DPP07-2007-000817

Abstract for an Invited Paper
for the DPP07 Meeting of
the American Physical Society

New directions in the theory of hydromagnetic dynamos[1]

FAUSTO CATTANEO, University of Chicago/ Argonne National Laboratory

In dynamo theory a distinction is made between small- and large-scale dynamo action. The former refers to the generation of magnetic fields on scales smaller than or comparable with the characteristic scale of the velocity. It is now widely believed that in a turbulent fluid, small-scale dynamo action is always possible provided the magnetic Reynolds number is sufficiently high. Large-scale dynamo action, on the other hand, refers to the generation of large-scale fields, i.e the generation of magnetic flux which is of considerable importance in many astrophysical situations. The traditional view is that large-scale generation occurs via an inverse cascade of magnetic helicity driven by turbulence lacking reflectional symmetry. This view, however, is becoming increasingly at odds with numerical simulations that show that the cascade is either absent or ineffective. The question then arises of what are the alternative mechanisms that can leads to the generation of large-scale fields. I will discuss two possible resolutions: one based on the role of boundary conditions in releasing the constraints of helicity conservation, the other based on the existence of special classes of velocity fields that are generated by magnetic instabilities and that are particularly suited to dynamo action. In both cases I will discuss important analogies between the astrophysical and the laboratory situations.

[1]This work was supported byt the NSF sponsored Center for Magnetic Self-Organization