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Ultrafast control of electronic interactions in low-dimensional cuprate superconductors

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(via Zoom)
Ultrafast optical excitation has recently emerged as a powerful means to control and induce new functionalities in quantum materials. One of the most ambitious goals is to selectively drive structural or electronic degrees of freedom to bring about nonequilibrium superconductivity at temperatures far above the equilibrium critical temperature Tc. While this phenomenon has been observed in a variety of systems ranging from copper oxides to organic molecular metals [1,2,3,4], the microscopic physics of these dynamics is still largely unexplored. In layered copper oxides, resonant scattering experiments have revealed that transient superconductivity is accompanied by a suppression of charge order correlations [5] and that the following dynamics at sub-meV scales are overdamped and diffusive [6,7]. Further, the CO phase exhibits dynamical critical scaling, a universal behavior arising from the propagation of topological defects. In order to explore whether these dynamics are universal among cuprate families and peculiar to the two-dimensional limit, we investigate charge order in light-driven Sr14Cu24O41 (SCO). SCO is a quasi-1D cuprate compound with a ladder-like structural subunit that is superconducting when doped with Ca and at high pressure (TC ~ 9 K, 3 GPa). The stoichiometric compound exhibits a robust charge order with a Tc of about 210 K and a (0, 0, 0.2) modulation wavevector [8]. When excited with 1.55 eV pulses, we find that the stripe phase behaves in markedly distinct ways than what found in La2-xBaxCuO4 and does not show the hydrodynamic fluctuation behavior observed in the 214 compounds [9]. We discuss the implications of our experiments for the origin of charge order in the cuprates and for the physics of light-induced superconductivity in these materials.

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