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Symmetry constraints in frustrated magnets with strong magnetoelastic coupling

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Geometrical frustration, related to the specific topology of certain crystal structures, plays a crucial role in forming exotic magnetic ground states. The presence of frustrated spins often leads to the suppression of long-range magnetic ordering and promotes short-range correlations due to fluctuations between nearly or totally degenerate ground states. The well-known structural topologies causing the presence of geometrical frustration are the three-dimensional pyrohlore and two-dimensional Kagome lattices. Compounds whose structural motif embraces these lattices are of great interest as model systems and have been the focus of numerous studies. In some cases, frustration is partially or entirely released by structural distortions through a strong magnetoelastic coupling and long-range magnetic order is established at a finite temperature. In the resulting distorted phases, complex noncollinear or partially disordered spin configurations can be observed. The phase transitions to the ordered state are quite often first order and may involve several irreducible representations of the paramagnetic space group and sometimes, like in the case of ZnCr2O4, even several propagation vectors which do not belong to the same star. The approach to determine magnetic structures in these systems, based on representation theory, should take into account the coupling free-energy invariants relating the magnetic and structural order parameters. Application of magnetic space groups and superspace groups is especially useful and can be efficiently combined with the representation theory. Based on specific examples, I will demonstrate how both approaches can be combined to provide symmetry constraints sufficient to solve complex magnetic structures in some geometrically frustrated systems.

Keywords: geometrical frustration, magnetoelastic coupling