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Ion-momentum imaging of dissociative-electron-attachment dynamics in CO_2, N_2O, HCCH and CF_4

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Synopsis We present experimental results for dissociative electron attachment to CO_2, N_2O, HCCH and CF_4 from an ion-momentum imaging technique. From our measured ion-momentum results we extract fragment kinetic energies and angular distributions. We directly observe the dissociation dynamics associated with the formation of transitory negative ions. We compare the experimental results with *ab initio* electronic structure and fixed-nuclei scattering calculations and obtain good agreement.

In recent years, low energy dissociative electron attachment (DEA) interactions have been of interest to varying biological and technological applications. To study the dynamics resulting from DEA, we used an ion-momentum imaging apparatus based on the Cold Target Recoil Ion Momentum Spectroscopy (COLTRIMS) technique in which a molecular beam is crossed by a pulsed electron beam. The beam interaction takes place in a 4π pulsed electrostatic spectrometer that collects the anion fragments resulting from DEA. The molecular beam is formed by a supersonic expansion which results in a well-localized and cold target. An overview of the apparatus is given in Ref. [1].

Using this apparatus we have investigated the DEA dynamics for several small molecules: CO_2 at the 4 eV shape resonance [2] and the 8 eV Feshbach resonance [3]; N_2O at the 2.3 eV shape resonance [4]; HCCH at the 3 eV shape resonance [5]; and CF_4 near the 7 eV resonance.

The experimental ion-momentum results are compared to *ab initio* electronic structure and fixed-nuclei scattering calculations to gauged the resulting dynamics driven by DEA. In many cases, conical intersections play a pivotal role in driving the dynamics. Some of these systems exhibit non-axial recoil conditions indicative of a bending dynamics in the transitory negative ion state while others exhibit a direct axial recoil dissociation without any bending.

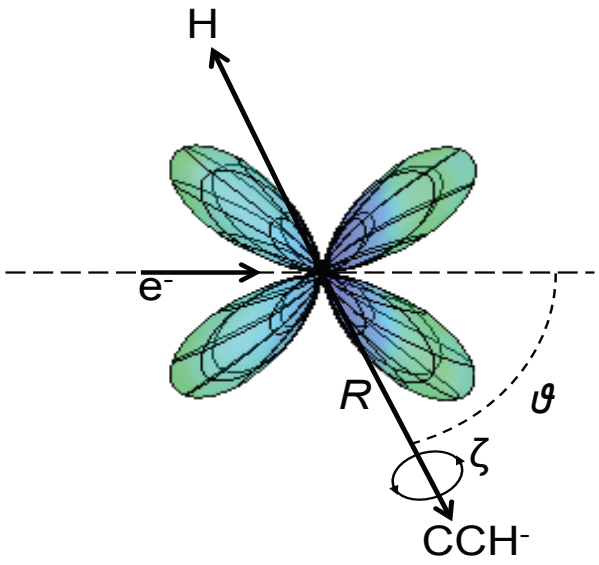

Figure 1. Modified axial recoil approximation for DEA to HCCH. The attachment amplitude lobes are shown along with the incoming electron and outgoing dissociation fragments in a rotated frame.

References

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