Seminar 2 Exp4 SS2020

1

$$E = \frac{m_0 c^2}{\sqrt{1-(v/c)^2}} \qquad \frac{v}{c} \equiv x$$

Taylor expansion for small x:

$$\frac{1}{\sqrt{1-x^2}} \approx 1 - \underbrace{\frac{1}{2}\frac{-2x}{(1-x^2)^{3/2}}\bigg|_{x=0}}_{0} \cdot x +$$

$$+ \frac{1}{2}\cdot\frac{2}{2}\frac{1}{(1-x^2)^{3/2}}\bigg|_{x=0} \cdot x^2 + \underbrace{\dots}_{0} + O(x^4)$$

$$\approx 1 + \frac{x^2}{2}$$

$$E = m_0 c^2 \left(1 + \frac{1}{2}\left(\frac{v}{c}\right)^2\right)$$

$$K = E - m_0 c^2 = \frac{1}{2} m v^2$$

2

$$I = \frac{N e}{1\,s} \qquad \frac{I_{sat} = 10^{-10}\,A}{N - ?}$$

$$\Rightarrow N = \frac{I}{e} = \frac{10^{-10}}{1{,}6\cdot 10^{-19}} \approx 6\cdot 10^{8}$$

3

$$h\nu = A. \qquad \nu = \frac{c}{\lambda} \qquad \frac{A = 4.28\,eV}{\lambda - ?}$$

$$\lambda = \frac{hc}{A} = \frac{6.6\cdot 10^{-34}\cdot 3\cdot 10^{8}}{4.3\cdot 1{,}6\cdot 10^{-19}}$$

$$= 2{,}88\cdot 10^{-7}\,m = 288\ nm$$

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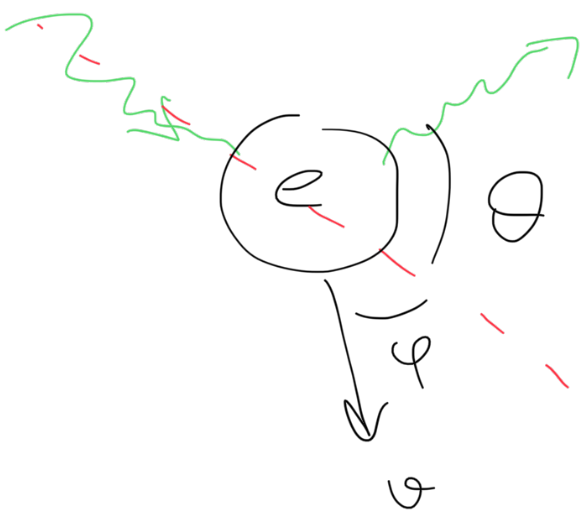
(4)



$\boxed{\text{Eq } 1.20}$ $E_{ph} + E_0 = E'_{ph} + E'_e$ | energy conserv.

$$E'_e = E_0 + (E_{ph} - E'_{ph})$$

$$E_{ph} = h\nu = \frac{hc}{\lambda} \qquad E'_{ph} = \frac{hc}{\lambda'} = \frac{hc}{\lambda + \lambda_c(1-\cos\theta)}$$

$$E_{ph} - E'_{ph} = hc\left[\frac{\lambda_c(1-\cos\theta)}{\lambda^2\left[1 + \frac{\lambda_c}{\lambda}(1-\cos\theta)\right]}\right]$$

$$= \frac{hc}{\lambda}\left[\frac{\frac{\lambda_c}{\lambda}(1-\cos\theta)}{1 + \frac{\lambda_c}{\lambda}(1-\cos\theta)}\right]$$

$$p'^2_e = \frac{E'^2_e - E_0^2}{c^2} \quad (*)$$

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for $\theta = 90°$ and $\lambda = 0.02$ nm

$$\Delta \equiv E_{ph} - E'_{ph} = \frac{hc}{\lambda}\,\frac{\lambda_c}{\lambda + \lambda_c} = \frac{6.6\cdot 10^{-34}\cdot 3\cdot 10^{8}\cdot 2{,}4\cdot 10^{-12}}{2\cdot 10^{-11}\cdot 2.2\cdot 10^{-11}}$$

$$\approx 10{,}8\cdot 10^{-16}\ \text{J}$$

$$\sim 7\ \text{keV}$$

$E'_e = m_0c^2 + \Delta$

$$p_e' \approx 4 \cdot 10^{-23}\ \frac{J}{m}s \quad (*)$$

5

$$p_e' \cos\varphi = \frac{h}{\lambda} - \frac{h}{\lambda'}\cos\theta$$

$$p_e' \sin\varphi = \frac{h}{\lambda'}\sin\theta$$

$$\operatorname{tg}\varphi = \frac{\sin\theta}{\lambda'/\lambda - \cos\theta}$$

$$\frac{\lambda'}{\lambda} = 1 + \frac{\lambda_c}{\lambda}(1 - \cos\theta)$$

$$\frac{\lambda'}{\lambda} = 1 + \frac{2.4 \cdot 10^{-12}}{2 \cdot 10^{-11}} \approx 1{,}12$$

$$\operatorname{tg}\varphi \approx 0{,}83 \Rightarrow \varphi \approx 41{,}5^\circ$$