Electronic response to X-ray free-electron laser pulses

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X-ray free-electron lasers (XFEL) [1] open a new era in science and technology, offering many unique opportunities that have not been conceivable with conventional light sources. Because of their very high x-ray photon fluence within very short pulse duration, materials interacting with XFEL undergo significant radiation damage and possibly become highly ionized. To comprehend underlying physics, it is crucial to understand detailed ionization and relaxation dynamics in individual atoms during XFEL pulses [2]. In this talk, I will present a theoretical framework to treat X-ray–induced atomic processes and to simulate electronic damage dynamics, introducing an integrated toolkit for X-ray and atomic physics, XATOM. It can provide fundamental insight into the electronic response of atoms to ultraintense and ultrashort XFEL pulses. It has been successfully applied to study many exciting XFEL-related phenomena, for instance, X-ray scattering dynamics in relation to hollow-atom formation [3], nonlinear X-ray absorption processes [4,5], ultra-efficient ionization of heavy atoms [6], and novel diffraction method with heavy atoms [7]. I will discuss how this theoretical work can explain recent experiments conducted at LCLS, the world's first hard-X-ray FEL, and how it can lead to new XFEL experiments.

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