Laser induced electron diffraction in aligned molecules

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Abstract

The ionization of a molecule in a strong laser field leads to a photoelectron wavepacket that oscillates in the laser field and may re-collide with its parent ion. Laser induced electron diffraction (LIED) is a technique that makes use of the elastically scattered photo-electrons to construct diffraction images of the parent molecule. By performing LIED experiments on laser aligned molecules it is possible to link features in the Photo-electron Angular Distribution (PAD) specifically to the molecular frame and identify those features that arise due to the diffraction of the re-scattered electrons. This results in a significant enhancement in the diffraction pattern visibility.

We have performed LIED experiments on CF_3I molecules for intensities in the range of $4 \cdot 10^{13}$ - $2 \cdot 10^{14}$ W/cm^2 and using 800 and 1300 nm probe laser wavelengths. The CF_3I molecules are impulsively aligned with an 800 nm laser pulse. The PADs of strong field ionized molecules are subsequently recorded at the alignment and anti-alignment revival peaks with a Velocity Map Imaging Spectrometer. Taking the difference between aligned and anti-aligned molecular PADs we see a rich structure. Modelling the diffraction of re-scattered electrons using a simple semi-classical approach to strong field theory confirms that the experimental PADs show clear diffraction effects. Even for conditions with photoelectron re-collision energies below 10 eV we see signatures of diffraction caused by the parent ion. Numerical simulations of the PADs using Time-Dependent Density-Functional Theory have also been performed.