Abstract

Magnetohydrodynamics

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Magnetic field sustainment against ohmic dissipation by turbulent flow is referred to as the turbulent dynamo effect. Theoretical research into dynamo mechanisms has been actively pursued for several decades, culminating recently in massive computer simulations of the Earth's core. The majority of these studies has employed the equations of magnetohydrodynamics (MHD), a nonlinear theory of electrically conducting fluids.

The EDQNM (Eddy-Damped Quasi-Normal Markovian) closure is designed so that the turbulence equations derived from Navier-Stokes dynamics can be closed and satisfy the realizability condition of positivity of the kinetic energy spectrum. In the two-fluid-like case of MHD turbulence, realizability requires more work. Leaf Turner and I have previously proved that equations analogous to those expected of the EDQNM closure for MHD without mean fields satisfy the appropriate realizability conditions.

For my senior thesis I would like to further explore this area. I propose to close the MHD equations with the EDQNM closure and examine the additional requirements needed to make the MHD equations realizable more generally with the EDQNM closure. I wish to investigate aspects of MHD turbulence when mean fields are present. Two aspects are worthy of investigation: the utility of a quasinormal closure when the mean fields are inhomogeneous vs homogeneous, and the effect of the presence of mean fields on realizability. Some of these effects can be studied directly in the purely Navier-Stokes turbulence case. This proposal would likely require numerical simulation. This thesis would build on work begun with Leaf Turner at Los Alamos National Laboratory during the summer of 1999.

Previous Reading:
I have previously studied Uriel Frisch's book *Turbulence* and the closures in it. I've also studied Leaf Turner's papers on closures in turbulence, as well as several articles he recommended. These include H. K. Moffatt's book on electrically conducting fluids, Orszag's work on turbulence, as well as more recent articles. I intend to continue studying these works and any others on magnetic fluids, turbulence, dynamos, and closure schemes that I come across. One interesting source might be: A. Pouquet, U. Frisch, and J. Leorat, J. Fluid Mech. 77, 321-354 (1976).

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