HIDDEN AND CONSPICUOUS MAGNETIC ORDER IN GADOLINIUM GARNETS

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Frustrated magnetic materials are considered to be most promising candidates for new states of matter as in these materials lattice geometry may suppress conventional magnetic dipole order and allow *hidden* order to emerge instead. This report describes the latest developments in studying magnetic properties of $Gd_3Ga_5O_{12}$ (GGG), a canonical highly frustrated magnet. We use neutron diffraction to probe the magnetic ground state of GGG in zero field, as well as neutron spectroscopy to explore the excitations present in this magnet in an applied field. In zero-field, a combination of neutron-scattering experiments and reverse Monte Carlo refinements point to the existence of a *hidden* order at low temperature. This is long-range order with a diverging correlation length, in which multipoles are formed from ten-spin loops [1]. In a magnetic field, analysis of the diffraction data shows that the spins in GGG are not fully aligned, but are canted slightly as a result of the dipolar interaction. The dominant contribution to the inelastic scattering at large momentum transfers is from a band of almost dispersionless excitations. We show that these excitations correspond to spin waves localised on the ten-spin loops, and that the spectrum at higher fields is well described by spin wave theory [2].

[1] J.A.M. Paddison *et al*., Science **350**, 179 (2015)
[2] N. d'Ambrumenil *et al*., PRL **114**, 227203 (2015)