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Spin transitions in cementite

It was proposed over 45 years ago by W.S. Fyfe that the effect of pressure deep inside the Earth may be to collapse the atomic orbitals of iron from the high-spin to the low-spin state. This transition would represent a major change in chemical-bonding character for one of the most important elements in the Earth with predictions suggesting as much as a 45% collapse in the ionic volume of ferrous iron in silicates and oxides. Elastic moduli, thermal conductivity, electrical transport, and other physical and chemical properties of Fe-bearing minerals could be dramatically altered due to this transition. Consequently, there has been much interest in the high- to low-spin transition, and high-pressure studies of the past decade have demonstrated that it can indeed take place in oxides similar to those thought to be present in the deep mantle.

In this talk I will outline the basic physics of spin transitions in iron and consider experimental results for magnesiowustite to demonstrate the general effect on mantle properties. Details of recent experiments on cementite will then be presented.

Primary author: Dr CLARK, Simon (Macquarie University)

Presenter: Dr CLARK, Simon (Macquarie University)