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Outer core compositional layering and constraints on core liquid transport properties

George Helffrich
Earth Sciences, U. Bristol, Bristol, United Kingdom

A variety of studies of the Earth's outer core report wave speeds near the top of the core slightly lower than reference models for core properties. One interpretation of the slower wavespeed profile is that it could represent a change in the core's light element concentration with depth in the core. I explore the consequences of this idea by interpreting the velocity profile as arising from diffusion gradients imposed in the outer core by various mechanisms. I also examine theories for transport properties of high pressure metallic liquids that are based on hard-sphere models. These theories predict core diffusivities on the order of $1 - 20 \times 10^{-9}\ \mathrm{m^2 s^{-1}}$. From the seismic wavespeed profile, an effective diffusivity may be obtained, which ranges from $0.1 - 10 \times 10^{-7}\ \mathrm{m^2 s^{-1}}$ depending on the particular boundary condition or initial condition chosen. The upper bound on the range is much higher than expected from high pressure experiments and models of diffusivity in liquid metals. The lower bound is within the uncertainty of theoretical predictions and experimental determinations given the range of expected outer core temperatures if diffusion involves low Z elements. Plausible agreement arises from a class of models that represent diffusion out of a compositionally different layer existing from the time of the formation of the Earth. If the wavespeed profile in the core is diffusive in nature, the data suggest that it is an original feature of the core.