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Ultrafast electron dynamics in finite atomic systems

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With the LCLS free-electron-laser source at Stanford coming on line, new possibilities of light-matter couplings arise. This talk will focus on ultrafast electron dynamics in clusters as a result of a sudden removal of inner shell electrons by photo ionization through a high frequency (about 10 keV) XFEL pulse. A detailed understanding of this electron dynamics is crucial to realize one of the prime goals envisaged with XFEL beams: single molecule imaging. We will show that field induced electron migration influences the motion of the nuclei and is therefore important for imaging. The electric field under discussion is generated by the (photo)-ionized atoms. Time permitting another – quite surprising – ultrafast multi-electron process will be introduced. It can be triggered by a few seed atoms implanted in a rare gas cluster when illuminated by a standard 800nm strong laser pulse with 50 fs duration. Preferential ionization of the seed atoms (with ionization potential lower than those of the cluster) again creates a strong electric field gradient which removes very quickly (on a time scale of 1 fs) many electrons bound to atoms of the cluster. We will explain the effect which occurs for both, linear and elliptic polarization of the laser.