Title:

Coherent terahertz (THz) dynamics of collective excitations in a Weyl charge density wave

Abstract:

Understanding the fundamental collective excitations of a many-body interacting system has been a crosscutting theme throughout many branches of physics. Key questions about the dynamics of these excitations in the presence of both strong correlations and topology are currently driving numerous major research efforts in quantum materials. One such material is $(TaSe_4)_2I$ - a Weyl semimetal that undergoes charge density wave (CDW) ordering below 260 K. I will discuss two of our recent experiments using nonlinear light-matter interaction in the terahertz (THz) range to directly probe the dynamics of the collective excitations of $(TaSe_4)_2I$. I will first show how upon transient photoexcitation at low temperatures, $(TaSe_4)_2I$ strikingly emits coherent, narrow-band THz radiation. The frequency, polarization and temperature-dependence of the emitted radiation imply the existence of a phason that acquires mass by coupling to long-range Coulomb interactions, giving a direct measurement of the Anderson-Higgs mechanism. Second, I will show our recent results using THz pump, IR Kerr probe spectroscopy on $(TaSe_4)_2I$ to highlight how THz-driven phonons can induce a dynamic optical Kerr rotation in this otherwise time-reversal invariant system. I will briefly discuss both these results in the context of the predicted axion electrodynamics in $(TaSe_4)_2I$.

Ref: S. Kim, Y. Lv, …., F. Mahmood. “Observation of a massive phason in a charge density wave insulator”. Nature Materials 22, 429-433 (2023).