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Nonequilibrium control of the magnetic exchange interaction

Martin Eckstein

Max Planck Research Department, University of Hamburg

Controlling complex phases of correlated systems on ultra-short timescales is an intriguing application of nonequilibrium ideas in condensed matter physics. In this talk will focus on the control of magnetic states. Magnetic order is determined by the exchange interaction J, which emerges from the Coulomb interaction and the Pauli principle. Driving the electrons out of equilibrium thus modifies J and allows for ultra-fast manipulation of magnetism without using strong magnetic fields. Theoretically, nonequilibrium electron dynamics in solids can be addressed using dynamical mean-field theory (DMFT) on the Keldysh contour [1]. In the talk discuss two pathways to modify J with ultrashort laser pulses, which are photo-doping (exciting a nonequilibrium distribution of doublon and hole carriers in a Mott insulator) [2], and coherent control of J with a laser that is not resonant to the charge transfer excitation. In the latter case, it is even possible to reverse the sign of the exchange coupling under strong driving, which amounts to a propagation of the many-body spin dynamics backward in time and may allow to study fundamental questions related to the reversibility of quantum many-body dynamics.

[1] H. Aoki, N. Tsuji, M. Eckstein, M. Kollar, T. Oka, and Ph. Werner, RMP 86, 779 (2014).
[2] J. H. Mentink, M. Eckstein, arXiv:1401.5308.