# Imaging ultrafast spin dynamics with x-ray free electron lasers

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Understanding the ultrafast interplay between charge, magnetic and lattice degrees of freedom is central to gaining control of condensed matter phenomena as diverse as insulator-metal transitions and magnetic switching. While discovered early [1], perhaps still the least understood is the coupling of magnetism with other degrees of freedom. Magnetism, by symmetry could be expected to couple only weakly to phonons and electrons, however the observed ultrafast demagnetization [1] and all-optical magnetic switching [2,3], have proven this to be far from correct. Femtosecond x-ray pulses from the Linac Coherent Light Source, the world's first x-ray free electronl laser, offer the unique opoertunity to image in realtime the ultrafast spin dynamics that lead to magnetization reversal [4]. The insights gained in how magnetism evolves on time- and lengthcales associated with the exchange interaction opens a new way of engineering the relaxation path in magnetic systems.

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