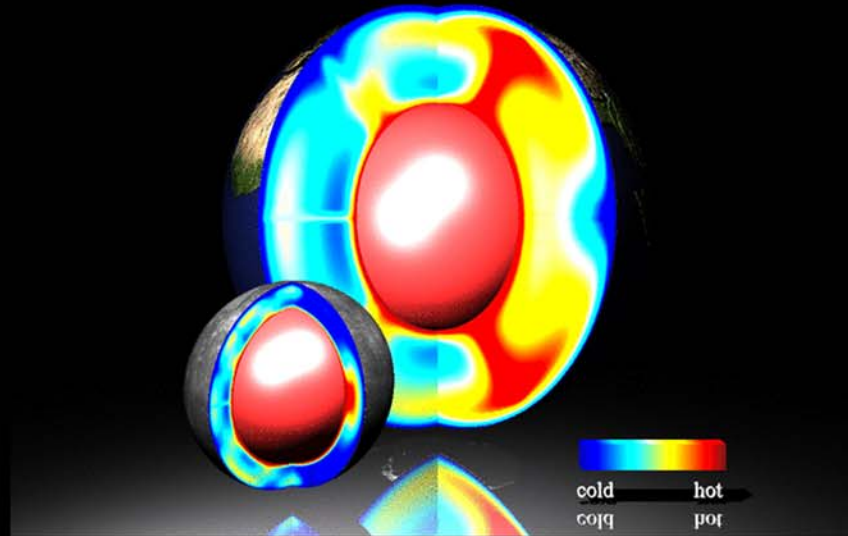


# Mantle Convection



**Heat Transfer:** Thermal energy, or heat, from the hot interior of the planet flows out of the surface into space. When an object is at a different temperature than its surroundings, heat will transfer from the region of higher temperature to the region of colder temperature to achieve thermal equilibrium. The mantle transfers heat from the hot core at the planet's center to the colder surface. This happens primarily by either *conduction* or *convection*.

**Conduction:** Hot vibrating atoms and molecules transfer energy (heat) to neighboring atoms and molecules. An example of this is the handle of a frying pan getting hotter as heat from the stove slowly moves along the handle.



**Convection:** Heat is transferred by the movement of fluid. The bulk motion of the material moves heat. An example is boiling water. Water at the bottom of the pan is heated by the stove. The increase in temperature produces a reduction in density and the warm, less dense (buoyant) water begins to rise and the colder, denser water near the surface is displaced and sinks.

**Mantles:** The mantles of the planets conduct heat, but can also convect. Mantles are solid. How do they convect? Over very long time scales (10's - 100's of millions of years) the mantle rocks under extreme pressures and temperatures slowly deform like an extremely thick (viscous) fluid. This is called solid-state convection. On short time scales they still behave like a solid. For another example of time-scale dependent behavior, consider silly putty. If squeezed slowly it deforms in your hand (long time-scale) but if thrown at a wall it bounces like a solid ball (short time-scale). If temperature gradients in the mantle are large enough, then convection will occur. Convection is the primary mode of heat transfer in the Earth's mantle. It is unknown if convection occurs presently in Mercury's mantle though it likely did in the past when its interior was hotter. The figure above shows computer simulations of convecting mantles.