A theoretical analysis on electron emission in collisions between charged and neutral particles on atomic targets

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Synopsis Target ionization and projectile electron loss is investigated employing a distorted wave model where a dynamic projectile charge depending on the momentum transfer is considered in the final continuum.

The present investigation is focused on the electron emission in collisions between beams of charged ions and neutral atoms on different atomic targets. The prior version of the Continuum Distorted Wave-Eikonal Initial State model (CDW-EIS) is modified in order to allow the description of the impact of partially charged and neutral beams. With such a goal in mind, for the case of electron target emission, the projectile charge in the two-center continuum final state is chosen as a dynamical one depending on the momentum transfer. This choice was proposed by different authors (see for example [1]) within the first-order Born approximation to study screening effects produced by projectile electrons on the resulting spectra.

The interaction between the projectile and the target electron is here represented by a Green-Sellin-Zachor potential [for details see [2]). Roothaan-Hartree-Fock wave functions are used to describe target bound states.

In order to analyze projectile electron loss, the role of projectile and target is reversed during the collision. Results are compared with existing experimental data for electron target ionization and projectile electron loss double differential cross sections (DDCS) for different collision systems. The influence of different charge states of the same projectile is studied. Very good description of DDCS experimental data is obtained for the case of 440 keV/u Li^+ impacting on He atoms as a function of the ejected electron energy at fixed electron emission angles. It is observed that for all angles, the spectrum of total electron emission is dominated by target ionization at very slow electron energies as well as in the binary encounter region for forward emission. In addition, at small angles of the order of 10°, electrons ejected from the projectile give the main contribution to the DDCS. Moreover, at large angles and high emission energies, where backscattering plays a main role, projectile electron loss appears to be the dominant process. It can be interpreted as a forward emission in the inversed collision system, where the target penetrates close to the projectile nucleus.

For the case of 200 keV/u He + Ar at 0° emission angle, the presence of a capture to the continuum cusp appears for target ionization even in this case of a neutral projectile impact, as it was observed in experiments by the first time for He projectiles [3]. Different authors studied this effect proposing that the origin could be a consequence of short-range interactions or that the cusp could be produced by a low-lying virtual state resonance between the electron and an excited state of the He projectile (see [4]). It must be noted that this last formulation was applied with success to explain diverse experimental measurements.

Results obtained for other collision systems will be also presented during the conference, paying attention on other effects as the influence of the contribution of excited projectile states present in the impacting ion beam.

References

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