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Vortex-Core-Driven Magnetization Dynamics

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Micron and sub-micron magnetic patterns are fundamental building blocks of magneto-electronic devices. The magnetic ground state of an important class of patterns-disks and squares-is the vortex state, a flux closure state that is characterized by a curling magnetization. Only recently have experiments resolved the complex internal magnetic structure of the only a few nm wide core of a vortex. Going beyond static experiments we will demonstrate using time-domain imaging that the vortex dynamics are dominated by the dynamics of the core spins. We will demonstrate utilizing experiments and simulations that the core trajectory and speed critically depend on the internal structure of the core and the large magnetostatic internal effective field in its proximity. The small size of the core demands for a technique with a spatial resolution far beyond the abilities of light optics. The two-color time-resolved imaging technique used here for the first time-laser pump X-ray Photoemission Electron Microscopy-has the ability to study magnetization and spin dynamics on the fundamental spatial and temporal scales of magnetic materials: the exchange length (~ nm) and the precession frequency (~ GHz).