Order-by-Disorder versus Spin Freezing in XY Pyrochlore Antiferromagnets

The XY antiferromagnet on the pyrochlore lattice is a well-studied frustrated spin model. With one fewer spin degree of freedom compared to the spin liquid-like Heisenberg antiferromagnet model, the ground state of the XY model should order through the mechanism called order-by-disorder. This occurs because of an accidental continuous degeneracy of the ground state at the mean field level which is expected to be lifted by thermal, quantum, or quenched fluctuations (i.e. bond disorder). I will review strong evidence, based on our time-of-flight neutron scattering experiments, for this “order-by-disorder” transition in \(\text{Er}_2\text{Ti}_2\text{O}_7\). For many years, \(\text{Er}_2\text{Ti}_2\text{O}_7\) was the only known example of an XY antiferromagnetic pyrochlore material. A new candidate has recently emerged on the scene; \(\text{NaCaCo}_2\text{F}_7\). Our neutron scattering experiments reveal that \(\text{NaCaCo}_2\text{F}_7\) supports XY spin correlations arising from the same continuous manifold of states as described above, but freezes instead of undergoing order-by-disorder. \(\text{NaCaCo}_2\text{F}_7\) shows that there is yet more to understand about order-by-disorder in the XY pyrochlore antiferromagnet. I will compare and contrast these two physical realizations of XY antiferromagnetic pyrochlores.