Black-hole jets and their environments with new X-ray and radio telescopes

Supervision team: Dr Judith Croston, Dr Beatriz Mingo and Prof. Andrew Norton

Lead contact: Dr Judith Croston

Description:
Energetic jets from supermassive black holes have a profound influence on how galaxies evolve. Combining X-ray and radio observations offers a uniquely powerful way to investigate the environmental conditions that trigger jet activity and the resulting influence of jets on their surroundings (e.g. Hardcastle & Croston 2020). This project will combine X-ray information from XMM-Newton and the recently launched eROSITA X-ray telescope, with the deepest ever radio survey of the northern sky (the LOFAR Two-Metre Sky Survey) to investigate radio-galaxy jet environments and energetic impact.

LOFAR is a novel pan-European radio telescope array, operating at low frequencies to produce a world-leading sky survey that reveals the full life cycle of jet activity in galaxies (e.g. Mingo et al. 2019). This PhD project aims to build a complete census of jet environments and impact by combining LOFAR data with observations from an XMM-Newton large programme, and from eROSITA, the newest X-ray telescope in orbit, which is currently mapping the X-ray sky to unprecedented depth. The project will make use of versatile techniques for combining and modelling radio and X-ray data developed by Croston and her group for smaller-scale studies with the Chandra and XMM-Newton observatories. The student will build and characterise radio jet samples with LOFAR and use XMM and eROSITA data to map their environments and non-thermal X-ray emission, which acts as a probe of particle and magnetic field content and energetics (e.g. Ineson et al. 2017, Croston et al. 2018).

The student will be part of the LOFAR Extragalactic Surveys key science project, working with team members in the UK, Netherlands, Italy and France. In later stages of the project there may be an opportunity to be involved in preparatory work for the next-generation ESA L-class Athena X-ray Observatory, for which Croston is a member of the Science Study Team.

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. Mingo, B. et al. (2019) *Monthly Notices of the Royal Astronomical Society*, 488, 2701
3. Ineson, J. et al. (2017) *Monthly Notices of the Royal Astronomical Society*, 467, 1586
4. Croston. J.H. et al. (2018) *Monthly Notices of the Royal Astronomical Society*, 476, 1614

Qualifications required: 1st or 2:1 MSci/MPhys in Physics, Astrophysics or similar. Students with a 1st class BSc and strong computing/programming experience may be considered. Python programming experience desirable.