

Investigation of the non-statistical production ratio of $1s2s2p\ ^4P$ and $1s2s2p\ ^2P$ states by e- capture to the $1s2s\ ^3S$ state of He-like ions – a progress report

T. J. M. Zouros^{1,2}, E. P. Benis³, S. Doukas⁴, I. Madesis^{1,2},
A. Dimitriou^{1,2}, A. Laoutaris^{2,5}, O. Sise⁶, B. Sulik⁷, T. Kirchner⁸

¹Dept. of Physics, University of Crete, GR 71003, Heraklion, Greece

²Tandem Accelerator Laboratory, INPP, NCSR Demokritos, GR 15310, Ag. Paraskevi, Greece.

³Dept. of Physics, University of Ioannina, GR 45110, Ioannina, Greece

⁴Dept. of Material Science and Engineering, University of Ioannina, GR 45110, Ioannina, Greece

⁵Dept. of Applied Physics, National Technical University of Athens, GR 15780, Athens, Greece

⁶Dept. of Science Education, Faculty of Education, Suleyman Demirel University, 32260 Isparta, Turkey

⁷Institute for Nuclear Research (MTA ATOMKI), Bem tér 18/c, H 4026 Debrecen, Hungary

⁸Dept. of Physics & Astronomy, York University, Toronto, Ontario, M3J 1P3 Canada

Using the new experimental station of the APAPES [1] initiative which is dedicated to atomic collision physics research at the 5 MV TANDEM Van de Graaff accelerator of the NCSR Demokritos in Athens, we have performed zero-degree Auger projectile spectroscopy (ZAPS) measurements using the new setup consisting of single stage hemispherical spectrometer with injection lens and 2-dimensional position sensitive detector combined with a doubly-differentially pumped gas target.

As a first step in our planned systematic isoelectronic investigation of K-Auger spectra emitted from *pre-excited* ions in collisions with gas targets we report on new measurements using carbon and other He-like beams to determine the cross section ratio $\sigma(1s2s2p\ ^4P)$ to $\sigma(1s2s2p\ ^2P)$ produced by e- capture to the $1s2s\ ^3S$ state beam component of the He-like ion beam.

Our new results were obtained with mixed ($1s^2$ and $1s2s\ ^3S$) beams so far, but we have recently installed a gas terminal stripper which will also allow us to determine capture to pure $1s2s\ ^3S$ beams which we plan to present.

To date, based on subtracted Transfer-Excitation estimates from previously published data on carbon [2] and our new solid angle determination procedure [3] for long-lived states, we have evaluated our new 12 MeV C^{4+} + He and Ne mixed beam data and found significant differences in the observed $^4P/{}^2P$ ratios from older reported results [2,4]. In addition the ratio of the doublets ${}^2P+{}^2P-$ have also been evaluated in an effort to further test the systematics of our results. In Figure 1, we show representative electron spectra. Our observed 4P lines are seen to be surprisingly stronger than previously published spectra taken with a two-stage parallel plate analyzer [2].

We shall present a progress report on the analysis of these results and our understanding to

date of the observed differences. The goal of the APAPES investigation is to provide a deeper understanding of the neglected importance of cascade feeding of metastable states in collisions of ions with gas targets and further elucidate their role in the non-statistical production of excited three-electron states by electron capture, recently a field of differing interpretations awaiting further resolution [4-5].

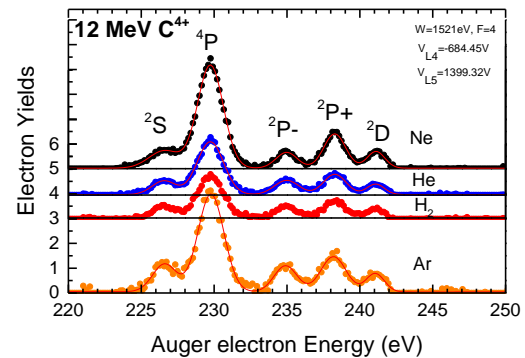


Figure 1. New ZAPS spectra for 12 MeV C^{4+} mixed beam ($1s^2+1s2s\ ^3S$) state in collisions with Ne, He, H_2 and Ar.

References

- [1] Atomic Physics with Accelerators: Projectile Electron Spectroscopy - <http://apapes.physics.uoc.gr/>
- [2] D. Strohschein, D. Röhrbein, T. Kirchner, S. Fritzsche, J. Baran and J.A. Tanis, *Phys. Rev. A* **77** (2008) 022706
- [3] S. Doukas, I. Madesis, A. Dimitriou, A. Laoutaris, T. J. M. Zouros and E. P. Benis, *Rev. Sci. Instr.* **86** (2015) 043111
- [4] T. J. M. Zouros, B. Sulik, L. Gulyás and K. Tökési, *Phys. Rev. A* **77** (2008) 050701R.
- [5] D. Rohrbein, T. Kirchner and S. Fritzsche, *Phys. Rev. A* **81** (2010) 042701.