Contribution ID: **134** Type: **Talk**

Multi-Frequency Analysis of Megaparsec-scale DDRGs: Spectral Ageing and Duty Cycle Dynamics of Inner and Outer Lobes

One of the most outstanding issues regarding active galactic nuclei (AGN) is the recurrent activity in AGN. Notable evidence of intermittent nuclear activity in AGN is found in the form of double-double radio galaxies (DDRGs), characterised by the presence of two pairs of radio lobes, typically aligned along the same jet axis, indicating two distinct cycles of activity. Investigating the properties of DDRGs is of utmost importance to refine our understanding of the duty cycle of AGN activity and feedback processes in AGN. This study allows the reconstruction of episodic activity history through the analysis of radio spectra and the information of source morphology. The study of megaparsec-scale DDRGs (size > 0.7 Mpc) holds particular significance as their vast dimensions aid a clearer distinction between two episodes of activity, unlike smaller DDRGs (~300 kpc). This larger volume coverage and reduced likelihood of emission overlap from different epochs make them relatively easier to analyse.

In our ongoing research, we have selected a sample of 14 megaparsec-scale (or giant) DDRGs from the LOFAR Two-metre Sky Survey (LoTSS) sample (Dabhade et al. 2020a). These DDRGs, with their high-quality LOFAR 144 MHz maps, form the cornerstone of our investigation. Crucially, low-frequency observations are key in accurately determining injection indices. Our objectives include determining the injection spectral indices of the newer and older activity represented by inner and outer doubles and scrutinising potential differences. We aim to estimate their spectral ages and constrain the duty cycle of AGN activity. In addition, our study focuses on examining the propagation of jets within the cocoon formed during the initial cycle, along with exploring the physical conditions and re-acceleration processes within the lobes. To achieve this, we have harnessed a wealth of multifrequency data, systematically acquired through our dedicated uGMRT band 4 (550-900 MHz) and JVLA S (2-4 GHz), C (4-8 GHz), and X (8-12 GHz) band observations. The strategic use of JVLA arrays across all frequencies has been pivotal, enabling us to obtain high-resolution arcsecond maps. These detailed maps are essential for our comprehensive analysis, allowing us to scrutinise the overall spectral characteristics, precisely identifying spectral breaks and accurately estimate spectral indices, injection indices for two cycles of activity, spectral ages and magnetic fields of various components. They also facilitate the study of variations in these properties across different parts of the sources, such as lobes and plumes. Therefore, the combination of uGMRT and JVLA data, alongside the pre-existing LOFAR dataset, provides us with expansive frequency coverage from 144 MHz to 12 GHz, integral to our multifaceted study. We can also possibly examine and model particle re-acceleration if present in the lobes. This study stands out as the pioneering exploration into the mapping and analysis of giant DDRGs across such a wide range of frequencies. Previous studies on spectral ageing in DDRGs were conducted, but they were limited to a handful of sources and lacked the extensive frequency coverage that our sample study offers.. Through our observations from the C & D arrays of JVLA, we have successfully captured most of the diffuse emissions associated with the DDRGs.

In the presentation at SPARCS meeting (2024), we will highlight a segment of our work specifically featuring a subset of 10 sources from our sample. Our focus will be on unveiling findings derived from our recent observations conducted with uGMRT and JVLA, placing particular emphasis on the spectral ages of both inner and outer components of giant DDRGs. Additionally, we will present the outcomes of modelling our source evolution, employing the JP and KP models facilitated by Broadband Radio Astronomy Tools (BRATS). We will also present our examination of asymmetries in the inner and outer doubles. Additionally, our findings delve into understanding the effects of the surrounding environment on these asymmetries and their potential connections to spectral age variations.

In the future, our aim is to conduct a comparative study involving small sized DDRGs. The primary objective is to discern potential differences in the duty cycle of AGN activity and particle acceleration mechanisms. This investigation aims to shed light on the factors that contribute to the growth of DDRGs, allowing them to manifest as giants.

keywords

AGN, restarted AGN, multifrequency observation

In-person or online?

in-person

Career level

Student

Primary authors: MAHATO, Mousumi (University of Tartu); DABHADE, Pratik (Instituto de Astrofísica de Canarias (IAC, Spain)); SAIKIA, Dhruba (Inter-University Centre for Astronomy and Astrophysics)

Presenter: MAHATO, Mousumi (University of Tartu)

Session Classification: AGN/ High-z