



Contribution ID: 36

Type: Talk (17 + 3 min)

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

Tuesday 21 March 2023 12:10 (20 minutes)

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  $\text{Gd}^{3+}$ . 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,  $\text{Gd}_2\text{Ti}_2\text{O}_7$  (GTO) [1],  $\text{Gd}_2\text{Sn}_2\text{O}_7$  (GSO) [2] and  $\text{Gd}_2\text{Pt}_2\text{O}_7$  (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 multi-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  $\text{Gd}_2\text{Ti}_2\text{O}_7$ . *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  $\text{Gd}_2\text{Sn}_2\text{O}_7$ . *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  $\text{Gd}_2\text{Pt}_2\text{O}_7$ . *Phys. Rev. B*, 105(9), 094402. (2022) <https://doi.org/10.1103/PhysRevB.105.094402>

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**Session Classification:** Frustrated Magnets 2

**Track Classification:** Magnetism, Superconductivity, Topological Systems, Magnetic Thin Films and other electronic phenomena