VLBI monitoring of two distant quasars as a showcase for 'EVN Lite'

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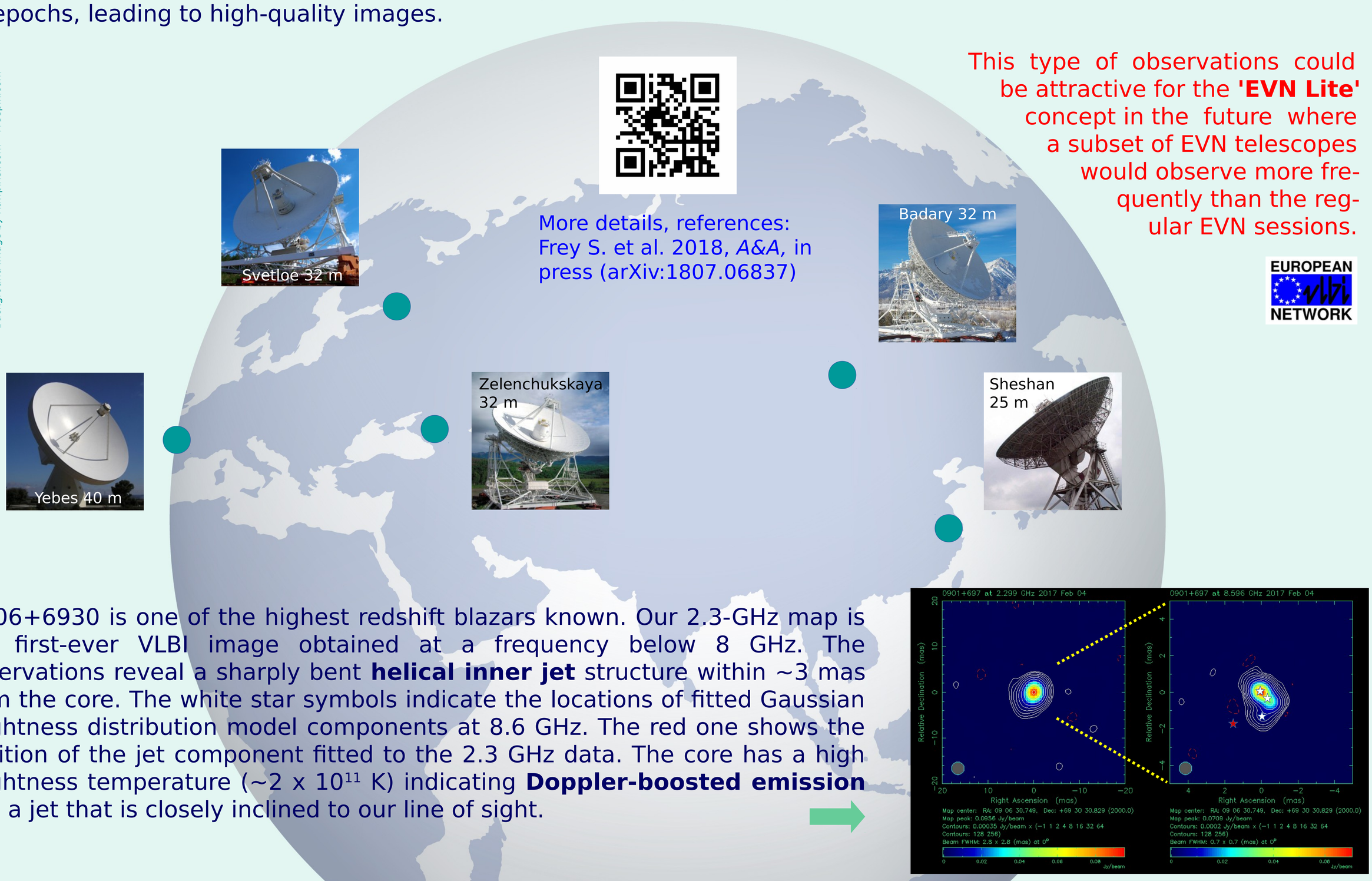
Radio-loud active galactic nuclei in the early Universe are rare. The quasars **J0906+6930** at redshift z=5.47 and **J2102+6015** at z=4.57 stand out from the known sample with their compact emission on milliarcsecond (mas) angular scale with high (0.1-Jy level) flux densities measured at GHz radio frequencies. This makes them ideal targets for **very long baseline interferometry (VLBI)** observations.

