Modeling the 1s2l2l′ Auger projectile spectrum in C^{4+} (1s2s ^{3}S) collisions with He including radiative cascade repopulation and Auger depletion

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Abstract

We investigate the production of the 1s2s2p ^{4,2}P states populated by single electron capture in 12 MeV C^{4+} + He collisions. The ^{4}P/^{2}P ratio of Auger electron yields has been found not to obey the expected spin recoupling statistics, but instead is enhanced [1, 2]. Various explanations have been proposed [1-3], but none of them can fully account for the observed enhancement. Here, we combine our recent Monte Carlo approach for simulating the projectile Auger spectrum utilizing the SIMION package [3] including the important solid angle corrections to the long lived ^{4}P line together with calculations of single electron capture into (1s2s ^{3}S)*nl* states [4] which include repopulation by radiative cascades and Auger depletion to model the experimental spectra.

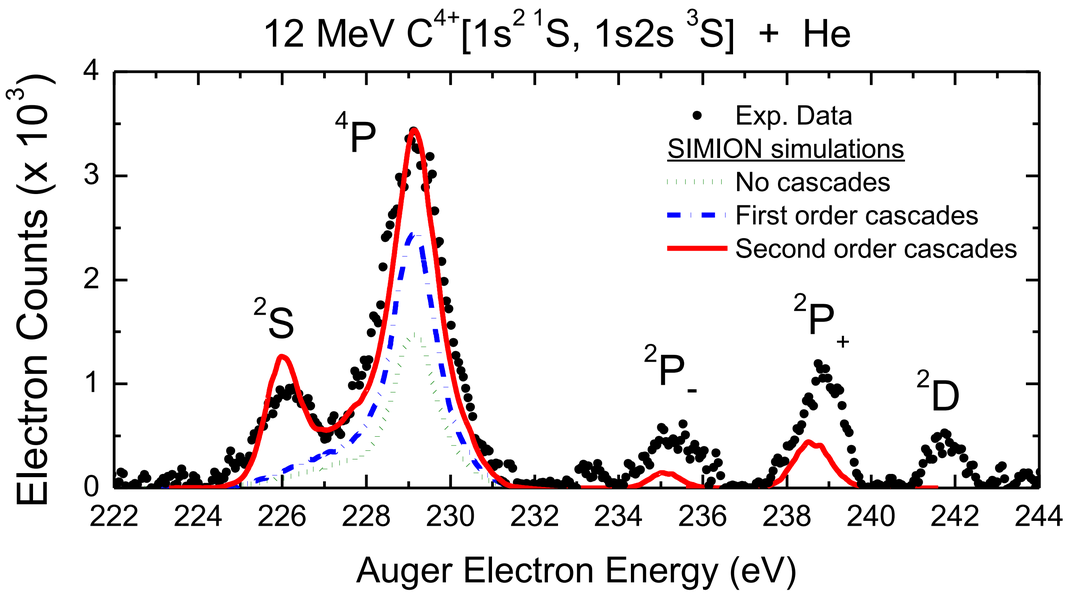

Fig. 1: 1s2l2l′Auger projectile spectrum from 12 MeV C^{4+} + He collisions measured with our hemispherical analyzer. Lines: SIMION simulations including model contributions (normalized to the ^{4}P yield) are compared to the spectrum (black dots). The ^{4}P line is seen to be strongly enhanced by cascades. The observed excess electron yield in the $^2P_{\pm}$ and ^{2}D states is due to Transfer-Excitation from the ground state not included in the capture calculations.

