Magnetoconvection in the fluid layer with anisotropic diffusivities rotating around horizontal axis

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A b s t r a c t : The influence of anisotropic viscosity and thermal diffusivity on the problem of rotating magnetoconvection in the horizontal fluid layer was studied. The layer rotates about horizontal axis, which is perpendicular to the imposed homogeneous horizontal magnetic field. The anisotropy in the sense of various coefficients in the vertical direction and horizontal directions (e.g. $\nu_{xx} = \nu_{yy} \neq \nu_{zz}$) is included and the anisotropic parameter, α, the ratio ν_{xx}/ν_{zz} as a measure of anisotropy is introduced. The linear stability analysis in the cartesian geometry is adopted and the convection is in the form of steady and/or non-stationary horizontal rolls. The influence of anisotropy on the critical Rayleigh number, critical wave numbers and critical frequency is investigated. Anisotropic diffusivities may inhibit or facilitate the onset of convection and they also determine the spatial and temporal structures of arising convection. The critical mode, i.e. the mode with minimum Rayleigh number is determined globally in the space of parameters, Λ, E_z, q, α, i.e. the Elsasser number, Ekman number, Roberts number, and anisotropic parameter, respectively, so the ΛE_z and Λq_z regime diagrams are presented.

Results are compared with the study of model with vertical rotation axis (Šoltis and Brestenský, 2010). In the isotropic case the comparisons with the results in (Eltayeb, 1972, 1975) and in (Kurt et al, 2004) are made.

The anisotropy has more complex influence on the stationary and non-stationary convection than in the model with vertical rotation axis. It strongly depends on two distinct definitions of Rayleigh number. Therefore, the possibility of various definitions of the Rayleigh number in the anisotropic case is also discussed. Further, in the case of non-stationary

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convection the curious oblique mode, which is almost perpendicular to the magnetic field and which has no analogy in the case with vertical rotation axis, appears. The properties of this mode are confirmed by suitable asymptotic techniques.

Key words: anisotropic diffusive coefficients, rotating magnetoconvection, Earth's core, geomagnetic field

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