Double ionization Compton profile for He–like systems and Compton scattering at relativistic energies

M. Lerotić[1], T. Surić, K. Pisk

R. Bošković Institute, P. O. Box 1016, 10000 Zagreb, Croatia
[1] *Department of Physics, University of Zagreb, 10000 Zagreb, Croatia*

For many years Compton scattering experiments have been used as an important tool in investigation of electron momentum density (EMD) in atomic, molecular and solid matter systems[1]. In most of those experiments doubly differential cross sections were measured and interpreted in terms of the Compton profile[1], which is a two dimensional integral over EMD. Recently, the impulse approximation approach for double ionization in Compton scattering is developed [2], and double–ionization Compton profile has been suggested for studying the correlation effects in He–like systems[3]

Unlike the ordinary Compton profile, which gives information on EMD (while correlation effects are relatively small, of the order of 1%), the double Compton profile accounts for e–e interaction, and one can expect the initial state correlation effects (beyond an independent particle model) much more pronounced for weakly bound systems. Similarly to ordinary Compton profile, double Compton profile is extracted from the doubly differential cross section measurements in double ionization, through the detection of scattered photons, and the validity of impulse approximation is essential for the correct interpretation of the Compton profiles. Recent extended analysis of the Compton scattering mechanisms and impulse approximation has shown that the accurate double Compton profile interpretation for He–atom requires photon energies above about 50–60 keV[4]. Also, the calculation of the He–like double ionization profiles using uncorrelated double continuum wave functions in the framework of $\mathbf{A}^2$ T–matrix element, gives excellent agreement with the prediction of impulse approximation[5]. However, at these and higher energies (double ionization Compton scattering experiments from He have already been performed at around 100 keV) relativistic effects influence cross sections of Compton scattering.

In this work we investigate double Compton profiles for simple two electron systems (He and H^-), in the framework of the relativistic impulse approximation (which is based on sudden approximation). The EMD of the light systems is accurately described within the nonrelativistic approach, while relativity enters through the Compton scattering dynamics. In our study we use the multiconfiguration expansion[6] for the ground state of our two–electron systems as well as a simple effective (screened) charge approach.

We discuss our results, compare them with other existing calculations [5], and estimate the experimental possibilities for measurements of double Compton profiles at energies at which relativistic effects affect Compton cross sections.

[1] M. J. Cooper, Rep. Prog. Phys. **48,** 415 (1985).

[2] T. Surić, K. Pisk, B. A. Logan and R. H. Pratt, Phys. Rev. Lett. **73,** 790 (1994).
[3] R. H. Pratt, T. Suric and K. Pisk, J. Korean Phys. Soc. **32,** 356 (1998).
[4] Z. Kaliman, T. Suric, K. Pisk, and R. H. Pratt, Phys. Rev. A **57**, 2683-2691 (1998); Z. Kaliman *et al.,* to be published in Fizika, Zagreb.
[5] M. A. Kornberg, U. D. Rodrigez, J. E. Miraglia, Phys. Rev. A **57,** 4490 (1998).
[6] R. K. Nesbet and R. E. Watson, Phys. Rev. **110,** 1073 (1958).