Experimentelle Physik 2

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Photo-Induced Nonequilibrium Response in Underdoped Cuprates Probed by Time-Resolved Terahertz Spectroscopy

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Employing ultrashort laser pulses to probe and manipulate quantum materials has led to significant discoveries, including light-induced transient superconductivity in cuprates. Initially claimed in the normal state of $La_{1.675}Eu_{0.2}Sr_{0.125}CuO_4$, and subsequently in underdoped $YBa_2Cu_3O_{6+x}$ and $La_{1.885}Ba_{0.115}CuO_4$, light-induced superconductivity is evidenced by a reflectivity edge in the c-axis terahertz reflectance spectrum and divergent 1/ω behavior near zero frequency in the imaginary part of optical conductivity. These responses were previously attributed to Josephson tunneling emerging in the equilibrium superconducting state.

In further exploration, we conducted non-equilibrium terahertz spectroscopy on underdoped $YBa_2Cu_3O_{6+x}$ and $La_{2-x}Ba_xCuO_4$ samples. Our research calls for a reconsideration of the notion of light-induced superconductivity in cuprates. We challenge the view that this phenomenon should be exclusively interpreted as "transient superconductivity" and question the necessity of phonon resonant pumping for its occurrence. Significantly, our findings reveal that the transient responses along the CuO_2 planes diverge significantly from the superconducting condensation signatures, suggesting an alternative explanation of the transient c-axis responses involving the generation of quasi-particles rather than Josephson tunneling.

[1] S. J. Zhang *et al.*, Phys. Rev. X **10**, 011056 (2020).
[2] S. J. Zhang *et al.*, Phys. Rev. X **14**, 011036 (2024).
[3] T. Dong, S. J. Zhang, and N. L. Wang, Advanced Materials, 2022: 2110068 (2022).