

Unconventional magnetic order in GeFe_2O_4

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The spinel structure is widely occurring in natural and synthetic materials. The oxides of this family exhibit the general formula AB_2O_4 , where the oxygen forms a ccp arrangement, the B cation coordinates in edge-sharing octahedra and the A cation occupies tetrahedra. The technological and scientific significance of these materials has risen in the last few decades, but their geological relevance had focused their characterisation under high-temperature and high-pressure conditions. The low temperature behaviour of most materials in this class is remarkably under-explored.

GeFe_2O_4 is a normal spinel, where the octahedral site is occupied by Fe(II) cations and the tetrahedral site is occupied by Ge(IV). The 3D arrangement of the Fe(II) outlines a pyrochlore lattice; as such, the structure has the potential for frustration upon magnetic ordering of the iron moment, which is reported as antiferromagnetic ($T \sim 10$ K) by early physical measurements. [1]

We report a full magnetic structure solution, derived from neutron powder diffraction data collected at D2B and D20 at the ILL reactor, France.

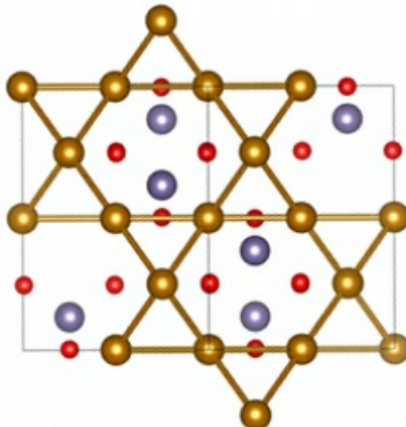
Contrary to reports on other germanate spinels in the transition metal series (GeCo_2O_4 , GeNi_2O_4 [2][3]), the GeFe_2O_4 structure shows no signs of distortion in the crystal structure and remains cubic $\text{Fd-}3\text{m}$ below the Néel temperature. The appearance of magnetic Bragg peaks reveals the ordering temperature to be $T = 8.6$ K. Keeping the cubic symmetry, the magnetic structure was solved with incommensurate propagation vector $\mathbf{k} = [\frac{2}{3} + \delta, \frac{2}{3} + \delta, 0]$, with $\delta = 0.025$.

Due to the inherent frustration of the pyrochlore lattice, a complex spin structure is required to achieve antiferromagnetic ordering without distorting the cubic symmetry. This unusual magnetic ordering and its implications will be presented.

[1] Blasse, G. & Fast, J. F. (1963) Philips Res. Rep. 18, 393;

[2] Barton, P.T et al. (2014) Phys Rev B 90, 064105;

[3] Diaz, S. et al. (2006), Phys. Rev. B 74, 092404



Pyrochlore lattice of edge-sharing iron-iron octahedra

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