Ultrafast Nonequilibrium Dynamics of Room Temperature Charge Density Wave Fluctuations in 1T-$TiSe_2$

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1T-$TiSe_2$ is known to exhibit a charge-density-wave (CDW) transition below 200 K, a phenomenon that arises from an interaction between excitons and phonons. This makes $TiSe_2$ an ideal system for studying the coupling between electronic states and lattice vibrations. While the band structure changes accompanying the low-temperature CDW phase are well characterised, the nature of CDW-related fluctuations at higher temperatures remains to be disentangled. In this work, we use time-resolved ultraviolet angle-resolved photoemission spectroscopy combined with density functional perturbation theory and directly observe signatures of CDW fluctuations at room temperature. We examine how these fluctuations respond to ultrafast, non-resonant optical excitation and uncover a persistent coherent amplitude mode governing the recovery dynamics even at elevated temperatures. Our time-, energy-, and momentum-resolved photoemission results point to electron-phonon interactions as the dominant mechanism driving these high-temperature CDW fluctuations. These results not only widen the understanding of CDW physics but also have broad implications for the study of fluctuating phases in other materials.