# Detecting Higgs mode and its coupling with other collective modes developed in the pseudogap phase in cuprate superconductor

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We present nonlinear terahertz third harmonic generation (THG) measurement on different doping YBa2Cu3O6+x thin films and electron-doped LCCO thin films. Different from conventional superconductors, the THG signal starts to appear in the normal state, which is consistent with the crossover temperature $T^*$ of pseudogap over broad doping levels. Upon lowering temperature, the THG signal shows anomaly just below Tc. Strikingly, we observe a beat pattern directly in the measured real time waveform of THG signal. We elaborate that the Higgs mode, which develops below Tc, couples to the mode already developed below $T^*$, resulting in an energy level splitting. The strong coupling effect offers new insight into the interplay between superconductivity and pseudogap. The result suggests that the pseudogap phase is not likely a precursor of superconductivity but represents a distinct order.

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