Cusp Electron Measurements at the NCSR "Demokritos" Tandem Accelerator Laboratory

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The production of the cusp shape peak due to the electron capture to continuum (ECC) process is investigated in collisions of 0.5-4.5 MeV/u protons and deuterons with He, Ne and Ar gas targets. The cusp electrons were measured at zero degrees with respect to the ion beam. The experiments were conducted with our electron spectroscopy setup operating at a beamline dedicated to atomic physics research (see Fig. 1) at the 5.5 MV 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 (BEe), recorded in the same spectrum as the cusp peak, as shown in Fig. 2. Our measurements are accompanied by standard calculations based on the continuum distorted wave eikonal initial state approximation (CDW-EIS) [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 in order to stringently test more sophisticated theories like the recent four-body distorted wave approximation (4B-DW-EIS) [4].

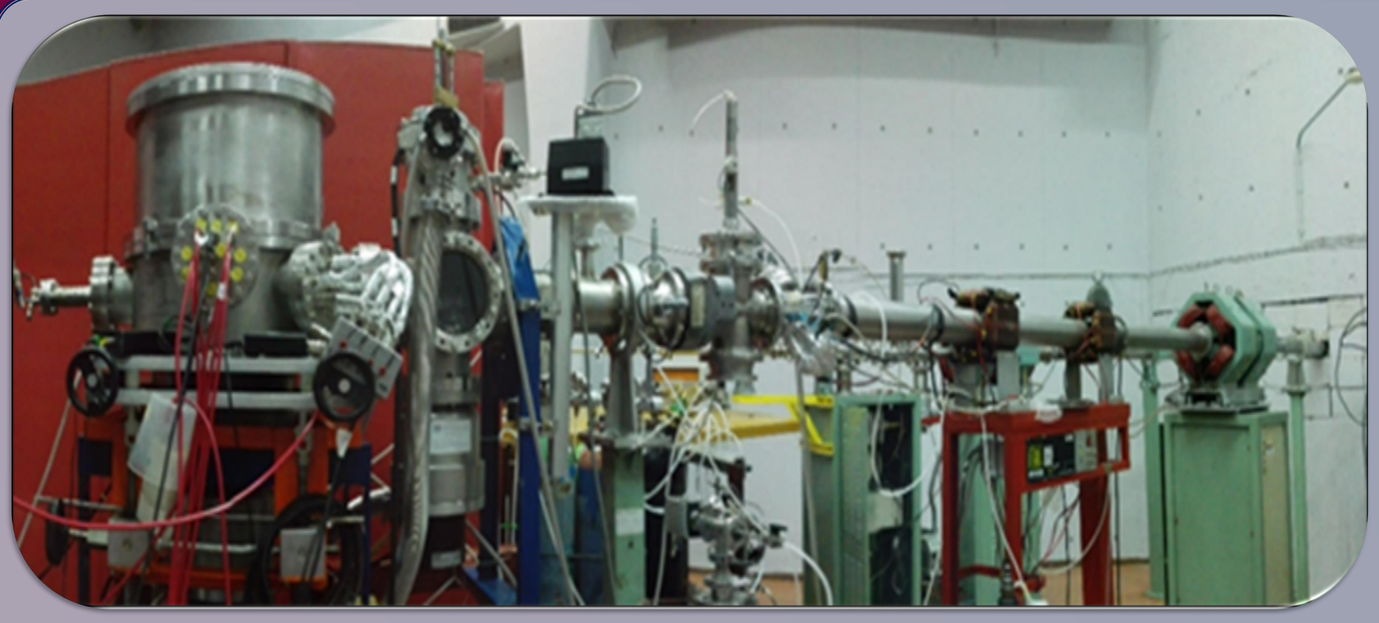

Figure 1a. The atomic physics beamline operating at the TANDEM accelerator laboratory of the NCSR "Demokritos" in Athens.

