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Publication date

2020

Document Version

Final published version

Published in

The astronomer's telegram

License

Unspecified

[Link to publication](#)

Citation for published version (APA):

van den Eijnden, J., Degenaar, N., Wijnands, R., Russell, T. D., Sivakoff, G. R., Miller-Jones, J. C. A., Rouco Escorial, A., Herádez Santisteban, J., & Reynolds, M. (2020). VLA detection of the radio counterpart of the BeXRB 1A 0535+262. *The astronomer's telegram*, 14193. <http://www.astronomerstelegam.org/?read=14193>

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VLA detection of the radio counterpart of the BeXRB 1A 0535+262

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on 18 Nov 2020; 09:54 UT

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Subjects: Radio, Neutron Star, Transient, Pulsar

After the announcement of a new outburst of the transient Be/X-ray binary and X-ray pulsar 1A 0535+262 (Atel #14157), and its continuously increasing X-ray flux since then (Atel #14170, Atel #14171, Atel #14173, Atel #14179), we have observed this source with the Karl G. Jansky Very Large Array (VLA) to search for a radio counterpart. Radio observations during its 2010 and 2011 outbursts previously returned non-detections (Atel #2798, Atel #3198).

We observed 1A 0535+262 with the VLA on 10 and 15 November 2020, with the array in the BnA and the BnA->A configurations, respectively. In both observations we observed at C band, centred at 6 GHz and a bandwidth of 4 GHz. The primary calibrators were 3C 48 and 3C 286, respectively, while we used J0547+2721 as the secondary calibrator in both observations. We analysed the observations using the Common Astronomy Software Applications (CASA) version 5.4.1 (McMullin et al. 2007, ASPC, 376, 127), imaging the observations using a Briggs weighting scheme and a robust parameter of 1. We then used the imfit tool to measure the source flux density by fitting, in the image plane, a 2D elliptical Gaussian with FWHM and angle equal to the synthesized beam.

In the first observation, 1A 0535+262 was marginally detected at a flux density of $13 \pm 4 \mu\text{Jy}$. In the second observation, the radio counterpart had brightened to $39 \pm 4 \mu\text{Jy}$. Swift/BAT monitoring showed that, between these days, the source evolved in X-rays (15-50 keV) from 0.34 to $1.67 \text{ cts cm}^{-2} \text{ s}^{-1}$, or approximately 1.5 to 7.5 Crab. Assuming the Gaia distance of 2.13 kpc to the source (Bailer-Jones et al. 2018, AJ, 156, 58; Treuz et al. 2018, arxiv:1806.11397), the radio flux densities correspond to luminosities of $4.2E26 \text{ erg s}^{-1}$ and $1.3E27 \text{ erg s}^{-1}$, respectively. The measured flux densities are below the deepest previous radio upper limit of $160 \mu\text{Jy}$, when the source's Swift/BAT flux was 3 Crab, during the 2011 outburst (Atel #3198).

Related

- 14227 Super-critical accretion onto the Be/X-ray binary pulsar 1A 0535+262 during its 2020 giant X-ray outburst
- 14193 VLA detection of the radio counterpart of the BeXRB 1A 0535+262
- 14179 NICER and NuSTAR observations of the Be/X-ray binary pulsar 1A 0535+262 during the 2020 November giant outburst
- 14173 MAXI/GSC observation of the giant outburst from the Be/X-ray binary pulsar A 0535+262
- 14171 Optical spectroscopic observations of A 0535+262 during its ongoing giant outburst
- 14170 X-ray pulsar A 0535+262 reached ~3 Crab: update with Neil Gehrels Swift Observatory
- 14157 Swift/BAT detection of flaring activity from X-ray binary pulsar A 0535+262
- 12092 MAXI/GSC detection of the X-ray outbursts from Be/X-ray binary pulsars, A 0535+26 and GRO J10087-57
- 8977 MAXI/GSC detection of the onset of the X-ray outburst from Be/X-ray binary pulsar A 0535+26
- 8592 MAXI/GSC detection of the outburst onset from Be/X-ray binary pulsar GX 304-1
- 8055 MAXI/GSC detection of the X-ray outbursts from Be/X-ray binary pulsars, GX 304-1 and A 0535+26
- 8024 Rise in optical activity of HDE245770/A0535+26 system
- 7441 MAXI/GSC detection of an onset of X-ray brightening from Be/X-ray binary pulsar GX 304-1
- 7435 Optical Polarimetry of A0535+262 in February and

We measure a best-fit radio position in the second observation of
 RA (J2000) = 05h 38m 54.571s +/- 0.008s
 Dec (J2000) = 26d 18' 56.79" +/- 0.09"

where the uncertainties correspond to 10% of the beam size due to standard VLA systematics uncertainties in astrometry. This position is consistent within its uncertainties with the Gaia position of 1A 0535+262, with an angular separation of 0.07". The position of the radio source in the first observation is also consistent with the Gaia source.

The coupled increase in X-ray and radio flux of 1A 0535+262 show that the radio emission is directly related to the current accretion state, similar to the behaviour seen in the transient BeXRB Swift J0243.6+6124 (Van den Eijnden et al. 2018, Nature, 562, 233). With continued monitoring in X-ray and radio during the outburst rise, peak, and decay, we will further test and study this connection.

We thank the VLA operators for rapidly performing these observations, especially in the light of current operational challenges. We strongly encourage multi-wavelength follow-up observations.

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7029	Shrinking of the Be disk whilst the X-ray activity increases in the binary system A0535+262
7015	MAXI/GSC detection of the onset of the outburst from Be/X-ray binary pulsar A0535+26
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