ESRF

Experiment title:

Compton Double Ionization of Helium at High Energy

Experiment number: MI78

Beamline: BL25 ID15

Date of Experiment: from: 27.9.95 to: 3.10.95

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Names and affiliations of applicants (*indicates experimentalists):

R. Wehlitz, J. C. Levin, I. A. Sellin
Department of Physics and Astronomy, University of Tennessee, Knoxville, TN 37996-1200
R. Hentges, G. Prümper, U. Becker
Fritz-Haber-Institut der MPG, D-14195 Berlin, Germany
A. Farhat, N. Berrah
Departement of Physics, Wetsem Michigan University, Kalamazoo, MI 49008-5151, USA
T. Buslaps
ESRF, B. P. 220, F-38343 Grenoble Cedez, France

Report:

We have measured the Compton double-to-single ionization ratio of helium [1-5] using an ion time-of-flight spectrometer along with monochromatized synchrotrons radiation of 57 keV. This photon energy is higher than all former published experiments and probes the "Compton ionization alone since the photoionization gives only a negligible contribution to the total cross section. The experiment was performed at the new high-energy beam-line BL25 behind wiggler ID15 operated in 16-bunch mode. The energy resolution is about 0.1 %. The photon beam entered the vacuum chamber through a beryllium window. The helium ions, which were produced in the interaction region defined by the intersection of the photon beam and the effusive gas beam, were detected with an ion time-of-flight spectrometer [6,7]. A fast timing signal, provided by the ESRF and derived from the storage ring electronics, served to provide a stop pulse for the time-to-amplitude converter. The voltages across the microchannel plates of the spectrometer were chosen such that an equal detection efficiency for He^{+} and He^{2+} was assured [8]. The gas pressure of helium in the chamber was 1 x 10-5 mbar which is low enough to assure negligible pressure dependence because of inelastic scattering.

According to Amusia and Mikhailov [5] the ratios for both photoionization and Compton ionization have the same asymptotic value. A few theories predict an lower asymptotic value of 0.80% to 0.84% [2,4] in which case our measured ratio lies higher. However, another theory predicts that the ratio falls slowly and suggests that the asymptotic value is reached only above 75 keV [13].

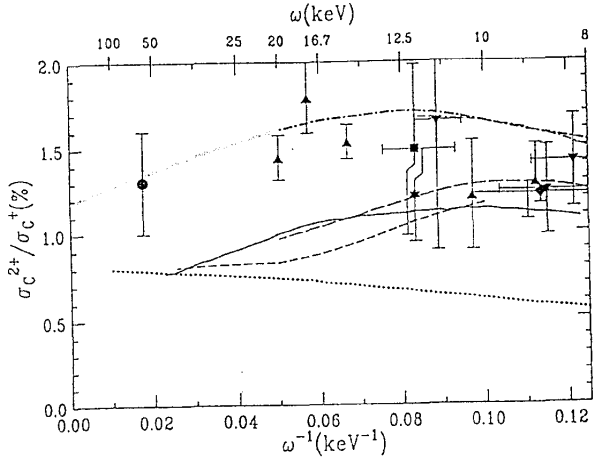

Figure 1: Comparison of our Compton double-to-single ionization ratio (circle) with other experimental data (square [6], diamond [9], star [l0], triangles [l1,12]) and theoretical calculations (solid line [1], short dashed line, uncorrelated final state [2], long dashed line, correlated final state [2], dotted line [4], thin dashed-dotted line [3], bold dashed-dotted line [13]). The gray line is an extrapolation of the bold dashed-dotted line using a third order polynomial curve.

Because the new data point (1.25*0.3)% at (57±0.06) keV is slightly lower than the data points above 12 keV there is an indication that the ratio is still steadily decreasing with increasing photon energy as suggested by Bergstrom et al. [13]. An extrapolation of the theoretical ratios calculated by Bergstrom et al. [13] using a third order polynomial curve yields an asymptotic limit of 1.18%. Thus in order to prove the high-energy behavior and to distinguish decisively among the different theoretical predictions measurements at higher photon energies but also with better accuracy are required.

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