

Non-equilibrium dynamics of electronic excitations in strongly correlated materials

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Electronic excitations in strongly correlated materials induce variations of the electronic structure which can be of electronic or bosonic character. Examples for both will be presented here.

The valence electronic structure of the transition metal dichalcogenide $1T\text{-TaS}_2$ is determined by a combination of charge density wave (CDW) and Mott physics. The corresponding fundamental excitations are the CDW amplitude mode and the Doublon which hosts two electrons at a single site. Both are investigated experimentally using femtosecond time-resolved photoelectron spectroscopy including substitutional electron doping of Ta [1-4]. Spectroscopy in the time domain is specifically sensitive to these excitations based on their energies and lifetimes. Doublon excitations are observed to decay on ultrafast timescales [1,4]. Doping introduces impurities which pin excitations. As a result, Holon-Doublon recombination and thermalization of electronic excitations are inhibited.

The response of the charge transfer insulator NiO to across gap excitations was investigated by time-resolved soft x-ray and optical spectroscopy [5]. A transient pre-edge feature observed at the Ni L_3 absorption is assigned to a transiently ($t < 5$ ps) occupied many-body multiplet. Time-resolved optical spectroscopy experiments were conducted under comparable excitation conditions and identify long-living ($t > 100$ ps) excitations which are associated with local structural modifications known from polaron formation. For sufficiently high pump fluence we consider to induce a metastable structural modification.

- [1] Ligges et al., Phys. Rev. Lett. **120**, 166401 (2018).
- [2] Avigo et al., Appl. Sci. **9**, 44 (2019).
- [3] Jayabalan et al., Phys. Rev. B **113**, 245107 (2026).
- [4] Avigo et al., Phys. Rev. Research **2**, 022046(R) (2020).
- [5] Lojewski et al., Phys. Rev. B **110**, 245120 (2024).