Coherent manipulation of materials near topological and ferroelectric phase transitions

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In this presentation I will describe recent experiments that use a variety of methods, including time-resolved x-ray and THz spectroscopy, to address the question of how the excitation of large-amplitude coherent structural modes can give unqiue insights into the dynamics of materials near phase transitions where a key order parameter is tied to structure.

In measurements on the excited state of WTe_2, we show that in addition to the strong excitation of a shear mode that modulates the transition to an inversion-symmetric structure, a variety of other coherent excitations are excited that have an important impact on the electronic properties of this Weyl-type semimetal. Time resolved x-ray diffraction offers a uniquely quantitative view of these additional modes that give insight into the transient electronic properties.

In the wide-bandgap ferroelectric $Sn_2P_2S_6$, we show using time-resolved x-ray diffraction that a broadband THz pulse drives partially softened structural modes at temperatures near the phase transition and can use these measurements to verify the order-disorder component of the transition. I then discuss recent experiments using a combination of electronic and THz excitation to drive coupled dynamics in the binary ferroelectric GeTe. Here we see evidence of coupling between the structural soft modes, in combination with a change of the interatomic potential toward the paraelectric phase. I discuss the potential of using such coupling for coherent structural control.