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The anisotropic magnetism of the cobalt-doped rare earth iron garnet Lu3Fe4Co0.5Si0.5O12

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The rare earth iron garnets (IGs, $REFe_5O_{12}$, where RE is a rare earth) have been a source of scientific interest for decades due to their ferrimagnetic properties [1] and corresponding magnon dynamics [2]. The most famous rare earth IG, YIG, is the cornerstone of advances in spintronic technology, due to its exceptionally low magnon damping, microwave and magneto-optical properties [2]. Less well known are the magnetic excitations of other rare earth IGs, such as LuIG.

The rare earth IGs are described by space group $Ia3d$. The distribution of magnetic Fe ions among different sites leads to ferrimagnetism. Lu, being the smallest of the rare earths, is more likely to create antisite defects within the material. When combined with doping on the non-magnetic and magnetic sites, this leads to phenomena such as the inverse Faraday effect [3] and the spin Seebeck effect [4]. $Lu_3Fe_4Co_{0.5}Si_{0.5}O_{12}$ is a specific example of doped LuIG with increased anisotropy due to the Co^{2+} substitution. Inherent in this large unit cell are frustrated exchange interactions. In a thin film sample this led to a magnetic phase transition at 200 K and an additional cluster spin glass phase below 190 K [5].

We have now studied $Lu_3Fe_4Co_{0.5}Si_{0.5}O_{12}$ in the bulk, using a single crystal sample for inelastic neutron scattering on the PELICAN and TAIPAN instruments at ANSTO, and neutron diffraction on D10 at the ILL. Our results show a clear anisotropy gap and a smaller gap between the acoustic magnon modes compared to YbIG [6] and YIG [7], as well as magnetocrystalline anisotropy that is strongly temperature dependent. The key differences in the magnetic structure, spin wave spectra and exchange parameters will be discussed.

References

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Topics

Magnetism and Condensed Matter

Primary author(s) : Dr TOBIN, Siobhan (University of Oxford & ANSTO); Prof. BOOTHROYD, Andrew (University of Oxford); Dr PECANHA-ANTONIO, Viviane (ISIS & University of Oxford); Prof. RULE, Kirrily (ANSTO & UOW); Dr MOLE, Richard (ANSTO); Dr KIBALIN, Iurii (ILL); Dr PRABHAKARAN, Dharmalingam (University of Oxford)

Presenter(s) : Dr TOBIN, Siobhan (University of Oxford & ANSTO)

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