Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

Measuring attosecond time-delays between dissociating vibrational states of D_2^+ using a two-color laser field[1] T. SEVERT, BEN BERRY, M. ZOHRABI, PEYMAN FEIZOLLAH, BETHANY JOCHIM, KANAKA RAJU P., J. MCKENNA, B. GAIRE, K. D. CARNES, G. S. J. ARMSTRONG, D. URSREY, J. V. HERNANDEZ, F. ANIS, B. D. ESRY, I. BEN-ITZHAK, J.R. Macdonald Laboratory, Physics Department, Kansas State University, Manhattan, KS 66506, USA — There is considerable interest in studying attosecond time-delays in the photoionization of neighboring electronic states of atomic and more complex targets. The underlying assumption of that work is that electron dynamics are responsible for such short delays, since they match the natural electronic timescale. Recent theoretical work has shown that the two-color dissociation probability of adjacent vibrational states in the HeH^+ molecule exhibit time-delays of tens of attoseconds. Since electronic excitation is negligible in HeH^+ for the considered laser parameters, this demonstrates that attosecond delays occur for purely nuclear motion. Here, we present an analogous experiment on a D_2^+ ion beam, where attosecond time-delays are observed using an intense two-color (800/400-nm) laser field. In the two-color field, interfering pathways ending in opposite parity states result in a spatial asymmetry with respect to the laser polarization. By comparing the phase shifts of the spatial asymmetry parameter between the $v = 7$ and $v = 8$ vibrational states of the $1s\sigma_g$, we observe a 53-as delay.

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

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Date submitted: 06 Feb 2017 Electronic form version 1.4