

Ultrafast study of out-of-equilibrium quantum materials

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The study of quantum materials in out-of-equilibrium conditions following excitation with ultrafast lasers represents one of the novel research frontiers in condensed matter physics. With femtosecond optical pulses, electronic and lattice degrees of freedom can be transiently decoupled, giving the opportunity of stabilizing new states inaccessible by quasi-adiabatic pathways.

This becomes particularly interesting for the study of strongly correlated materials, since their rich phase diagram often translates into an equally rich out-of-equilibrium behavior; as well as for the study of topological matter, where the unique features of Dirac fermions turn into peculiar photoconductivity properties after ultrafast excitation. Selected studies of prototype Mott-Hubbard compounds and topological materials will be discussed in more detail; in particular, it will be shown how the combination of different time-resolved experimental techniques - ARPES, optical reflectivity, FEL-based X-ray diffraction [1] – can give access to the evolution of both electrons and lattice, providing a complete picture of out-of-equilibrium quantum matter.

Reference:

[1] G. Lantz et al., Nat. Commun. 8, 13917 (2017).