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Title: Ultrafast Structural Dynamics Observed with Atomic Scale Resolution.

Abstract: Ultrafast optical spectroscopy has long been used with great success to generate and probe non-equilibrium electronic excitations with femtosecond time resolution. The spatial resolution in these techniques, however, is limited to micron scales and structural dynamics can only be inferred indirectly. I will report direct measurements of structural dynamics with atomic scale spatial resolution by using ultrafast electron diffraction (UED). In UED, a femtosecond laser pulse is split into two, the first part is used to induce structural change and the second part is used to generate ultrafast high energy electron packets via photoelectric effect. Recording the diffraction pattern of these electron packets at different times after the photo-excitation of the sample provides a movie of the laser induced structural change with sub-picosecond temporal and sub-Angstrom spatial resolution. I will discuss recent experiments where we used UED to observe lattice dynamics in cuprate superconductors in response to photo-excitation of the charge carriers. Above certain threshold laser intensity, we observe direct conversion between two structures with different c axis lattice constants indicating a non-equilibrium structural phase transition.