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Molecules in Intense Laser Fields and Electron-Nuclear Dynamics form Femto Attosecond Time Scales

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The photophysic of atoms with high intensity lasers is dominated by the process of electron ionization and laser induced electron recollision, with the parent ion [1]. The recollision time can be tuned as a function of laser frequency to span few femtoseconds (fs) (10^{-15}sec) to attoseconds (asec) (10^{-18}sec) times. Molecules introduce a new complexity, nuclear time scales which for protons occur in the region 8-10 fs. In intense fields, dissociative ionization, allows for molecules to reach large internuclear distances where Charge Resonance Enhanced Ionization (CREI) occurs thus increasing by several orders of magnitude ionization rates [2-3]. During recollision in molecules, electrons will undergo Coulomb refocusing. Both nonlinear effects, enhanced ionization and refocusing of the recollision electron leads to new efficient sources of high order harmonic generation (HOHG) from symmetric and nonsymmetric molecules [4]. Molecular electron recollision can lead to Laser Induced Electron Diffraction (LIED) [5] and molecular orbital tomography by inversion of HOHG spectra [6]. Finally, using asec pulses synthetized from HOHG spectra [7], one can create coherent molecular electron wavepackets. These are localized on asec time scales on various nuclei. Methods of detection and characterization of such electron wavepackets in molecules will be proposed from numerical solutions of the time-dependent Schroedinger equation for the molecular ion, [8].

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