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Deducing multi-k magnetic structures via spin-waves in Gd-pyrochlores

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Pyrochlore Heisenberg antiferromagnets (HAFs) are commonly studied as an archetypal example of three-dimensional geometrical magnetic frustration. The study of these so-called "highly frustrated magnets"provides a route to access a large variety of fascinating emergent low-temperature magnetic states including spin-liquids, spin-glasses, spin-ices, and fragmented spin-structures.

Gd-pyrochlores should, in principle, be rather simple examples of pyrochlore HAFs due to the spin-only ground state of Gd^{3+}. However, dipolar interactions, and admixed orbital states, result in a variety of magnetic ground states ranging from the co-planar *Palmer–Chalker* (PC) state, to fascinating partially ordered multi-k structures.

We will present spin-wave studies on 3 examples of Gd-pyrochlore HAFs, $Gd_2Ti_2O_7$ (GTO) [1], $Gd_2Sn_2O_7$ (GSO) [2] and $Gd_2Pt_2O_7$ (GPO) [3]. GSO and GPO are uncontroversial PC magnets, where powder TOF-INS measurements on isotopically substituted samples elucidate the leading magnetic interactions. In the case of GTO, analysis of the spin-wave spectra, even in a powder sample, is found to solve the multi-k problem - where (even single crystal) diffraction cannot decide between mutli-k variants, but the ground state excitations are decisive in this regard.

[1] J A M Paddison, *et al.*, Suppressed-moment 2-k order in the canonical frustrated antiferromagnet Gd2Ti2O7. npj Quantum Materials, 6(1), 99 (2021). https://doi.org/10.1038/s41535-021-00391-w

[2] J R Stewart, *et al.,*. Collective dynamics in the Heisenberg pyrochlore antiferromagnet Gd 2Sn2O7. Physical Review B, 78(13), 3–6 (2008). https://doi.org/10.1103/PhysRevB.78.132410

[3] P G Welch, *et al.*, Magnetic structure and exchange interactions in the Heisenberg pyrochlore antiferromagnet Gd2Pt2O7. Phys. Rev. B, 105(9), 094402. (2022) https://doi.org/10.1103/PhysRevB.105.094402

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