Highlights of Astronomy, Volume 16
XXVIIIth IAU General Assembly, August 2012
T. Montmerle, ed.

doi:10.1017/S1743921314011740

MHD turbulence in the intracluster medium

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Abstract. In this work we discuss the turbulent evolution of structures in the intracluster medium based on the two fluid approximations: MHD and collisionless plasma under Chew Goldberger Low (CGL) closure. Turbulence excited by galactic motions and gas inflow in intracluster medium will develop in very different ways considering the two fluid approaches. Statistics of density distributions, and velocity and magnetic fields are provided. Compared to the standard MHD case, the instabilities that arise from CGL-MHD models strongly modify the probability distribution functions of the plasma velocity and density, basically increasing their dispersion. Moreover, the spectra of both density and velocity show increased power at small scales, due to the instabilities growth rate that are larger as smaller scales. Finally, in high beta plasmas, i.e. $B^2 << P$, a fast increase of the magnetic energy density is observed in the CGL-MHD models, faster than the standard MHD turbulent dynamo that operates at timescales $\tau \sim L/v_L$. The signatures of the increased power at small scales and the increase of magnetic field intensity from CGL-MHD models could be observed at radio wavelengths. A comparison of the structure function of the synchrotron emission, as well as the statistics of Faraday rotation effects on the synchrotron polarization, for both the MHD and CGL-MHD models is provided.

Keywords. galaxies: clusters: general, galaxies: intergalactic medium, galaxies: magnetic fields

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Several observational studies of Faraday rotation of synchrotron emission at radio wavelengths have reveal the presence of μG magnetic fields in the intracluster medium (ICM). Standard cosmological dynamo theories predict maximum amplitudes of 10^{-9}G at intergalactic scales, at $z \rightarrow 0$. The origin of the relatively strong magnetic field of the ICM is still a matter of debate. Turbulence at the ICM, triggered by AGNs and galactic dynamics within the cluster, could help solve the issue (Falceta-Gonçalves *et al.* 2010). The turbulent kinetic energy density of the ICM is estimated as 10^{11}erg cm^{-3}, large enough to explain the observed magnetic fields. However, the timescales for the turbulent dynamo to occur are still too large.

The ICM is collisionless, i.e. present anisotropic pressures. Pressure anisitropies may result in instabilities such as the mirror and firehose, studied numerically in Kowal *et al.* (2011). We show that in a turbulent ICM both instabilities are triggered naturally and that the firehose instability result in magnetic field amplification in timescales much shorter than the turbulent dynamo. Statistical analysis of the simulated density and magnetic field distributions may also be directly compared to observations (Falceta-Gonçalves *et al.* 2008, Burkhart *et al.* 2009).

References

Kowal, G., Falceta-Gonçalves, D. A., & Lazarian, A. 2011, *NJPh* 13, 3001

Falceta-Gonçalves, D., de Gouveia Dal Pino, E. M., Gallagher, J. S., & Lazarian, A. 2010, *ApJL* 708, 57

Falceta-Gonçalves, D., Lazarian, A., & Kowal, G. 2008, *ApJ* 679, 537

Burkhart, B., Falceta-Gonçalves, D., Kowal, G., & Lazarian, A. 2009, *ApJ* 693, 250