Attosecond Delays in Molecular Photoionization: The effect of the Molecular Potential

Andrei Kamalov[1,2], Siqi Li[1], Zhaoheng Guo[1] ,
Jordan O'Neal[1,2],Philip H. Bucksbaum[1,2,3], James P. Cryan[1]

[1]Stanford PULSE Institute, SLAC National Accelerator Laboratory
[2]Department of Physics, Stanford University
[3]Department of Applied Physics, Stanford University

Recent advances in laser technology, particularly in strong-field driven high harmonic generation (HHG), have led to the ability to produces bursts of XUV radiation with temporal durations of a few hundred attoseconds. The availability of such pulses has led to exploration of photoionization dynamics on attosecond timescales. Early experiments in this field found that the emission of electrons from different atomic targets or from different sub-shells of an atomic target are temporally delayed from one another. This temporal delay is related to the phase of the emitted electron wavepacket; this phase is acquired as a result of the interaction with the atomic potential. More specifically, this delay measures the derivative of the spectral phase of the electron wavepacket with respect to the electron's kinetic energy. Although these delays have been well studied in noble gas atoms, relatively few experiments have consider photoionization of molecular targets in the time-domain. We present our measurements of the temporal dynamics of photoionization in a number of small molecular systems. These measurements showcase the effect that the molecular potential has on photoionization dynamics. We reference our measurements to the well-understood atomic argon system in order to extract an absolute delay for the different molecular species. The results presented are obtained from a train of attosecond pulses, but I will discuss the extension of these measurements to isolated attosecond pulses (IAPs) derived from a free-electron laser (FEL) source.