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EXPERIMENTAL AND THEORETICAL STUDY OF TWO CENTER ELECTRON EMISSION IN 25-MeV/u Mo^{40+} + He COLLISIONS

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During the past several decades considerable effort has been devoted to the understanding of the fundamental process of ionization in fast atomic collisions. It has been shown previously[1] that electron emission from He by 5-MeV H^+ impact is well described by the plane wave Born approximation (PWBA) with a final state (continuum) wave function centered at the target. This one-center picture is valid for fast, low Z-ions whose effect on the ejected electron may be considered as a small perturbation. However, for highly charged projectiles it is expected that of the second (Coulombic) center has an influence beyond first-order perturbation. The purpose of this work is to study both experimentally and theoretically the two-center aspect of electron emission in collisions with fast, multiply charged projectiles. It is shown that two-center electron emission is important for ions with energies in the GeV range.

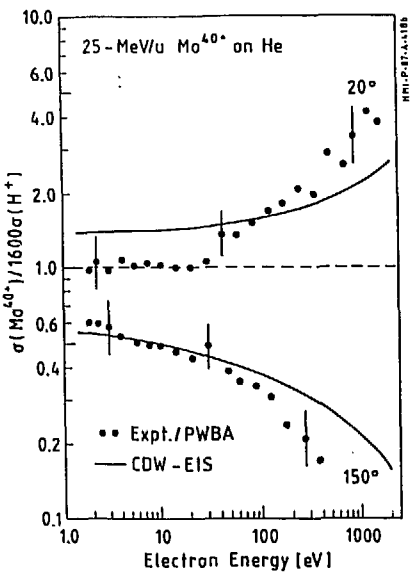

FIGURE 1 Ratio of cross sections for electron production by 25-MeV/u Mo^{40+} and H^+ impact. Observation angles are 20° and 150°.

The experiments were carried out at the "LISE" beam line of the GANIL* accelerator facility, Caen, using the electron spectroscopy apparatus[2] from the HMI, Berlin. The energy and angular distributions were measured for electrons produced by 25-MeV Mo^{40+} incident on He under single-collision conditions. Electrons were observed over an angular range from 20° to 160° and an energy range from 2 eV to 5 keV giving absolute doubly differential cross sections. Fig. 1 shows typical results which have been divided by corresponding cross sections evaluated from the Born approximation using methods similar as described in Ref. 1. The Born results are to be considered as data form 25-MeV H^+ impact multiplied by 1600, i.e. using the Z^2 scaling law of the PWBA. Moreover cross sections for Mo^{40+} and H^+ impact were evaluated by means of the continuum distorted wave (CDW) approximation[3]. The CDW approach employs a two-center wave function in the final state to account for the influence of the projectile beyond first-order perturbation theory.

With respect to the scaled H^+ data the experimental cross sections for Mo^{40+} impact are significantly reduced at backward angles and enhanced at forward angles. This finding is in agreement with the predicted influence of the second center on the ejected electron as shown by the CDW calculations. The two-center effect is seen to increase with increasing electron energy, and this may be understood from the fact that a fast electron probes the two-center aspect of a rapidly disintegrating collision system more strongly than an electron emerging slowly from the target.

Footnotes and References

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