PhD project in ASTROPHYSICS

Title of the Project: Tales of tails: unraveling the tumultuous evolution of tailed radio galaxies in cluster of galaxies

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Supervisor UniBo: Prof. Daniele Dallacasa

Scientific Case:

New generations of radio telescopes, precursors and pathfinders of the SKA, are reveling that head-tail radio galaxies in galaxy clusters (i) often exhibit longer extensions than what expected by the radiative lifetime of relativistic electrons, (ii) may feature regions of surface brightness and spectral index flattening (contrary to the gradual steepening expected by particle aging), and (iii) frequently display filaments and disturbed morphology, especially at their terminal ends, where the tail structure "breaks". These properties suggest a non-trivial ongoing interplay between the non-thermal components in tails and the surrounding thermal gas, leading to processes that can sustain particles lifetime for periods of time and distances longer than usually expected.

Outline of the Project:

The PhD candidate candidate will work on multi-frequency observations performed with state-of-the-art instruments of nearby galaxy clusters hosting prominent head-tail radio galaxies. Data to be explored include the deep LOFAR, uGMRT, and JVLA observations available on A2255, A2256, and 3C129 (Figure). The candidate will utilize the sensitive and wide frequency range covered by these observations to constrain the spectral properties of the tails. These results will be combined with numerical simulations and theoretical models to determine the properties of magnetic fields and particle-acceleration mechanisms.

Part of the PhD project will also involve the statistical analysis of a large sample of tailed radio galaxies from the LOFAR and ASKAP surveys (LoTSS, LoLSS, EMU). The student will investigate the occurrence and properties of tailed sources in relation to the environment. As matter accretion in clusters occurs along cosmic filaments, the candidate will search for a correlation between the presence of tailed sources and the large-scale structure. This is crucial for understanding both the evolution of radio galaxies and the seeding of cosmic ray electrons in cosmic filaments, which are important scientific drivers for SKA.

The PhD student will be part of the LOFAR and EMU teams and have access to the most recent analysis technique. The PhD student will also be involved in international working groups, and travels to visit collaborators in Europe are planned.

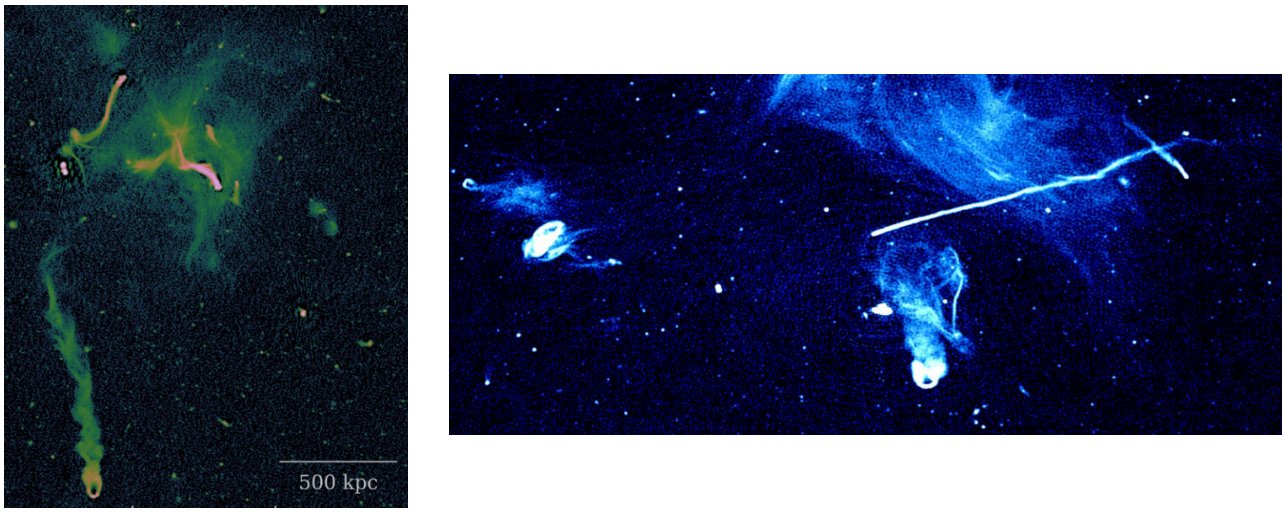

Figure: LOFAR image of Abell 2255 (left) and uGMRT image of Abell 2256 (right) showing numerous prominent tailed radio galaxies with complex morphologies. From Botteon et al. (2022) and Rajpurohit et al. (2022).