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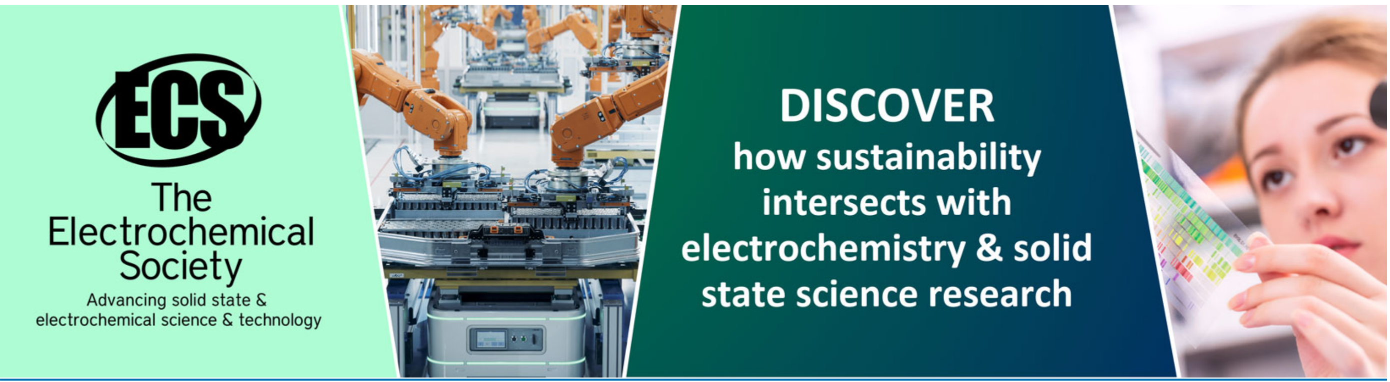

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Experimental and theoretical study of singly ionizing 1-MeV p+He collisions at different energy and momentum transfer values

O Chuluunbaatar[1,2], K A Kouzakov[3], S A Zaytsev[4], A S Zaytsev[4], V L Shablov[5], Yu V Popov[6,1], H Gassert[7], M Waitz[7], H-K Kim[7], T Bauer[7], A Laucke[7], Ch Müller[7], J Voigtsberger[7], M Weller[7], J Rist[7], K Pahl[7], M Honig[7], M Pitzer[7], S Zeller[7], T Jahnke[7], L Ph H Schmidt[7], H Schmidt-Böcking[7], R Dörner[7] and M S Schöffler[7]*

[1]Joint Institute for Nuclear Research, Dubna, Moscow region 141980, Russia
[2]Institute of Mathematics, National University of Mongolia, UlaanBaatar, Mongolia
[3]Faculty of Physics, Lomonosov Moscow State University, Moscow 119991, Russia
[4]Pacific National University, Khabarovsk 680035, Russia
[5]Obninsk Institute for Nuclear Power Engineering of the National Research Nuclear University MEPhI, Kaluga Region, 249040 Russia
[6]Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Moscow 119991, Russia
[7]Institut für Kernphysik, Universität Frankfurt, 60438 Frankfurt, Germany

Synopsis We present ultra-high-resolution COLTRIMS data on single ionization of helium induced by 1 MeV proton impact and compare it with theoretical calculations. Our analysis clearly shows the limitations of the first Born approximation.

In our earlier study [1], we reported high-resolution COLTRIMS data for the emission of electrons with energy $E_e = 6.5 \pm 3.5$ eV in 1-MeV proton-helium collisions at momentum transfer $q = 0.75 \pm 0.25$ a.u. The data exhibited a well-pronounced nodal structure, which is in agreement with predictions of the first Born approximation (FBA) for the electron three-dimensional angular distribution. At the same time, some discrepancy between the FBA theory and experiment was found in the scattering plane: the binary and recoil peaks appeared to be shifted towards smaller emission angles with respect to the FBA calculations.

In this contribution we present the experimental data and numerical calculations for the fully differential cross section (FDCS) in the form

$$\text{FDCS} = \frac{d^5\sigma}{dE_e d\theta_e d\phi_e dq d\phi_q}, \qquad (1)$$

where θ_e and ϕ_e are the polar and azimuthal angles of the emitted electron, and ϕ_q is the azimuthal angle of the momentum transfer q. We study the cases of momentum-transfer values $q = 0.5, 1.0,$ and 1.75 a.u. and (for each momentum-transfer value) the ejected-electron energies $E_e = 2.5, 5, 10$ and 20 eV. Fig. 1 shows experimental and FBA values for FDCS when $E_e = 20$ eV. The FBA calculations are averaged within the experimental E_e- and q-gates.

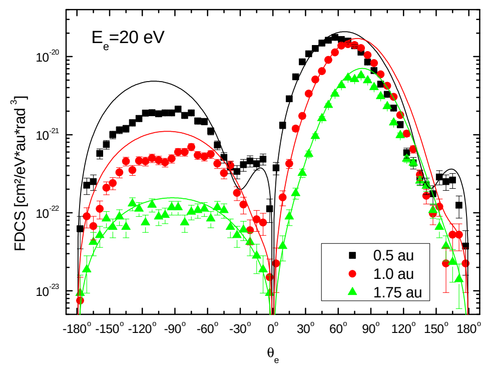

Figure 1. Experimental angular distribution in the scattering plane for $E_e = 20 \pm 5$ eV kinetic energy. The black squares correspond to a momentum transfer $q = 0.5 \pm 0.15$ a.u., the red circles to $q = 1.0 \pm 0.25$ a.u. and the blue triangles to $q = 1.75 \pm 0.4$ a.u. Solid lines correspond to the FBA using a Hartree-Fock wave function of helium.

We examine theoretical approaches beyond the FBA, such as the 3C model with effective charges [2], replacing potentials by T matrices, and semiclassical post-collision interaction.

References

[1] Gassert H *et al* 2016 *Phys. Rev. Lett.* **116** 073201
[2] Chuluunbaatar O *et al* 2017 *Phys. Rev. A* **96** 042716

*E-mail: schoeffler@atom.uni-frankfurt.de