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The nature of compact radio-loud AGN: a systematic look at the LOFAR AGN population

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The advent of long-baseline interferometers such as the LOw-Frequency Array (LOFAR) telescope enables high angular resolution and sensitivity, which is crucial for understanding synchrotron emission processes and the low-frequency spectral behaviour of radio-loud active galactic nuclei (RLAGN). Using the large RLAGN sample constructed from the LOFAR Two-metre Sky Survey (LoTSS) first data release, we have selected 55 candidates of unresolved high-excitation radio galaxies to investigate the nature of an emerging population of low-luminosity compact RLAGN numerically dominating the local Universe on sub-kpc scales. These objects are unresolved at 6 arcsec angular resolution at 150 MHz. We use high-frequency 6 GHz Very Large Array (VLA) observations of these sources to resolve them on the sub-kpc scale. We show that many of these objects remain compact at 0.3 arcsec angular resolution, which corresponds to an upper limit of less than 1 kpc in physical size, whereas a small fraction of sources shows sub-kpc extended radio emission. The latter exhibit varied radio morphologies including double-lobed, one-sided, and two-sided structures. The radio spectra of our sample computed between 150 MHz and 6 GHz range from steep to flat/inverted and span the range seen for various sources such as compact symmetric objects, compact steep-spectrum sources, and gigahertz-peaked spectrum sources. We investigate the environments in and around these compact objects using synchrotron self-absorption and free-free absorption models and find that the former is the likely explanation of the spectral turnover observed in some sources at 150 MHz. Using the power/linear size diagram, we speculate that our objects, in terms of luminosity, could represent a continuity between Seyferts and radio-quiet quasars in AGN unified models. A comparison with so-called FR0 sources indicate that they could be drawn from the same spectral index distribution and share similar radio-powers and morphologies.

keywords

galaxies: jets – galaxies: active – radio continuum: galaxies

In-person or online?

in-person

Career level

Student

Primary authors: CHILUFYA, Jones (University of Hertfordshire); Prof. HARDCASTLE, Martin (University of Hertfordshire); Dr PIERCE, Jonathon (University of Hertfordshire); Dr CROSTON, Judith (The Open University); Dr MINGO, Beatriz (The Open University); Dr ZHENG, Xuechen (Leiden University); Dr BALDI, Ranieri (INAF - Instituto di Radioastronomia); Prof. RÖTTGERING, Huub (Leiden University)

Presenter: CHILUFYA, Jones (University of Hertfordshire)

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