IONIZATION AND ELECTRON LOSS TO THE CONTINUUM IN COLLISIONS OF 2.5 MEV/U C^{4+} IONS WITH HELIUM ATOMS*

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Recently we reported preliminary absolute cross-section data[1] for electron emission, doubly differential in electron energy and angle, in collisions of 2.5 MeV/u C^{5+} and C^{4+} ions with helium atoms. Electron energy spectra for the case of C^{4+} impact exhibit broad electron-loss-to-the-continuum (ELC) peaks centered at about 1200 eV (essentially independent of scattering angle). These ELC features, very prominent in the forward direction and decreasing rapidly with scattering angle, are discernable at virtually all angles.

The width, energy and angular dependence of the observed ELC peaks suggest that they arise partly from the metastable $1s2s(^3S)$ state of the projectile ions. The Compton profile of the $1s^2$ (^1S) ground state is relatively broad therefore leading to a broader distribution of ELC electrons than those due to the metastable $1s2s$ (^3S) state.

Projectiles are prepared in the tandem Van de Graaff accelerator at KSU. Negative carbon ions are extracted from a sputter ion source and accelerated to a terminal at 6.0MV where they pass through a gas cell containing N_2 in which electrons are stripped. Positive ions exiting the cell are further accelerated, charge-state selected and directed into the target chamber.

The target chamber is that described by Gealy et al[2]. A magnetically shielded chamber is flooded with helium to a pressure of approximately 0.1mT. Electrons are energy selected by a hemispherical electrostatic analyzer with resolutions of 5.0% in energy and ±1.1° in angle. The range of electron energies and angles surveyed is 1.0eV to 6.0keV, and 15° to 160°, respectively.

The present theoretical work includes two components. Target ionization is modeled with Continuum Distorted Wave (CDW) calculations assuming a bare projectile with an effective charge of 5.02. Projectile ELC is modeled with a first Born approximation calculation assuming a projectile consisting of a mixture of $1s^2$ and $1s2s(^3S)$ ions.

A weighted fit of the theoretical calculations to the data suggests that the beam contains a metastable fraction of approximately 10%. The observed dependence of the ELC features on scattering angle is very accurately reflected in the calculations. Future work will include an independent experimental assessment of this fraction. When this is accomplished we will be able to present corrected absolute cross sections for ground-state C^{4+} impact on helium.

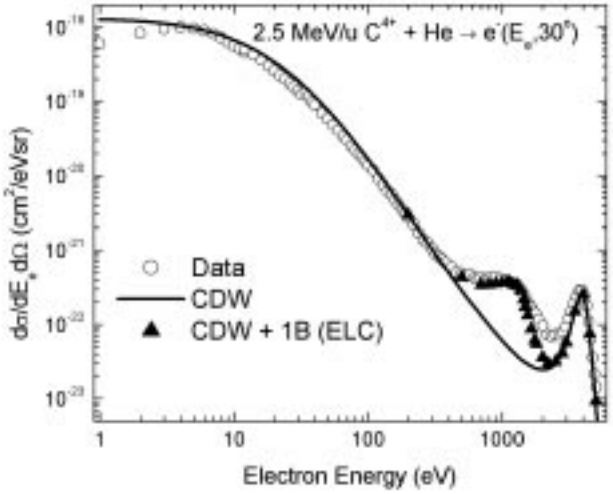

Figure 1. DDCS for 2.5 MeV/u C^{4+} + He collisions. Open circles are measured data, solid line is CDW theory, solid triangles are CDW plus first Born calculation of ELC for a projectile beam containing a 10% $1s2s(^3S)$ metastable component.

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