Determination of the $^4P^o/^2P$ ratio in single electron capture of C^{4+} ($1s^2$, $1s2s\ ^3S$) mixed state ion beams in 6-18 MeV collisions with H_2, He, Ne and Ar targets

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Synopsis: Zero-degree Auger projectile electron spectroscopy of pre-excited He-like ions colliding with various gas targets is used with a new experimental technique which relies on the combination of gas and foil strippers to vary the metastable fraction sufficiently to allow for the determination of the ratio $^4P^o/^2P$ of recent interest. Results to date for C^{4+} ions will be presented.

A zero-degree Auger projectile spectroscopy apparatus composed of a single stage hemi-spherical deflector analyzer with four-element injection lens and a position sensitive detector combined with a doubly differentially pumped gas target has been newly set up for high resolution studies of electrons emitted from ions colliding with gas targets. Using this setup we have started a systematic isoelectronic investigation of projectile K-Auger electrons emitted from pre-excited He-like ions in collisions with gas targets [1]. The goal is to study single electron capture to the *1s2s* ^3S long-lived component of the typically mixed state ($1s^2$, $1s2s\ ^3S$) He-like ion beam. The observed KLL Auger lines for 9 MeV C^{4+} collisions, shown in Fig. 1, can be produced either by direct electron capture to the *1s2s* ^3S component or by transfer-excitation from the $1s^2$ ground state [2-4]. The ratio R_m of $^4P^o/^2P$ line intensities due to capture to the *1s2s* ^3S has been found to be greatly enhanced from the spin statistics [2-5] predicted value of 2, invoking contentious explanations. To isolate the *1s2s* ^3S capture contributions, a new technique is employed [5] requiring the measurement of two Auger KLL spectra using C^{4+} ions with sufficiently different *1s2s* ^3S metastable fraction. This fraction can be varied by the judicious use of terminal and/or post (terminal) foil or gas stripping [5].

The measured R_m values depend critically on the solid angle correction of the ^4P_J yields. These states are long-lived, Auger decaying all along the projectile path, after excitation in the target gas cell. This correction has been determined and applied to our measurements using a new Monte Carlo electron trajectory simulation approach [6] with the use of the SIMION charged particle optics software [7].

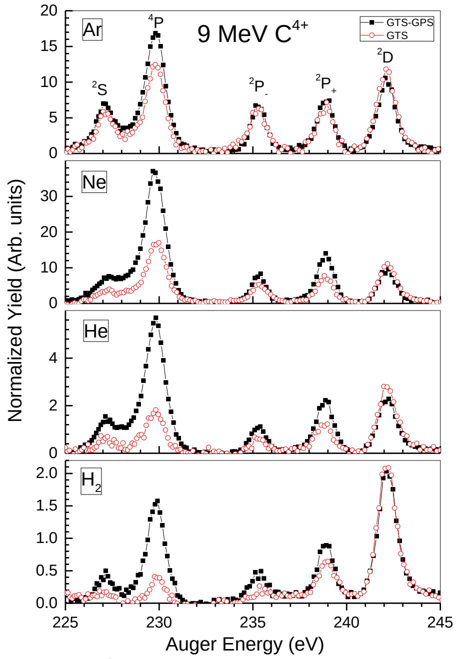

Figure 1. C^{3+}(*1s2l2l′*) Auger KLL spectra from 9 MeV C^{4+} collisions with various gas targets for different *1s2s* ^3S metastable beam fractions depending on gas terminal stripping (GTS) or gas post-stripping (GPS). The ^4P line intensity is proportional to the *1s2s* ^3S beam content.

References

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