

Electron Capture to Continuum in 0.5 – 4.5 MeV/u Collisions of Protons and Deuterons with Gas Targets

S Nanos^{1*}, A Laoutaris^{1,2}, I Madesis^{1,2}, T J M Zouros^{1,2} and E P Benis³

¹Tandem Accelerator Laboratory, INPP, NCSR Demokritos, GR 15310 Ag. Paraskevi, Greece

²Department of Physics, University of Crete, Heraklion, Greece

³Department of Physics, University of Ioannina, GR 45110 Ioannina, Greece

Abstract

A systematic study of the production of electron capture to continuum (ECC) cusp shape peak in collisions of 0.5-4.5 MeV/u protons and deuterons with He, Ne and Ar gas targets is reported. The measurements were obtained at zero degrees with respect to the ion beam using our electron spectroscopy setup operating at the 5.5MV TANDEM accelerator laboratory of the NCSR "Demokritos" in Athens [1]. Double differential cross sections (DDCS) were obtained after normalizing the measured electron yields to the binary encounter electron peak, recorded in the same spectrum as the cusp peak, as shown in Fig. 1. The many electrons contribution of the atomic shells to the ECC is provided by the Ne and Ar targets measurements, where a crossing of the energy dependence of the ECC cross sections around the energy of 0.75 MeV/u for the deuterons was observed. The situation is depicted in Fig. 2, where the behavior of the Ne and Ar DDCSs around the energy of 0.75 MeV/u is shown. Our measurements are accompanied by standard calculations based on the continuum distorted wave eikonal initial state approximation [2] performed with the Ion-Atom/Argon Program [3], showing a reasonable overall agreement, but calling for more elaborate theories to reach a better agreement as shown in Fig. 3. Our goal is to provide a complete set of data for the above energy collision systems that can provide a stringent test of more sophisticated theories like the recent four-body distorted wave approximation (4B-DW-EIS) [4].

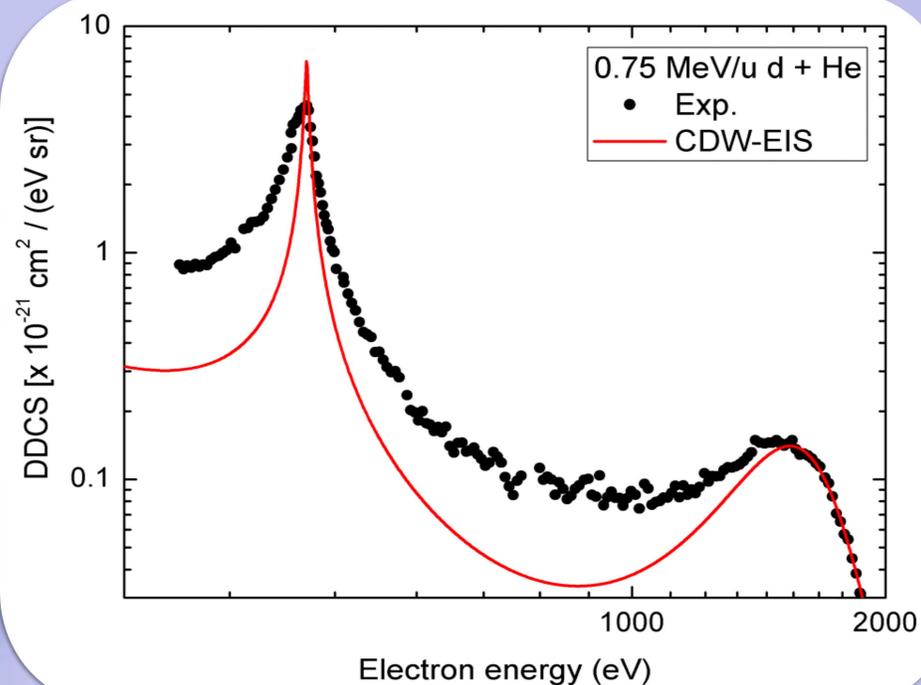


Figure 1. Full spectrum of 12 overlapping energy slices covering cusp and binary encounter electron peaks (black dots), along with the CDW-EIS calculation (red line). This spectrum was obtained in collisions of 0.75 MeV/u deuterons to He gas target.

