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Ultrafast X-ray Science at SLAC and LCLS[1]

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Hard x-rays (E greater than 1 keV) can probe the structure of matter on the length scale of a chemical bond. Ultrafast lasers (t less than 1 ps) can capture the quantum dynamics of single vibration in a crystal lattice or in a molecule, and they have also been used to view the transient molecular-scale transformations of chemical reactions. Until recently, only laser-induced plasma radiation was capable of capturing these ultrafast dynamics and also viewing them on the scale of a single chemical bond. The recent Sub-Picosecond Pulse Source experiment at SLAC was the first instrument based on synchrotron radiation from an undulator that could do both. During its two-year run, its 8 keV, 80 fs x-ray pulses were the brightest ultrafast x-rays in the world. This is just the beginning. The planned X-ray free electron laser at SLAC (LCLS) will generate focused x-ray fields as strong as atomic binding fields, comparable to today' highest intensity lasers. These new tools are creating some special opportunities for new science, and also some challenges. I will discuss these, and present recent progress in ultrafast x-ray sources and science.

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