Multi-electron molecular systems in intense short laser fields

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Strong laser fields ($I>10^{13}$ W/cm^2) constitute a great tool for "filming" electron trajectories in atoms and molecules due to the possibility to produce extremely short (< femtosecond) pulses of light. Considering a single molecule, isolated from any possible intermolecular interaction, allows for a detailed study of the fundamental processes occurring during its interaction with the field. Following the electronic excitation induced by the laser pulse, the molecule relaxes in a few hundred attoseconds (1 attosecond = 10^{-18} seconds). One of the main goals in strong-field physics is to detect the initiated molecular dynamics.

When the field intensity is large the electrons are stripped out of the molecule sequentially. For smaller intensities, one electron is temporally ionized by tunnelling through the Coulomb barrier, and later can return to recollide with its parent ion. Inelastic rescattering on the parent ion results in high-harmonic generation or in further collisional excitation or ionization of the molecule. Here, I will first present a case of high-harmonic generation by the two-electron H_3^+ ion. Then, I will discuss the possible pathways for non-sequential double ionization of the N_2 molecule. In both studies, the influence of the laser field parameters will be demonstrated.