Nonlocal memory effect of the alpha-effect of the dynamo

Shigeo Yoshida[1]; Kumiko Hori[2]

[1] Earth and Planetary Sci., Nagoya Univ.; [2] Max Plank Institut.

http://epp.eps.nagoya-u.ac.jp/~yoshida/

We examine nonlocalness and non-instantaneousness of the electromotive force (the alpha effect) for G.O. Roberts' kinematic dynamo. We calculate the response function of the electromotive force and find a complex behaviour. Non-instantaneousness, which has often been ignored, is found to be significant. For small magnetic Reynolds numbers, the alpha effect is local and instantaneous. However, for magnetic Reynolds numbers of $O(1)$, nonlocalness and non-instantaneousness become important. Above a certain critical magnetic Reynolds number, the small-scale dynamo effect appears, invalidating the well-known high Reynolds number limit.