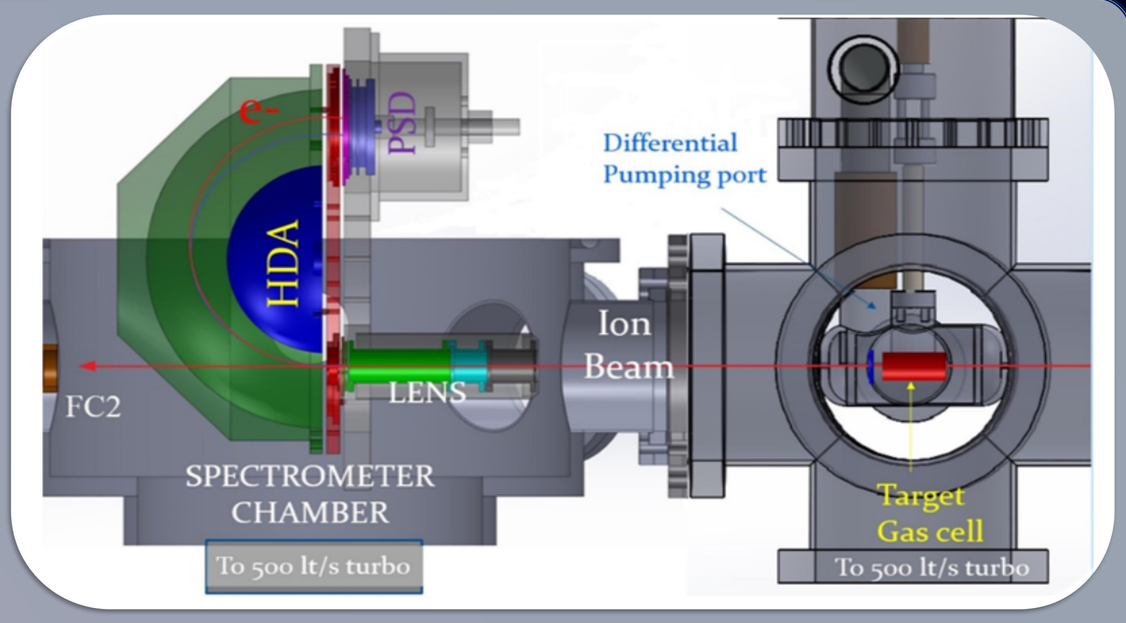

Figure 1b. Schematic illustration of the electron spectroscopy apparatus.

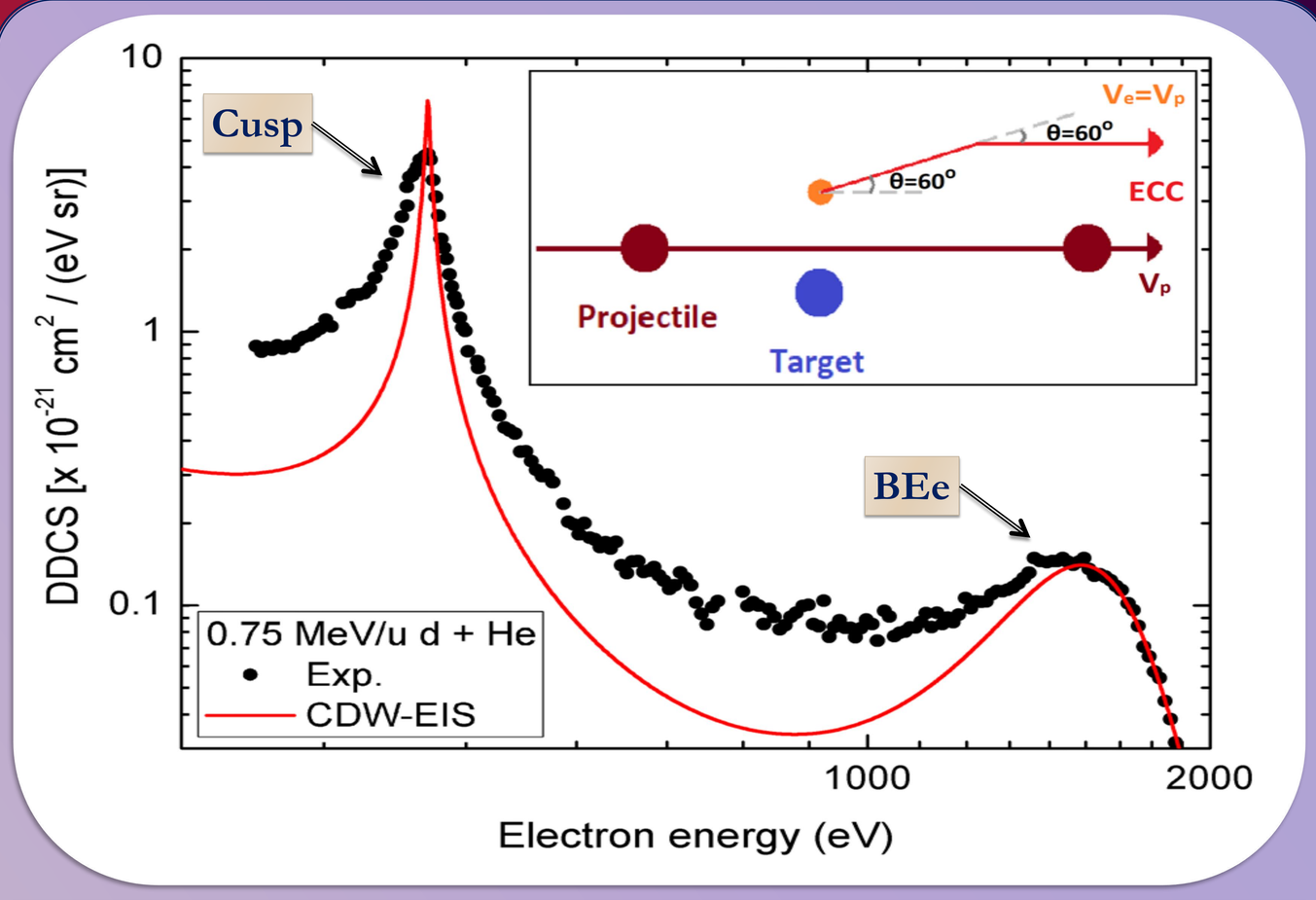

Figure 2. Full spectrum of 12 overlapping energy slices covering the cusp and binary encounter electron peaks (black dots), along with the CDW-EIS calculation (red line). The spectrum was obtained for the collision system: 0.75 MeV/u d + He. In the upper right corner the ECC process is shown schematically within the classical double scattering picture.

