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Ultrafast strong field xray interactions with aligned molecules at LCLS[1]

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The laser-molecule interaction with focused intense ($10^{20} W/cm^2$) ultrafast (5-100 fsec) coherent x-rays (800-2000 eV) is the subject of ongoing research at the LCLS x-ray free electron laser. This unprecedented combination of short wavelength, short pulse duration, and high intensity leads to several new experimental regimes. We have performed the first x-ray studies of transient molecular ion states, including coherent rotational alignment of diatomic molecules, as well as the excited states of the nitrogen dication. We have also studied the intense-field phenomenon of simultaneous multiple core hole formation, both within the same atom and on different atoms in the same molecule. The x-ray matter interaction is affected by competition between the laser ionization rate and Auger relaxation rates. Our initial results show how the ultrashort pulse duration affects ionization and dissociation dynamics in the molecule. These early results also establish new techniques for ultrafast time resolution in pump-probe experiments.

[1]The LCLS AMO 02709 Collaboration, http://pulse.slac.stanford.edu/amo02709, Supported by the Office of Basic Energy Sciences, U.S. Department of Energy