DAMOP07-2007-020012

Abstract for an Invited Paper
for the DAMOP07 Meeting of
the American Physical Society

Ionization and dissociation of molecular ion beams by intense ultrafast laser pulses[1]

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Laser-induced dissociation and ionization of a diatomic molecular-ion beam were simultaneously measured using coincidence 3D momentum imaging, with direct separation of the two processes even where the fragment kinetic energy is the same for both processes. We mainly focus on the fundamental H_2^+ molecule in 7-135 fs laser pulses having 10^{13}-10^{15} W/cm^2 peak intensity. At high intensities the kinetic energy release (KER) distribution following ionization of H_2^+ was measured to be broad and structureless. Its centroid shifts toward higher energies as the laser intensity is increased indicating that ionization shifts to smaller internuclear distances. In contrast, a surprising structure is observed near the ionization threshold, which we call above threshold Coulomb explosion (ATCE) [1]. The angular distributions of the two H^+ fragments are strongly peaked along the laser polarization, and the angular distribution is described well by $[\cos^2\theta]^n$, where n is the number of photons predicted by our ATCE model [1]. Our data indicates that n varies with the laser wavelength as predicted by the model. The KER and angular distributions of H_2^+ dissociation change dramatically with decreasing pulse width over the 7-135 fs range in contrast to the reported trend for longer pulses. Others contributing to this work: *A.M. Sayler, P.Q. Wang, J. McKenna, B. Gaire, Nora G. Johnson, E. Parke, K.D. Carnes, and B.D. Esry.* Thank are due to Professor Zenghu Chang for providing the intense laser beams and Dr. Charles Fehrenbach for his help with the ion beams.

[1] B.D. Esry, A.M. Sayler, P.Q. Wang, K.D. Carnes, and I. Ben-Itzhak, Phys. Rev. Lett. **97**, 013003 (2006).

[1]Supported by the Chemical Sciences, Geosciences, and Biosciences Division, Office of Basic Energy Sciences, Office of Science, U.S. Department of Energy.