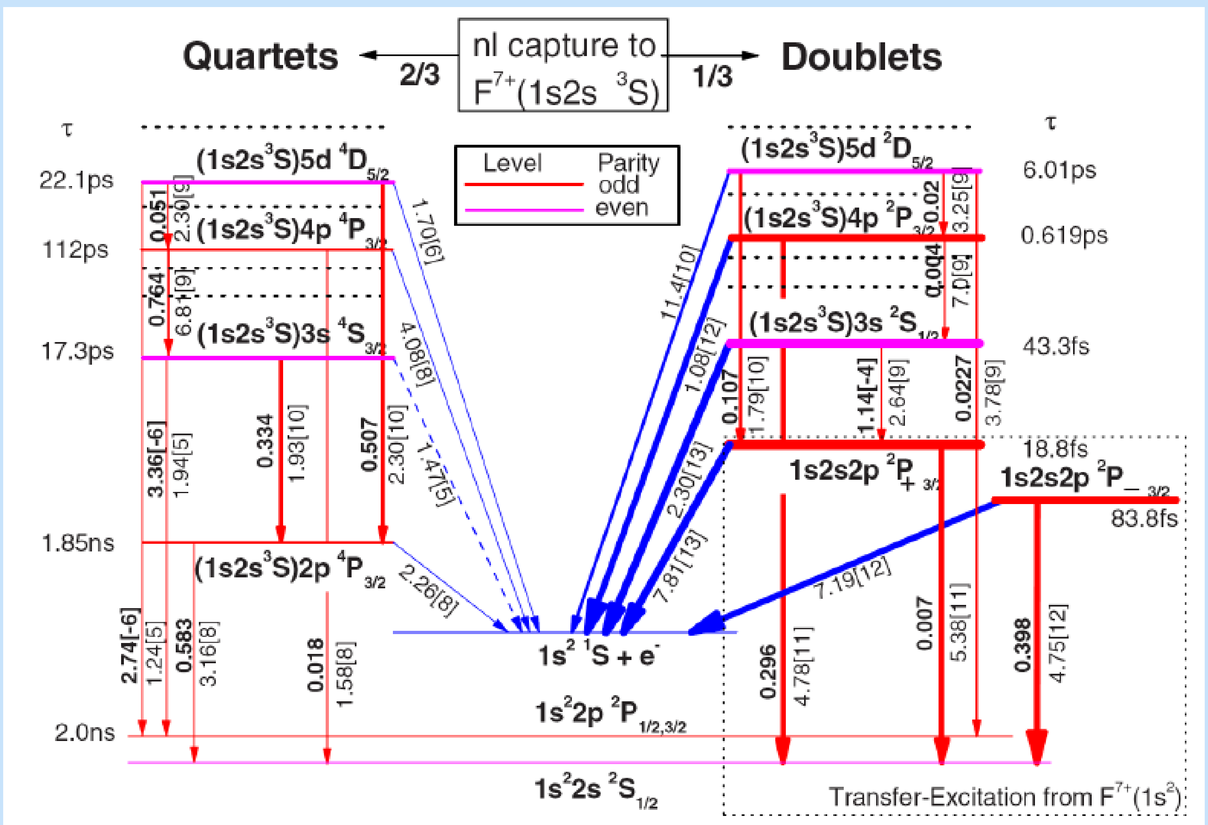

Fig. 2: Li-like ^{4}P and ^{2}P F^{6+}1s2snl energy level scheme (not to scale) resulting from single electron *nl* capture to F^{7+} 1s2s ^{3}S. Only a few representative levels are indicated for clarity. Arrows represent transitions with widths roughly proportional to their strength radiative E1 vertical red lines and Auger slanted blue lines.

