Nothing about midterm \~\~

Dipole Approximation (last bit of 3.3)

lowest order expansion

particles in region of size L
characteristic time τ

$\tau \gg L/c$ __differences__ in retardation can be neglected L/c time takes light to travel distance is much less than τ

$\nu = 1/\tau$ frequency of emmitted radiation

$\longrightarrow \quad \lambda \gg L$

$$\vec{E}_{rad} = \sum \frac{q_i}{c^2} \frac{\vec{n} \times (\vec{n} \times \dot{\vec{u}}_i)}{R_i} \approx \frac{\vec{n} \times (\vec{n} \times \ddot{\vec{d}})}{c^2 R_0}$$

R_0 ↳ avg distance

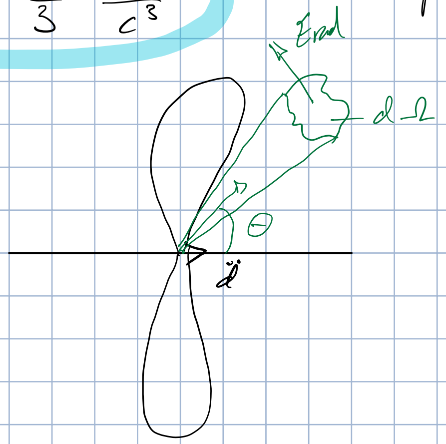
$\vec{d} = \sum q_i \vec{r}_i$ dipole moment

power

$$\frac{dP}{d\Omega} = \frac{\ddot{d}^2}{4\pi c^3} \sin^2\theta$$

$$P = \frac{2}{3} \frac{\ddot{d}^2}{c^3}$$

dipole approximation



$$E(t) = \frac{\ddot{d}(t) \sin\theta}{R_0 c^2}$$

$E(t) = |\vec{E}(t)|$
$d(t) = |\vec{d}(t)|$

$$d(t) = \int_{-\infty}^{\infty} \hat{d}(\omega) e^{-i\omega t} d\omega$$

$$\ddot{d}(t) = -\int_{-\infty}^{\infty} \omega^2 \hat{d}(\omega) e^{-i\omega t} d\omega$$

$$E(\omega) = -\frac{1}{c^2 R} \omega^2 d(\omega) \sin\theta$$

$$\frac{dW}{d\omega d\Omega} = \frac{\omega^4}{c^3} |d(\omega)|^2 \sin^2\theta$$

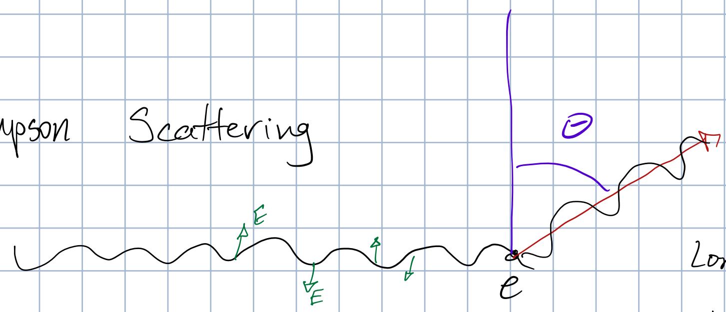
$dA = R^2 d\Omega$

energy density per unit frequency

$$\frac{dW}{d\omega} = \frac{8\pi\omega^4}{3} |d(\omega)|^2$$

not true for relativistic particles

Thompson Scattering



polarized light

Lorentz force

unit vector of polarization

$$\vec{F} = e\,\vec{\epsilon}\,E_0 \sin(\omega_0 t)$$

true if $h\nu \ll m_e c^2$

$$m\ddot{\vec{r}} = e\,\vec{\epsilon}\,E_0 \sin(\omega_0 t) \rightarrow \ddot{\vec{r}} = \frac{e}{m}\,\vec{\epsilon}\,E_0 \sin(\omega_0 t)$$

