State-selective electron capture in He^{+} + He collisions at intermediate energies

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Synopsis A combined experimental and theoretical study on single capture in 30- and 100-keV He^{+} on He collisions was performed. We report on experimental state-selective cross sections and projectile angular-differential cross sections and compared with the theoretical results by using dynamic screening classical trajectory Monte Carlo method (dCTMC), and the significance of different electron-electron correlations are discussed. The structure observed in the projectile angular-differential cross sections is explained in terms of Fraunhofer-type diffraction of the He^{+} projectile de Broglie wave.

The studies of charge exchange processes using fully stripped ions as projectiles have been extensively made in the past. Processes involving dressed projectiles therefore deserve special attention. In this work, we performed a combined experimental and theoretical investigation on the single capture at 30 and 100 keV impact energies for He^{+} + He collisions.

In the present experiment, the recoil ion He^{+} was recorded in coincidence with the scattered projectile He by using a reaction microscope. The state-selective cross sections and the projectile angular-differential cross sections have been extracted from the measurements [1]. We show the state selective cross sections as a function of the impact energy in Figure 1. It was found that the ground-state transfer process is dominant over excited-state transfer and transfer excitation processes. A comparison of the experimental results with our dCTMC calculations shows a reasonable agreement.

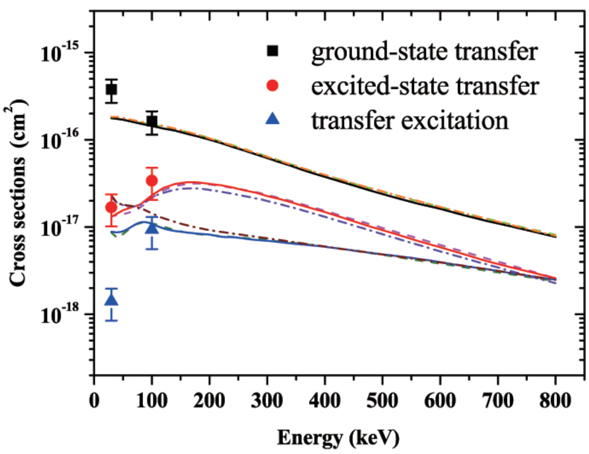

Figure 1. The state selective cross sections as a function of impact energy. Solid symbols: experiment; solid lines: dCTMC results; dash lines: dCTMC-c results; dash dot lines: CTMC-s results (see details in Ref. [1])

In Figure 2 we show the projectile angular distributions for ground-state transfer. With the impact parameter range obtained from dCTMC calculations, the positions of the first dark and first bright fringes expected from the Fraunhofer-type diffraction theory are indicated by arrows. The strikingly good agreement of the positions of arrows and the experimental results suggests that the oscillation structure appearing in the angular-differential cross sections originates from atomic-size Fraunhofer-type diffraction.

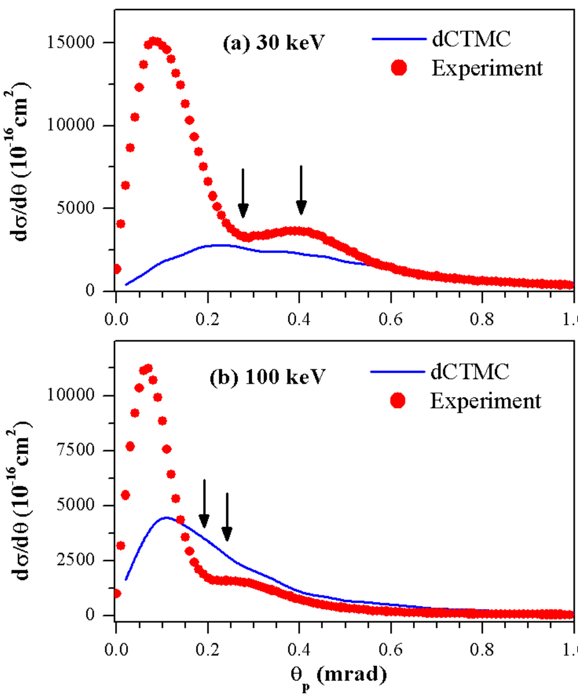

Figure 2. The projectile angular-differential cross sections for ground-state transfer.

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References

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