From vortices to jamming: photoinduced transitions revealed in STM

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The non-equilibrium processes leave very specific imprint on the metastable order, “hidden” in topological defects and, more generally, in various correlation functions. We are able to recover it using the combination of scanning tunnelling microscopy (STM) and in situ ultrafast excitation [1]. Are those imprints a part of a bigger picture? To this end, we need to understand whether qualitative changes can be introduced in this way in charge-ordered systems.

A variety of photoinduced transitions rely on slight transformation of the charge order, resulting in metastable states reminiscient of the nearby equilibrium ones. Here we present the counter-example, where a single femtosecond-scale optical pulse, applied to the prototypical transition metal dichalcogenide 1T-TaS2, converts a perfect hexagonal charge order into a dramatically different metastable jammed state of strongly correlated electrons [2]. Despite the apparent randomness of the resulting localized charge pattern, the system keeps perfect atomic lattice order and demonstrates charge hypeuniformity – the hidden “order” emerging from Coulomb interactions.

We further build the phase diagaram of this transition as a function of fluence and temperature on multiple time and length scales. The time evolution of the localized charge pattern together with theoretical calculations [3, 4] confirm that *charge frustration* is important for the state's unusual stability. We argue that charge frustration and jamming dynamics and the generic features of charge-ordered systems that can be exploited for tailoring the photoinduced metastability in a variety of quantum materials and paving the way to photoinduced superconductivity.

References:

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