Magnetic fragmentation in pyrochlore iridates

Among the original magnetic states which emerge from frustrated magnetic systems, spin ice has aroused a strong interest because its macroscopically degenerate ground state belongs the class of Coulomb phases: its organising principle is dictated by a local constraint called the ice-rule, which can be interpreted as a divergence free condition of an emergent gauge field. Magnetic excitations in spin ice, called magnetic monopoles, correspond to a violation of the local ice-rule and introduce a non-zero divergence in the emergent field.

Recently, theoreticians have introduced the concept of magnetic moment fragmentation, whereby the local magnetic moment field fragments into the sum of two parts, a divergence full and a divergence free part. In spin ice, if the monopoles organise as a crystal of alternating magnetic charges, the fragmentation leads to the superposition of an ordered configuration and of an emergent Coulomb phase. Experimentally, the fragmentation manifests itself via the superposition of magnetic Bragg peaks, characteristic of the ordered phase, and a pinch point pattern, characteristic of the Coulomb phase.

In this talk, I will show how this magnetic fragmented state can be stabilized in pyrochlore iridates $R_2Ir_2O_7$, with R =Ho, Dy [1, 2]. First, I will present the experimental signatures of the fragmented ground state. Then, I will focus on the novel dynamics and field induced phases observed in these compounds. The comparison of our data with existing models provide evidence for the important role of long range interactions. In addition, our data reveal low energy excitations, as well as a large distribution of energy barriers that are not anticipated in the models.

[1] E. Lefrançois et al., Nature Commun. 8, 209 (2017)

[2] V. Cathelin et al., Phys. Rev. Research 2, 032073(R) (2020)