Post collision interactions in differential and total cross-sections for four-body charge transfer processes

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Synopsis Single charge exchange in collisions between fast bare projectiles and helium like atomic system is investigated by means of the four-body model that includes the final state post collision interactions between all two-particle pairs without electron-electron interaction. The present results show reasonable agreement with the experimental results.

From the fundamental and practical points of view, single electron capture by the multiply charged ions from multi-electron atoms is an old and great important problem. Since helium is the simplest multielectronic atom existing in nature, it offers a unique opportunity to understand the complex dynamics of many particle collisions, both from the experimental and theoretical sides. As to applications, we can mention plasma physics, astrophysics, controlled thermonuclear fusion research and medical accelerators. In this paper, we will consider single capture (SC) and transfer with target excitation (TTE). For SC, one of the electrons in helium atom does not change states whereas TTE is the process in which one electron is capture and the remaining target electron is promoted to an excited state. So in the TTE process, there are four active particle and thus a four body model must be used to calculate the cross-sections both for total and differential. The scattering amplitude in the four-body model of post collision interaction (PCI-4B) may be written as

$$T_{if} = \langle \psi_f^- | (V_i) | \psi_i \rangle,$$

where ψ_i is the exact initial state wavefunction which is approximated as

$$\psi_i = e^{i\vec{K}_i \cdot \vec{r}_i} \phi_i(\vec{x}_1, \vec{x}_2).$$

The projectile-helium atom initial state interaction potential is given by

$$V_i = \frac{Z_P Z_T}{R} - \frac{Z_P}{s_1} - \frac{Z_P}{s_2}.$$

In the final state, we include two-particle interactions except electron-electron interaction. Thus, the final state wavefunction is approximated as

$$\psi_f^- = e^{i\vec{K}_f \cdot \vec{r}_f} \phi_P(\vec{s}_1) \phi_T(\vec{x}_2) \chi_f^-,$$

where χ_f^- is written as

$$\chi_f^- = C_{T-e_1}(\vec{x}_1) C_{P-e_2}(\vec{s}_2) C_{T-P}(\vec{r}_f).$$

We will represent theoretical result for SC cross sections of $X^{q+}(q = 1, 2, 3, 5, 6, 8) - He$ collision.

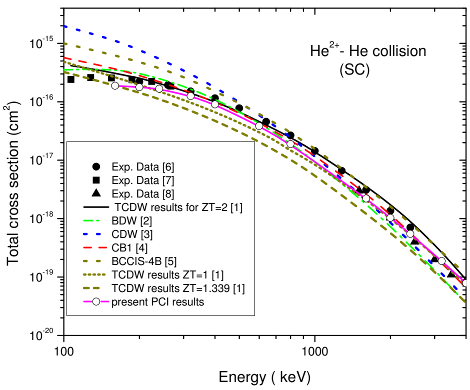

Figure 1. $He^{2+} - He$ collision for single charge (SC) transfer

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