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Ultrafast Observation of the Coexistence of Antiferromagnetism and Superconductivity in the High-T_c Superconductor Tl-2223 ELBERT E.M. CHIA, JIAN-XIN ZHU, D. TALBAYEV, A.J. TAYLOR, R.D. AVERITT, Los Alamos National Laboratory, IN-SUN JO, KYU-HWAN OH, SUNG-IK LEE, Pohang University — In high-T_c superconductors (HTSC), it is commonly believed that Cooper pairing occurs via antiferromagnetic spin fluctuations. These spin fluctuations can be shown to exist if the competing ground state to the superconducting (SC) state is antiferromagnetism (AFM). It reveals itself when, for example, the SC state is destroyed or suppressed using an externally applied magnetic field. Ultrafast spectroscopy has been widely used in probing the relaxation dynamics of photoexcited quasiparticles in correlated electron systems, and in particular, cuprate HTSCs. However, no such measurements have been taken for the regime where AFM and SC might possibly coexist. We report the first ultrafast relaxation measurements in such a coexistence phase in the HTSC $Tl_2Ba_2Ca_2Cu_3O_y$. Without applying any external magnetic field, we see a qualitative change in the relaxation dynamics below $\sim$40 K, which is suggestive of an entry into the AFM+SC coexistence phase. To quantitatively explain our data, we combined a coupled model describing the time-evolution of quasiparticles and high-frequency phonons in the presence of a gap in the density of states, and a mean field model that gives rise to a decrease in the SC gap as one enters the coexistence state.

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