Scaling Relations Study of Radio Halos in the MGCLS

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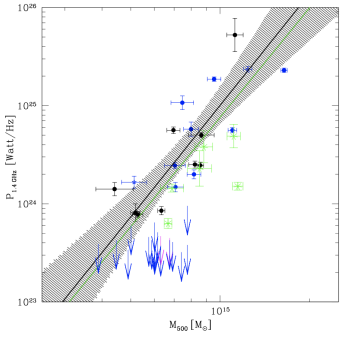
Abstract:
Radio halos have been closely linked to galaxy clusters with tracers of dynamical disturbance. Statistical studies have linked radio halo properties to the mass of the host cluster. The aim of this project is to compute scaling relation studies of the radio halos in the MeeKAT Galaxy Cluster Legacy Survey and compare them to the studies in the literature. The student will learn to compute scaling relation plots, relate them to the existing theory, and use astronomical tools to produce radio images.

Scientific Motivation:
According to turbulent re-acceleration models (e.g. Brunetti et al. 2001; Brunetti & Lazarian 2016; Pinzke et al. 2017), the formation history of radio halos (RHs) depends on the cluster merging rate throughout cosmic epochs and on the mass of the hosting clusters themselves, which ultimately sets the energy budget that is available for the acceleration of relativistic particles. Studies of statistical properties of RHs in clusters and their connection with the cluster dynamics are extremely useful to constrain the origin of halos. Multiple studies have linked the RHs' radio power and largest linear size to the mass of the host clusters (Cassano et al. 2013, 2023; Cuciti et al. 2021, Di Gennaro et al. 2021). For this project, we will use the MeeKAT Galaxy Cluster Legacy Survey (MGCLS; Knowles 2022) observations to extract properties of RHs and compute their scaling relations. The MGCLS observed 115 galaxy clusters, 26 of which were confirmed to host RHs. These RHs are found in galaxy clusters covering a wide redshift range of $0.01 < z < 0.9$. Hence an interesting sample for comparing the scaling relations as a function of redshift.

Project Outline:
The student will extract the flux, largest linear size, and halo radio power of all the confirmed radio halos in the MGCLS. They will then proceed to compute the LLS vs M_500 and the P_1,4GHz vs M_500 scaling relations. Finally, they will compare the occurence rate in multiple redshift bins.



P_1.4 vs M_500 plot from Cassano et al. 2013

Required skills:
Python programming. Experience with SAODS9 will be an advantage.