Quantum Spin Ice States in Ce-based Pyrochlore Magnets

Bruce D. Gaulin [1]

[1] *McMaster University, Hamilton, ON, Canada*

Pyrochlore magnets have been a playground for the study of exotic magnetic ground states as many of these are characterized by quantum S=1/2 degrees of freedom decorating a three-dimensional network of corner-sharing tetrahedra - one of the canonical crystalline architectures supporting geometrical frustration in materials. Recently, we and others have been studying Ce-based pyrochlores, whose S=1/2 degrees of freedom possess both a dipolar and an octupolar character, by virtue of the symmetry properties of Ce^{3+}'s ground state crystal field doublet. In principle, this allows a ground state phase diagram for such materials that includes both ordered and quantum disordered ground states each of which can have either dipolar character or octupolar character. I will discuss how this exotic dipole-octupole S=1/2 degree of freedom arises in the J=5/2 Ce^{3+} ion in this environment. I will then review recent experimental work, based mainly on low temperature thermodynamics and neutron scattering, that makes the case that $Ce_2Zr_2O_7$ displays a disordered quantum spin ice ground state [1-5]. If time permits, I will discuss related experimental work on two sister pyrochlore compounds $Ce_2Sn_2O_7$ and $Ce_2Hf_2O_7$.

[1] J. Gaudet et al., Physical Review Letters 122, 187201 (2019).
[2] B. Gao et al, Nature Physics, 15, 1052 (2019).
[3] E.M, Smith et al, Physical Review X 12, 021015 (2022).
[4] E.M. Smith et al, Physical Review B 108, 054438 (2023).
[5] J. Beare et al, arXiv:2308.02800, and Physical Review B (to appear).