Exploration of a rare-earth candidate Kitaev quantum magnet

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The cooperative magnetism on honeycomb lattices has been recently much explored in search for unconventional magnetic orders or topological Kitaev quantum spin liquid physics predicted for strongly anisotropic exchanges between spin-orbit entangled magnetic moments. Whilst most research so far 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 challenges in materials synthesis. We have successfully synthesized both powders and single crystals of a polymorph of Na_2PrO_3, with Pr^{4+} 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 neutron powder diffraction we reveal a noncollinear magnetic structure, and using inelastic neutron scattering we observe a rich spectrum with strongly dispersive magnetic excitations above a substantial spin gap. Those observations cannot be accounted for by conventional isotropic spin exchanges, but can arise naturally from the cooperative effect of frustrated anisotropic exchanges. Our results highlight that rare-earth ions such as 4*f* Pr^{4+} could provide an important platform, next to 4*d* Ru^{3+} and 5*d* Ir^{4+}, for exploring novel forms of cooperative quantum magnetism of spin-orbit entangled magnetic moments. Work in collaboration with Ryutaro Okuma, Kylie MacFarquharson, Roger D. Johnson, David Voneshen, and Pascal Manuel.