Prior collision interactions in differential cross sections for charge transfer processes

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Synopsis A three-body Born distorted wave approximation is applied to computed the differential cross sections for single charge exchange in P-He collisions. The main purpose of the present study is to investigate the role of the intermediate ionization continua in one-electron capture from a target by a projectile at high impact energies. In order to achieve this purpose, the obtained results are compared with those of the first- and second-order theories. The theoretical results are also compared with the experiments and good agreement is found.

The collision process to be discussed is single charge transfer in proton+helium collisions. This process can be treated as a three-body problem, since one of the electrons does not change states. Here we use the fully quantum mechanical BDW model introduced by Belkić [1]. It is a hybrid-type model which is intermediate to the CDW-3B and CB1-3B approximations. The prior form of the BDW-3B method takes into account the pure electronic continuum intermediate states in the entrance channel. Hence, by comparing our results with the BCIS-4B and CB1-4B methods [2], the relative important of the intermediate ionization electronic continua and the role of the passive electron can be assessed.

Figure 1 and 2 show the angular distributions at high energies 1.3 and 2.5 MeV. As can be seen from figures, the shapes of these curves in the BDW-3B method are all similar to each other. At forward scattering angles, good harmony with the experiments [3] and other theories [2] is found for the present resuts. Therefore, the cintribution of the passive electron in the differential cross sections is negligible at small scattering angles. The difference between the present results and the four body methods with full potential is at larger scattering angles. In this angular region, the present results overestimate the experiments. It can be seen from Fig.2 that our results converge towards the experiments as the scattering angle increases.

Our results have maximam at the forward angle $\theta = 0$ and the Thomas angle located at about $\theta \simeq 0.47$ mrad. The intensity of the Thomas peak increase as the projectile energy increases. As can be seen from figures, the Thomas peak is not detected by the CB1-4B method that, as the first-order approximation, completely ignores the electronic continuum intermediate states. Hence, the electronic continuum intermediate states of the captured electron play an important role for single charge transfer.

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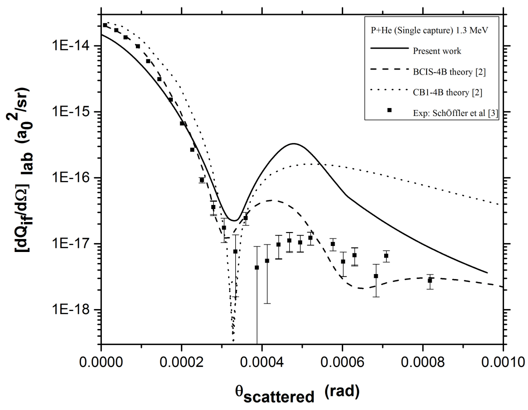

Figure 1. Differential cross sections as a function of scattering angle in the laboratory frame at incident energy E=1.3 MeV.

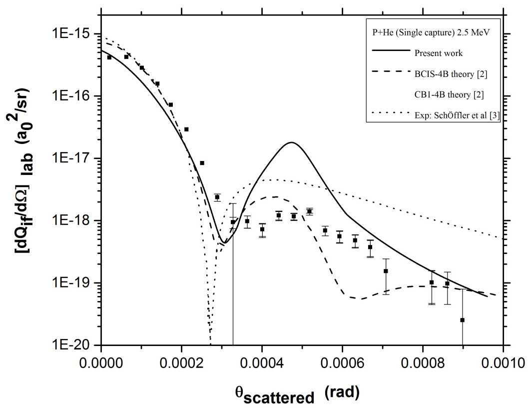

Figure 2. The same as figure 1 but for E=2.5 MeV impact energy.

References

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[3] D. Fischer *et al.* 2010 *Phys. Rev. A.* **81** 012714.