$FeMn_3Ge_2Sn_7O_{16}$: a "Partial" Spin-liquid Candidate with a Perfectly Isotropic 2-D Kagomé Lattice

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MARTES 31 DE MAYO A LAS 12:00

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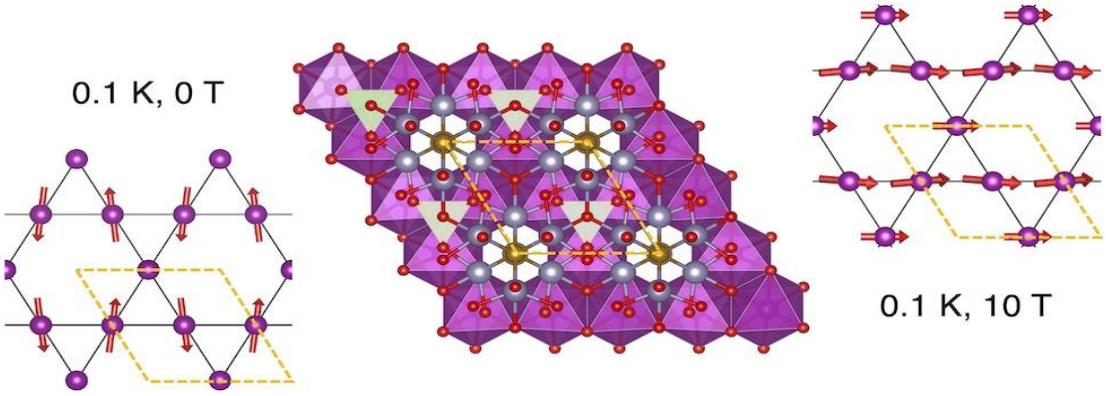
$FeMn_3Ge_2Sn_7O_{16}$ [1] is a fully ordered stoichiometric phase containing an undistorted hexagonal kagomé lattice of Mn^{2+}cations. It represents not only an important expansion of the chemistry of the complex composite $FeFe_3Si_2Sn_7O_{16}$ structure type,[2,3] by replacing silicon with germanium, but also an improvement on the perfection of the kagomé lattice by replacing anisotropic high-spin Fe^{2+} (d^6, L = 2) with isotropic high-spin Mn^{2+} (d^5, L = 0), controlled by the size-matched replacement of SiO_4^{4-} with GeO_4^{4-} bridging units. This anisotropy was suspected of playing a role in the unique "striped" magnetic structure of $FeFe_3Si_2Sn_7O_{16}$ below T_N = 3.5 K,[4,5] which breaks hexagonal symmetry and leaves one-third of the magnetic moments geometrically frustrated and fluctuating. We observe the same striped magnetic structure in $FeMn_3Ge_2Sn_7O_{16}$ down to at least 40 mK, ruling out single-ion anisotropy as the driving force for the apparent 'partial spin-liquid' nature of these compounds. Furthermore, conventional and polarised neutron powder diffraction data show that for both $FeFe_3Si_2Sn_7O_{16}$ and $FeMn_3Ge_2Sn_7O_{16}$, one-third of the paramagnetic scattering persists below T_N; while an applied magnetic field can relieve the geometric frustration, induce a canted ferromagnetic state with ordered moments on all the magnetic sites.

[1] Allison, M.C., et al., Chem. Mater. **34**, 1369–1375 (2022).
[2] Söhnel, T., et al., Z. Anorg. und Allg. Chemie **624**, 708–714 (1998).
[3] Allison, M.C., et al., Dalton Trans. **45**, 9689–9694 (2016).
[4] Ling, C.D., et al., Phys. Rev. B **9**, 180410 (2017).
[5] Dengre, S., et al., Phys. Rev. B **103**, 064425 (2021).



Structure of $FeMn_3Ge_2Sn_7O_{16}$ (Fe = gold, MnO_6 = purple, Sn = grey, GeO_4 = green, O = red) with its zero-field and in-field magnetic structures.