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$Ba_3Yb_2Zn_5O_{11}$: A model system for anisotropic exchange on the breathing pyrochlore lattice

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Competing strongly anisotropic exchange interactions can stabilize a range of unusual phenomena; this can include unusual magnetic and non-magnetic orders as well as disordered classical and quantum spin liquids. In many of such compounds, the physics is very delicate and accurate determination of the effective exchange interactions is crucial in making definite progress. In this talk we present a study of the breathing pyrochlore compound $Ba_3Yb_2Zn_5O_{11}$. Due to the nearly decoupled nature of its tetrahedral units, this compound serves as an ideal testbed for exploring the nature of anisotropic exchange in a theoretically and experimentally tractable rare-earth system. The relevant low-energy model of the Yb3+ tetrahedra is parametrized by four anisotropic exchange constants and is capable of reproducing the inelastic neutron scattering data, specific heat, and magnetic susceptibility with high fidelity. Surprisingly, the fitted exchange parameters reveal a Heisenberg antiferromagnet with a very large Dzyaloshinskii-Moriya interaction. Using this model, we predict the appearance of an unusual non-Kramers octupolar paramagnet at low temperatures. We further speculate on possible collective, inter-tetrahedron physics of these non-Kramers doublets. Finally, we will discuss what we can learn from $Ba_3Yb_2Zn_5O_{11}$ about anisotropic exchange in other rare-earth magnets.