Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Atoms and Molecules in Strong Mid-infrared Laser Fields

By

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When atoms and molecules are subjected to low frequency laser fields whose electric fields rival the atomic and molecular ones, the liberated photoelectrons can revisit and subsequently rescatter on their parent ions within a fraction of the laser period. In the last few years, using near-infrared pulses it has been shown that the photoelectron momentum distribution carries the fingerprint of a diffraction pattern from which for molecules it is possible to extract structural information. Given that the maximum kinetic energy of the returning photoelectron wave packet increases with the intensity and the square of the wavelength of the driving field, intense mid-infrared laser pulses should be used instead, since they create wave packets that can have an associated de Broglie wavelength smaller than the ionic size. Coupled with the sub-cycle dynamics of the electron wave packet, this diffraction-based mechanism can form the basis of a molecular camera, capable of "viewing" chemical reactions.

As a first step in the development of such a camera, we recorded high resolution momentum distributions for atoms and molecules extracting diffraction patterns for both near-infrared and mid-infrared driving laser fields. In addition, a low energy structure present in the photoelectron spectra not predicted by analytical models has been investigated. Finally, a study of laser-driven Auger decay was performed, exploring the regime in which the rescattering wave packet returns with a kinetic energy larger than the binding energy of inner shell electrons.

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