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# More pc-scale jets detectable in dwarf galaxies

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## Abstract

The population of massive black holes ($10^2$ – $10^6$ solar mass), i.e. intermediate-mass black holes (IMBHs), in faint dwarf galaxies plays a "ground truth" role in probing the growth of black holes and galaxies in the early Universe. To date, only about ten IMBHs have been firmly identified by multi-band observations in the active nuclei of dwarf galaxies. Among them, the dwarf galaxy SDSS J090613.77+561015.2 has a relatively bright radio counterpart and spatially extended IMBH-driven gas outflows in its halo. With the EVN observations at 1.6 GHz, we revealed two 1-mJy jet components with a separation of ~49 pc. Compared to the previously only known IMBH jet in NGC 4395, the new jet is ~$10^5$ times more powerful and 160 times longer. The existence of such a pc-scale jet strongly indicates that more IMBH jets are detectable with the existing and future radio facilities in particular in nearby dwarf galaxies.

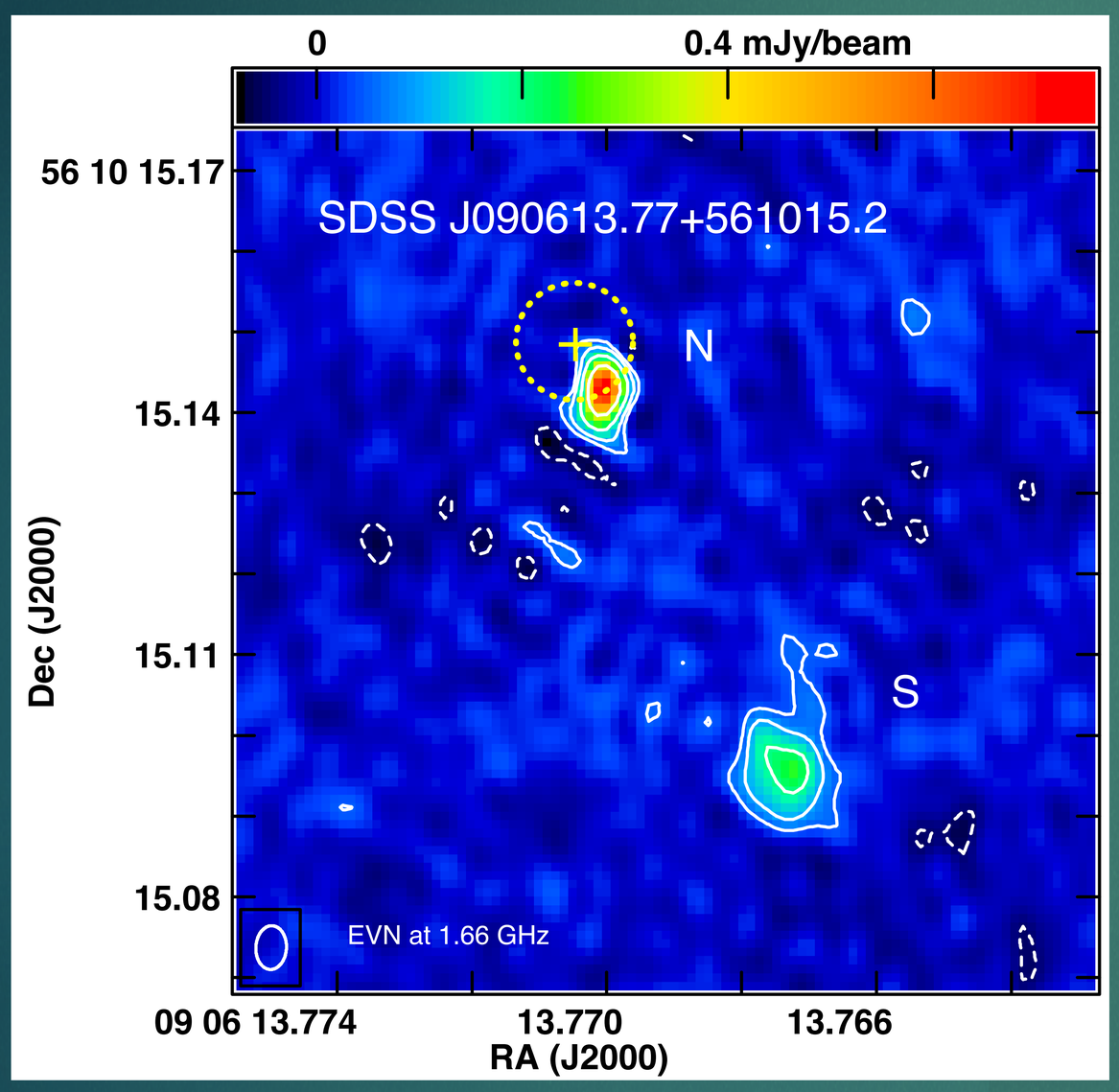


**Fig. 1.** The two-component brightness distribution observed by the EVN at 1.66 GHz in the dwarf galaxy SDSS J0906+5610 hosting an accreting IMBH (Yang et al. 2020). The yellow cross and circle mark the optical (Gaia DR2) centroid and the error circle. The contours represents the levels of $3\sigma \times (-1, 1, 2, 4, 8)$.

IMBHs are very rare objects in the local Universe because of the rapid growth of galaxies and black holes (BHs). Finding these nearby faint "leftover" objects would allow us to shed light on the formation and growth of seed BHs, galaxies and jet activity in the very early Universe (see a recent review by Greene, Strader & Ho 2020).

Currently, jetted radio-emitting outflows on sub-pc scales have been revealed in only one dwarf galaxy, NGC 4395 at 4.4 Mpc (Wrobel & Ho 2006). The dwarf elliptical galaxy J090613.77+561015.2 (hereafter, J0906+5610) host an IMBH with a mass of about $3.6 \times 10^5$ $M_{sun}$ at 193 Mpc (Baldassare et al. 2016). The exiting radio observations of J0906+5610 report that it has an optically thin power-law spectrum and shows a compact structure on the kpc scales (Reines et al. 2020).

Our high-resolution EVN observations of J0906+5610 at 1.66 GHz reveal two 1-mJy extended jet components. The image is displayed in Fig. 1. The northern feature N is quite close the optical centroid and likely represents the inner jet base or emerging jet component launched by the accreting IMBH. The southern feature S is a quite diffuse jet component. Compared to the component N, it has much larger separation and thus represents the early jet activity. Owing to no significant stellar activity in the host galaxy, the observed radio structure can only result from the central IMBH jet activity (Yang et al. 2020).

Compared to the first IMBH jet in NGC 4395, the 2nd IMBH jet in J0906+5610 has $1.6\times10^2$ times larger structure and ~$10^5$ times higher radio luminosity. This finding implies that there would be more IMBH jets detectable in particular in the nearby dwarf galaxies with the existing radio facilities.

## References

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