A series of regular 1-day VLBI sessions is being performed to determine the accurate **astrometric positions** of the two high-redshift quasars and their possible changes over a longer period of time. Apart from astrometric measurements, VLBI data can be used to **image the inner radio structure** of quasars and model their brightness distribution to better understand the geometry of the jet and the physics of the sources.

We obtained sensitive high-resolution VLBI images of J0906+6930 and J2102+6015 at two observing frequencies, **2.3 and 8.6 GHz**. The data were taken with a global five-element radio telescope array at five different epochs from February to August 2017. The apparent flux density invariability of the quasars allowed us to **combine the data** taken at all epochs, leading to high-quality images.

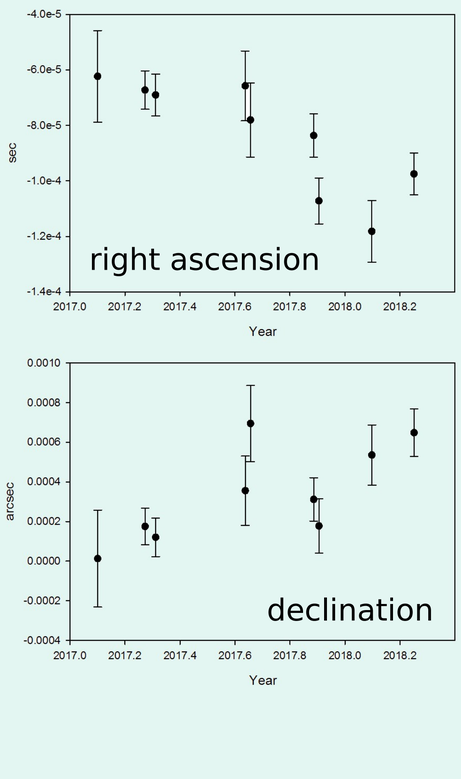


More details, references:
Frey S. et al. 2018, *A&A*, in press (arXiv:1807.06837)

This type of observations could be attractive for the **'EVN Lite'** concept in the future where a subset of EVN telescopes would observe more frequently than the regular EVN sessions.

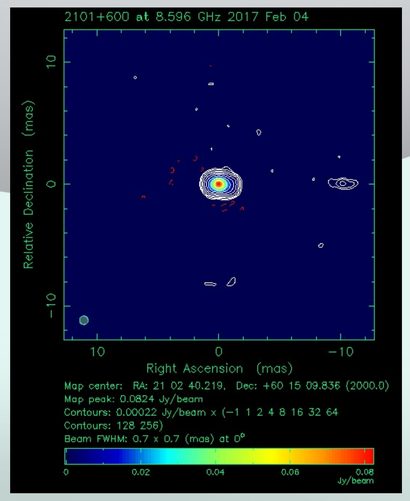
J0906+6930 is one of the highest redshift blazars known. Our 2.3-GHz map is the first-ever VLBI image obtained at a frequency below 8 GHz. The observations reveal a sharply bent **helical inner jet** structure within ~3 mas from the core. The white star symbols indicate the locations of fitted Gaussian brightness distribution model components at 8.6 GHz. The red one shows the position of the jet component fitted to the 2.3 GHz data. The core has a high brightness temperature (~2 x 10^{11} K) indicating **Doppler-boosted emission** and a jet that is closely inclined to our line of sight.

J2102+6015



The most accurate celestial reference frame is maintained through regular high-accuracy VLBI measurements of compact radio-loud active galactic nuclei. The estimated source positions are affected by intrinsic source structures and their proper motion.

Because of the limited data currently available at high redshifts, it is yet unclear if apparent source **proper motions** show any deviation for the most distant quasars known. Our data are from an astrometric monitoring programme of z>4 quasars.



J2102+6015 shows an **elongated** radio structure in the **east–west direction** within the innermost ~2 mas. It can be described with a symmetric three-component brightness distribution model at 8.6 GHz. Based on the imaging, there is no evidence for Doppler-boosting in this powerful gigahertz-peaked spectrum source.

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