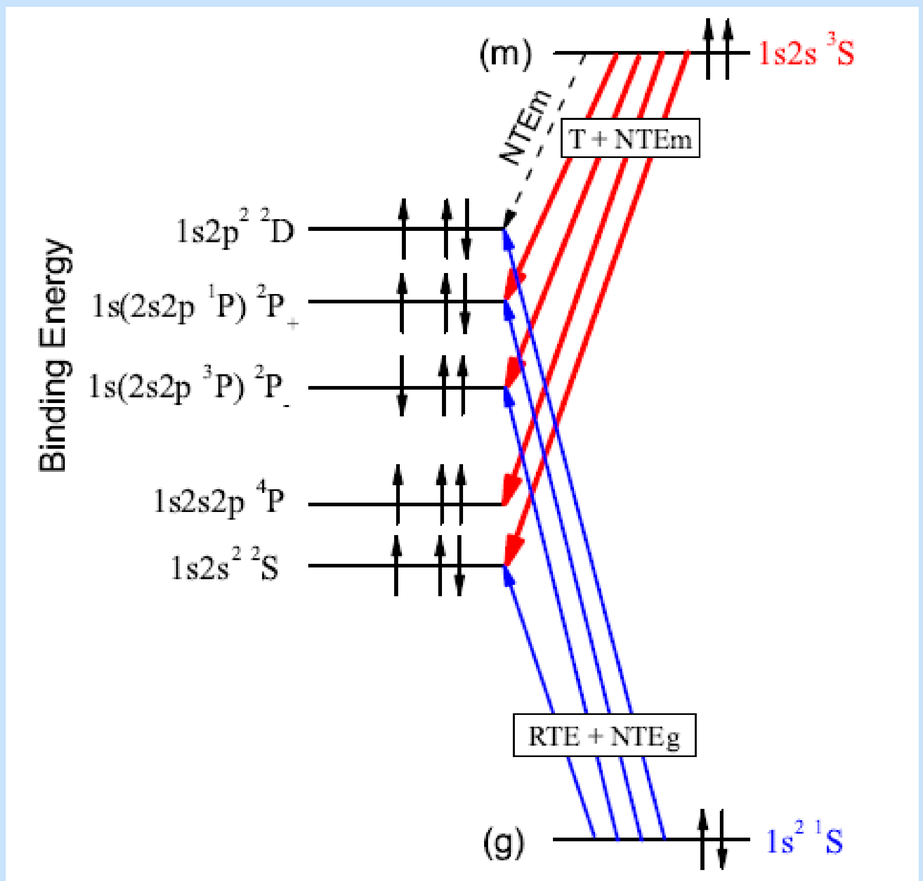

Fig. 3: Energy level diagram showing the expected dominant mechanisms for the production of the 1s2l2l′ $^{(2S+1)}L$ doubly excited states formed in collisions of energetic He-like mixed beams with H_2 and He targets. Single 2p or 2s electron transfer or NTE2 to the metastable state (m) in red, RTE and NTE1 from the ground state (g) in blue.

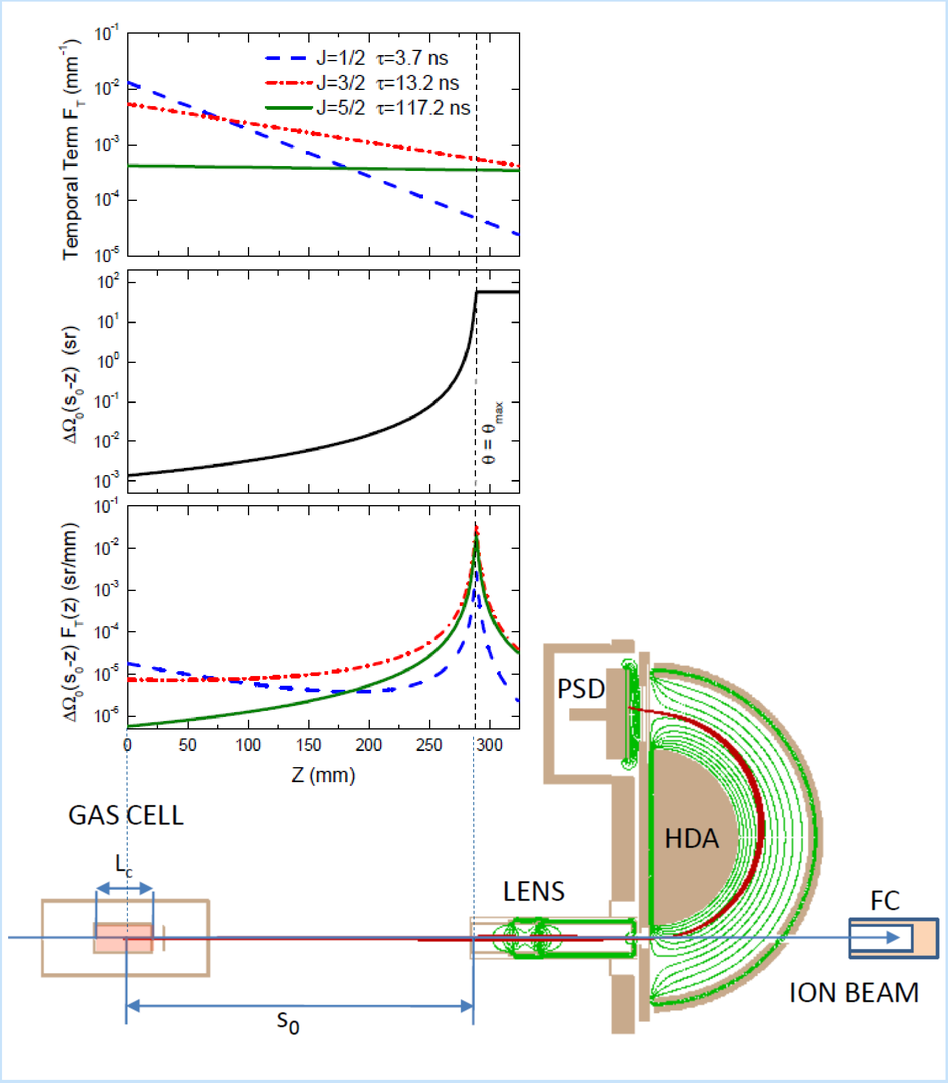

Fig. 4: z-dependence along the ion trajectory for the probability decay density (top), the point source solid angle $\Delta\Omega 0(z)$ (middle) and their product (bottom) as calculated for the 1s2s2p ^4P_J states in the case of a 12.0 MeV C^{4+} ionic beam. At the very bottom drawn to scale is the experimental geometry showing the gas cell, the lens and the HDA.

References

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