

PhD Project: The role of jet redirection in jetted subgalactic-size radio sources

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Scientific context

Jetted subgalactic-size (JSS) radio sources are radio-loud AGN whose active radio emission remains confined within the host galaxy. Their physical nature and evolutionary path are still not fully understood. In the standard framework, they are interpreted as young radio sources that will eventually evolve into large-scale radio galaxies. However, their observed number is too high to be explained by a simple youth scenario alone, indicating that a substantial fraction of them may follow a different path.

At present, the short-lived scenario is generally regarded as the most plausible explanation for this overabundance, suggesting that many JSS radio sources undergo an early interruption of their activity and therefore remain compact. At the same time, growing observational evidence suggests that this may not be the only mechanism at work. In particular, some sources may remain compact because the jet changes direction on relatively short timescales, owing to rapid precession or orbital motion in interacting or merging systems. In this jet-redirection scenario, the jet energy is distributed over a wider region, reducing the efficiency of sustained growth along a single direction.

Recent VLBI observations have revealed complex morphologies and kinematics in several compact radio sources, including S-shaped structures, low-surface-brightness lateral emission, and possible non-radial motions of hot spots. The main goal of the proposed PhD project is to establish whether jet redirection is only a marginal effect or instead a statistically significant mechanism contributing to the compactness of a substantial fraction of JSS radio sources.

Project outline

The project will start with the definition of **a representative sample of JSS radio sources selected to allow a meaningful multi-epoch and multi-frequency VLBI analysis**. The first year will be devoted to the construction of the sample, the search for archival radio data, the analysis of proprietary data already available for selected sources, and the preparation of new observing proposals. These will include multi-epoch VLBI observations to monitor source expansion and possible transverse or translational motions of hot spots, as well as low-frequency VLBI observations aimed at detecting diffuse steep-spectrum emission from aged electron populations.

During the second year, archival, proprietary, and newly acquired radio data will be reduced and analysed in order to derive a consistent morphological, spectral, and kinematic description of the sample. In parallel, the host galaxies of the selected sources will be studied to assess whether JSS radio sources are preferentially associated with disturbed systems, merger signatures, or environmental conditions different from those of galaxies hosting extended radio sources.

In the third year, the observational results will be compared with theoretical models and numerical simulations for the evolution of compact radio sources, including jet-medium interaction and jet redirection caused by precession or orbital motion.

The final goal will be to assess the role of jet redirection in the evolution of JSS radio sources and, in particular, whether it contributes significantly to the compactness of a substantial fraction of the population.