MCMD P3 – Monte Carlo simulation of Compton scattering

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1 First exercise

We create a program that samples the photon path lengths according to the exponential distribution in an environment defined by the attenuation coefficient μ and the mass density of the material ϱ

$$p(d) \propto \exp\left[-\mu(h\nu)\varrho d\right] \tag{1}$$

where the attenuation is dependent on the energy of the incoming photon.

The distribution for the obtained lengths at various energies are provided in Fig 1.

2 Second exercise

We construct a generator for Compton scattering of photons with input energy $h\nu$ and output energy $h\nu'$ together with the corresponding scattering angle θ. We plot the angular distribution as a function of energy in Fig 2. Next we determine the distribution of the energies of the scattered electrons, see Fig 3. The electron energies are scaled according to the incoming photon in order to have a similar region of comparison at all energies. For the peak points in Fig 3 we samples the corresponding angles and find that the energy peaks at a scattering angle of 170°.

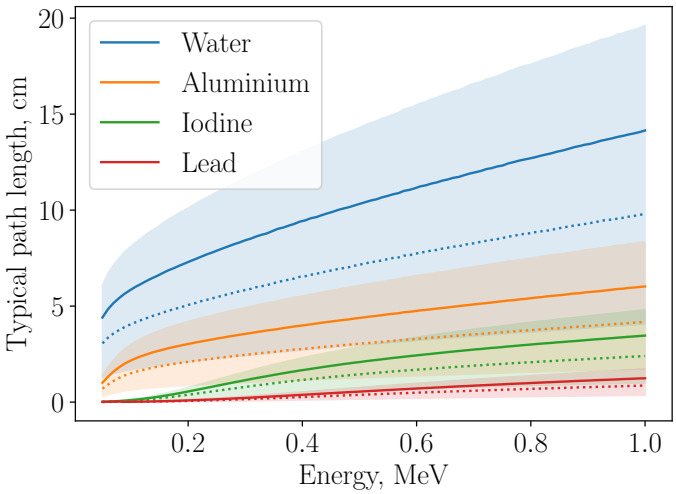

Figure 1: Characteristic path lengths for the different materials: water, aluminium, iodine and lead. The full line indicates the path mean, the dotted the median and the shaded area are lengths in the 25^{th} to the 75^{th} percentile range.

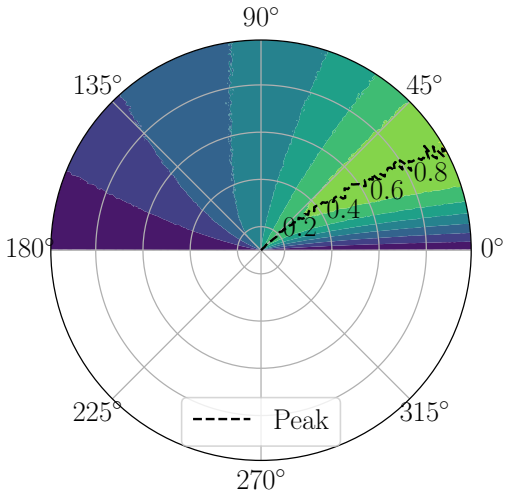

Figure 2: Angular distribution of the scattered photons with energies in the range 0.1 to 1 MeV. The dashed line indicate the peak angle.

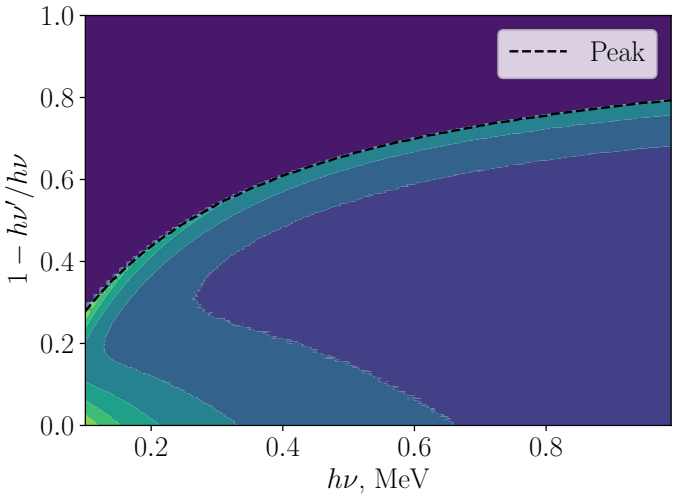

Figure 3: Distribution of energy of the scattered electrons relative to the energy of the incoming photons. The dashed line indicates the peak.