Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

Thursday, November 17th, 2022 – 10:00 a.m.
CFEL Seminar room I,II,III (Bldg. 99)

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Quantum spectroscopies for quantum materials

The rich phase diagrams of many transition metal oxides (TMOs) is the result of the intricate interplay between electrons, phonons, and magnons. This makes TMOs very susceptible to external parameters such as pressure, doping, magnetic field, and temperature which in turn can be used to finely tune their properties. The same susceptibility makes TMOs the ideal playground to design experiments where the interaction between tailored electromagnetic fields and matter can trigger the onset of new, sometimes exotic, physical properties. This aspect has been explored in time domain studies [1] and has led to the demonstration that ultrashort mid-IR light pulses can "force" the formation of quantum coherent states in matter, disclosing a new regime of physics where thermodynamic limits may be bridged and quantum effects can, in principle, appear at ambient temperatures.

In this presentation, I will review our recent results in archetypal strongly correlated cuprate superconductors and demonstrate the feasibility of a light-based control of quantum phases in real materials [2,3,4]. I will then introduce our new approaches to time domain spectroscopy going beyond mean photon number observables [5-10] and show that the statistical features of light can provide richer information than standard linear and non-linear optical spectroscopies[11,12]. Finally, I will elaborate on the possibility offered by embedding complex materials into resonant optical cavities[13, 14] and show how properties for the light-matter assembly different from those of its constituents can emerge.

[1] Advances in physics 65, 58-238, 2016
[2] Science 331, 189-191 (2011)
[3] Phys. Rev. Lett. 122, 067002 (2019)
[4] Nature Physics 17, 368–373 (2021)
[5] Phys. Rev. Lett. 119, 187403 (2017)
[6] New J. Phys. 16 043004 (2014)
[7] Nat. Comm. 6, 10249 (2015)
[8] Nat. Comm. 13, 2667 (2022)
[9] J. of Physics B 53, 145502 (2019)
[10] Optics Letters 45, 3498 (2020)
[11] Light: Science & Applications, 11, 44 (2022)
[12] PNAS March 19, 116 (12) 5383-5386 (2019)
[13] Rev. Sci. Inst. 93, 033102 (2022)
[14] https://arxiv.org/abs/2210.02346

Host: Simone Latini

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