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Seismic structure of the Earth's core

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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 the seismic structure of the inner core using both short period compressional body wave observations and long period normal mode splitting functions.

Using compressional body waves, we find evidence for hemispherical variations in the isotropic and anisotropic structure of the Earth's inner core, confirming previous studies. However, because of the limited distribution of earthquakes and receivers, the global extent of the hemispherical variations is 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 been elusive due to lack of theory and suitable data. Previous studies have 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.

Here, we report splitting function observations 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 and opens 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. Such links would be limited by the possible super rotation of the inner core, which we show may be less robustly found in seismic data than has been claimed in previous studies.