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Emergent Order in the Frustrated Kagome Magnet $Dy_3Mg_2Sb_3O_{14}$

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Frustrated magnetic materials - in which the lattice occupied by spins prevents all their interactions from being satisfied simultaneously - can host exotic states of matter that are both disordered and strongly correlated, such as spin ices and quantum spin liquids. The magnetic diffuse scattering measured in neutron-scattering experiments is highly sensitive to such states, but data analysis is often challenging, especially when only powder samples are available. In my talk, I will discuss the information content of powder neutron-scattering data for frustrated magnets. In particular, I will address how such data can be converted into a magnetic-structure model without advance knowledge of the underlying magnetic interactions, using the atomistic method of reverse Monte Carlo refinement [1].

I apply this approach to the recently-synthesised material Dy3Mg2Sb3O14, in which kagome layers of corner-sharing triangles are occupied by Ising spins that point either "in" our "out" of the triangles [2]. Remarkably, at very low temperatures (<0.3 K), our neutron-scattering data show a co-existence of strong magnetic diffuse scattering with magnetic Bragg peaks. Using atomistic refinement to both Bragg and diffuse scattering simultaneously, we show that our data can be explained by ordering of emergent magnetic charges - a "magnetic charge" being the sum of "in" (+1) and "out" (-1) spins for a triangle of the kagome lattice. In this emergent-charge ordered state, a macroscopic degeneracy of spin arrangements coexists with a component of the spin-correlation function that does not decay with distance, so that the material resembles both a spin ice and a spin crystal simultaneously. Although theoretically predicted for isolated kagome layers of Ising spins [3], our results represents the first experimental evidence for this behaviour in a bulk material. Our thermodynamic measurements and Monte Carlo simulations show that this state is stabilised by an interplay of magnetic interactions, spin canting, and chemical disorder.

Finally, I will discuss briefly how these methods - here applied to powder data - can be extended to analyse large single-crystal datasets.

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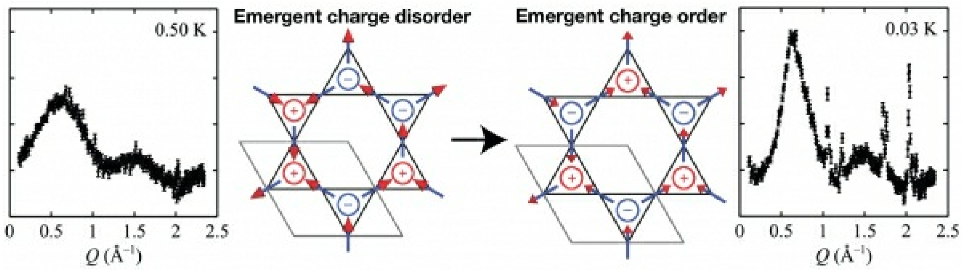

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