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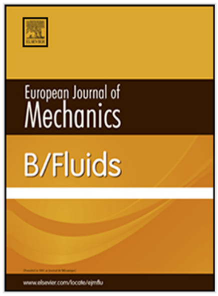

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D.V. Lyubimov, F.H. Busse, T.P. Lyubimova, E.S. Sadilov, A.V. Burnysheva

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Rotating magnetic field effect on an onset of convection in a horizontal layer of conducting fluid

D.V.Lyubimov[1], F.H.Busse[2], T.P.Lyubimova[1,3], E.S.Sadilov[3] and A.V.Burnysheva[3]

[1]Perm State University, 15, Bukireva Str., 614990, Perm, Russia
[2]Institute of Physics, University of Bayreuth, D-95440, Bayreuth, Germany
[3]Institute of Continuous Media Mechanics UB RAS, 1, Koroleva Str.,614013, Perm, Russia

The onset of convection in a horizontal layer of an electrically conducting fluid heated from below is studied in the presence of a horizontal magnetic field rotating about a vertical axis. Two different ranges of the rotation frequency are considered: (1) the case of high frequencies of rotation for which the averaging approach is used and (2) the case of finite frequencies for which the averaging approach might be implemented. It is shown that in general the magnetic field stabilizes the static state of pure thermal conduction. However, there exists a parameter range where the inhomogeneity of the magnetic field is strong enough to provide energy for the growth of disturbances even if the fluid layer is stably stratified.

1 Introduction

The problem of the onset of convection in a plane horizontal fluid layer heated from below is a classical problem of hydrodynamic stability theory. There are also many works on the effect of various external fields on the onset of convection. The present paper deals with the investigation of the onset of convection in infinite plane horizontal layer of electrically conducting fluid subjected to a rotating magnetic field. It is known that in the case of a finite size cavity a rotating magnetic field induces an azimuthal flow in the fluid. In infinite layers, for fluids of not too high electrical conductivity, rotation is absent.

In early works on the effect of magnetic fields on the onset of convection in electrically conducting fluids by Thompson [1] and Chandrasekhar [2]-[4], plane horizontal layers subjected to the uniform static magnetic fields were considered. It was shown that the effects of vertical and horizontal components of magnetic field are different. The boundary of monotonous instability is affected only by the vertical component of the magnetic field. It leads to the growth of the critical Rayleigh number and the critical wave number , i.e. magnetic field increases the stability of the conductive state and shifts the instability to shorter wavelength perturbations. Moreover, the property of isotropy and degeneracy (the possibility of the existence of convective patterns both in the form of rolls and in the form of the superposition of the several rolls) related to that isotropy, are kept in the case of a purely vertical magnetic field. Contrary to that, the presence of a horizontal

[1] Perm State University, 15, Bukireva Str., 614990, Perm, Russia
[2] Institute of Physics, University of Bayreuth, D-95440, Bayreuth, Germany
[3] Institute of Continuous Media Mechanics UB RAS, 1, Koroleva Str., 614013, Perm, Russia