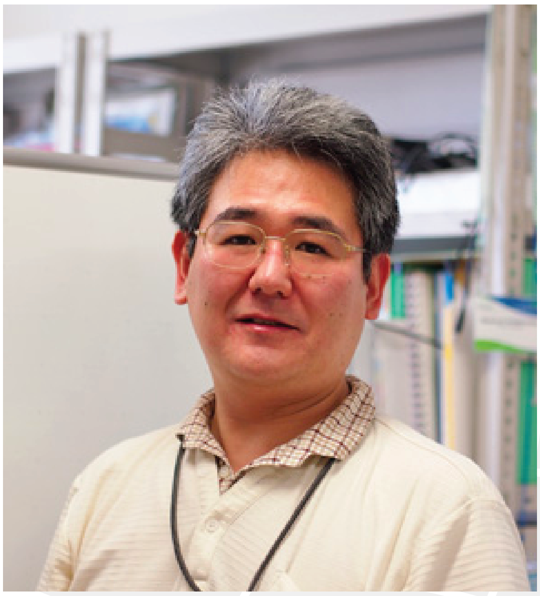
THE GEODYNAMICS SEMINAR №568



Dr. Masanori Kameyama
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2020.03.11 (Fri.) 16:30 ~

Venue: Zoom

A link will be sent @grc-all within 30 minutes before the beginning of the seminar.

Keywords: 1. Mantle convection
2. super-Earths
3. Adiabatic compression

Linear analysis on the onset of thermal convection of highly compressible fluids with variable viscosity and thermal conductivity in spherical geometry: Implications for the mantle convection of super-Earths

We carried out a series of linear analyses on the onset of thermal convection of highly compressible fluids whose physical properties strongly vary in space in convecting vessels either of a three-dimensional spherical shell or a two-dimensional spherical annulus geometry. The variations in thermodynamic properties with depth are taken to be relevant for the super-Earths with 10 times the Earth's mass, while the thermal conductivity and viscosity are assumed to exponentially depend on depth and temperature, respectively. Our analysis showed that, for the cases with strong temperature-dependence in viscosity and depth-dependence in thermal conductivity, the critical Rayleigh number is on the order of 10 to the 8-th to 9-th power, implying that the mantle convection of massive super-Earths is most likely to fall in the stagnant-lid regime very close to the critical condition, if the properties of their mantle materials are similar to the Earth's. Our analysis also demonstrated that the structures of incipient flows of stagnant-lid convection in the presence of strong adiabatic compression are significantly affected by the depth-dependence in thermal conductivity and the geometries of convecting vessels. When the increase in thermal conductivity with depth is sufficiently large, the thermal stratification can be greatly stabilized at depth, further inducing regions of insignificant fluid motions above the bottom hot boundaries. We can therefore speculate that the stagnant-lid convection in the mantles of massive super-Earths is accompanied by another motionless regions at the base of the mantles if the thermal conductivity strongly increases with depth (or pressure), even though their occurrence is hindered by the effects the spherical geometries of convecting vessels.

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