Unconventional states and topological defects in Fe-langasite

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Topology of defects in ordered states of matter is determined by dimensionality and symmetry properties of the order parameter. Larger number of variables needed to describe an ordered state gives rise to a greater diversity and complexity of topological defects, a prominent example being the A-phase of superfluid ^{3}He. The order parameter describing non-collinear antiferromagnetic orders in the swedenborgite, $CaBaCo_2Fe_2O_7$, and Fe-langasite, $Ba_3TaFe_3Si_{24}O_{14}$, is an SO(3) matrix [1,2]. The iron langasite spin lattice is built of triangles formed by antiferromagnetically coupled Fe^{3+}-ions (S = 5/2). The orientation of three co-planar spins added into the zero total spin is described by three Euler angles. This amazing material is both chiral and magnetically frustrated. It shows a non-collinear 120^o spin ordering at the scale of one unit cell, a spiral with a period of 7 lattice constants and complex spin superstructures at the scale of 1000 Å. Lifshitz invariants allowed by the lack of inversion symmetry give rise to interesting modulated magnetic phases and stabilize particle-like topological defects previously discussed in very different physical contexts, e.g. nuclear physics and superfluid ^{3}He.

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[2] M. Ramakrishnan *et al*., npj Quantum Materials **4**, 60 (2019).

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