Striped Magnetic Ground State on an Ideal S=2 Kagomé Lattice

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We have used representational symmetry analysis of neutron powder diffraction data to determine the magnetic ground state of Fe₄Si₂Sn₇O₁₆. We recently reported a long-range antiferromagnetic (AFM) Néel ordering transition in this compound at TN = 3.0 K, based on magnetization measurements. [1] The only magnetic ions present are layers of high-spin Fe²⁺ (d⁶, S = 2) arranged on a perfect kagomé lattice (trigonal space group P-3m1). [2] Below TN = 3.0 K, the spins on 2/3 of these magnetic ions order into canted antiferromagnetic chains, separated by the remaining 1/3 which are geometrically frustrated and show no long-range ordered down to at least T = 0.1 K. Moessbauer spectroscopy shows that there is no static order on the latter 1/3 of the magnetic ions – i.e., they are in a liquid-like rather than a frozen state – down to at least 1.65 K. A heavily Mn-doped sample Fe₁.₄₅Mn₂.₅₅Si₂Sn₇O₁₆ has the same ground state. Although the magnetic propagation vector \( k = (0, 1/2, 1/2) \) breaks hexagonal symmetry, we see no evidence for magnetostriction in the form of a lattice distortion within the resolution of our data. To the best of our knowledge, this type of magnetic order on a kagomé lattice has no precedent experimentally and has not been explicitly predicted theoretically. We will discuss the relationship between our experimental result and a number of theoretical models that predict symmetry breaking ground states for perfect kagomé lattices.


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