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X-ray FEL induced multiphton ionization and molecular dissociation

LI FANG, Western Michigan University

X-ray Free electron lasers (FELs) enable multiphoton absorption at the core levels which is not possible with conventional light sources. Multiphoton ionization and the subsequent core-hole states relaxation lead to dramatic dynamics of the molecules. We present our experimental as well as theoretical results on multiphoton ionization and molecular fragmentation dynamics with the Linac Coherent Light Source (LCLS) at SLAC National Laboratory. We investigated simple diatomic system, N2 molecules, where we used multiphoton ionization as an internal clock for imaging the dynamics in time and the internuclear separation domain [1]. We observed the modification of the ionization dynamic by varying the x-ray beam parameters and the effect of the spatial distribution on the ionization. We also investigated a complex system, C60, where we developed a full model to simulate the multiphoton ionization that results in various molecular ions and atomic carbon ions up to charge 6+. The calculation agrees well with our experimental results in ion kinetic energy distribution and charge state distribution. Moreover, our model provides further insights into the photoionization and dissociation dynamics as a function of time and molecular size.

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[1] *Multiphoton ionization as a clock to reveal molecular dynamics with intense short X-FEL pulses.* L. Fang, T. Osipov, B. Murphy, F. Tarantelli, E. Kukk, J.P. Cryan, M. Glownia, P.H. Bucksbaum, R.N. Coffee, M. Chen, C. Buth and N. Berrah, Phys. Rev. Lett. **109**, 263001 (2012)