Structural Dynamics of $SrTiO_3$ Films under Single-Cycle THz Excitation

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Time-domain x-ray scattering has recently enabled exploration of molecular and structural dynamics on the Angstrom and sub-picosecond scales (e.g. [1]). This technique can thus provide a complementary tool to all-optical methods towards exploring structural phase transitions in complex materials.

The incipient ferroelectric Strontium Titanate ($SrTiO_3$, STO) [2] provides a model system to explore the detailed motion of atoms in transition metal oxides with perovskite structure under instigation of an ultrafast light pulse. We present x-ray scattering measurements of thin-film STO driven by single-cycle THz fields using the XPP end station at LCLS. From the change in scattering intensity we explore models of atomic motion induced by the THz field. Via temperature-dependent studies we show coupling of the THz field to the lowest-frequency zone-center optical mode. This mode in turn couples at strongest fields to a second mode with a frequency far from the bandwidth of the THz pulse, indicative of nonlinear phonon interactions.

[1] M. Minitti et al. *Phys. Rev. Lett.* **114** 255501 (2015)
[2] K.A. Müller and H. Burkard. *Phys. Rev. B* **19** 3593-3602 (1979)