Scaling laws for numerical dynamos

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The parameters regime relevant to dynamo action in natural objects is out of reach of present numerical models because of computational limitations. It is thus useful to derive scaling laws to extend numerical results to real world dynamos.

We show that traditional power based scaling laws for the magnetic field strength are too general. They mainly traduce the statistical balance between the energy production and dissipation, and are thus satisfied by any dynamo in statistical equilibrium. We show that predictive scaling laws (i.e. depending on input parameters only) can be derived for the magnetic field strength in numerical dynamos, by guiding our reasoning on physical arguments. We thus show that dipolar dynamos operate in a viscous dynamical regime, which is not relevant to natural objects. The issue of parameters being controlled or measured, depending on the thermal boundary conditions, will also be addressed. Finally we show that the dipolar-multipolar transition occurring in numerical models can be described by a single non-dimensional parameter corresponding to a three-terms balance.