Abstract Submitted
for the DPP06 Meeting of
The American Physical Society

Simulation of the Magnetothermal Instability[1] IAN PARRISH, JAMES STONE, Princeton University — In many magnetized, dilute astrophysical plasmas, thermal conduction occurs almost exclusively parallel to magnetic field lines. In this case, the usual stability criterion for convective stability, the Schwarzschild criterion, which depends on entropy gradients, is modified. In the magnetized long mean free path regime, instability occurs for small wavenumbers when $(\partial P/\partial z)(\partial \ln T/\partial z) < 0$, which we refer to as the Balbus criterion. We refer to the convective-type instability that results as the magnetothermal instability (MTI). We use the equations of MHD with anisotropic electron heat conduction to numerically simulate the linear growth and nonlinear saturation of the MTI in plane-parallel atmospheres that are unstable according to the Balbus criterion. The linear growth rates measured from the simulations are in excellent agreement with the weak field dispersion relation. The instability saturates when the atmosphere becomes isothermal as the source of free energy is exhausted. By maintaining a fixed temperature difference between the top and bottom boundaries of the simulation domain, sustained convective turbulence can be driven. This paper presents 2D and 3D studies of the MTI in a variety of geometry and field configurations. In addition, we explore the implications of this instability for a variety of astrophysical systems. The most important application is to the dilute, magnetized plasma that makes up the hot intracluster medium of galaxy clusters.

[1]Supported by the DOE Computational Science Graduate Fellowship

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Date submitted: 24 Jul 2006 Electronic form version 1.4