APAPES

ATOMIC PHYSICS with ACCELERATORS: PROJECTILE ELECTRON SPECTROSCOPY

I.Madesis[1,2], A. Lagoyannis[2], M. Axiotis[2], T.J. Mertzimekis[2,3], M. Andrianis[2], E.P. Benis[4], S. Harissopulos[2], T.J.M. Zouros[1,2]

[1]Department of Physics, University of Crete, P.O Box 2208, GR-71003 Heraklion, Greece
[2]Tandem Lab, INPP, NCSR Demokritos, P.O Box 60228, GR-15310, Ag.Paraskevi, Greece
[3]Department of Physics, University of Athens, Zografou Campus, GR-15784 Athens, Greece
[4]Department of Physics, University of Ioannina, P.O Box 1186 ,GR-45110 Ioannina, Greece

Abstract

The only existing heavy-ion accelerator in Greece, the 5.5MV TANDEM at the National Research Center "Demokritos" in Athens has been used to date primarily for investigations centering around nuclear physics. Here, we propose to establish the new (for Greece) discipline of Atomic Physics with Accelerators, a strong field in the EU with important contributions to fusion, hot plasmas, astrophysics, accelerator technology and basic atomic physics of ion-atom collision dynamics, structure and technology. This will be accomplished by combining the existing interdisciplinary atomic collisions expertise from three Greek universities, the strong support of distinguished foreign researchers and the high technical ion-beam know-how of the TANDEM group into a cohesive initiative.

Using the technique of Zero-degree Auger projectile spectroscopy (ZAPS), we shall complete a much needed systematic isoelectronic investigation of K-Auger spectra emitted from collisions of pre-excited ions with gas targets using novel techniques. Our results are expected to lead to a deeper understanding of the neglected importance of cascade feeding of metastable states[1] 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 conflicting interpretations awaiting further resolution.

[1]T. J. M. Zouros, B. Sulik, L. Gulyás and K. Tőkési, Selective enhancement of 1s2s2p ^4P_J metastable states populated by cascades in single-electron transfer collisions of $F^{7+}(1s^2/1s2s\ ^3S)$ ions with He and H_2 targets, Phys. Rev. A **77** (2008) 050701R.
[2]E. P. Benis and T. J. M. Zouros and P. Richard, Nucl. Instrum. Meth. Phys. Res. B**154** (1999) 276.
[3]Omer Sise, Mevlut Dogan, Genoveva Martinez, Theo J. M. Zouros, J. Electron Spectroscopy and Related Phenomena **177** (2010) 42.
[4]D. Strohschein, D. Röhrbein, T. Kirchner, S. Fritzsche, J. Baran, and J. A. Tanis, Phys. Rev. A **77**, (2008) 022706**.**

