Magnetic imaging of skyrmion lattice in FeGe

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Magnetic skyrmions are topologically protected spin structures that have recently attracted considerable interest as a result of their physical properties and potential applications in energy-efficient spintronic devices for information technology. Magnetic skyrmions were first observed in B20 compounds, whose non-centrosymmetric crystal structure gives rise to strong spin-orbit coupling. In these materials, the Dzaloshinskii-Moriya interaction results in the formation of a particle-like chiral spin structure in a regular hexagonal lattice. Transmission electron microscopy (TEM) offers a variety of methods for imaging the magnetic structure of skyrmions, including the Fresnel mode of Lorentz TEM combined with phase retrieval based on the transport of intensity equation, scanning TEM combined with differential phase contrast imaging and off-axis electron holography (EH). In this work, we discuss recent advances in EH-based methods and related techniques for imaging skyrmion and helical spin structures in B20 FeGe single crystals as a function of temperature and applied magnetic field. Skyrmions were studied as a function of both temperature and magnetic field, which was applied parallel to the electron beam direction using the objective lens of the microscope (in free lens control mode). The twin construction of the objective lens used allowed the strength and polarity of the magnetic field to be changed continuously, in order to study the magnetization reversal dynamics of the skyrmions in situ in the TEM.