

Transfer ionization of D^+ and He^+ projectiles with H_2 -molecules – electron emission dependency on the internuclear axis

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Synopsis: It's well known for atomic targets that the ionization in transfer ionization originates from electron knock-off or initial state correlated shake-off. For H_2 molecules we have observed a similar behavior and additionally a dependency of the electron emission from the internuclear axis

Transfer ionization (TI), the simultaneous electron capture accompanied by an additional ionization, in atoms has been subject of numerous investigations, both experimental and theoretical, in the last 20 years. Due to the electron transfer the TI is very sensitive to the ground state wave function of the target atom and continuum electron shows a rich structure in momentum space [1-3].

Figure 1 (right) show the electron momentum distribution longitudinal vs. transversal for protons colliding with an atomic (He) target. The separation in forward and backward electrons originates from two different mechanisms lifting the electron into the continuum. An independent binary collision of the projectile with the remaining electron knocks the electron off, leading to a forward emission of the electron (two-step-2, TS2). Contrary the backward emitted electron originates from initial state correlation in the target.

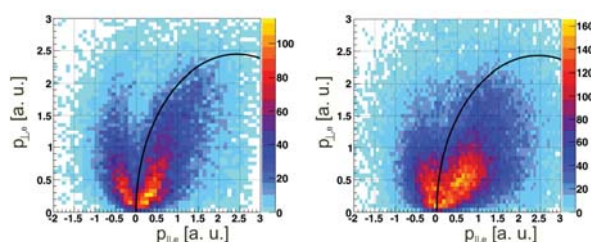


Figure 1: Electron momentum distribution (parallel vs. transversal) for 150 keV/u D^+ projectile colliding with H_2 (left) or He (right).

It was shown for Helium [2] that the angular distribution of the shake-off (SO) contribution is extremely sensitive to the initial state. The backward emission was explained with non- s^2

contributions [3] in the ground state wave function of Helium.

Here we report the first kinematically complete experiments on transfer ionization of D^+ and He^+ projectiles (150 keV/u) colliding with H_2 -molecules. Therefore we used the COLTRIMS technique (Cold Target Recoil Ion Momentum Spectroscopy) [4] to measure all fragments in coincidence (H^+ , H^+ , e^- , D^0/He^0). The ion beam from the Van-de-Graaff accelerator (150 keV/u) is intersected with a supersonic gas jet of H_2 . Only projectiles that captured an electron are detected on a position and time sensitive MCP detector. Electrons and ions are projected with a homogeneous weak electric field (20-40 V/cm) onto position and time sensitive detectors. A parallel weak magnetic field (10 Gauss) guides the electrons. Momentum conservation was applied during offline-analysis to suppress background.

The results, shown in Figure 1 (left), exhibit that also for a H_2 a very similar electron emission pattern can be observed. The distribution is divided into forward and backward emitted electrons. This is surprising as the initial state wave functions and the ground state correlation of Helium and H_2 are rather different. Furthermore the ratio of forward emitted knock-off electrons (TS2) and backward emitted SO electrons depends on the molecular orientation. Additional measurements with He^+ projectiles were performed to confirm this result.

References

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