Transport properties of iron mixtures at Earth’s core conditions

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The Earth is a dynamic planet, reshaping its surface and its interior on geological time scales. Most of the energy responsible for these activities was deposited in the original accretion process 4.5 billion years ago, and is continuously produced in the decay of radioactive material.

On much shorter time scales (thousands of years), the Earth’s liquid outer core recycles and mixes throughout. These convective motions are responsible for the generation of the Earth magnetic field, and for transporting heat from the bottom of the core to the base of the mantle, where it is used to drive mantle convection.

Transport of heat mechanisms in the core are determined by the thermal conductivity of core material. Ohmic dissipation of the magnetic field generating currents depends on the electrical conductivity. Knowledge of these two parameters is therefore essential to build a thermal model of the Earth and its magnetic field.

Here I will present first principles computer simulation of the electrical and thermal conductivity of core material. Our results are significantly higher than conventional estimates based on extrapolation from ambient conditions, and have important consequences for our understanding of the Earth’s thermal structure. I will also discuss recent experiments which appear to confirm the theoretical predictions.