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Magnetic Excitation Spectrum of a Coulomb Spin Liquid

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Conventional magnets are characterized by symmetry breaking and the formation long-range magnetic order at low temperatures. New and unanticipated phases of matter can arise when such symmetry breaking is inhibited by highly frustrated magnetic interactions. A spectacular example of this is the pyrochlore lattice with isotropic antiferromagnetic interactions, where the collective behavior of fluctuating magnetic moments is described by an emergent divergence free field. The microscopic magnetic degrees of freedom continue to fluctuate even at zero
temperature, as if in a liquid state, but all configurations must obey the divergence condition; hence, this phase is termed a Coulomb spin liquid. In this talk, I will discuss a new pyrochlore lattice magnet, NaCaNi2F7, which realizes the isotropic Coulomb spin liquid with S=1 spins. I will present neutron scattering and calorimetric measurements that were used to uncover the magnetic correlations in this material and determine the magnetic Hamiltonian. Na+ - Ca2+ are randomly populated in the crystal structure of NaCaNi2F7 creating a rugged energy landscape that acts to freeze a small fraction of the magnetic degrees of freedom. However, the energy scale set by this disorder is small, and the Heisenberg interactions prevail. Only a small fraction of the available moment is frozen, and the magnetism in NaCaNi2F7 is dominated by a persistently fluctuating component that appears as a broad continuum of magnetic signal in inelastic neutron scattering measurements. These measurements demonstrate a beautiful realization of the Coulomb spin liquid and provide new insight into the interplay between disorder and magnetic exchange interactions in highly frustrated magnets.

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