Anwendung kernphysikalischer Methoden in der interdiszipl. Forschung 1

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Photoelectric Effect and Pair Production

Show that one needs a partner for photoelectric effect and pair production (momentum of the photon!)

Compton Effect

A γ–ray photon (energy E_γ) scatters inelastically on a free electron.

a) Calculate the energy of the scattered γ'–ray photon $E_{\gamma'}$ and the kinetic energy T_e of the electron as a function of the scattering angle $\theta_{\gamma'}$.

b) Calculate th energy of a 1 MeV γ'–ray photon after Compton scattering through 90°.

b) Why can a γ'–ray photon, scattered with an angle of $\theta_{\gamma'} > 60°$, in its further "life" produce no more electron - positron pairs?

Bethe - Bloch - Formula

The specific energy loss for heavy charged particles via Coulomb scattering is described by the Bethe–Bloch–Formula:

$$\frac{dE}{dx} = -4\pi n_e \frac{(Z_p e^2)^2}{m_e v_p^2} \cdot \left[\ln\left(\frac{2m_e v_p^2}{I}\right) - \ln\left(1-\beta_p^2\right) - \beta_p^2 \right]$$

Z_p	=	atomic number of the projectile
v_p	=	velocity of the projectile
m_e	=	electron rest mass
n_e	=	electron density
I	=	mean ionization potential

a) Describe the trend of the curve of a function of the energy and the atomic number of the projectile.

b) Sketch the curve of the energy loss of a charged particle when penetrating into matter a function of depth.

c) A <u>nonrelativistic</u> ion (mass M_p, energy E_0, charge Z_p) hits first a detector with a thickness x. The energy loss is ΔE. Then the ion rest energy $E_R = E_0 - \Delta E$ is stopped in a second detector. Calculate from the specific energy loss ΔE the range R and show that one can determine $M_p \cdot Z_p^2$ with this ΔE - E - telescope.

d) What must be determined additionally to get M_p and Z_p?