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Molecular alignment resolved (e,2e) cross sections for H_2 at 38 eV impact energy

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Synopsis Fully differential cross sections for electron impact ionization of H_2 are determined experimentally using a reaction microscope. For dissociation of the final H_2^+ ion in its electronic ground state the measurement of the proton momentum allows to conclude on the molecular alignment during the collision. The cross sections obtained are compared to published theoretical data.

Kinematically complete studies of the electron impact ionization of small atomic and molecular systems give important information concerning dynamical correlation in few-particle reactions. Here we present a (e,2e) study for molecular hydrogen where the spatial alignment of the molecular axis at the instant of the collision is determined.

The molecular axis alignment with respect to the incoming projectile momentum should be relevant in multiple or higher-order scattering of both active electrons within the molecule. In addition for possible Young's double-slit type interferences due to electron scattering at two indistinguishable centers the molecular alignment determines the observed interference pattern.

In the past only a few (e,2e) experiments have resolved the alignment of the molecular axis. This was realized by studying reactions where the H_2^+ ion in its electronic ground state [1,2] or in excited states [3,4] dissociates. Then the emission direction of the proton allows to determine the molecular axis direction.

Using a reaction microscope we measured the (e,2e) cross section of H_2 molecules at the impact energy of E_0 = 38 eV where the outgoing electrons share 20 eV excess energy. For this case non-perturbative theoretical calculations demonstrated a strong alignment dependence of the cross section [5] which, so far, was not confirmed experimentally. Furthermore, strong discrepancies between theoretical results and experiments that do not resolve the molecular alignment angle were observed for the coplanar scattering geometry.

For the dissociative ionization of H_2, resonant autoionization can interfere with direct ionization into the dissociating ionic ground state at particular electron emission energies in the range of 5 - 10 eV. In order to separate pure direct ionization, we choose kinematics for E_2 < 5 eV at low impact energy where only few autoionizing states are populated. This is facilitated by significant improvements of the spectrometer's electron energy resolution and a new pulsed photoemission electron gun [6].
Results and a detailed discussion will be provided at the conference.

References

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