A NEW APPARATUS FOR THE INVESTIGATION OF ELECTRON IMPACT INDUCED IONIZATION AND FRAGMENTATION OF MOLECULES

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We present a new experimental approach for the investigation of low energy electron-molecule collisions. The goal is to determine the momenta of all charged particles emerging in molecular ionization and/or fragmentation processes. Therefore the collision kinematics of the reaction is completely determined and in many cases the detection of molecular fragments will allow to determine the molecular orientation in space during the collision and therefore enable electron scattering experiments on fixed-in-space molecules.

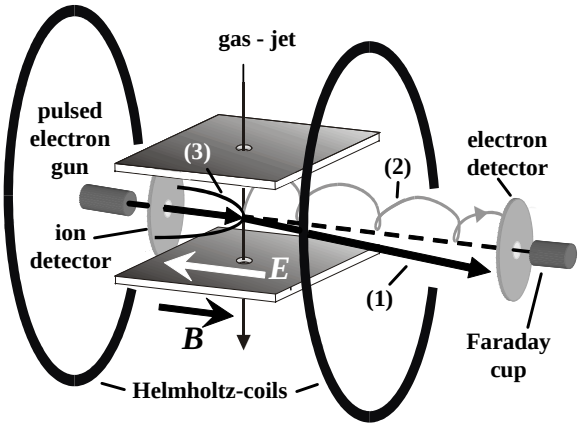

Figure 1: Schematic of the new reaction microscope. (1) Scattered projectile electron. (2) Ionized slow target electron. (3) Positive fragment ions.

The apparatus (Fig. 1) is a modified "reaction microscope" (COLTRIMS technique) in which a dense target gas jet is crossed with a pulsed electron beam. The charged fragments of a reaction are extracted by means of electric and magnetic fields and projected onto time and position resolving multi-hit-detectors with central bores to allow the passage of the primary projectile beam. In contrary to conventional COLTRIMS spectrometers the collision kinematics is not determined by means of the recoiling ion momentum but the scattered projectile electron itself is detected (in addition to all electrons emitted by the target). The coincident detection of one or several ions allows the additional characterization of the molecular fragmentation process. While so far projectile energies down to 20 eV where realized, in future energies in the few eV range with sub 100 meV energy resolution are envisaged using a GaAs photo emission electron source.

For illustration, in Fig. 2, the (e,2e) fully differential cross section for emission of a 10 eV electron is shown for the helium target and all possible emission angles. Presently first measurements on molecular hydrogen are performed.

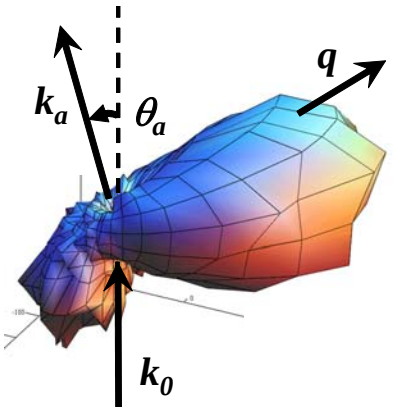

Figure 2: Fully differential cross section for emission of a 10 eV electron by impact of a 107 eV electron (momentum $\boldsymbol{k}_0$) on helium. The projectile scattering angle θ_a is 20° (momentum $\boldsymbol{k}_a$). $\boldsymbol{q}$: momentum transfer.