PRINT FIRST NAME	PRINT LAST NAME	PRINT STUDENT ID	GRADE

Experiment 7

The Compton effect

The Compton effect can be studied and the scattering formula verified. The apparatus has been set up as shown if Figure 7.1. Measure the energy, E', of the scattered gamma photons as a function of their scattering angle θ.

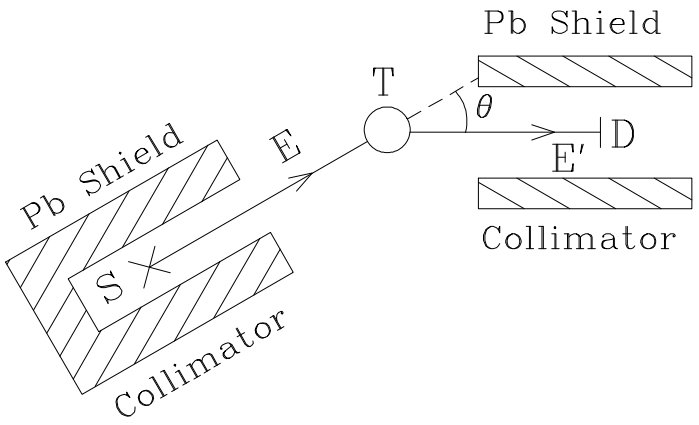

Figure 7.1: Compton scattering arrangement

S Cs^{137} gamma source; Energy 0.661 MeV; Strength 25 millicuries.

E Direction of the collimated gamma photon beam of energy E.

Note: The 25 millicurie source produces an intense collimated beam. DO NOT stand in the direct line E.

T Aluminum target that contains the free electrons from which the gamma rays will be scattered.

E' Direction of the scattered photons of energy E'.

D NaI gamma ray detector.

Both S and D are well shielded with lead. The source shielding minimizes the radiation intensity in all directions except within a small solid angle centred on the beam direction, E. The detector shielding is designed to admit the scattered photons, E', and to exclude entrance to photons incident from other directions. The scattering angle, θ, is varied by rotating the source assembly, S, about

the target position, T. To measure E' use the energy calibration that you made earlier. Check it out if there has been an interval between laboratory sessions!

Accumulate the pulse height spectrum of the scattered photons as a function of the scattering angle and so determine $E'(\theta)$. The Compton formula is usually given in terms of incident wavelength λ and scattered wavelength λ':

$$\lambda' - \lambda = \frac{h}{m_0 c}(1 - \cos\theta).$$

Show that in terms of photon energies E' and E this formula becomes

$$\frac{1}{E'} - \frac{1}{E} = \frac{1}{m_0 c^2} \cdot (1 - \cos\theta)$$

Plot your experimental data as $1/E'$ versus $(1 - \cos\theta)$ and from the results determine E and the electron rest mass energy $m_0 c^2$.

The minimum value of the scattering angle θ at which the Compton scattering energy shift is observable will be determined by the energy resolution of the detector and the effectiveness of the lead collimator which defines the solid angle of emergence of the cesium photon beam. If the scattering angle is made too small, the direct shine of the cesium gamma photons into the detector will completely mask the small Compton energy shift. Only a small fraction of the photons are scattered in the target. The intensity of the scattered beam is much less than that of the incident beam. The recording time required to obtain a satisfactory spectrum may be many minutes. If there is any direct shine into the detector the recording time will be seconds rather than minutes!