The role of He-like mixed ($1s^2\ ^1S$, $1s2s\ ^{1,3}S$) ionic states in the investigation of population mechanisms of He-like and Li-like excited states

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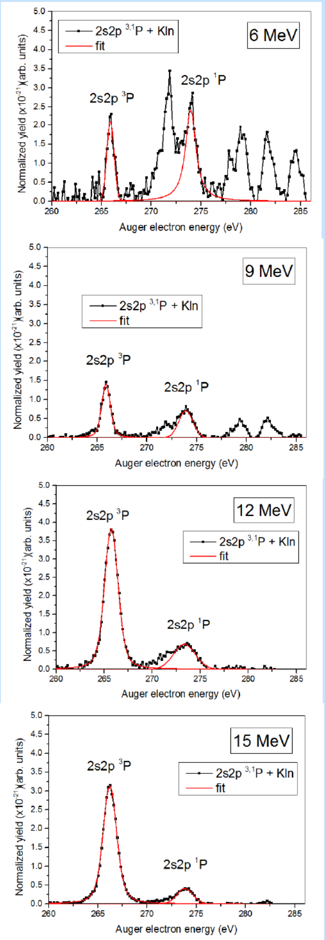
Abstract

Recently, we have published a new method for separating the contributions from the $1s^2$ and $1s2s\ ^3S$ components of the mixed ($1s^2$, $1s2s\ ^3S$) beam [1] that allowed us to investigate selective cascade feeding mechanisms in single electron transfer to the $C^{4+}(1s2s\ ^3S)$ state [2-4]. Here we extend our study to include results on separated contributions from both the ground state and the metastable $1s2s\ ^{3,1}S$ states on (a) Li-like KLL and KLn states (with n going all the way out to the series limit) and (b) He-like $2s2p\ ^{3,1}P$ hollow ionic states. Our experimental results are compared to state-of-the-art three-electron Atomic Orbital Coupled Channel (AOCC) calculations using the semi-classical close-coupling approach [5]. This is a work in progress and results to date will be presented.

Zero-degree Auger Projectile Spectroscopy (ZAPS) setup at the Demokritos TANDEM

$C^{4+}(1s^2, 1s2s\ ^{1,3}S) + He \rightarrow C^{3+}(2s2p\ ^{1,3}P) + He^+$



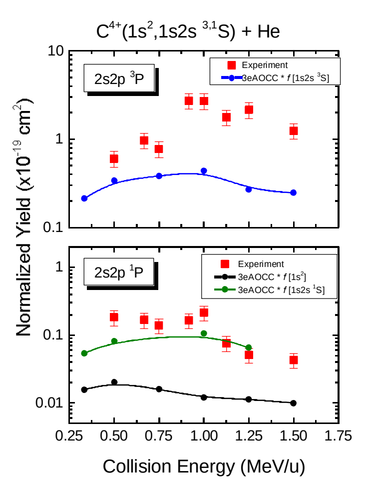


Fig. 1
[Left] Zero-degree C^{3+} Auger line spectra for $C^{4+}(1s^2, 1s2s\ ^{1,3}S)$ collisions with He. **[Right]** Comparison of 3-electron AOCC (3eAOCC) calculations to experimental data left. 3eAOCC calculations involve two projectile electrons and one target electron. The experimental normalized yields left, were multiplied by 4π to obtain the total yields, but do not account for the beam content. 3eAOCC calculations were multiplied with the corresponding beam fractions.

$C^{4+}(1s^2, 1s2s\ ^3S) + He \rightarrow C^{3+}(1s2s2l\ ^{2,4}L) + He^+$

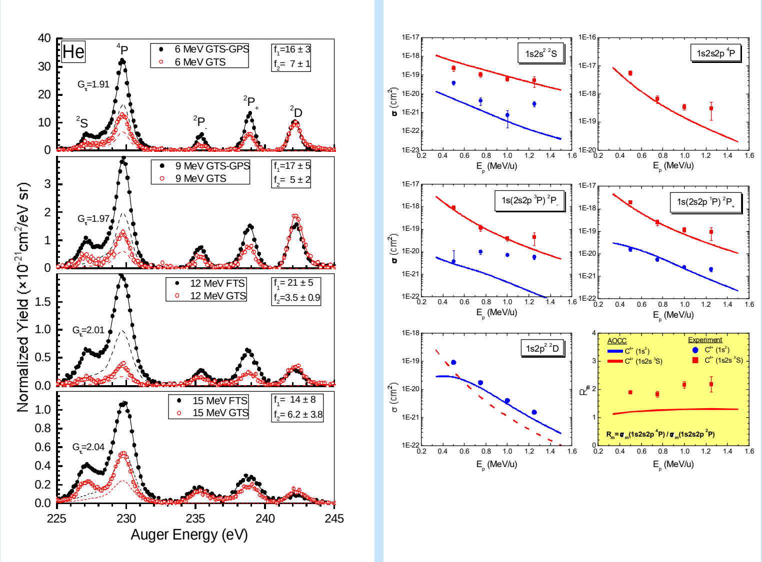


Fig. 2.
[Left] Zero-degree C^{3+} Auger line spectra for $C^{4+}(1s^2, 1s2s\ ^3S)$ collisions with He. Two spectra are shown for each collision energy with different metastable ($1s2s\ ^3S$) beam fraction ($f_1 > f_2$) content, (in %) as judged by the corresponding ^4P yields. These spectra are used within the method described in [3] to separate the contributions of the ground $C^{4+}(1s^2)$. and metastable $C^{4+}(1s2s\ ^3S)$ parts to the formation of the $1s2lnl'\ ^{2,4}L$ states.
[Right] Comparison of 3eAOCC calculations to the experimental data obtained with zero-degree Auger projectile spectroscopy. The 3eAOCC calculations involve two projectile electrons and one target electron. The experimental normalized yields (left) were converted to SDCS using our new method [1] which were then multiplied by 4π to obtain the total cross sections. The graph with the yellow background is the ratio $R_m = \sigma_m(^4P)/\sigma_m(^2P)$ that is examined in order to identify cascading contribution effects to the $1s2s2p\ ^4P$.

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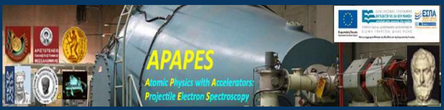

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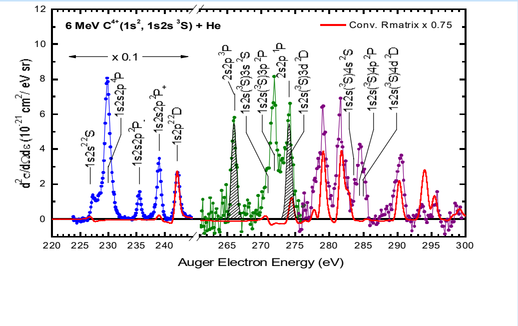
Fig. 3. Measured spectrum covering the entire KLn (n≥2) range. R-matrix calculations [6] convoluted with the spectrometer function account for the contributions from the $C^{4+}(1s^2)$. Capture to the $C^{4+}(1s2s\ ^3S)$ leads to the population of $1s2snl\ ^{2,4}L$ states, of which only the ^2L strongly autoionize and can be seen in the spectrum, while the ^4L cascade down to the $1s2s2p\ ^4P$.



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