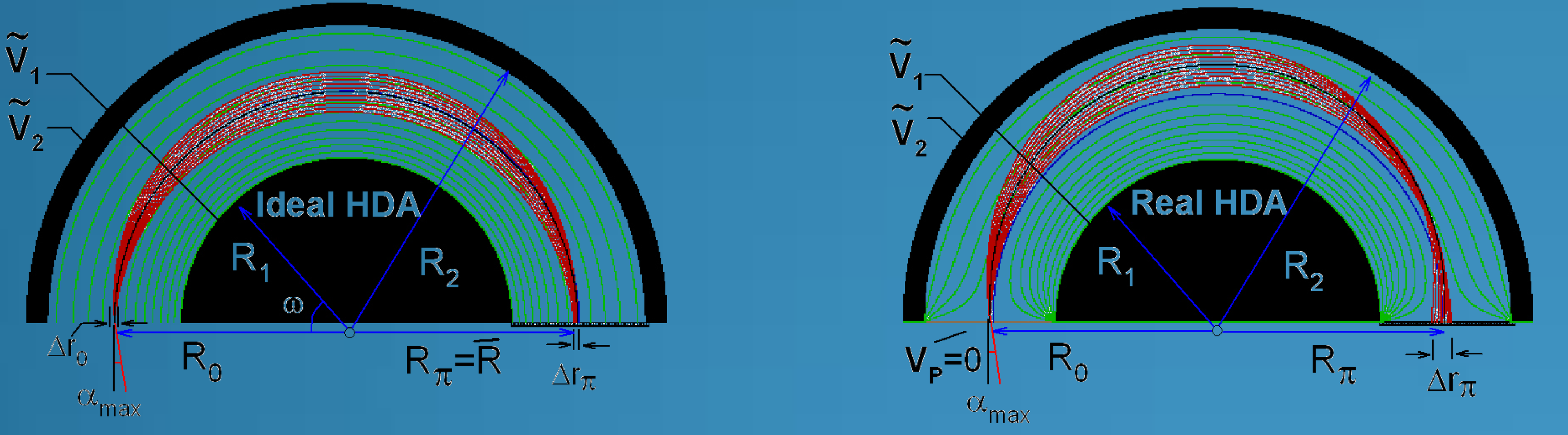

Fig. 1. Electron trajectories in an ideal and a fringing field HDA

Electrostatic energy analyzers are irreplaceable as high-resolution monochromators and energy spectrometers of ions and electrons in various atomic collision experiments, as well as in almost every experimental set-up for surface characterization. In general, a hemispherical deflector analyzer (HDA) combined with a cylindrical input-lens-system is used to measure the energy of the scattered or ejected electrons in collision experiments. Since the electrostatic field of the HDA differs from the ideal uniform field, an extensive study of the fringing field developed is needed, in order to avoid phenomena such as distorted trajectories, the degradation of first-order focusing and corresponding loss in energy resolution and/or transmission. Extensive study is conducted for the application of corrections, such as biased paracentric entry HDA.

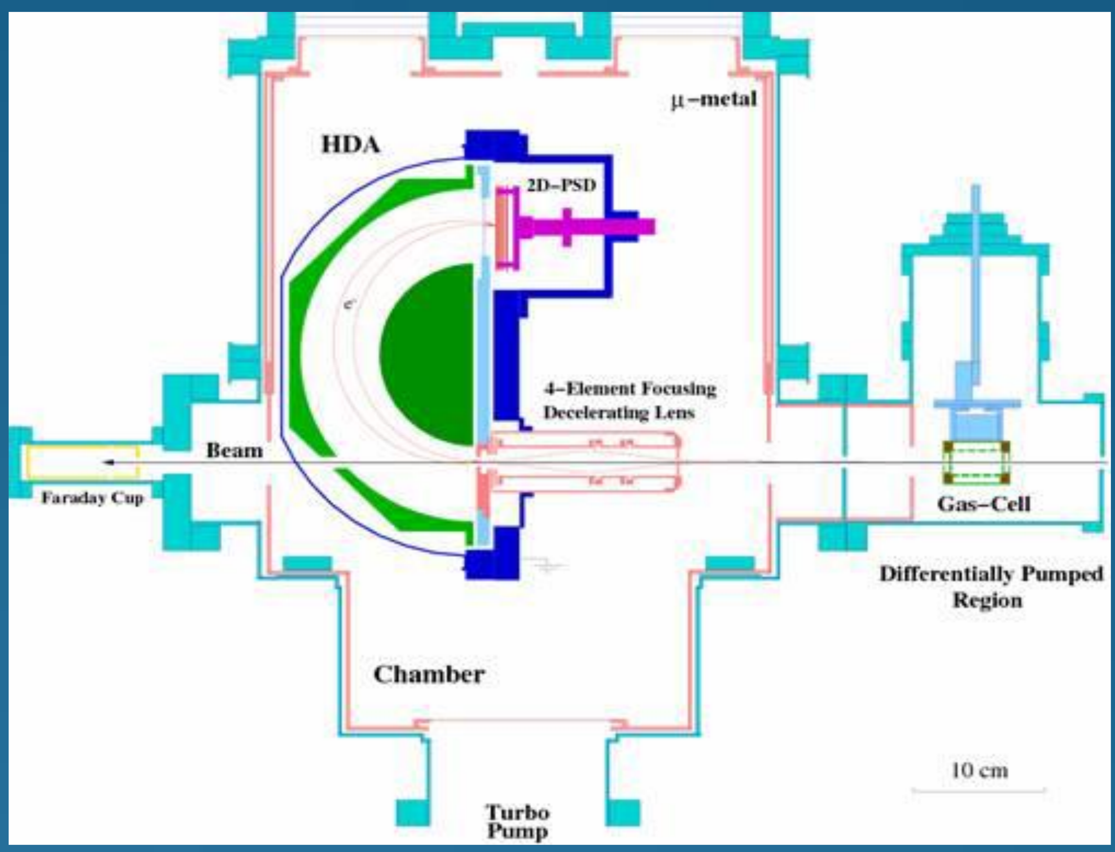

Fig.2 Proposed Zero degree Auger Projectile Spectroscopy experimental setup.

This ZAPS setup is the only existing high efficiency high resolution system in the world making it about 15-20 times more efficient than conventional single channel devices (e.g. two-stage parallel plate electron spectrometers [2]). Thus, it is ideally suited for use in the electron spectroscopy of weak ion beams such as the ones called for in this proposal. Additionally, the paracentric entry of the HDA is a novel feature adding further high resolution capability not available to conventional centric HDAs [3].

