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Electron Emission and Fragmentation of Linear Alcohol Molecules in Intense Laser Fields

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We have carried out the first electron spectroscopy and electron-ion coincidence experiments on linear alcohol molecules in intense laser fields (400 nm and 800 nm wavelength, 30-150TW/cm^2). We regard these molecules as archetypical linear polyatomics of modest dimension.
Electron spectra measured at different intensities show the following: at lower intensities, peak structure due to above-threshold ionization (ATI) is clearly resolved. Within the framework of the atomic Keldysh-Faisal-Reiss (KFR) model, $\gamma > 1$ corresponds to the multi photon ionization (MPI) regime and, indeed, distinct ATI structure is evident in the observed spectra. At higher intensities, for $\gamma \sim 1$, ATI peaks become less prominent and the spectra become dominated by the continuous structure.
Our electron spectroscopy results are somewhat unexpected in that the corresponding values of the Keldysh parameter, [$\gamma = (I_e/2U_p)^{1/2}$] provide a better description than the length modified Keldysh parameter. To probe the full reaction pathways of these atom-like molecular dynamics, we have performed electron-ion coincidence experiments for ethanol. Spectra of electrons correlated to different ions map out the correlation between the electron emission and subsequent fragmentation. It revealed the following: electron spectra correlated to relatively large ions $C_2H_nO^+$ have structure characteristic of MPI and ATI, while those correlated to C^+, C^{++}, C^{+++} exhibit continuum structure with a high energy tail due to backward electron rescattering. In summary, non-coincidence electron spectra reveal atom-like behavior of polyatomic molecules in the evolution of MPI to TI regimes whereas coincidence electron spectra correlated to the different fragment ions enable us to disentangle different contributions to the electron spectrum by the coincident ions. These different contributions leading to ionic fragments of different size and charge state typically belong to different intensity regions of the laser focus for a single experimental intensity setting of the laser.

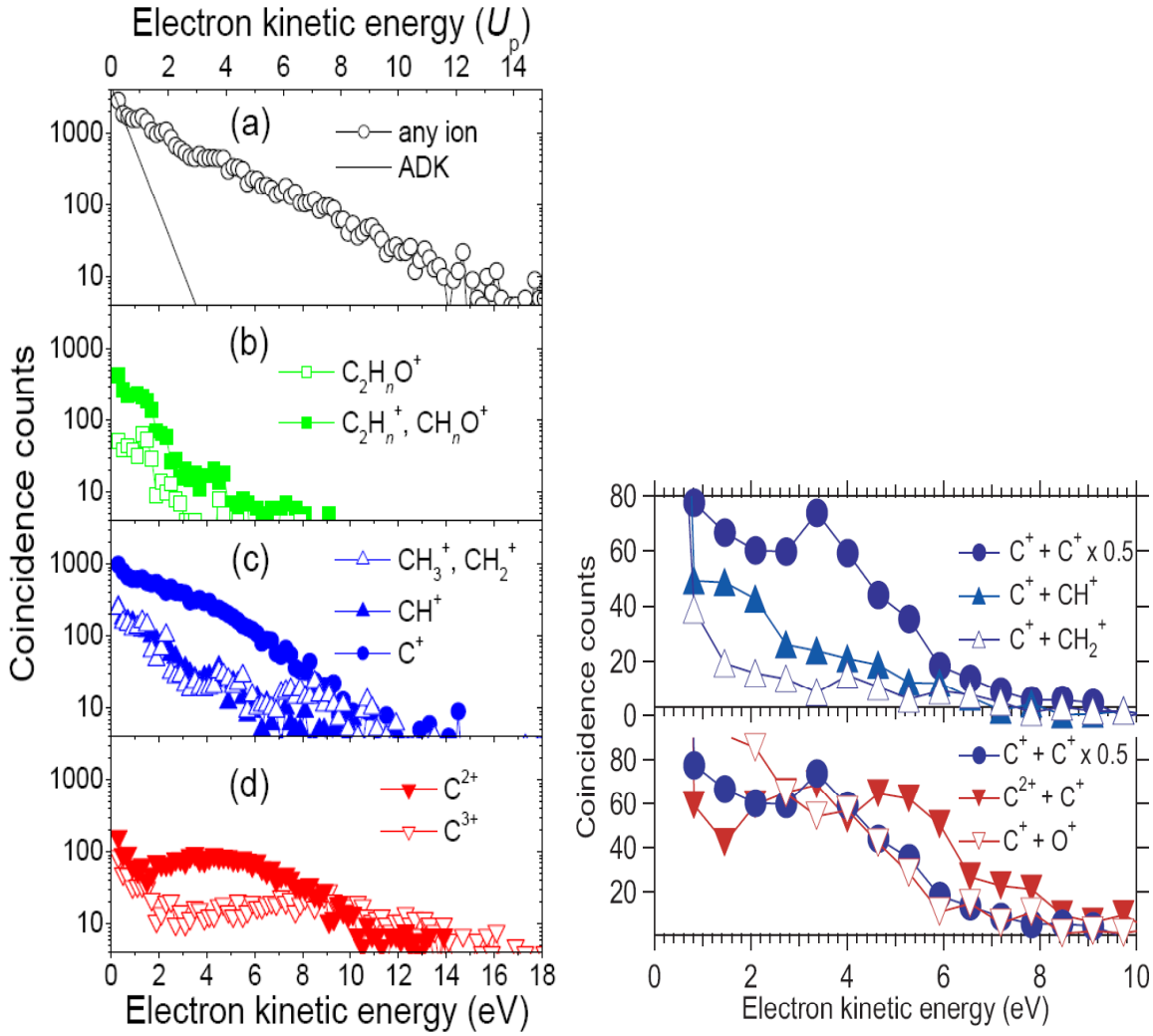

Figure1: Spectra of electrons detected in coincidence with specific ions or ion pairs.

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[2] B. Delone and V. P. Krainov, J. Opt. Soc. Am. B **8**, 1207 (1991).