$$\vec{d} = e\vec{r} \rightarrow \ddot{\vec{d}} = e\ddot{\vec{r}} \qquad \rightarrow \qquad \ddot{\vec{d}} = \frac{e^2 E_0}{m}\,\vec{\epsilon} \sin(\omega_0 t)$$

$$\vec{d} = -\left(\frac{e^2 E_0}{m\omega_0^2}\right)\vec{\epsilon} \sin(\omega_0 t) \longrightarrow \vec{d}_0 = \frac{e^2 E_0}{m\omega_0^2}\,\vec{\epsilon}$$

oscillating dipole

Time averaged power

$$\frac{dP}{d\Omega} = \frac{e^4 E_0^2}{8\pi m^2 c^3} \sin^2\theta$$

$$\rightarrow P = \frac{e^4 E_0^2}{3m^2c^3}$$

Note incident flux: $\langle S \rangle = \frac{c}{8\pi} E_0^2$

$$\frac{dP}{d\Omega} = \langle S \rangle \cdot \frac{d\sigma}{d\Omega} = \frac{e^4 E_0^2}{8\pi} \frac{d\sigma}{d\Omega}$$

$$\frac{d\sigma}{d\Omega} = \frac{e^4}{m^2c^4} \sin^2\theta = r_0^2 \sin^2\theta \qquad r_0 = \frac{e^2}{mc^2}$$

classical electron radius

integrate

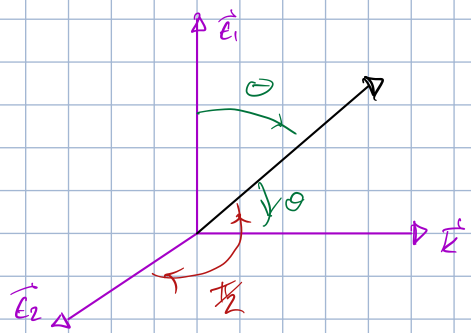
$$\sigma = \frac{8\pi}{3} r_0^2$$

for electron, Thompson cross-section

Why is sky blue? so theres this thing called Larmor's eqn

Nonpolarized light

generalize to 2 beams w/ $\perp$ polarization



$\vec{\epsilon}_1$ as before

$\vec{\epsilon}_2$ is $\perp$ to $\vec{\epsilon}_1$ & $\vec{n}$

$\theta = \pi/2 - \Theta$

$$\left(\frac{d\sigma}{d\Omega}\right)_n = \frac{1}{2}\left[\left(\frac{d\sigma(\theta)}{d\Omega}\right)_p + \left(\frac{d\sigma(\pi/2)}{d\Omega}\right)_p\right]$$

$$= \frac{1}{2} r_0^2 (1+\sin^2\Theta)$$

$$= \frac{1}{2} r_0^2 (1-\cos^2\theta)$$

symmetric wrt $\theta \to -\theta$

total cross section for unpolarized is same as for polarized

$$\Pi = \frac{1-\cos^2\theta}{1+\cos^2\theta} \geq 0$$

$\theta = 0$ nonpolarized
$\theta = \pi/2$ 100% polarized

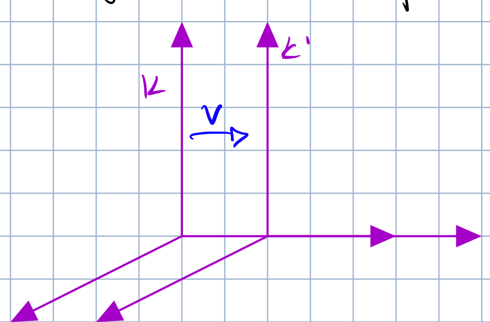
end of Chapter 3.4

now chapter 4!

Lorentz Transformations

Bro you just talking. Cool, but it's all going over my head

Dawg what u saying.



$$x' = \gamma(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma\left(t - \frac{vx}{c^2}\right) \quad *$$

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

$$|\vec{v}| < c$$

$$\ell = \sqrt{x^2 + y^2 + z^2}$$

can rotate & be same, unchanged

$$s^2 = (ct)^2 - |\vec{x}|^2$$

preserved by Lorentz transformations *