Probing laser-induced demagnetization dynamics in nanomaterials using ultrafast electron diffraction

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Ultrafast demagnetization is the sub-picosecond quenching and subsequent recovery of the ferromagnetic order induced by femtosecond optical pulses. Since its first discovery in 1996, it has been extensively studied with time-resolved optical spectroscopy by monitoring the relaxation of the charge carriers and spins in real time. However, the associated lattice dynamics remains largely unresolved in these studies. In a system that encompasses strong couplings among spin, charge and lattice, the abrupt state change of one subsystem, such as ultrafast demagnetization in spins, could profoundly modify the timescale and subsequent dynamics of another coupled subsystem such as lattice. Here, I report the results of investigating the lattice thermalization dynamics in Nickel nano-films and FePt quantum dots under the influence of ultrafast magnetism using ultrafast electron diffraction. I will discuss the temperature-dependent electron-phonon coupling in Nickel films obtained by monitoring the energy flow kinetics and the dynamics of magnetostriction in FePt nano dots by measuring the coherent lattice vibrations, and also the implication of these results on demagnetization dynamics.