TRANSFER IONIZATION FOR 100-400 keV INCIDENT ENERGY IN p-He COLLISIONS

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The collision of protons (p) with helium (He) is a fundamental two-electron system involving electron-electron correlation. Recently, a kinematically complete experiment for the transfer ionization (TI) cross section between 0.15 and 1.4 MeV has been measured by cold target recoil ion momentum spectroscopy (COLTRIMS)[1]. The TI cross sections from COLTRIMS agree well with the experimental data of Shah and Gilbody[2] for overlapping energies between 150 and 400 keV. There exists several theoretical calculations[3,4] for TI cross sections with different degrees of theoretical sophistications but they show obvious discrepancies with experiments in the energy region between 150 and 400 keV.

In this report we used the semiclassical impact parameter close-coupling approximation to treat the collision of protons with helium atom by expanding the time-dependent two-electron wave function in terms of eigenstates of helium atoms, of two-center atomic states representing transfer ionization channels, and of atomic states representing single capture accompanied by target excitation channels, such that all the dominant inelastic channels are included in the basis functions. Pseudostates centered on the target atom are used to represent the ionization channels. The electron-electron correlation effect is fully accounted for throughout the collision.

We have also performed the calculation within the independent particle model (IPM)[5] where each electron of the helium atom is assumed to be in a Coulomb potential $V_t=-Z_{eff}/r$ with an effective charge Z_{eff} such that the binding energy of each electron is half of the double ionization energy. In view of the result from IPM that single capture cross section to H(1s) with helium ion in the $He^+(1s)$ state accounts for more than 90% of total single capture cross section between 100 and 400 keV, we included only capture to H(1s) state in our two-electron two-center calculation. In Figure 1, our results of TI cross sections agree well with the experimental data[1,2] between 100 and 300 keV, but deviation begins to appear at 400 keV.

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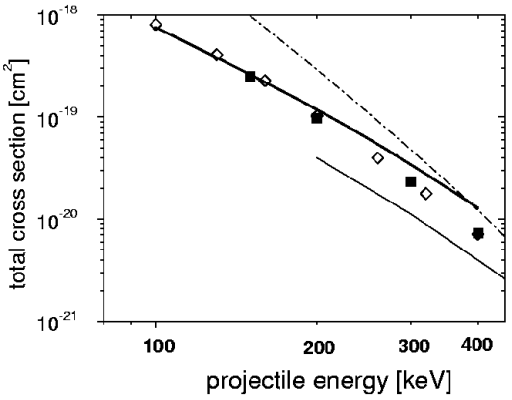

Figure 1. Total cross section for TI: present, thick solid line; CDW-Born IEM, dashed-dotted line; RIA-4B thin solid line; COLTRIMS, solid squares; Shah and Gilbody, open diamonds.

References

1. l. V. Mergel et al., Phys. Rev. Lett. **79**, 387 (1997).

2. M. B. Shah and H. B. Gilbody, J. Phys. B, **18**, 899 (1985).

3. R. Gayet and A. Salin, Nucl. Instrum. Methods Phys. Res., Sec B **56/57**, 82 (1991).

4. Dž. Belkić, Nucl. Instrum. Methods Phys. Res., Sec B **99**, 218 (1995); Phys. Scr.53, 414 (1996).

5. R. Shingal and C. D. Lin, J. Phys. B, **24**, 251 (1991).

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