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Lattices of Magnetic Vortices in a Frustrated Mott Insulator

CRISTIAN BATISTA[1], Los Alamos National Laboratory

Chiral spin textures with different length scales emerge in some itinerant magnets and are attracting increasing interest in the study of magneto-transport and possible applications to magnetic data storage and spin-electronic devices. It is natural to ask if similar topological textures can emerge in Mott insulators and also lead to magneto-electric effects. In this talk I will show that this is indeed possible when the exchange interactions are geometrically frustrated. For this purpose, I will consider a frustrated S=1/2 XXZ Hamiltonian that is a low-energy effective model for Ba_3Mn2O_8, a novel layered spin-dimer compound, comprising magnetic dimers of Mn^{5+} ions arranged on triangular planes. Successive layers are stacked following an ABC sequence, such that the dimer units on adjacent planes are positioned in the center of the triangular plaquettes of the layers above and below. The effective exchange anisotropy of the low-energy model results from frustration between exchange interactions connecting the same pair of dimmers. The competition between intra and inter-layer exchange interactions leads to a triplon dispersion with six-fold degenerate minima at the incommensurate wave vectors $\pm Q_n$ ($1 \leq n \leq 3$). This degeneracy leads to a very rich quantum phase diagram near the magnetic field induced quantum critical point, that is constructed by adding ladder diagrams and minimizing the resulting energy functional. The phase diagram includes different multi-Q magnetic orderings, which combine up to the six degenerate incommensurate lowest-energy modes $\pm Q_n$ ($1 \leq n \leq 3$). In particular, it includes a six-Q state that consists of a lattice of magnetic vortices and other complex spin textures associated with different multi-Q ordered states.

[1]Work done in collaboration with Yoshitomo Kamiya