Jet/environment interactions over cosmic time

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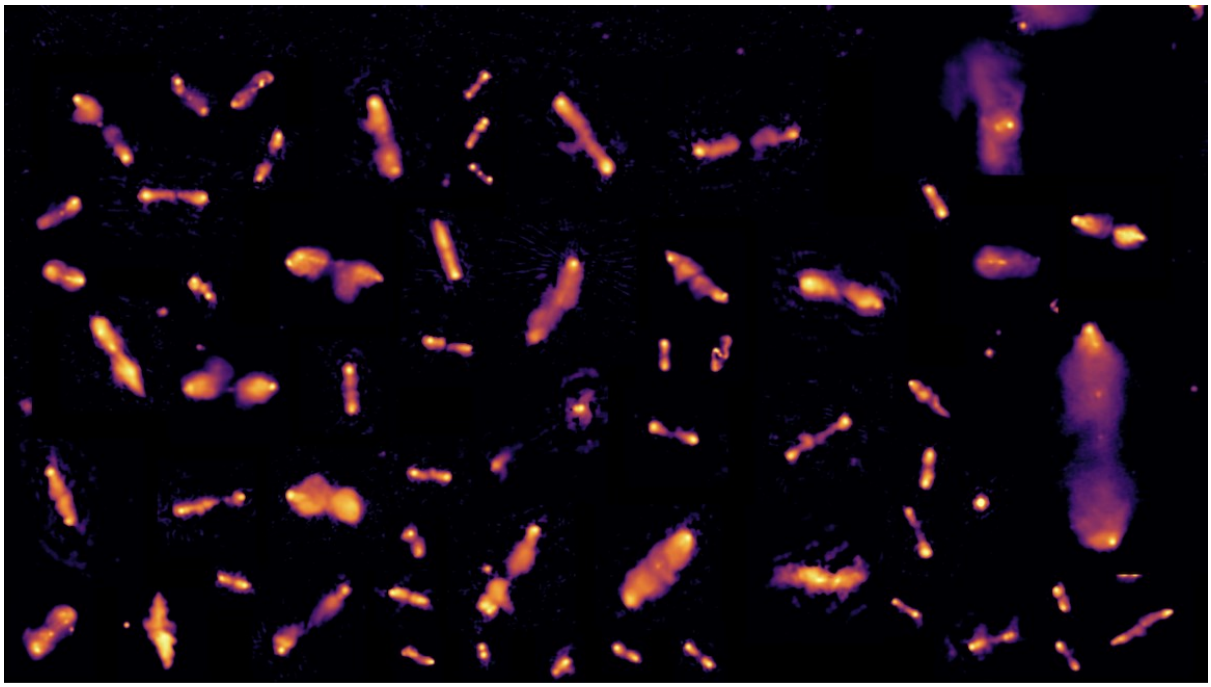

Project highlights:

- Tackle one of the most fundamental questions in galaxy evolution: how black holes and galaxies co-evolve.
- Exciting discovery potential, working with the largest ever survey of the radio sky, see e.g. www.lofar-surveys.org .
- Collaborate with astronomers from across Europe as part of the international LOFAR surveys team.
- Develop sought-after skills in radio interferometry and working with very large, complex datasets.

Project description:

Jets from supermassive black holes dramatically affect how galaxies grow and change over the history of the Universe. Jets transport energy through the interstellar and intergalactic medium, influencing when and where stars are formed, and controlling the size and appearance of present-day galaxies. A key unknown in galaxy evolution models is how these processes, and the environments in which they operate, have changed over the history of the Universe.

New very deep, wide area radio surveys are providing the deepest view of jets to date, over a wide range of astrophysical environments. Our group at the OU has a leading role in surveys with the International LOFAR Telescope (www.lofar-surveys.org), which spans all of Europe, with its core in the Netherlands, and stations from Ireland to Poland. LOFAR's sensitivity at the lowest radio frequencies provides a unique view of jets at all stages in their

life cycles, because the lowest frequencies enable the detection of older radio plasma. The second data release of the LOFAR Two-Metre Sky Survey (Shimwell et al. 2022) contains around 4 million radio sources, making it the biggest ever survey of the radio sky. The upcoming WEAVE-LOFAR survey will provide rich, complementary redshift and host-galaxy information across an unprecedented redshift range, while new subarcsec imaging capability enables detailed investigation of the source structure for samples and objects of interest. The OU team have also recently compiled the largest ever catalogue of galaxy group and cluster environments of radio-loud AGN, which will be extended to higher redshifts when WEAVE-LOFAR spectra become available.

This PhD project will combine these rich new datasets to carry out a systematic investigation of the relationship between jets and their environments across eight billion years of cosmic history. Examples of questions that will be explored include:

- Does the relationship between jet properties and environment evolve with redshift?
- Have the locations of energy injection within the cosmic web for jets of a given power and/or accretion rate changed from z~1 to the present day?
- How do the inferred histories of jet energy injection in galaxy groups and clusters compare with predictions from cosmological simulations?

You will be a member of the LOFAR Surveys team, collaborating with researchers in the UK and across Europe, and will have opportunity to travel to key European partner institutes.

References:

1. Hardcastle, M.J. & Croston, J.H. (2020) “Radio galaxies and feedback from AGN jets”, *New Astronomy Reviews*, vol 88 (https://arxiv.org/abs/2003.06137)
2. Shimwell, T. et al. (2022) “The LOFAR Two Metre Sky Survey V. Second Data Release” A&A 659 1
3. Croston et al. (2019) “The environments of radio-loud AGN from the LOFAR Two-Metre Sky Survey” A&A 622 A10
4. Mingo, B. et al. (2022) “Accretion mode vs radio morphology in the LOFAR deep fields” MNRAS 511 3250