

Low-energy ($E_0 = 65$ eV) electron-impact ionization of neon: Internormalized triple-differential cross sections in 3D kinematics

XueGuang Ren^{*†1}, Sadek Amami[§], Oleg Zatsarinny[†], Thomas Pflüger^{*‡}, Marvin Weyland^{*‡}, Woon Yong Baek^{*}, Hans Rabus^{*}, Klaus Bartschat[†], Don Madison[§], Alexander Dorn[‡]

^{*} Physikalisch-Technische Bundesanstalt, 38116 Braunschweig, Germany

[‡] Max-Planck-Institute for Nuclear Physics, 69117 Heidelberg, Germany

[§] Physics Department, Missouri University of Science and Technology, Rolla, Missouri 65409, USA

[†] Department of Physics and Astronomy, Drake University, Des Moines, Iowa 50311, USA

Synopsis We present a combined experimental and theoretical study on the low-energy ($E_0 = 65$ eV) electron-impact ionization of neon. The experimental data are compared to predictions from a hybrid second-order distorted-wave Born plus R -matrix approach (DWB2-RM), the distorted-wave Born approximation with inclusion of post-collision interaction (DWBA-PCI), a three-body distorted-wave approach (3DW), and a B -spline R -matrix (BSR) with pseudostates approach. Excellent agreement is found between experiment and the 3DW and BSR theories. The importance of PCI effects is clearly visible in this low-energy electron-impact ionization process.

The electron-impact ionization dynamics have now been well understood for simple systems such as atomic hydrogen and helium [1, 2, 3]. Recent studies for the ionization of neon by 100 eV electron-impact showed an unprecedented agreement between experiment and BSR predictions [4]. The physical effects of PCI as well as electron exchange and charge-cloud polarization in the projectile-target interaction are expected to become even more pronounced with decreasing projectile energy. Here, we investigate the low-energy ($E_0 = 65$ eV) electron-impact ionization of neon to thoroughly test state-of-the-art theoretical approaches.

The experimental data were measured using a reaction microscope [5, 6], which can cover nearly the entire 4π solid angle for the secondary electron emission. The measured cross sections are internormalized across all different scattering angles (θ_1) and ejected energies (E_2), which provide a thorough test ground for theory. As one example, the (e, 2e) triple-differential cross sections (TDCS) for $\theta_1 = -12.5^\circ$ and $E_2 = 2$ eV are presented in Figure 1 for the scattering plane and the full-perpendicular plane. The experimental data are compared to various theoretical predictions from the 3DW, BSR, DWB2-RM, DWBA-PCI models. Excellent agreement is found between experiment and the 3DW and BSR theories. Significant discrepancies between DWB2-RM and experiment are observed near the projectile forward direction, while the DWBA-PCI model provides a clear improvement over the DWB2-RM calculations in this angular range.

This indicates that PCI effects play a very important role in the low-energy ionization process studied here [7]. More results, including three-dimensional (3D) presentations of the TDCS, will be shown at the conference.

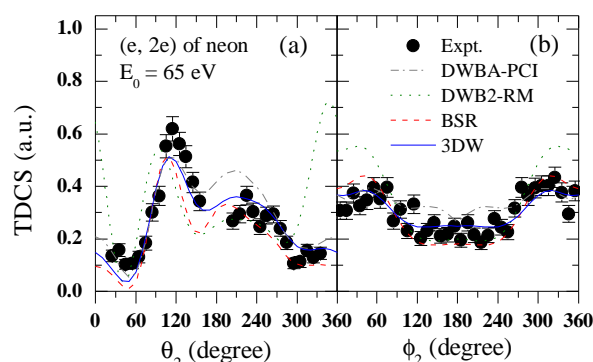


Figure 1. TDCS for the ionization of Ne (2p) presented as a function of the secondary electron (e_2) emission angle at $\theta_1 = -12.5^\circ$ and $E_2 = 2$ eV. (a): TDCS in the scattering plane; (b): TDCS in the plane perpendicular to the incident beam direction.

References

- [1] T. N. Resigno *et al* 1999 *Science* **286** 2474
- [2] X. Ren *et al* 2011 *Phys. Rev. A* **83** 052711
- [3] O. Zatsarinny *et al* 2011 *Phys. Rev. Lett.* **107** 023203
- [4] T. Pflüger *et al* 2013 *Phys. Rev. Lett.* **110** 153202
- [5] J. Ullrich *et al* 2003 *Rep. Prog. Phys.* **66** 1463
- [6] X. Ren *et al* 2014 *J. Chem. Phys.* **141** 134314
- [7] X. Ren *et al* 2015 *Phys. Rev. A* **91** 032707

¹E-mail: xue.g.ren@ptb.de