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Probing intriguing properties of BL Lac object 2021+317 With mm-VLBI Polarimetry

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The state of the art mm-VLBI provides an adequate penetrability and a sub-mas angular resolution to directly probe the innermost part of AGN jets, which have not achieved their equilibrium yet thus are full of instabilities and complexities. Fermi-detected BL Lac object 2021+317 (z=0.227), targeted by our mm-VLBI survey[1], exhibits intriguing properties: according to the multi-epoch 15, 22 and 43GHz VLBI observations conducted between 2010 and 2021, it's jet has been rotating systemically since 2013, and its core region is elongated transversely since 2010 September, thus can be fitted by two Gaussian components namely E and W respectively.

The systemic jet rotation of 2021+317 in a time span of several years may indicate a potential periodicity with a time scale of more than ten years. Periodicity of jet wobbling is very rarely seen, and is often treated as an evidence of the existence of a binary black hole system, inducing the regular precession of the jet nozzle. Given this, the transverse elongation in the core region of 2021+317 can not be simply interpreted as a standing shock offsetting from the inner jet axis, or just an abrupt jet bending near the core region like in other cases.

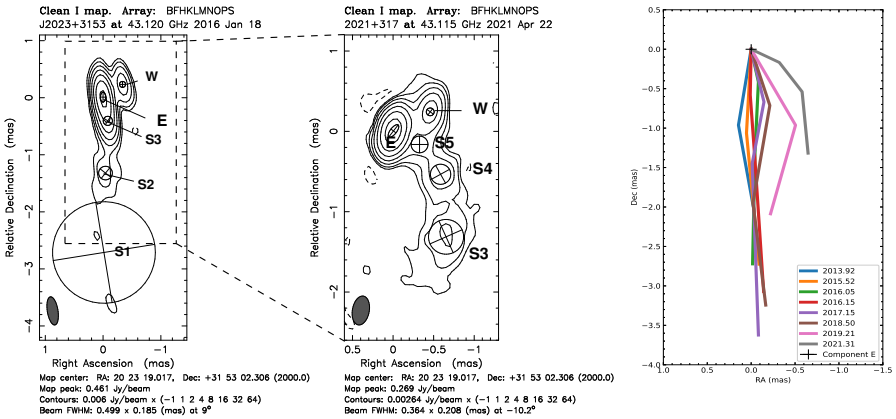

Figure 1. The left and middle panel shows the 7 mm VLBI map of 2021+317 obtained in 2016 and 2021 respectively. It is clearly seen that the orientation of the knotty jet had changed by several tens of degrees between 2 epochs. The right panel shows the evolution of the approximate jet ridge-line.

We will present the initial results of our latest KaVA observation on 2021+317 conducted in 2023 April, in the dual-polarization mode at 22 and 43 GHz. With the observation, the latest morphology of the jet is imaged. At such high frequencies, the depolarization and Faraday rotation induced by ambient medium are minimized, thus we obtain the intrinsic configuration of polarization in the transversely elongated core region. These information will help us understand the nature of the core components E and W. We will propose multi-epoch VLBI observations at 22 and 43 GHz in the future to monitor the jet orientation to look for the potential periodicity. If possible, phase-referencing will be applied to measure the motion of E and W.

References

[1] Cheng, X.-P., An, T., Frey., et al. 2020, ApJ, 247, 57