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# MHD dynamo turbulence for realistic magnetic Prandtl and Reynolds numbers

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MHD dynamo turbulence, which is present in natural objects like in the Earth's core or the solar convection zone, is difficult to study experimentally or numerically, for at least two reasons: small Pm (magnetic Prandtl number, defined as Pm=$\nu/\eta$, $\nu$ and $\eta$ being the fluid viscosity and the magnetic diffusivity), and large Rm (magnetic Reynolds number, defined as Rm=$ul/\eta$, $u$ and $l$ being characteristic fluid velocity and scale). In liquid metal experiments, Pm has the right order of magnitude ($10^{-6}$), but Rm is far less than those of natural objects. One consequence is that, provided dynamo action is obtained, the ohmic dissipation scale is rather close to the forcing scale, preventing the formation of any clear magnetic inertial range. In addition the level of magnetic energy which is obtained is far from equipartition, the Lorentz forces being presumably of little effect on the flow, contrary to what is expected in natural objects. In direct numerical simulations Rm can be rather high, but only for Pm of order unity [1] which, again, is far from realistic values. A consequence is that, for example, the energy transfers between the flow and the magnetic field are strongly different from what is expected in natural objects. An alternative to these approaches is to make some compromises on the physics, for example using shell models of MHD turbulence. Assuming homogeneity and isotropy, the spatial dependency in these models is reduced to only one parameter (wave number). Solving a set of ordinary differential equations, statistical quantities like spectra, fluxes, transfer functions, and scaling exponents can be calculated for realistic values of Rm and Pm [2].

Using a new MHD shell model, we compare MHD turbulent energy spectra in two cases: with and without global rotation. Different spectral slopes (-2 and -5/3) are obtained [3], in agreement with phenomenological arguments. Such spectral slopes have also been identified in the analysis of sunspot numbers, depending on whether the solar magnetic activity is minimum or maximum [4]. Interpreted as the signature of the underlying MHD solar turbulence, these two slopes would then correspond to two turbulent regimes depending on whether rotation is relevant (during the magnetic minima), or not (magnetic maxima). Finally, intermittency spectral exponents have been calculated from both shell models and sunspots time series. They show a much stronger intermittency than in pure hydrodynamic turbulence.

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