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Molecular analogs for studying the time-dependence of atomic ionization[1]

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Many groups around the world are trying to use attosecond laser pulses to study the time-dependence of electron motion in atoms and molecules. We propose an alternative method that is capable of revealing insight into this motion without the need for attosecond pulses. Specifically, we have used the process of above threshold dissociation (ATD) of HeH^+as an analog to the atomic phenomenon of above threshold ionization (ATI). This analogy is verified by calculations made for the kinetic energy release spectrum for ATD that show the spectrum to contain several clear peaks, like the photoelectron spectrum for ATI. The laser parameter regime of ten-cycle pulses with intensities of 10^{14} W/cm^2 and a range of wavelengths from 2000 to 2400 nm has been shown to produce experimentally detectable dissociation probabilities for HeH^+. Since the ATD of HeH^+produces fragments, $HeH^+ + nh\nu \rightarrow He(1s^2) + H^+$, that are much more massive than an ionized electron, current pump-probe techniques can be used to experimentally verify predictions for the time-dependence of the nuclear motion in ATD for this laser parameter regime. By analogy, this allows experimental verification of predictions for electron motion in ATI.

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