APR11-2011-000851

Abstract for an Invited Paper
for the APR11 Meeting of
the American Physical Society

Magnetogenesis and magnetothermal equilibria in turbulent galaxy-cluster plasmas

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We do not know the exact mechanism of magnetic field generation in magnetised weakly collisional (or collisionless) turbulent plasma. We do know that large-scale MHD motions in such plasmas are subject to fast small-scale kinetic instabilities (mirror and firehose) triggered (at high beta) by pressure anisotropies and that these anisotropies will always arise in a turbulent plasma. Therefore, standard MHD equations cannot be used to describe the turbulent dynamo. I will argue that the likely scenario in such plasmas is explosively fast growth of magnetic fluctuations to dynamical levels. I will further argue that if an efficient turbulent dynamo is assumed, radiative cooling in such plasmas can be balanced in a thermally stable way by turbulent heating, whose rate is set by the condition that plasma locally remains in a marginal state with respect to the mirror and firehose instabilities. This thermal stability suggests that a cooling catastrophe is not inevitable, although whether this old problem is thus resolved depends on whether a number of assumptions about the nonlinear behaviour of the instabilities, strength of turbulence and efficiency of the dynamo are borne out by first- principles microphysical theory, simulations or plasma experiments.

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