

Galaxy Cluster Studies

(Manzoor A Malik)

Galaxy clusters, the largest virialized objects, are ideal laboratories to study in detail the cosmic evolution of the universe. They provide critical estimates on cosmological parameters like density fluctuations (σ_8), matter density (Ω_m), dark energy density (Ω_Λ) which are independent from those determined using type Ia supernovae, and the primordial cosmic microwave background radiation (CMB). The robust estimates of these parameters require precise knowledge of the evolution of galaxy clusters with redshift and thermodynamic properties of ICM. The X-ray band is one of the observational techniques for studying galaxy clusters. The thermal X-ray bremsstrahlung emission is due to the hot ($10^7 - 10^9$ K) diffuse intra-cluster medium (ICM). The ICM constitute roughly 90% of cluster baryonic material.

The work in this area is being conducted under an ISRO sponsored project "X-ray studies of Galaxy Clusters" granted to Prof. Manzoor Malik (PI) in collaboration with Prof. Somak, IUCAA (Co-I), Prof. Gulab, IUCAA (Co-I) and Dr. Subha Majumdar, TIFR (Co-I). In this work, we plan to study thermodynamic properties of ICM, dark matter profile, test the degree of deviations from the hydrostatic equation and presence of non-thermal pressure in galaxy clusters from the quantities like X-ray density and temperature profiles of ICM,. Moreover, from X-ray scaling relations between cluster properties like Mass-Temperature, we plan to probe the extent of self-similarity in clusters and nature and extend of non-gravitational processes involving injection of feedback energy from active galactic nuclei etc raising the entropy profile of clusters. We plan to extend our work using upcoming data from Astrosat. Due to the larger field of view of the ASTROSAT's Soft X-ray telescope (SXT) than Chandra and XMM-Newton satellites, it is possible to study the cluster physics up to the virial radius unlike Chandra and XMM-Newton which could only go upto R500. Moreover, Large Area Xenon Proportional Counter (LAXPC) will be instrumental in studying Hard X ray emission from the non-thermal distribution of electrons which is still a mystery. This project will serve as starting point for X-ray studies using ASTROSAT data as and when it becomes available.

Note: Shahnawaz Malik is working as a JRF in the project since 2017.