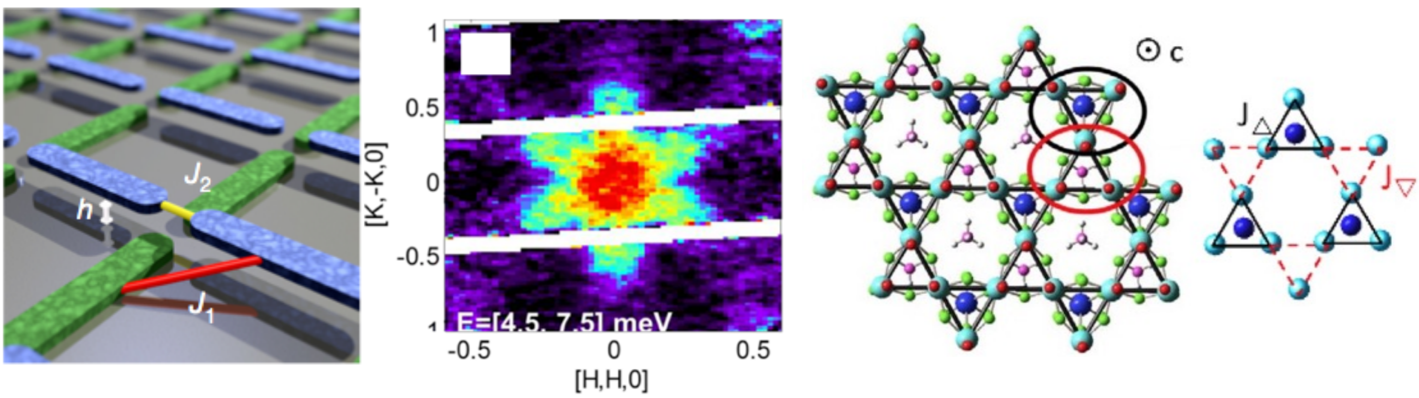
Emergent Phenomena in Frustrated Magnetism

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

A fascinating property of spin liquids is the possibility to describe them by emergent gauge fields, measurable by neutron scattering, and making contact with yet unobserved high-energy phenomena. These gauge fields often support fractionalised excitations, where a spin degree of freedom can be divided into distinct components, taking the form of quasi-particles. Famous examples are the Majorana fermions of Kitaev materials and the magnetic monopoles of spin ices. Recently, these ideas have been extended to gauge fields in a large variety of situations: confinement in magnetic thin films, presence of impurities or coexistence with a partial magnetic order - a phenomenon dubbed “fragmentation”.

The absence of conventional ordering may also lead to chiral spin configurations, supporting macroscopic properties such as the anomalous Hall effect, strong magneto-electric coupling in multiferroics, or 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 [1] || Inelastic neutron scattering of α-$RuCl_3$ showing the short-range correlations of a Kitaev spin liquid [2] || DQVOF kagome material, a realisation of the breathing kagome lattice [3]

[1] Y. Perrin et al, Nature **540**, 410 (2016)
[2] A. Banerjee et al, Science **356**, 1055 (2017)
[3] J.-C. Orain et al, Phys. Rev. Lett. **118**, 237203 (2017)