 0.26$ . This is consistent with the flat to inverted spectrum that is expected from synchrotron jet emission by a compact steady jet in the hard accretion state of an X-ray binary.

The preliminary source position in the 8-12 GHz image is  
 RA (J2000) = 17:39:29.983 +/- 0.012 (264.874929 deg; +/- 0.16 arcsec)  
 DEC (J2000) = -29:42:08.71 +/- 0.22 (-29.702421 deg; +/- 0.22 arcsec),

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where the errors only indicate the statistical errors from the source fitting procedure. We note that nominal systematic uncertainties are estimated to be of order 10% of the beam size, i.e.,  $0.7 \times 0.5$  arcseconds. This position is 2.5 arcseconds from the Swift X-ray position (ATel #8704) and is clearly unassociated with the nearby Be star (Motch et al., A&A, 1998, 132, 341) once thought to be the stellar counterpart. Visual inspection of UKIDSS (Lawrence et al. 2007, MNRAS, 379, 1599) J/H/K images does not indicate clear detection of the infrared counterpart during quiescence.

Swift XRT data indicate that the X-ray binary is in the hard spectral state. Swift/XRT observations on Feb. 19 and 23 had similar X-ray fluxes of  $(2.0 \pm 0.2) \times 10^{-10}$  erg/s/cm<sup>2</sup> in the 0.5-10 keV band, slightly below the February 15th flux (ATel #8704). Assuming that the X-ray luminosity has not changed in the past 3 days, the 0.5-10 keV X-ray luminosity of the source is  $\sim 1.5 \times 10^{36}$  (d/8 kpc)<sup>2</sup> during the VLA observation.

To classify the source we consider the radio luminosity at 5 GHz assuming a flat spectrum,  $\sim 10^{29}$  (d/8 kpc)<sup>2</sup> and 1.0-10 keV X-ray luminosity of  $\sim 10^{36}$  (d/8 kpc)<sup>2</sup>. At this X-ray luminosity, hard-state neutron stars tend to have radio luminosities of  $\sim 10^{28}$  erg/s, while radio-louder black hole X-ray binaries (BHXBs) have radio luminosities of  $\sim 4 \times 10^{29}$  erg/s. In between these regimes at  $\sim 10^{29}$  erg/s, radio-quieter BHXBs, some accreting millisecond X-ray pulsars (AMXPs), and transitional millisecond pulsars (tMSPs) have been detected (Deller et al. 2015, ApJ, 809, 13). We therefore classify GRS 1736-297 as either a candidate (radio-quiet) BHXB or AMXP/tMSP. XMM-Newton data taken on February 26, Gemini J/H imaging on February 24, and continuing Swift/Integral observations should help shed light on the nature of the accretor and the outburst's properties.

We encourage multiwavelength followup of this new candidate BHXB or AMXP.

We thank NRAO for awarding Director's Discretionary Time and rapidly scheduling our observations, as well as Swift for its continued monitoring of this source's outburst.

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