Newly catalogued sources at low radio frequencies: high-redshift radio galaxies?

Research Field
Radio Astronomy

Project Suitability
Honours

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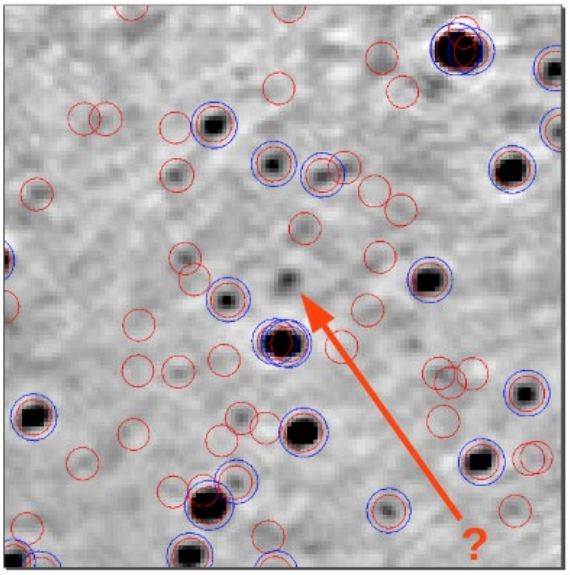
The latest generation of low-frequency radio surveys (below about 250 MHz; e.g. Heald et al. 2015, A&A, 582, A123; Hurley-Walker et al. 2017, MNRAS, 464, 1146; Intema et al. 2017, A&A, 598, A78; Shimwell et al. 2019, A&A, 622, A1) have already catalogued hundreds of thousands of sources. However, some of these sources were not seen before in corresponding higher-frequency radio surveys, and hence are newly catalogued. What are these objects?

First, why would a radio source be seen at lower frequencies only? One possibility is that it is variable, or a transient, and it was only detected because the low-frequency survey happened to be conducted when the source was 'on' and emitting electromagnetic radiation. Another possibility is that the radio source is detectable at low frequencies, but the flux density decreases rapidly as the observing frequency increases. Such sources are said to have an ultra-steep (USS) radio spectrum. An example is shown in the figure below, where a detection was made in a LOFAR map at 150 MHz (greyscale), but not in the higher-frequency WENSS (325 MHz; blue circles) and NVSS (1400 MHz; red circles) surveys.

A variety of radio source classes can be characterised by very steep spectra, for example rapidly spinning, millisecond pulsars found in our Galaxy. USS selection is also an efficient way of finding the most distant radio galaxies in the Universe: the so-called high-redshift radio galaxies (HzRGs; e.g. review by Miley & De Breuck 2008, A&AR, 15, 67). HzRGs are crucial tracers of massive galaxy formation in the early Universe but are rare objects. Could some of the newly catalogued sources be HzRGs?

In this project, you will use a selection of low-frequency survey data from both the Murchison Widefield Array (MWA) in Australia and the Low-Frequency Array (LOFAR) in the Netherlands, as well as additional multi-wavelength data, to start to uncover the true nature of these objects. How many could be distant galaxies, and how many are 'interlopers' in the much more nearby Universe? How can we use multi-wavelength data to begin to build a classification scheme to more efficiently select the best HzRG candidates, especially when we will soon have catalogues comprising billions of galaxies in the era of the Square Kilometre Array (SKA)? This project will address these questions, and additional, related topics.



NVSS 1.4 GHz
WENSS 325 MHz