Condensed Matter Physics Seminar

Experimental evidence for a spin-liquid in a three dimensional Heisenberg magnet

Thursday

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4:00 P.M.

Rm 184 NSH

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While the existence of a spin-liquid phase for isotropically interacting spins on the pyrochlore lattice was first speculated by Jaques Villain nearly 40 years ago, there have been no controlled experimental realizations — either classical or quantum — of this model. In real materials, the spin-liquid phase is more often than not preempted by small perturbations or intrinsic disorder that stabilize a broken symmetry state. In this talk, I will discuss a new material, $NaCaNi_2F_7$, where spin-1 Ni ions occupy the B-site pyrochlore sublattice, and there is completely random Na^+ - Ca^{2+} occupation of the A-site. We use neutron scattering and calorimetric measurements to uncover the magnetic correlations in this material and fully determine the magnetic Hamiltonian. The ionic disorder creates a rugged energy landscape that acts to freeze a small fraction of the magnetic degrees of freedom in time. However, the energy scale set by this disorder is small, and the Heisenberg interactions prevail. In fact, only 20% of the available moment is frozen, and the magnetism in $NaCaNi_2F_7$ is dominated by a persistently fluctuating component. In this case, rather than spoiling the spin-liquid, disorder actually works to stabilize the spin-liquid against additional perturbations that are present. Our measurements provide the first experimental confirmation of Villain's prediction and a new insight into the interplay between disorder and magnetic exchange interactions in highly frustrated magnets.