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CFEL Seminar room IV, 01.111 (Bldg. 99)

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### 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  $\text{La}_{1.75}\text{Sr}_{0.25}\text{NiO}_4$  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)