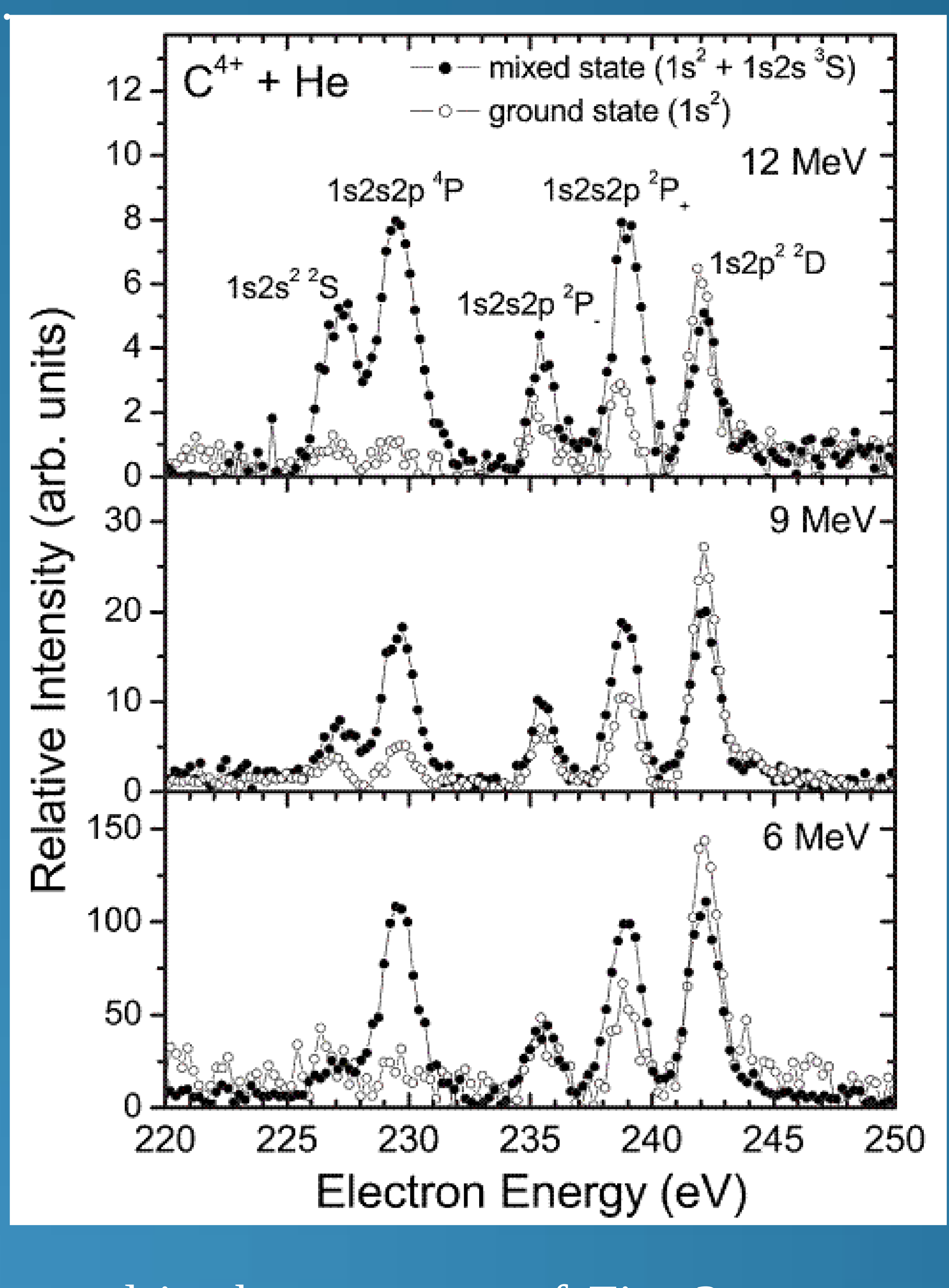

Fig.3
K-Auger spectra from mixed and pure ground state C^{4+} beams at three collision energies[4]

The various 1s2s2l lines observed in the spectrum of Fig. 3 must result from the capture of a target electron to one of the possible $C^{3+}(1s2s2l)$ states. Basic quantum mechanics requires the spin coupling of a 2p electron to the 1s2s ^3S state to yield 1s2s2p ^4P quartet and 1s2s2p ^2P doublet states in the ratio 2 to 1 or $R=\sigma(1s2s2p\ ^4P)/\sigma(1s2s2p\ ^2P)=2$. However, the values of R extracted from the spectra of Fig.3 are much larger R~6-9.

Open Position.

A position for a Postdoctoral researcher is available in the APAPES project. For further information, visit the APAPES web page at http://apapes.physics.uoc.gr/

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