Detection of static and dynamic magnetization of twists in magnetic insulators

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Nature is full of beautiful patterns that arise from simple building blocks interacting in complex ways. In magnetic systems lacking inversion symmetry, similarly rich behavior unfolds, giving rise to twisted spin structures like helices, spirals, and skyrmions. Chiral helimagnets, in particular, host these non-trivial configurations and exhibit collective excitations spanning an impressive range, from a few GHz to the THz regime. This makes them promising for applications in next-generation spintronics and neuromorphic computing [1].

In this talk, I will present our recent findings on the magnetization dynamics of the insulating chiral magnet Cu_2OSeO_3. By combining magnetic resonance spectroscopy and resonant elastic X-ray scattering, we uncovered a unique regime in the phase diagram where **distorted tilted conical spirals** coexist with skyrmion textures [2]. Strikingly, at lower magnetic fields, we observe signatures of a rarely seen magnetic phase—**elongated skyrmions** [3]. These states show distinct excitation modes, shedding light on their internal structure and stability.

Additionally, I will show how a surface-sensitive electrical technique—**spin Hall magnetoresistance**—reveals that surface magnetism in chiral magnets can differ markedly from their bulk behavior [4], highlighting the importance of dimensionality and boundary conditions in these systems. Together, these insights provide a deeper understanding of topological magnetic textures and their dynamics—an essential step toward harnessing them in future devices.

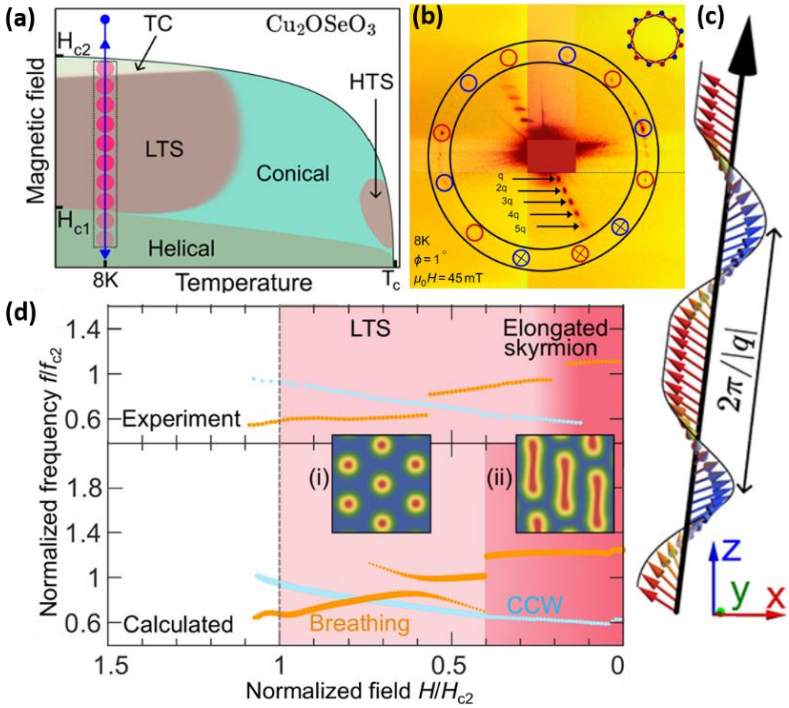

Figure 1. (a) Schematic magnetic phase diagram for magnetic field applied along ⟨001⟩, indicating the high-temperature skyrmion (HTS), low-temperature skyrmion (LTS), and tilted conical spiral (TC) phases. The highlighted region indicates the field range where distorted TC spirals and skyrmions coexist. **(b)** Reciprocal space map revealing coexisting distorted TC spiral and skyrmion lattice phases, as observed via CCD imaging. **(c)** Real-space magnetic configuration of the distorted tilted conical spiral phase. (d) Experimental and simulated spectra showing distinct magnetic resonance modes associated with the LTS and elongated skyrmion phases.

References

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