Anisotropic spin separation in the Gd pyrochlore iridate

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The Ir-5d electrons in most iridate pyrochlores $R_2Ir_2O_7$ (R = Rare Earth) exhibit a spin-orbit driven metal-insulator transition accompanied by an ordering of the Ir sublattice in the so-called "all-in all-out" order: magnetic moments pointing towards or away from the centre of each corner-sharing tetrahedron, as shown in the figure. This induces a non-collinear magnetic field on the R moments through the R-Ir magnetic interactions. **This well-controlled staggered molecular field is a new parameter allowing to explore the rich physics of frustrated rare-earth pyrochlores** [1]. At low temperature, it favours new magnetic ground states in these systems due to its competition with the single-ion anisotropy of the rare-earth (with respect to the local <111> directions of the tetrahedron) and with the interactions between the rare-earth ions. In $Ho_2Ir_2O_7$, this staggered molecular field leads to the fragmentation of the magnetization [2,3].

At variance with the Ising Ho^{3+} moment, here we focus on the behaviour of the much more isotropic magnetic moment of the Gd^{3+} ion on the rare-earth site that we study through magnetometry and neutron scattering. We find a complex situation in $Gd_2Ir_2O_7$ where different components of the magnetic moment are decoupled. They contribute respectively to a high temperature all-in all-out order (easy-axis component of the magnetic moments) polarized by the Ir molecular field and to complex antiferromagnetic correlations between the easy-plane components that tend to order at much lower temperature. We succeeded in reproducing these exotic behaviours with a simple model comprising in particular the anisotropic dipolar interactions.

[1] E. Lefrançois *et al*. Phys. Rev. Lett **114**, 247202 (2015).
[2] E. Lefrançois *et al*. Nature Communications **8**, 209 (2017).
[3] Brooks-Bartlett *et al*. Phys. Rev. X **4**, 011007 (2014).

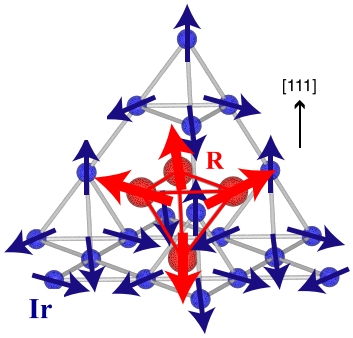

Figure 1: The two interpenetrating pyrochlore lattices with Ir^{4+} (blue) and the rare-earth R^{3+} (red). The Ir subattice orders in the all-in all-out arrangement inducing the same magnetic order on the R sublattice.