STABILITY OF ALMOST ADIABATIC CONVECTION IN ROTATING PLANETARY SHELLS

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The problem of thermal convective instabilities of a fluid in rotating self-gravitating spheres and shells has been subject of many papers mostly due to its importance for various geophysical and astrophysical applications including geodynamo problem. The fluid motion inside the Earth's outer core is examples of the flows for which knowledge on the general behaviour of such convection can be applied. In most of the works on this issue the Boussinesq fluid is considered. However, it is known that almost adiabatic states are typical for the deep convective interiors of all known planets and their moons. The asymptotic theory for the marginal stability of almost adiabatic geo-convection was given just recently by Starchenko et al. (2006). Asymptotic analysis was performed within the framework of local theory and new estimates of critical parameters differ from those obtained previously using the Boussinesq model.
Here we consider the marginal stability of well-mixed almost adiabatic states in rapidly rotating spherical shells, whose inner to outer radius ratio does not exceed that of the modern Earth. The buoyancy source is the non-convective entropy gradient that is purely radial and consist of two terms – first one is linear in r and second one is r^{-2} proportional. This second term can be treated as normalized difference between temperatures or heat fluxes on the inner and outer boundaries of the core, and the stabilizing first term corresponds to the inner cooling of the core.
The critical Rayleigh-type numbers, frequencies and solution structures of the marginal states are determined by both analytical and numerical methods. In each case we consider the range of convective layer widths and set of different values of Prandtl number.

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