Emergent Phenomena in Frustrated Magnetism

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& Ludovic Jaubert (LOMA, Bordeaux)

Journées de la matière condensée 2018

Invited talks:

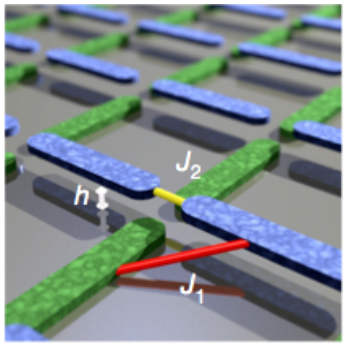
Leticia Cugliandolo (Sorbonne University & IUF)
Frustrated magnetism vs. glassiness

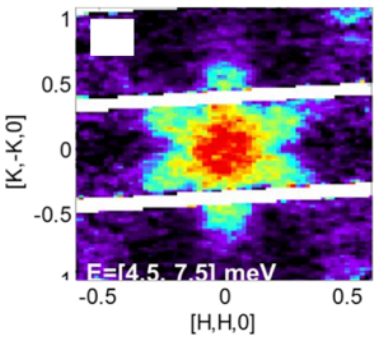
Sylvain Petit (CEA Saclay)
Quantum effects in frustrated pyrochlore magnets.

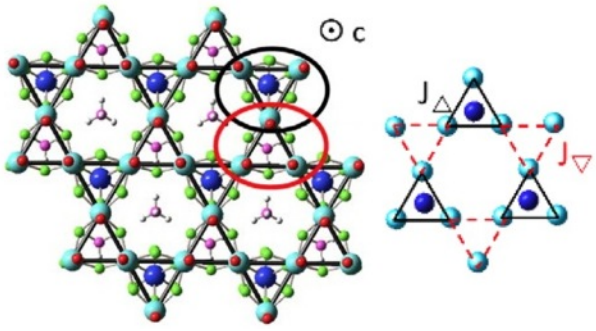
Magnetic frustration is a counter-example of one of the most natural physics intuition: matter is "expected" to order upon cooling. But in frustrated materials, magnetic order is prevented by a permanent competition between spin interactions. At very low temperatures geometric frustration leads to exotic phases of matter with the paradoxical properties of being disordered and strongly correlated: the spin liquids.

Spin liquids have now been confirmed on pyrochlore, kagome and triangular magnets (Herbertsmithite, $YbMgGaO_4$ …), thanks to complementary SQUID, μSR, NMR and neutron-scattering measurements, often at dilution-fridge temperatures. Their long-range entanglement have led to the development of powerful methods borrowed from quantum information (tensor network) and computer science (machine learning), and the possibility to describe spin liquids by emergent gauge fields has allowed contacts with yet unobserved high-energy phenomena, such as Majorana fermions in Kitaev materials or magnetic monopoles in spin ices. Beyond spin liquids, frustration naturally induces chiral magnetism supporting macroscopic properties such as the anomalous Hall effect, strong magneto-electric coupling in multiferroics, and the stabilisation of Kalmeyer-Laughlin topological states.

The goal of this mini-colloquium is to bring together the diverse communities of quantum magnetism & computation, topological phases, spin dynamics, solid-state synthesis, cryogeny, large instruments, statistical physics … to address the latest challenges in this field, and explore new directions across condensed matter.







From left to right: First artificial realisation of the square-ice degeneracy by nanolithography [Y. Perrin et al, Nature 540, 410 (2016)] || Inelastic neutron scattering of α-$RuCl_3$ showing the short-range correlations of a Kitaev spin liquid [A. Banerjee et al, Science 356, 1055 (2017)] || DQVOF kagome material, a realisation of the breathing kagome lattice [J.-C. Orain et al, Phys. Rev. Lett. 118, 237203 (2017)]