Pre melting in rare gases

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The Earth's inner core is thought to consist of an iron-nickel alloy with a few percent of light alloying elements. Seismic wave velocities through the inner core are known, but to date, seismological and mineralogical models in this region do not agree. Current mineralogical models derived from *ab initio* calculations predict a shear-wave velocity V_S that is up to 30% greater than the seismically observed values. Recent computer simulations at Earth's core conditions, revealed that the shear modulus, and therefore the seismic velocities of iron, reduces dramatically just prior to melting. These findings provide an elegant explanation for the discrepancy between mineralogical models and seismic data.

At present, these computer calculations on hcp-Fe are the only result on pre-melting of direct relevance to the Earth's core. It is crucial, therefore, that the role of pre-melting in the inner core is systematically tested for a range of P-T conditions. Measuring the pressure dependence of pre-melting effects on the elastic properties of iron, under inner core conditions and to the required precision, is extremely challenging. We therefore investigate to what extent pre-melting behaviour occurs in the elastic properties of other materials at more experimentally tractable conditions and combine these studies with computer simulations. In this particular study, we report the elastic properties of single-crystals of argon, prior to melting. Ar is an ideal test material since it crystallises in a simple monatomic face-centred structure which is easily modelled using classical potentials or *ab initio* methods. In addition, the compressibility of Ar is large and the temperature range required is within the capabilities of externally heated diamond-anvil cells so high pressures and temperatures close to the melting point can be readily achieved. The elastic constants, anisitropy, and the crystal orientation at each pressure and temperature are accurately determined by combinining Brillouin scattering measurements with X-ray diffraction.

We discuss the circumstances under which the pre-melting behaviour occurs, the mechanism(s) by which it occurs and which are the consequences of premelting for the Earth's core.