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Thermal transport of iron alloys and geodynamo in Earth's core

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Thermal transport properties of constituent iron alloys in Earth's core play an important role in our understanding of the thermal and thermochemical energy sources powering the geodynamo. The heat flux across the core-mantle boundary (Q_{CMB}) in turn drives the mantle convections and plate tectonic movements. It is thus of great importance to determine thermal and electrical conductivities of constituent iron alloys in order to model the dynamic processes and thermal evolution of deep Earth. In this presentation, I will discuss recent experimental results on the electrical and thermal conductivity of iron alloys at relevant Earth's core pressure-temperature (P-T) conditions. We have developed the four-probe van der Pauw method in a laser-heated diamond anvil cell (DAC) to measure the electrical resistivity and laser pump-and-probe techniques to measure the thermal conductivity of iron alloyed Ni, Si, C, and S at high P-T conditions. These results are used to discuss the validity of Wiedemann-Franz Law and the effects of light elements on thermal transport properties of iron in Earth's core. Specifically, the electrical resistivity of hcp-Fe increases almost linearly with temperature at pressures relevant to the topmost outer core, and is mainly dominated by electron-phonon scattering. Addition of a small amount of silicon light element (~2 wt% Si) in *hcp*-Fe significantly increases its resistivity by ~25%, but Ni does not have any noticeable effect on the conductivity of *hcp*-Fe at near CMB *P-T* conditions. Earth's outer is expected to contain 8-10 wt% light element(s). When a substantial amount of light element is added in iron, impurity scattering effect becomes dominant, leading to temperature-independent conductivity in Fe alloys. These results are combined with geodynamic modelling to provide constraints on the thermal and compositional energy sources for the geodynamo, dynamic processes in the outer core, and the age of the inner core.