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Parallax measurements of the AR Scorpii with phase-referenced VLBI

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AR Scorpii (AR Sco) is the only known radio-pulsing white dwarf binary. It shows pulsating emission in radio, IR, optical, and UV, with a period of about 117 seconds. The emission mechanism operating in AR Sco remains unclear. Marsh et al. proposed two scenarios for AR Sco: Collimated fast particle outflows, and the direct interaction of the magnetosphere of the white dwarf with the M dwarf. Aming at determining the annual parallax and confirming the compact radio emission of AR Sco, we performed multi-epoch very long baseline interferometry (VLBI) phase-referencing observations of AR Sco with the Chinese VLBI network (CVN) at 8.6 GHz and the European VLBI network (EVN) at 5 GHz. A strong source J1625-2527, 2.7 degrees away from AR Sco, was used as the traditional phase-referencing calibrator. A faint source PMN J1620-2259, only 18 arcmin away from AR Sco, was observed to provide a stationary reference point for astrometric fitting. We present an annual parallax measurement of AR Sco of 8.37 ± 0.19 mas. The corresponding distance is $119.5^{+2.8}_{-2.7}$ pc. This is the first measurement of this binary's annual parallax in radio. And this result derived from the radio method (VLBI) which anchored to the white dwarf is consistent with the distance derived from the optical (GAIA) which associated with the M5 dwarf. High resolution VLBI image show that the radio emission compact on milliarcsecond angular scales, implying that the radio emission originates from a compact region. No obvious evidence was found in our observations for collimated outflows in AR Sco.

1. Marsh, T. R., Gänsicke, B. T., Hümmerich, S., et al. 2016, Nature, 537, 374

2. Geng, J.-J., Zhang, B., & Huang, Y.-F. 2016, ApJL, 831, L10

3. Cui, Lang., Yang, Jun., Ma, Hongli., Liu, Jun., Chen, Wen., 2017, IAUS, 323, 376

4. Marcote, B., Marsh, T. R., Stanway, E. R., Paragi, Z., & Blanchard, J. M. 2017, A&A, 601, L7

5. Mukhopadhyay, Banibrata.,Rao, A.R.., Bhatia,Tanayveer Singh., 2017, MNRAS, 472,3564

6. Franzon B., Schramm S., 2017, MNRAS, 467, 4484

7. Bednarek, W. 2018, MNRAS, 476, L10