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Molecular dissociation dynamics driven by strong-field multiple ionization[1]

PHILIP BUCKSBAUM, Stanford University

We have studied and compared the dynamics of small molecules that have been multiply ionized and dissociated by strong ultrafast infrared lasers or by strong x-ray lasers. In both regimes we find that multiple ionization can occur on time scales comparable to the fastest interatomic motion, and therefore lead to dissociation patterns that can be related to the transient structure and internal motion of the molecules. The mechanisms that produce multiply charged ions are very different in these two cases. Infrared lasers induce field-ionization, while x-ray lasers induce core-ionization followed by Auger relaxation. This affects the dissociation dynamics. In experiments studying the dissociation of 1,3-cyclohexadiene we find that infrared laser-induced multiple ionization is greatly enhanced by transient processes that occur in the vicinity of conical intersections [Bucksbaum and Petrovic, *Faraday Discussions* **163**, 475 (2013); Petrovic et al., *J.Chem. Phys.* **139**, (2013)] When strong x-rays are used as the exciting source, the molecular geometry can influence the Auger process and change the fragment relative abundances [Petrovic et al., *Phys. Rev. Letters* **108**, 253006 (2012)]. We will discuss recent experiments in deuterated acetylene, which employed x-ray pulse-pairs to explore the x-ray fragmentation process in greater detail.

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