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Turbulent magnetic dynamo excitation at low magnetic Prandtl number

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Planetary dynamos likely result from turbulent motions in magnetofluids with kinematic viscosities that are small compared to their magnetic diffusivities. Laboratory experiments are in progress to produce similar dynamos in liquid metals. We present computations of thresholds in critical magnetic Reynolds number above which dynamo amplification can be expected for mechanically-forced turbulence (helical and non-helical, short wavelength and long wavelength) as a function of the magnetic Prandtl number [1]. Complications result from the fact that the kinetic turbulent spectrum is much broader in wavenumber space than the magnetic spectrum because of the high mechanical Reynolds number. The numerical difficulties are bridged by a combination of overlapping direct numerical simulations and subgrid models of MHD turbulence. Typically, the critical magnetic Reynolds number increases steeply as the magnetic Prandtl number decreases, and then reaches an asymptotic plateau at values of at most a very few hundred. In the turbulent regime and for magnetic Reynolds numbers large enough, both small and large scale magnetic fields are excited. The interaction between different scales in the flow will be also briefly discussed [2].

[1] P.D. Mininni, Y. Ponty, D.C. Montgomery, J.-F. Pinton, H. Politano, and A. Pouquet, ApJ 626, 853 (2005); Y. Ponty et al, PRL 94, 164502 (2005); P.D Mininni and D. Montgomery, arXiv:physics/0505192.
[2] A. Alexakis, P.D. Mininni, and A. Pouquet, arXiv:physics/0505183; arXiv:physics/0505189.