THEORY OF STRONGLY TURBULENT TWO-DIMENSIONAL CROSS FIELD CONVECTION OF CURRENT CARRYING SPACE PLASMAS*

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ABSTRACT

The "direct interaction approximation" of Kraichnan as modified by Kadomtsev is employed to develop a two-dimensional strong turbulence theory which predicts both nonlinear frequency broadening and a power law for the spectrum of a convecting plasma containing a gravitationally induced cross field current. These results are favorably compared with experimental observations, numerical simulations, and previous studies[1] of turbulent cross field convection of current-carrying plasma.

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1. Sudan, R.N. and M.J. Keskinen, Phys. Fluids, 22, 2305, 1979; Keskinen, M.J., Phys. Rev. Lett., 47, 344, 1981.

DISCUSSION

Migliuolo: What is the cause of the westward drift of ionospheric bubbles (in the simulation)?

Keskinen: The westward drift is approximately 60 m/s.

Wentzel: In ordinary hydrodynamic turbulence there is a qualitative difference between two- and three-dimensional turbulence. Can you identify any restrictions inherent in your 2-D approximation for the solar turbulence? Is there a preferred direction to justify 2-D?

Keskinen: In two dimensions the flux function ψ, $\underset{\sim}{B} = \underline{\hat{\lambda}} \times \nabla\psi$, $\underline{\hat{z}}$ in the direction of the magnetic field, is conserved. In three dimensions $K \equiv \int d^3 x\, \underset{\sim}{A}\cdot\underset{\sim}{B}$ is conserved in an ideal fluid where $\underset{\sim}{B} = \nabla \times \underset{\sim}{A}$.

Liu: You included only $\vec{V}\cdot\nabla\vec{V}$ nonlinearity in the equation of continuity, but neglected $\vec{V}\cdot\nabla\vec{V}$ nonlinearity in the equation of motion. Why?

Keskinen: We are studying length and time scales such that inertial effects in the equation of motion can be neglected.

Lotko: Can you say under what conditions we can apply the direct interaction approximation to MHD turbulence?

Keskinen: These conditions are adequately discussed in Sudan and Pfirsch (Phys. Fluids, 1984, to be published).

M. R. Kundu and G. D. Holman (eds.), Unstable Current Systems and Plasma Instabilities in Astrophysics, 475.