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Detection of radio emission at mas scales from HESS J0632+057 with the e-EVN

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HESS J0632+057 is a variable TeV gamma-ray source (Aharonian et al. 2007, A&A, 469, L1, Acciari et al. 2009, ApJ, 698, L94). The likely low energy counterparts of the source are XMMU J063259.3+054801, the B0pe-type star MWC 148 (Hinton et al. 2009, ApJ, 690, L101), and a point-like probable non-thermal radio source (#3 in Skilton et al. 2009, MNRAS, 399, 317).

Falcone et al. 2011 (ATEL #3152) reported increased X-ray activity detected by Swift-XRT between January 23 and February 6, 2011 (MJD 55584-55598). These authors propose a binary orbital period of ~320 days based on three X-ray activity periods. The VERITAS collaboration reported increased activity at energies above 300 GeV between 7 and 8 February, 2011 (MJD 55599-55600) (Ong et al. 2011, ATEL #3153). MAGIC reported increased gamma-ray flux above 200 GeV during February 7-9, 2011 (MJD 55599-55601) (Mariotti et al. 2011, ATEL #3161), confirming the VHE active state and lowering the measured energy threshold.

Following the reports of high energy activity of HESS J0632+057 we observed the source with the European VLBI Network (EVN). The radio continuum observations were conducted at 1.6 GHz using 7 stations (Ef, Jb, Mc, On, Tr, Wb, and Hh) during 8 hours on February 15, 2011 (MJD 55507), UTC 15:50 to 00:00. A data rate of 1024 Mbps per station was directly streamed to the central processor at JIVE and correlated in real-time (e-VLBI).

We produced a preliminary naturally weighted image with a restoring beam of 29 x 18 mas in PA -0.9 deg, and an rms noise of 45 microJy/beam (see e-EVN 1.6 GHz image). A faint radio source is detected with a total flux density of 780 +/- 80 microJy, and a peak flux density of 580 +/- 40 microJy. The deconvolved size of the fitted component has a major axis of 14 (+6/-14) mas and a minor axis of 12 (+6/-8) mas in PA 130 (+/- 40) deg. These results suggest the presence of slightly extended radio emission at mas scales. The corresponding brightness temperature of the source is above 10^6 K, compatible with the previously proposed non-thermal nature. The source position is RA = 06h32m59.2562s, Dec = +05d48'01.166" (J2000), with errors of 1 mas. The position is clearly compatible with the UCAC3 catalogue position of MWC 148, which has an uncertainty of 14 mas in each coordinate (Zacharias et al. 2010, AJ, 139, 2184). Therefore, the EVN detection is directly related to the Be star, and gives support to the non-thermal nature of the radio counterpart. We note that the three previously known gamma-ray binaries (LS 5039, LS I +61 303, and PSR B1259-63) also display radio emission at scales of tens of mas. Our results give further support to HESS J0632+057 being a binary system, and a new member of the selected class of gamma-ray binaries. New VLBI observations during this activity period are being planned to confirm the presence of extended radio emission in HESS J0632+057.

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e-EVN 1.6 GHz image of HESS J0632+057

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