From kHz to THz: wideband spectroscopy of unconventional metals

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The response to electromagnetic radiation can provide key information on the physics of metals and superconductors, from electronic lifetimes to superconducting gaps and collective modes. Spectroscopic measurements at low photon energies are of particular importance for metals with small densities of charge carriers, as well as unconventional superconductors and systems with charge-density wave order. In this talk, I will discuss our efforts to perform electromagnetic absorption spectroscopy in a wide range of energies, from audio frequencies (kHz) into the millimetre-wave region close to 1 THz, that have yielded interesting insights in a number of unusual metallic systems. First, I will show how ultra-low frequency experiments provide detailed information on slow relaxation processes related to intertwined superconducting and charge-stripe order in the high-T_c cuprate $(La,Ba)_2CuO_4$. Furthermore, a recently developed setup for microwave and millimetre-wave spectroscopy [1] has enabled us to perform measurements with circularly polarized radiation and uncover a new spin-chiral electron-phonon coupling mechanism in the low-density metal $SrTiO_3$ [2]. Finally, millimetre-wave absorption spectroscopy shows evidence of superconducting collective excitations in TaS_2-based materials, suggesting a highly unconventional pairing symmetry.

References:
[1] L. Rogić et al., Rev. Sci. Instrum. 96, 083101 (2025)
[2] N. Somun et al, arXiv:2606.03908 (2026)