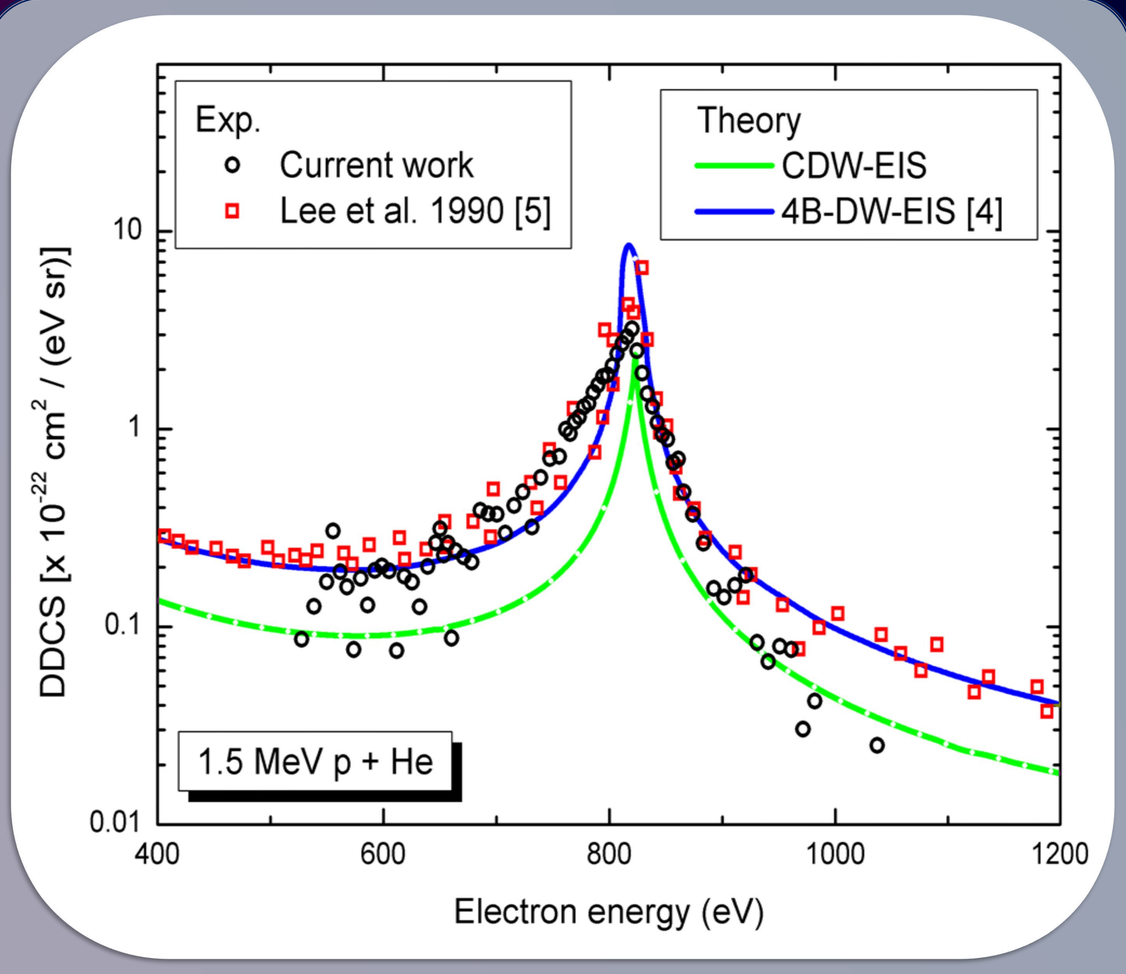

Figure 3. The ECC peak for the collision system 1.5 MeV p + He. Along with the experimental data: Current work (black circles); Lee et al. [5] (red squares), the CDW-EIS (green line) and 4B-DW-EIS (blue line) approximations are shown.

Acknowledgments

We acknowledge support of this work by the project "Cluster of Accelerator Laboratories for Ion-Beam Research and Applications - CALIBRA" (MIS 5002799) which is implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

References

[1] I. Madesis *et al.*, J. Phys: Conf. Ser. **583,** 012014 (2015)
[2] Dž. Belkic, J. Phys. B: At. Mol. Phys. **11,** 3529 (1978)
[3] D.M. McSherry *et al.*, Comp. Phys. Com. **155,** 144-155 (2003)
[4] J. Monti *et al.*, J. Phys. B: At. Mol. Phys.**42**, 19 (2009)
[5] Lee *et al.*, Phys. Rev. A **24**, 97 (1990)

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