Karlsruhe Institute of Technology

FAKULTÄT FÜR PHYSIK
Praktikum Moderne Physik

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Wird vom Betreuer ausgefüllt.

1. Abgabe am:

Rückgabe am: Begründung:

2. Abgabe am:

Ergebnis: + / 0 / - Fehlerrechnung: Ja / Nein

Datum: Handzeichen:

Bemerkungen:

Contents

2. Theory & Preparation

2.1 Compton scattering

Consider the scenario of a high-energy photon interacting with an unbound electron as shown in Figure 2.1a. To describe this process we choose a coordinate frame where the electron is at rest with respect to us. In the experiments to be presented in this report such a coordinate frame conveniently is the lab frame anyways.
From the conservation of energy and impluse we can construct a theoretical description of this process based on the inital and final energies of both particles.

$$\begin{aligned} E_{\gamma,i} + \underbrace{E_{e,i}}_{=0} &= E_{\gamma,f} + E_{e,f} \\ p_{\gamma,i} + \underbrace{p_{e,i}}_{=0} &= p_{\gamma,f} + p_{e,f} \end{aligned}$$

From the above relations an expression for the energy of the photon after interacting with the electron can be obtained and reads

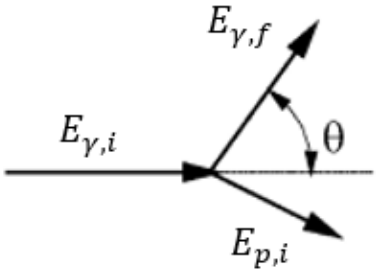
$$E_{\gamma,f} = \frac{E_{\gamma,i}}{1 + \frac{E_{\gamma,i}}{m_e c^2}(1 - \cos\theta)}, \tag{2.1}$$

where θ defines the angle spanned between the incident photon and its path post scattering. It follows that the electron gains energy from the interaction.

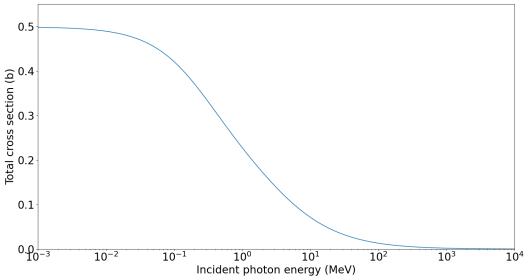
$$E_{e,f} = E_{\gamma,i} - E_{\gamma,f} = E_{\gamma,f} \cdot \frac{E_{\gamma,i}}{m_e c^2} \cdot (1 - \cos\theta). \tag{2.2}$$

The measureable change in the photons wavelength $\lambda = \frac{hc}{E_\gamma}$ due to the interaction is called the **Compton effect**. The underlaying elastic scattering of photons and unbound electrons is consequently labelled **Compton scattering**. It represents one important process by which electromagnetic radiation interacts with matter.

2.2 Cross section



(a) **Scattering kinematics**



(b) **Total cross section**

(a) A high energy photon scatters off a free electron at rest. The defining variables to describe this process are given by $E_{\gamma,i}$ and θ. Figure adapted with changes from [**?**] (b) The total cross section as a function of the incident photon energy. The cross section decreases for large energies due to the increased likeliness of pair production.

3. Experiment & Evaluation