Orbital ordering in MnV_2O_4

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Geometrically frustrated magnets with orbital degeneracy exhibit a variety of complex ground states with unusual magnetic and orbital orders. In my talk I will discuss one such situation, namely orbital and magnetic ordering in vanadium spinel MnV_2O_4. I will present an analytical model of spinel MnV_2O_4 assuming that the t_{2g} orbitals is split into a singlet and a doublet by a strong trigonal crystal field. This model is based on results of recent first-principles calculations indicating a strong trigonal distortion at vanadium sites of the compound [Phys. Rev. Lett. **102**, 216405 (2009)]. At the single-ion level, the trigonal crystal field leaves a doubly degenerate atomic ground state and breaks the approximate rotational symmetry of t_{2g} orbitals. We find that the effective interaction between the low-energy doublets is described by a quantum antiferromagnetic 120° model on the pyrochlore lattice. We obtain the classical ground state and show its stability against quantum fluctuations. The corresponding orbital order consisting of two inequivalent orbital chains is consistent with the experimentally observed tetragonal symmetry. A periodic modulation of electron density function along orbital chains is shown to arise from the staggering of local trigonal axes. In the presence of orbital order, single-ion spin anisotropy arising from relativistic spin-orbit interaction stabilizes the experimentally observed orthogonal magnetic structure.

The talk is based on the following paper:

Gia-Wei Chern, Natalia Perkins, and Zhihao Hao, Phys. Rev. B **81**, 125127 (2010).