Exploration of a rare-earth candidate Kitaev quantum magnet

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Cooperative magnetism on honeycomb lattices has recently been much explored in the search for unconventional magnetic order or topological Kitaev quantum spin liquid physics predicted for strongly anisotropic exchanges between spin-orbit entangled magnetic moments.

Whilst most research to date has focused on (transition metal) iridates and ruthenates, rare-earth ions have also been theoretically proposed as candidates to host such physics, but are experimentally largely unexplored due to major challenges in materials synthesis.

We have successfully synthesized both powders and single crystals of a polymorph of Na_2PrO_3, with the Pr Kramers ions arranged in a hyperhoneycomb lattice, which shares the same local threefold coordination as the planar honeycomb, but where additional bond rotations make it a fully three-dimensional structure, much studied theoretically as a potential host for unconventional magnetism.

Through powder neutron diffraction we reveal a noncollinear, four-sublattice magnetic structure, and using inelastic neutron scattering we observe a rich spectrum with strongly dispersive magnetic excitations above a substantial spin gap. These observations cannot be accounted for by conventional isotropic spin exchanges, but can arise naturally from the cooperative effect of frustrated anisotropic exchanges.

Work in collaboration with Ryutaro Okuma, Kylie MacFarquharson, Roger D. Johnson, David Voneshen and Pascal Manuel.