Unified theory of degenerate manifolds, helimagnets, and multi-Q chiral phases in the classical Heisenberg antiferromagnet on the face-centered-cubic, honeycomb and diamond lattice

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Frustration in face-centered-cubic, honeycomb, and diamond lattices with first and second neighbor Heisenberg exchanges leads to the appearance of a classical spin liquid ground state. First, I will present a detailed analysis of the classical Heisenberg model on the frustrated face-centered-cubic lattice in the presence of longer-range couplings within the Luttinger-Tisza framework. It reveals a rich ground state phase diagram that hosts chiral multi-Q, helimagnetic orders, and subextensively degenerate manifolds. Expressing the Hamiltonian as a sum of complete squares over different finite motifs tesselating the lattice explains the origin of manifolds. We applied the same idea to the honeycomb and diamond lattices: minimization of the complete squares naturally leads to a spiral spin-liquid phase in these models. Extension of this construction allows for smooth interpolation between the honeycomb and diamond lattice spiral spin-liquids and a natural connection between the spiral spin-liquids experimentally observed in the layered honeycomb magnet $FeCl_3$ and the diamond spinel $MnSc_2S_4$.
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