Seminar

Heating and cooling in laser-driven lattice systems

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Controlling material properties on ultrashort time scales by laser pulses is an appealing prospect. The “holy grail” in this active research field is the realization of light-induced electronic order such as superconductivity. I will start this talk by discussing a theoretical proposal how the driving of phonon modes in conventional phonon-mediated superconductors could enhance Tc. A careful analysis of this scheme revealed that the heating induced by the phonon driving dominates any potentially beneficial effect on pairing, and results in the weakening of superconductivity [1]. While heating is a generic side-effect, interesting recent papers have proposed the possibility of cooling the relevant electronic degrees of freedom in cuprates [2] or fulleride superconductors [3] by a reshuffling of entropy. In the second part of my talk, I will demonstrate such a cooling scheme in a light-driven Hubbard model [4]. The mechanism can be understood as an evaporative cooling resulting from the transfer of holes or electrons into narrow full or empty bands. This entropy cooling effect is not only interesting because of its potential relevance for photo-doping experiments, but also as a theoretical tool which allows to prepare and study "cold” nonequilibrium states [5], such as the eta-paired state in the strongly repulsive Hubbard model with a large density of doublons and holons.

[1] Phys. Rev. B 96, 045125 (2017)
[2] Phys. Rev. Lett 114, 137001 (2015)
[3] Nature Physics 14, 154 (2018)
[4] arXiv:1904.00822
[5] Phys. Rev. B 100, 155130 (2019)

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