Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

March 18th 2014 – 11:00
CFEL Seminar room IV, 01.111 (Bldg. 99)

Giacomo Coslovich

Materials Sciences Division, Lawrence Berkeley National Laboratory

Ultrafast Dynamics of Pseudogap States in Correlated Materials

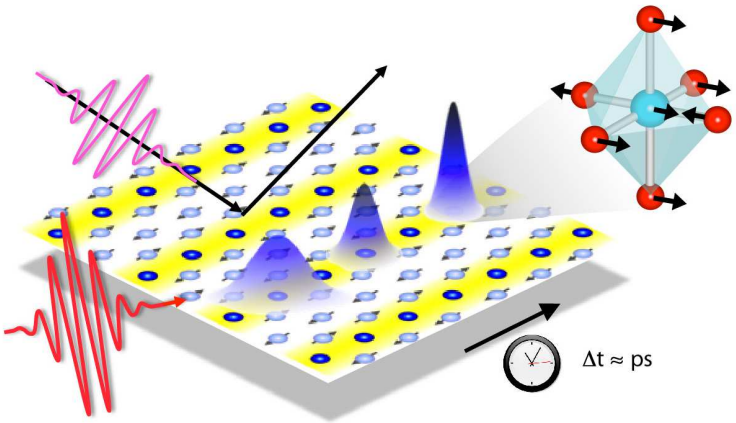
Ultrashort laser pulses provide the unique ability to transiently excite materials into non-thermal phases. By following the relaxation pathway toward equilibrium it is possible to distinguish highly entangled degrees-of-freedom in complex materials. This capability is critical for understanding the physics of strongly correlated materials and of high-temperature superconductivity.

In particular ultrafast techniques offer a new perspective to tackle the long-standing question about the origin and role of pseudogap phases in high-temperature superconductors and correlated materials in general. In this talk I review some recent ultrafast spectroscopy experiments on nickelates [1] and cuprates [2], which provide a new insight into the pseudogap phase.

Mid-infrared and X-ray experiments on $La_{1.75}Sr_{0.25}NiO_4$ single crystals reveal that the pseudogap phase in this material is associated with increased charge localization and a corresponding modulation of the electron-phonon coupling. Photo-excitation of this charge-localized state exhibits an ultrafast dynamics with relaxation time of about a picosecond. The experiment establishes the precursor role of the pseudogap phase to the formation of long-range electronic stripes.

In cuprates the relationship between pseudogap states and high-temperature superconductivity is of particular interest. Experiments using broadband near-IR pulses on Y-doped Bi2212 single crystals reveal the dynamical competition between pseudogap and superconducting states on ultrafast timescales. The results can be described by a set of coupled differential equations following the time-dependent Ginzburg-Landau theory. The sign and strength of the coupling term suggest a remarkably weak competition between the two phases, allowing their coexistence.

[1] G. Coslovich et al., Nature Communications **4**, 2643 (2013)
[2] G. Coslovich et al., Physical Review Letters **110**, 107003 (2013)



Host: Andrea Cavalleri

MAX-PLANCK-GESELLSCHAFT