

Connecting magnetic fields from sub-galactic scale to clusters of galaxies and beyond with cosmological MHD simulations

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Abstract. Using the MHD version of Gadget3 (Stasyszyn, Dolag & Beck 2013) and a model for the seeding of magnetic fields by supernovae (SN), we performed simulations of the evolution of the magnetic fields in galaxy clusters and study their effects on the heat transport within the intra cluster medium (ICM). This mechanism – where SN explosions during the assembly of galaxies provide magnetic seed fields – has been shown to reproduce the magnetic field in Milky Way-like galactic halos (Beck *et al.* 2013). The build up of the magnetic field at redshifts before $z = 5$ and the accordingly predicted rotation measure evolution are also in good agreement with current observations. Such magnetic fields present at high redshift are then transported out of the forming protogalaxies into the large-scale structure and pollute the ICM (in a similar fashion to metals transport). Here, complex velocity patterns, driven by the formation process of cosmic structures are further amplifying and distributing the magnetic fields. In galaxy clusters, the magnetic fields therefore get amplified to the observed μG level and produce the observed amplitude of rotation measures of several hundreds of rad/m^2 . We also demonstrate that heat conduction in such turbulent fields on average is equivalent to a suppression factor around 1/20th of the classical Spitzer value and in contrast to classical, isotropic heat transport leads to temperature structures within the ICM compatible with observations (Arth *et al.* 2014).

Keywords. methods: numerical, magneto-hydrodynamics, galaxy clusters

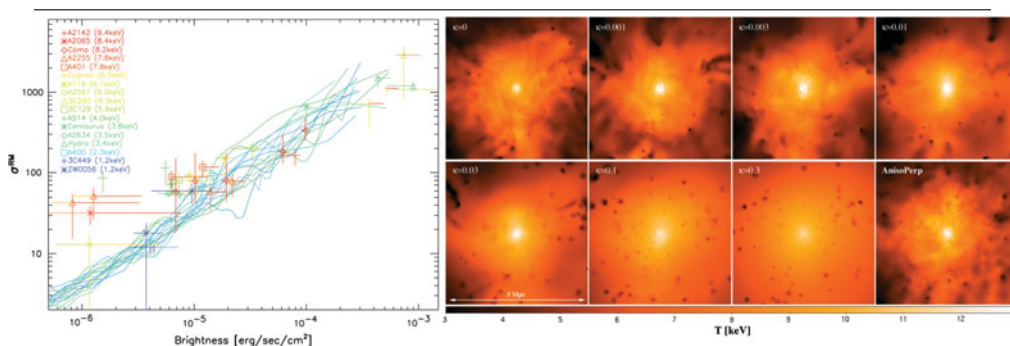


Figure 1. Left plot: Data points are observed rotation measures vs. X-Ray surface brightness for a collection of galaxy clusters, color coded by temperature. Lines represent the relation predicted from simulated clusters. Right plot: Temperature maps of simulated clusters with different levels of isotropic thermal conduction and anisotropic conduction, which takes the effects of magnetic fields on the heat transport within the ICM into account.

References

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