Regional Variation of Inner Core Anisotropy from Seismic Normal Mode Observations

Arwen Deuss[a], Jessica Irving [a], John H. Woodhouse[b],
[a] *Bullard Labs, University of Cambridge, UK*
[b] *Department of Earth Sciences, University of Oxford, UK*

The Earth's core, consisting of an iron alloy, makes up one third of our planet's total mass. As the Earth cools, the inner core grows by solidification of the fluid outer core. Solidification results in the release of light elements and latent heat, which drive the geodynamo generating the Earth's magnetic field. It is well known from seismological observations that the inner core is anisotropic and possibly rotating faster than the Earth's mantle. Here, we study inner core structure using long period normal mode splitting functions and make observations of regional variations in inner core anisotropy which are consistent with short period compressional body waves.

Previous seismic studies using compressional body waves had suggested hemispherical variation in the isotropic and anisotropic structure of the inner core. However, because of the limited distribution of earthquakes and receivers, the global extent of the hemispherical variations was poorly constrained. The observed signal may, for example, be due to more complicated regional variations. Normal mode observations have the potential to provide robust evidence, but so far had been elusive due to lack of theory and suitable data. Previous studies investigated isolated modes, which are only sensitive to even-degree structure, and showed strong evidence for inner core anisotropy. To investigate hemispherical variations, which is odd-degree structure, cross-coupling between pairs of modes has to be taken into account. We recently derived new theory, allowing us to make such observations for the first time.

Using data from recent large earthquakes, we report splitting function measurements of odd-degree structure for pairs of coupled modes sensitive to the inner core in comparison with body wave observations. The observed odd-degree structure suggests more complicated regional variations than a simple Eastern versus Western hemispherical pattern. Our results open up possibilities for directly linking regional variations in inner core structure to the strength of the magnetic field and thermal evolution of the Earth's core. The similarity of the observed seismic pattern with Earth's magnetic field suggests freezing-in of crystal alignment during solidification or texturing by Maxwell stress as origins of the anisotropy. These observations also limit the amount of inner core super rotation, but would be consistent with oscillation.