Département d'Astrophysique

Séminaires du DAp

Jeudi 06/09/2012, 11:00

Bat 713, salle de séminaires Galilée , CEA Saclay, Orme des Merisiers

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SUBCRITICAL MAGNETOROTATIONAL TURBULENCE AND DYNAMO ACTION IN ACCRETION DISKS

Turbulent transport and magnetic field generation in accretions disks are entangled astrophysical processes which are intimately related to the nonlinear dynamics of the magnetorotational instability (MRI). In recent years, exciting new results on what is usually referred to as MRI dynamo action, or zero net-flux MRI, have been obtained thanks to high-resolution simulations, but an in-depth physical understanding of the nonlinear processes at work in this problem is still lacking. This unfortunately makes it extremely hard to determine the actual physical conditions of existence of the MRI dynamo and to come up with robust theoretical estimates of the efficiency of the associated MHD turbulence at transporting angular momentum in disks.

Studying the nonlinear dynamics of the MRI dynamo in transitional regimes (magnetic Reynolds number close to criticality) provides an alternative and complementary avenue of research to brute-force numerical simulations and may help to make significant progress on this problem, as coherent nonlinear behaviour and essential nonlinear couplings can be identified and understood in a lot of physical details in such regimes. A detailed study of the nonlinear physics of the MRI dynamo may also teach us a lot about dynamo action in various astrophysical contexts, as this dynamo provides a wonderful prototype of dynamo action in differentially rotating flows prone to MHD instabilities.

I will first introduce the problem of transition to turbulent MRI dynamo action by demonstrating the subcritical nature of the transition, and will show that the dynamics in this problem has much in common with that of hydrodynamic transition in non-rotating shear flows. I will then present several new numerical results demonstrating the central role of nonlinear MRI dynamo cycles in triggering subcritical turbulence in this problem, at least in constrained geometries. The perspectives of these findings for the understanding of turbulence in disks, their relevance to several instability-driven dynamo problems and to the problem of hydrodynamic transition of shear flows will finally be discussed.

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