Imaging Electronic Motion with Attosecond Electron Pulses\textsuperscript{1}

HUA-CHIEH SHAO, ANTHONY F. STARACE, The University of Nebraska-Lincoln — Ultrashort electron pulses have been proposed to observe time-dependent phenomena in atoms and molecules \cite{1}. Owing to the temporal and spatial resolutions of short keV electron pulses, studying electronic motion in attosecond and sub-Angstrom regimes is feasible. We report benchmark calculations for oscillating electronic charge distributions in the H atom and in the H\textsubscript{2}\textsuperscript{+} molecule to determine the effect of such charge oscillations on the elastic scattering cross section for a sub-fs electron pulse. In the pump/probe calculations, a femtosecond laser pulse is used to excite a coherent superposition of states, whose charge distribution oscillates with the beat frequency. The electron pulse scattering cross sections are calculated in the Born approximation. For the H atom, the cross section exhibits an oscillating effective radius. For the H\textsubscript{2}\textsuperscript{+} molecules, the superposed state is chosen such that the electronic charge distribution oscillates from one nucleus to the other; hence, the differential cross section shows the localization of the electron.

\textsuperscript{1}This work is supported in part by NSF Grant PHY-0901673 and by a Nebraska Research Initiative grant.

\textsuperscript{1}P. Baum and A.H. Zewail, PNAS \textbf{104}, 18409 (2007).