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Benchmark measurements of differential cross-sections for electron-impact excitation using a time-of-flight approach

M. Lange[1,2], D.S. Newman[2], J. Matsumoto[2,3], J.C.A. Lower[2], S.J. Buckman[2]

[1] *Max-Planck-Institut für Kernphysik, Heidelberg, Germany*
[2] *RSPHysSE, The Australian National University, Canberra, Australia*
[3] *RIKEN, Japan*

Michael.Lange@mpi-hd.mpg.de

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The threshold region continues to be an interesting target for investigations of low-energy electron scattering from atoms and molecules. However this energy region, which is also important in many technological applications of electron collisions, proves to be very challenging both to theory and experiment. Measurements of the angular-differential cross section are often performed in crossed-beam spectrometers using an electrostatic analyzer and optics, whose electron transmission efficiency must be known at all scattered energies. While it can be reliably established at high scattered energies, near a threshold the kinetic energies for the elastic and inelastic channels can differ by more than one order of magnitude. This makes determination of the transmission function difficult at best, and is the dominant source of experimental error in this energy range. We have therefore developed a crossed-beam time-of-flight spectrometer, which by the complete absence of electrostatic optics for the scattered electrons has an almost uniform electron transmission, regardless of energy. Contrary to other TOF spectrometers [1,2], we use a pulsed electron gun which can access scattering angles of $47 - 129^\circ$ and which incorporates a monochromator, thereby improving energy resolution from 500 meV to $120 - 150$ meV.

Using this spectrometer we have performed a benchmark measurement of the differential cross-sections for electron impact excitation of helium atoms at incident energies of 20.30, 22.05 and 23.48 eV, and have compared the results with a convergent close-coupling calculation [3], as well as with an R-matrix [4] and a B-Spline R-matrix [5] calculation. In general we have found good agreement between the theories themselves, as well as between experiment and theory. However, remaining differences indicate that the treatment of the ionization continuum, as well as the quality of the multiconfiguration expansions used to describe the target states are of most importance for the reproduction of the measured cross-sections. Currently, additional near-threshold measurements are being carried out on the vibronic excitation of nitrogen molecules, and for electronic excitation of argon atoms.

[1] J. R. LeClair, S. Trajmar, M. A. Khakoo and J. C. Nickel, Rev. Sci. Instrum. **67** (1996) 1753.
[2] C. Ma, P. B. Lieschеski and R. A. Bonham, Rev. Sci. Instrum. **60** (1989) 3661.
[3] K. Bartschat, E. T. Hudson, M. P. Scott, P. G. Burke and V. M. Burke, Phys. Rev. A **54** (1996) R998.
[4] D. V. Fursa and I. Bray, Phys. Rev. A **52** (1995) 1279.
[5] O. Zatsarinny, Comp. Phys. Commun. **174** (2006) 273.