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Strong-field coherent control of molecular-ion-beam fragmentation[1]

ITZIK BEN-ITZHAK[2], J.R. Macdonald Laboratory, Department of Physics, Kansas State University

We have studied laser-induced fragmentation of molecular-ion beams using coincidence 3D momentum imaging, with direct separation of all the reaction products measured simultaneously. These measurements provide detailed kinetic energy release and angular distributions of the different fragmentation processes. We mainly focus on the fundamental H_2^+ and H_3^+ molecules (in 7-50 fs laser pulses having 10^{12}-10^{16} W/cm^2 peak intensity) as models for more complex systems. We use deuterium tagging to distinguish different final products and thus study how to control the interference between several fragmentation pathways responsible for the preference of one outcome over another. The preference for HD^+ to dissociate into either H^++D or H+D^+ is a good example of this kind of control – usually referred to as channel asymmetry. We expect the H^++D channel, associated with the HD^+ electronic ground state, to dominate over dissociation into H+D^+ for very slow fragmentation of HD^+ produced by a two-photon process called (net) zero-photon dissociation. Our experimental results confirm this prediction. The mechanisms of the strong-field control we demonstrate in these comparatively simple systems are applicable to more complex molecules, although identifying all of the important fragmentation pathways becomes more challenging. Nevertheless, the principles of determining the important control parameters remain the same.

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[2]Others contributing to this work: B. Gaire, M. Zohrabi, J. McKenna, U. Ablikim, A.M. Sayler, N.G. Johnson, K.D. Carnes, D. Ursrey, F. Anis, J. Hernandez, J.J. Hua, and B.D. Esry