

Nuclear and Particle Physics - Problem Set 4 - Solution

Problem 1)

a) At the average energy of the scattered electron, $E' = 15$ GeV, we have $\nu = 5$ GeV, $Q^2 = 1.85$ GeV², and $x = Q^2/2m\nu = 0.197$ (approx. $x=0.2$).

b) We are clearly in the scaling region: $Q^2 > 1$, and $W^2 = 8.4$ (way above the resonance region $W^2 \leq 4$). Therefore, we can assume that the structure functions F_1 and F_2 scale (which is an especially good assumption at intermediate x , as is the case here). Since $\tan^2 \theta/2 = 0.0015$, we can ignore the contribution from W_1 (F_1), and therefore write the cross section (Eq. 7.8) as

$$\frac{\Delta\sigma}{\Delta\Omega\Delta E'} = \left(\frac{d\sigma}{d\Omega}\right)_{Mott}^* \frac{F_2(x)}{\nu} = \frac{4\alpha^2(\hbar c)^2 E'^2 (\cos \vartheta/2)^2 F_2(x)}{Q^4 \nu}$$

Depending which source you use, $F_2(x)$ is somewhere between 0.32 and 0.35. I choose 0.34.

For the Mott* cross section, I get $5.444 \cdot 10^{-30}$ cm²/sr. The total cross section is then $3.7 \cdot 10^{-31}$ cm²/sr/GeV.

c) The luminosity comes out to $L = 2.6 \cdot 10^{35}$ /s/cm². Multiplying this with the cross section and the angular (0.002 sr) and energy (0.2 GeV) acceptance, I get a count rate of 39 per second.