Dynamical study of topological spin textures by ultrafast electron microscopy

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Abstract:

Topological magnetic structures, such as magnetic skyrmions and vortices, are regarded as one of the most ideal information carriers for future information storage and processing technologies due to their small scale, topological protection, and unique properties under the action of optical, thermal, magnetic and electric fields. The key to realizing their memory applications lies in the precise manipulation and understanding of their dynamical behaviors, while topological magnetic structures are as small as nanometer scale, and the spin response to external fields is as fast as picosecond scale, posing a double challenge to the temporal and spatial resolution of their dynamical study. Ultrafast electron microscopy, which combines the high spatial resolution of electron microscopy with the ultrafast temporal resolution of femtosecond lasers, provides an excellent means to observe dynamical processes such as morphological changes, structural transformations, carrier transport, and the evolution of magnetic structures of matter at ultrahigh spatial and temporal scales. In this talk, I will first briefly introduce the development and current research status of ultrafast electron microscopy technology, and then focus on our recent progress in the development of ultrafast electron microscopy with multi-field regulations and its application to the dynamics of topological magnetic structures. We have developed a variety of new room-temperature 2D topological magnetic materials, and realized in situ ultrafast controllable writing/erasure of topological spin structures in 2D topological magnetic materials by femtosecond laser pulse, revealing the underlying physical mechanism of the femtosecond laser interaction on the topological magnetic structures and providing the physical basis for the application of topological magnetic structures in feature advanced spintronic devices.