Liquid crystalline structures and elasticity in a cubic chiral helimagnet – a neutron scattering study

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Condensed matter provides convenient ways to observe and manipulate a large variety of complex long-range orders. Currently, a strong focus is put on the study of chiral magnets (ChM) belonging to the B20 family, such as MnSi, FeGe, MnGe, *etc.* These compounds indeed display a plethora of multiply modulated phases, including the topologically non-trivial skyrmion (SK) lattice stabilized under an applied magnetic field.

In a recent elastic neutron scattering study of the $Mn_{1-x}(Co,Rh)_xGe$ solid solutions, we have discovered that, upon chemical substitution, a ChM can undergo a transition from a helimagnetic to a weakly ferromagnetic ground state through a mixed-phase, within which topological defects proliferate even in zero field [1] (see Figure). The formal equivalence between the latter and the "twist-grain boundary" (TGB) phase already evidenced in certain chiral liquid crystals (ChLC) [2] underscores the deep connections between the two classes of systems.

In turn, this implies that ChMs might inherit the rich phenomenology of ChLCs. In the frame of this unifying gesture, we have recently checked the prediction of Radzihovsky and Lubensky that the helimagnetic ground state should support phason-like Goldstone modes [3]. To that end, we have used a cutting-edge quasi-elastic scattering method, the so-called MIEZE spectroscopy (see *e.g.* [4] and references therein), to study the temperature-dependence of the helimagnetic order lifetime in pure MnGe. We found that the latter is finite in a large temperature interval below the macroscopic ordering temperature. This suggests that thermally activated walls are moving across the ordered domains, in agreement with the above theoretical expectations.

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[2] L. Navailles *et al.*, Phys. Rev. Lett. **71**, 545 (1993)
[3] L. Radzihovsky and T.C. Lubensky, Phys. Rev. E **83**, 051701 (2011)
[4] N. Martin, Nucl. Instr. and Meth. in Phys. Res. A **882** (2018) 11-16

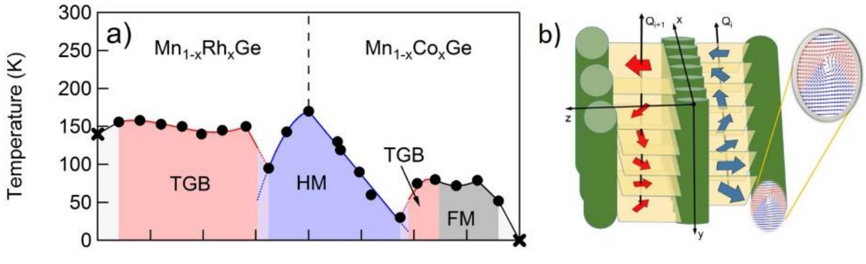

Figure: a) Magnetic phase diagram of the $Mn_{1-x}(Co,Rh)_xGe$ series. b) Proposed magnetic TGB phase, where screw dislocation lines separate elongated helimagnetic domains.