Coherence effects in dielectronic processes during swift $C^{4+}(1s^2)$ collisions with helium and hydrogen†

T J M Zouros[1,2*], I Madesis[1,2], E P Benis[3], A Laoutaris[1,2], J W Gao[4,5] and A Dubois[4]

[1] Department of Physics, University of Crete, P.O. Box 2208, GR 71003 Heraklion, Greece
[2] Tandem Accelerator Laboratory, INPP, NCSR Demokritos, GR 15310 Ag. Paraskevi, Greece
[3] Department of Physics, University of Ioannina, GR 45110 Ioannina, Greece
[4] Sorbonne Université, CNRS, Laboratoire de Chimie Physique-Matière et Rayonnement, Paris, France
[5] Institute of Applied Physics and Computational Mathematics, 100088 Beijing, China

Synopsis The two-electron process of transfer-excitation (TE) in 0.5-18 MeV $C^{4+}(1s^2)$ collisions with He and H targets is investigated. Results using the 3eAOCC non perturbative approach are compared to Auger projectile spectroscopy measurements. One-step resonant (RTE) and two-step non-resonant (NTE) contributions to TE are assessed and added incoherently for comparison to the full TE calculation. RTE/NTE coherence, as well as non perturbative effects, are then demonstrated and supported by the analysis of the semiclassical probabilities.

State-resolved cross sections for the production of $1s2s^2\,{}^2S$, $1s2s2p\,{}^2P_\pm$, and $1s2p^2\,{}^2D$ were determined using our zero-degree Auger projectile spectroscopy (ZAPS) setup at the 5.5 MV tandem accelerator laboratory at "Demokritos" [1]. These states are populated predominantly by transfer-excitation processes from the $1s^2$ and/or by single electron transfer processes to the $1s2s\,{}^3S$ metastable ion beam components. Using our recently reported dual measurement technique [2], we have separated KLL ground state from metastable state contributions in 6-15 MeV collisions of mixed-state $C^{4+}(1s^2\,{}^1S, 1s2s\,{}^3S)$ ions with He and H_2 targets.

For the interpretation and understanding of the experimental results we also performed calculations over the 0.5-18 MeV range using a semiclassical atomic orbital close-coupling approach, based on an asymptotic (atomic) description of the neutral and charged collision partners [3,4]. The electronic dynamics is then treated quantum mechanically solving the three-electron time-dependent Schrödinger equation with full configuration interaction (CI).

To describe TE to doubly excited states on the carbon center, three active electrons are taken into account: two of them are reserved for the He-like C^{4+} projectile, while the third is initially on the target and can be transferred in the collision to C^{4+} to describe 1-, 2- and 3-open-shell electronic configurations of the C^{3+} ions. An example of our results for the production of the $C^{3+}(1s2p^2\,{}^2D)$ state is shown in Fig. 1.

* E-mail: tzouros@physics.uoc.gr

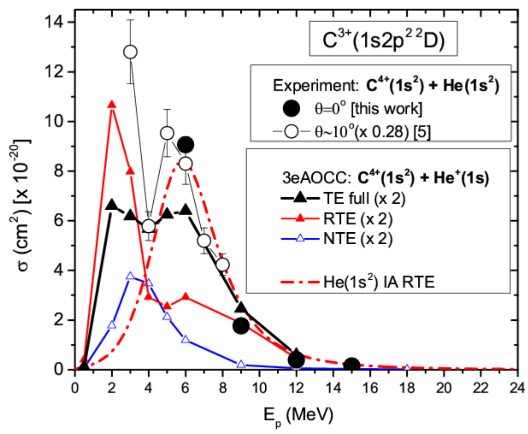

Figure 1. Cross section for the production of the $C^{3+}(1s2p^2\,{}^2D)$ state in collisions of $C^{4+}(1s^2)$ with helium.

References

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