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Coherent $\mathbf{A_{1g}}$ Phonon in thin Film Superconductor $\mathbf{FeSe_{0.5}Te_{0.5}}$: $\pi/2$ Phase Difference over Superconducting Phase Transition[1] JIMIN ZHAO, YANLING WU, MINHUI HU, YICHAO TIAN, LIXIN CAO, RUI WANG, Institute of Physics, Chinese Academy of Sciences — Coherent A_{1g} phonon mode in a thin film superconductor $FeSe_{0.5}Te_{0.5}$ was generated and detected using ultrafast laser pulses. At below and above the transition temperature T_c, the coherent lattice oscillation we observed exhibited a $\pi/2$ phase difference, manifesting a "displacive limit $\sim$ impulsive limit" transition upon crossing a phase transition within the same sample. We ascribe this $\pi/2$ phase difference to the different lifetimes (τ_c) of excited charge density components that couples to the fully symmetric A_{1g} phonon mode, i.e. the different strength of electron-phonon couplings. In the superconducting and paramagnetic metallic states the lifetimes of such carrier excitations are largely different. Our investigation reveals possible correlation of superconducting electrons with zone-center optical phonons. Our 170nm thin film sample contains tension stress, which leads to enhanced T_c and thus facilitated our measurements.

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Jimin Zhao
Institute of Physics, Chinese Academy of Sciences

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