1E22

Ballooning Modes in Thin Accretion Disks*

E.A. Keyes, B. Coppi

Massachachusetts Institute of Technology
Cambridge, MA 02139

Abstract

In astrophysical accretion disks, the observed rate of angular momentum transport is often explained by appealing to turbulence excited by plasma collective modes such as the Magneto-Rotational Instability,[1,2] originally derived as "long-cylinder" modes in a differentially rotating MHD fluid. When confined to a geometrically thin disk, however, these axisymmetric modes instead become of the ballooning type[3] and take on a much more limited character with a discrete spectrum and reduced growth rates, as shown by Coppi & Coppi.[4] Their excitation requires that the magnetic energy be considerably lower than the thermal energy, and while they are well-localized in the vertical direction, they acquire a characteristic oscillatory profile in the radial direction, leaving open the problem of identifying a physical factor which can make them radially localized.

The normal mode equation describing the modes is derived, and its solutions are shown to be of two types: a discrete spectrum of modes which are vertically well-localized compared to the disk height, and a continuous spectrum of quasi-localized modes which decay more slowly at the boundaries of the disk but which may leave open the possibility of constructing wave packets for radial localization. However, the power-law profiles of the quasi-localized modes are too gradual to be physically realistic except possibly in a narrow range of mode wavelengths for cases where the magnetic energy is extremely small.

We are currently verifying these results through numerical simulations of thin Keplerian MHD disks, a case that has not often been treated in other simulations in the field, which typically use vertically periodic or "fat torus" geometries.

* Sponsored in part by the U.S. Department of Energy.

1 Velikhov, E.P. 1959, *Soviet Phys*, JETP, **36**, 995
2 Balbus, S.A., and Hawley, J.F. 1991, *Ap J*, **376**, 2
3 Coppi, B. 1977, *Phys Rev Let*, **39**, 939
4 Coppi, B., and Coppi, P.S. 2001, *Phys Rev Let*, **87**, 5, 051101-1