Thermal conductivity of Super Earth's mantle

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Venue: Zoom

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Since the discovery of extrasolar planets with several Earth masses, the interest in the interior dynamics of the so-called "super-Earths" has significantly increased. Pressures at the base of the mantles of extrasolar rocky planets may reach tera-pascals (~1000 GPa), while that of the Earth's core-mantle boundary is ~100 GPa. Consequently, detailed information on transport properties (thermal conductivity and viscosity) and thermodynamic properties of the constituent materials under such ultrahigh pressures and temperature conditions are required to understand the thermal structure of the super-Earth's interior. However, little is known about these physical quantities especially on transport properties in the tera-pascal regime. We have recently established an ab initio computational approach based on the density-functional theory for determining lattice thermal conductivity of minerals.

In this presentation, I will report the thermal conductivities of MgO calculated up to ~1000 GPa and ~5000 K. The effect of phase transition from B1-type to B2-type on the conductivity will also be discussed. The Rayleigh number, an indicator for convection activity, is then estimated by combining present results with thermodynamic properties such as thermal expansivity and heat capacity also determined in this study. Our estimate suggests the vigorous mantle activity of a super-Earth with ten Earth masses composed of MgO mantle and iron core.

Keywords: 1. Super-Earth
2. Thermal conductivity
3. Computer simulation