Time-of-Flight Neutron Scattering and the Quantum Spin Ice Ground State of $Yb_2Ti_2O_7$

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New time-of-flight neutron scattering instrumentation is opening up opportunities for exciting new science, especially in the study of exotic magnetic ground states in materials. These low temperature states can arise as a consequence of geometrical frustration, low dimensional structures, and quantum fluctuations, all of which discourage order and allow the possibility for novel states of matter to appear. I will discuss some of our recent work on the frustrated pyrochlore magnet $Yb_2Ti_2O_7$. As I'll describe, this material can be thought of in terms of quantum s=1/2 spins with XY anistropy decorating a network of corner-sharing tetrahedra. At moderate temperatures, our results show unexpected two dimensional magnetism arising within a three dimensional crystal structure. At lower temperatures, a disordered ground state, and a magnetic field-induced quantum critical point is observed. Inelastic spin wave scattering within the polarized state at high fields allows a determination of much of the microscopic spin Hamiltonian for the system, and the zero-field ground state is argued to possess many similarities to that which ice (the kind you skate on) displays - albeit a magnetic, quantum version known as quantum spin ice.