SPHERICAL MAGNETOCONVECTION WITH ANISOTROPIC TURBULENT THERMAL DIFFUSION

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Turbulence in the Earth's core is modelled by anisotropic turbulent viscous and thermal diffusivities enhanced or diminished in the directions of the rotation axis, magnetic field and gravity (Braginsky & Meytlis 1990) using invariance arguments (Phillips & Ivers 2000). In the present study considers magnetoconvection in a rapidly rotating conducting fluid sphere ($r < a$) with basic state magnetic, velocity and temperature fields, $\mathbf{B}_0 = B_0(s/a)\mathbf{1}_\phi$, $\mathbf{v}_0 = \mathbf{0}$, $\Theta_0 \propto a^2 - r^2$. [$(r,\theta,\phi)$ are spherical polar coordinates and s is the cylindrical radius.] The turbulent thermal diffusion tensor is given by

$$\mathbf{D}_\kappa = \kappa\left[\mathbf{I} + \varphi(\Omega, B_0)B_0^2 s^2 \mathbf{1}_\phi\mathbf{1}_\phi + \zeta(\Omega, B_0)\mathbf{1}_z\mathbf{1}_z\right],$$

where Ω is the rotation rate, and the viscous diffusion is isotropic. The exterior is electrically insulating with no-slip, isothermal boundary conditions.

Critical modified Rayleigh numbers are determined for a range of viscous and magnetic Ekman, Elsasser and Roberts numbers approaching Earth core values. The main result is that enhanced anisotropic components of the turbulent thermal diffusion tensor in the rotation and magnetic field directions ($\zeta, \varphi > 1$) are stabilizing.

turbulence, anisotropy, core

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