MAR14-2013-020046

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Quantum Femtosecond Magnetism: Phase Transition in Step with Light in a Strongly Correlated Manganese Oxide[1]

JIGANG WANG, Dept of Physics and Astronomy, Ames Laboratory, Iowa State University Ames, IA

Research of non-equilibrium phase transitions of strongly correlated electrons is built around addressing an outstanding challenge: how to achieve ultrafast manipulation of competing magnetic/electronic phases and reveal thermodynamically hidden orders at highly non-thermal, femtosecond timescales? Recently we reveal a new paradigm called *quantum femtosecond magnetism*–photoinduced femtosecond magnetic phase transitions driven by quantum spin flip fluctuations correlated with laser-excited inter-atomic coherent bonding [1]. We demonstrate an antiferromagnetic (AFM) to ferromagnetic (FM) switching during about 100 fs laser pulses in a colossal magneto-resistive manganese oxide. Our results show a huge photoinduced femtosecond spin generation, measured by magnetic circular dichroism, with photo-excitation threshold behavior absent in the picosecond dynamics. This reveals an initial quantum coherent regime of magnetism, while the optical polarization/coherence still interacts with the spins to initiate local FM correlations that compete with the surrounding AFM matrix. Our results thus provide a framework that explores quantum non-equilibrium kinetics to drive phase transitions between exotic ground states in strongly correlated elecrons, and raise fundamental questions regarding some accepted rules, such as free energy and adiabatic potential surface. This work is in collaboration with Tianqi Li, Aaron Patz, Leonidas Mouchliadis, Jiaqiang Yan, Thomas A. Lograsso, Ilias E. Perakis.

[1] T. Li, *et al.*, Nature, 496, 69 (2013).

[1]This work was supported by the National Science Foundation (contract no. DMR-1055352). Material synthesis at the Ames Laboratory was supported by the US Department of Energy-Basic Energy Sciences (contract no. DE-AC02-7CH11358).