Compton profile cross-sections: Utilization of the data for medical and biological applications

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Compton profile cross-sections are evaluated at a number of energies in order to utilize them for medical and biological applications. Compton profile is a correction to the Klein-Nishina cross-section taking into account the motion of the electrons. This correction modifies the shape of the Compton peak and depends on the chemical elements in the compound analyzed. Thus, the Compton Profile can be used as a probe for the electronic structure of atoms or molecules. Based on this formalism, Compton profile cross-sections and Compton energy absorption cross-sections, for few biological materials are evaluated, for example, water, bone and adipose tissue. However, the shape of the Compton peak is also influenced from the geometrical factors or apertures of collimators used in the experimental setup. This paper also concerns a study about the influence of the geometrical broadening on the discrimination of different biological elements.

Utilization of the data for medical and biological applications:

In dosimetry calculations, use is frequently made of the Compton energy absorption cross-section per electron (σ_{en}), which expresses the probability of transfer of energy from a photon to an electron by the Compton process. It is equal to the total Compton scattering cross-section per electron (σ_{TC}), times the fraction (f) of photon energy which is converted to kinetic energy of the recoil electrons in a single collision, averaged over all directions of electron recoil ($\sigma_{en} = \sigma_{TC} f$). Since the range of the recoil electron is small, the Compton energy absorption cross-section per electron is a measure of the total energy communicated locally to the absorbing medium by the Compton process. The most intense Compton scattering is produced in the atomic region $1 \leq Z \leq 20$. For example, most biological and phantom materials of medical interest containing varying proportions of the elements in the above atomic region. It is an attempt to know the effect of Doppler broadening for single atoms, many of which constitute the biological materials. One particular area of interest for these values is in Monte Carlo simulation of photon transport in applications of medical physics.

The impact of Compton profile data on the computations of X-ray cross-section and attenuation coefficients seems not has been explored fully in the literature. The main task of the present work is to examine the Compton profile literature and explore what, if any, effect our knowledge of this line broadening has on theoretical computations of photon incoherent scattering cross-sections and total mass attenuation coefficients. Further, to generate the tables of total Compton, individual shell and Compton energy absorption cross-sections by means of double differential scattering cross-sections based on impulse approximation with the inclusion of Doppler broadening. This type of new tables is not available in the literature and will be useful for comparison, compilation and simulation purposes for medical and biological applications.

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