Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3416** Type: **Invited Speaker / Conférencier(ère) invité(e)**

(I) The quest for quantum spin liquids in frustrated rare-earth pyrochlores

Tuesday 7 June 2022 15:15 (30 minutes)

Geometrically frustrated magnets form a broad class of materials where competing interactions lead to the partial or complete suppression of classical magnetic order. While short-range magnetic correlations exist in the absence of long-range order, these systems remain disordered and fluctuating, exploring a largely degenerate and complex energy landscape. Such state is commonly named a spin liquid, as the magnetic moments behavior is analogous to the one of particles in a liquid. Classical spin liquids are driven by thermal fluctuations and exhibit slow dynamics at low temperatures. In contrast, quantum fluctuations can generate long-range entanglement of the magnetic moments, a state of matter called quantum spin liquid. The fundamentally quantum nature of this state attracts great interest, in particular because it is a playground to study emergent gauge theories with fractionalized excitations and of its potential relevance in quantum computing. Proving experimentally the existence of this quantum state however remains challenging.

Rare-earth based pyrochlore magnets form a large family of geometrically frustrated magnets that exhibit analogous effects to the proton disorder in water ice. I will discuss our experimental work on two quantum spin liquid candidates on this pyrochlore lattice. Using a combination of experimental techniques, and in particular neutron scattering, we evidenced that $Pr_2Hf_2O_7$ and $Ce_2Sn_2O_7$ exhibit many key features expected from a quantum spin liquid state. Interestingly, both systems are fundamentally different at the microscopic level. In $Pr_2Hf_2O_7$, while the magnetic dipoles are correlated, the quantum fluctuations are driven by interactions between the electric quadrupoles. In contrast, in $Ce_2Sn_2O_7$ it is the interactions between the magnetic dipoles that generate quantum fluctuations while the magnetic octupoles are entangled. These two examples illustrate that multipolar degrees of freedom provide novel routes to quantum fluctuations and quantum spin liquids.

Primary author: Dr GAUTHIER, Nicolas (Universite de Sherbrooke)

Presenter: Dr GAUTHIER, Nicolas (Universite de Sherbrooke)

Session Classification: T4-7 Fluctuations and Disorder in Condensed Matter (DCMMP) | Fluctuations et désordre en matière condensée (DPMCM)

Track Classification: Symposia Day (Tues. June 7) / Journée de symposiums (mardi, le 7 juin): Symposia Day (DCMMP) - Fluctuations and Disorder in Condensed Matter