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Ultrafast investigation of photo-excited carrier-lattice dynamics in PbTe using Fourier-transform inelastic X-ray scattering MASON JIANG, CRYSTAL BRAY, JESSE CLARK, TOM HENIGHAN, MIKE KOZINA, AARON LINDENBERG, MARIANO TRIGO, PETER ZALDEN, DAVID REIS, PULSE Institute, Stanford University, MATTHIEU CHOLLET, JAMES GLOWNIA, MATTHIAS HOFFMANN, DILING ZHU, LCLS, SLAC National Accelerator Laboratory, OLIVIER DELAIRE, ANDREW MAY, BRIAN SALES, Oak Ridge National Laboratory, STEPHEN FAHY, EAMONN MURRAY, IVANA SAVIC, Tyndall National Institute — We report with fine temporal and momentum resolution non-equilibrium electron-phonon and phonon-phonon dynamics in the widely-used thermoelectric material PbTe. The measurements are made possible by both the intense, ultrafast X-ray pulses of the Linac Coherent Light Source instrument and the recently developed Fourier-transform inelastic X-ray scattering (FT-IXS) technique. We demonstrate experimentally the various effects of impulsive optical photo-excitation on the lattice dynamics of the material as carriers are dramatically redistributed in the system. Specifically, coupled two-phonon states are excited throughout various Brillouin zones and possible plasmon-phonon modes are observed very near zone center. Coupled with calculations from density functional theory (DFT), an analysis of these photo-excited modes yields new insight into the origins of the incipient ferroelectricity and zone center anomalies noted in past measurements on PbTe.

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