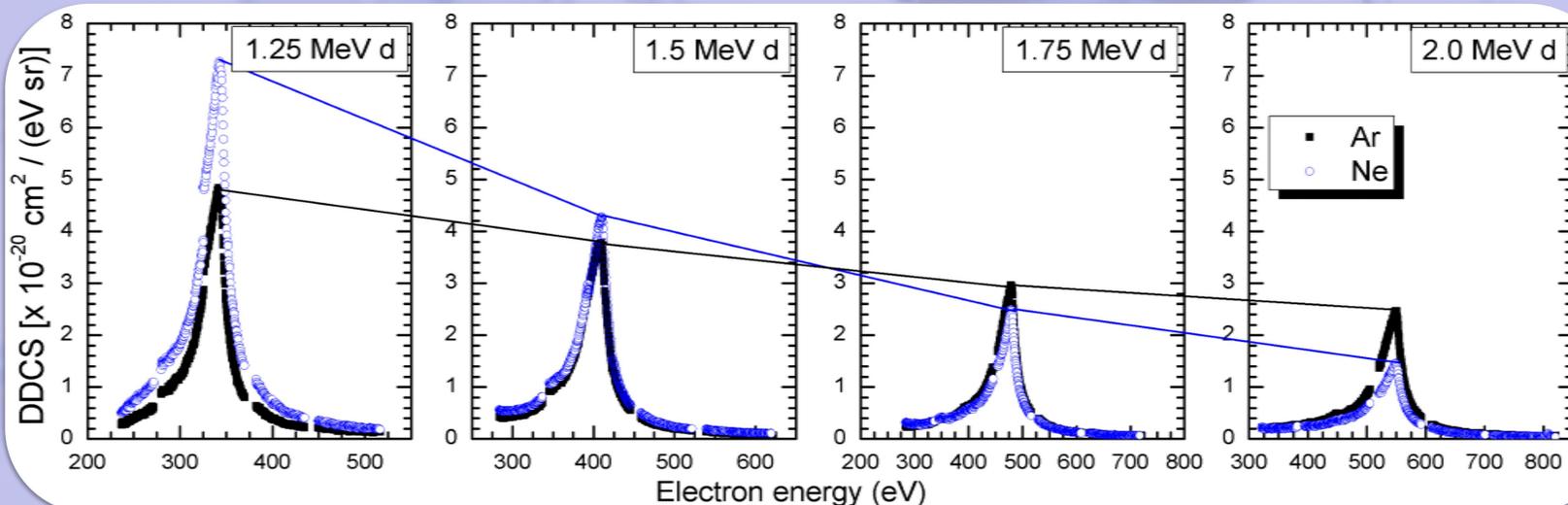


Figure 2. ECC cusp peaks obtained in collisions of deuterons with Ne (blue opened circles) and Ar (black squares) gas targets in collision energies ranging from 1.25 MeV to 2.0 MeV. A crossing of the single differential cross sections around the energy of 0.75 MeV/u is observed.

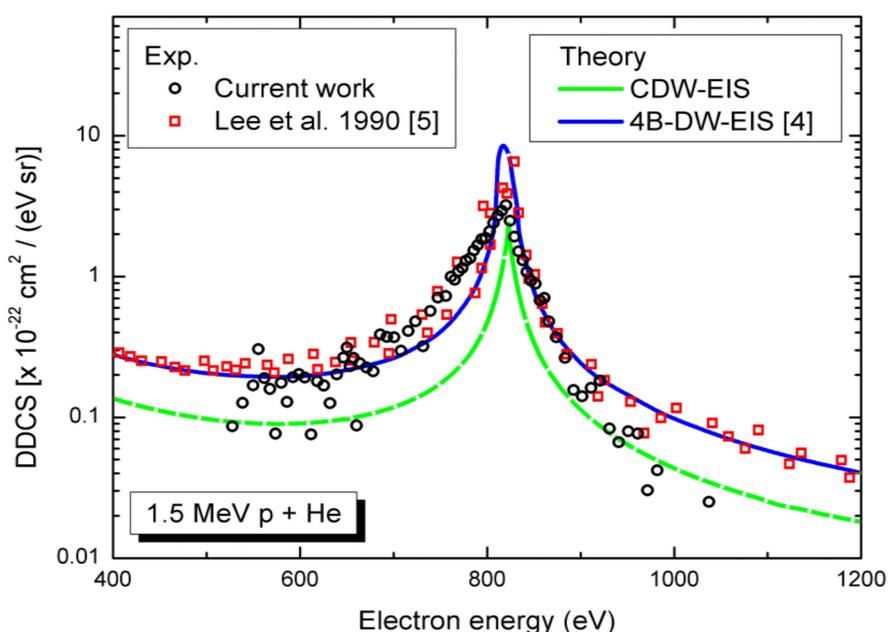


Figure 3. ECC peak for the collision system 1.5 MeV p + He. Along with the experimental data: Current work (black circles); Lee et al. [5] (red squares), the CDW-EIS (green line) and 4B-DW-EIS (blue line) approximations are shown.

References

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Acknowledgments

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*corresponding author: nanos@inp.demokritos.gr