Thermal-non thermal study of CHEX-MATE galaxy clusters

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Project description and activities

Galaxy clusters form with the accretion of sub-clusters and groups through mergers which release up to ~10^{64} ergs in the intra-cluster medium (ICM). Such energy is mainly dissipated as gas heating, making clusters shine in the X-ray band, but a small fraction of it can be channelled into particle acceleration triggering synchrotron emission of relativistic electrons in the magnetised (~μG) plasma. Based on the (re)acceleration mechanism, a variety of radio sources can be produced: halos, relics and even bridges between clusters. Giant radio halos are among the most extended cases of such emission. They are usually found in massive merging clusters as roundish, Mpc-scale radio sources, co-spatial with the X-ray emission and characterised by a steep spectral index ($\alpha<-1$, where $S_\nu \propto \nu^\alpha$). The commonly accepted scenario is that they are connected with turbulent re-acceleration, occurring during cluster mergers, of mildly relativistic electrons, already present in the ICM due to past energetic events (e.g. AGN activity), (e.g. Brunetti and Jones 2014). As the initial energy budget is set by the cluster's mass, massive systems will more likely host luminous radio halos emitting up to GHz frequencies. However, the details of this process are yet to be understood. With the advent of new generation radio telescopes (e.g. LOFAR, MeerKAT) we are now capable of spatially resolving the diffuse radio halo emission and studying in detail their properties.

So far, these studies have been made almost exclusively on single objects and always using different radio and X-ray facilities, with different sensitivities and at different frequencies. All these effects can deeply impact the final results and do not allow a comparison among different works.

We now aim to explore that connection in the GHz regime with high-quality MeerKAT data, which allows further comparison among radio spectral index and X-ray thermodynamic quantities. We will exploit the uniform X-ray coverage of the Cluster HEritage project with XMM-Newton-Mass Assembly and Thermodynamics at the End-point of structure formation (CHEX-MATE, CHEX-MATE Collaboration et al. 2021), a three mega-second Multi-Year Heritage Programme to obtain X-ray observations of a representative, signal-to-noise limited sample of galaxy clusters detected by Planck through the Sunyaev-Zel'dovic effect. **Combining the CHEX-MATE and MeerKAT data, the selected applicant will perform the first systematic and statistically representative study of resolved thermal and non-thermal properties in clusters**