Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

Thursday, February 11th 2016 – 11:00

Seminar room IV, CFEL, Bldg. 99

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Exploring the Nonequilibrium Dynamics of Collective Excitations in Strongly Interacting and Correlated Many-Body Systems

One of the distinctive characteristics of strongly interacting and correlated quantum systems is the non-trivial interplay between low- and high-energy degrees of freedom. The origin of this interplay lies in the electron-electron and electron-boson interactions, which redistribute the spectral weight of the conduction band over a wide energy range. To address this phenomenology, we investigate this class of solids by means of ultrafast optical spectroscopy covering a broad spectral range, both in the visible and in the ultraviolet (UV) [1-5]. This approach allows not only to develop realistic nonequilibrium models for the dielectric functions of these systems, but also to monitor the impact of coherent bosonic excitations on the optical properties.

In this talk, I will discuss the application of this technique on two prototypical transition metal oxides, *i.e.* magnetite (Fe_3O_4) and anatase titanium dioxide (TiO_2). In Fe_3O_4 we use a broadband visible probe to clarify the cooperative mechanism behind the Verwey transition and we demonstrate the ability of tailored photoexcitation to drive a charge-ordered state even above the equilibrium critical temperature [4]. In anatase TiO_2, the use of ultrafast two-dimensional UV spectroscopy reveals the signature of bound excitonic quasiparticles, retaining an intermediate character between the Frenkel and Wannier-Mott regimes [5]; the coupling between coherent acoustic phonons and these exotic charge excitations is also investigated.

[1] B. Mansart *et al.*, PNAS USA 110, 4539 (2013)

[2] A. Mann *et al.*, Phys. Rev. B 92, 035147 (2015)

[3] E. Baldini *et al.*, arxiv.org/abs/1510.00305 (under review in Nat. Comm.)

[4] S. Borroni, E. Baldini *et al.*, arxiv.org/abs/1507.07193 (under review in Phys. Rev. X)

[5] E. Baldini *et al.*, arxiv.org/abs/1601.01244 (submitted to Science)

Host: Andrea Cavalleri

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