Title: PHYS 781 - Lecture 4

Date: Sep 30, 2014 02:00 PM

URL: http://pirsa.org/14090085

Abstract:

$$\kappa_T \simeq 0.4 \ \mathrm{cm^2/g}$$

$$\kappa_{ff} \simeq 4 \times 10^{22} \ \mathrm{cm^2} \, \mathrm{g^{-1}} \, (1+X)\,(X+Y) \left(\frac{\rho}{\mathrm{g/cm^3}}\right) \left(\frac{T}{1\ \mathrm{K}}\right)^{-7/2}$$

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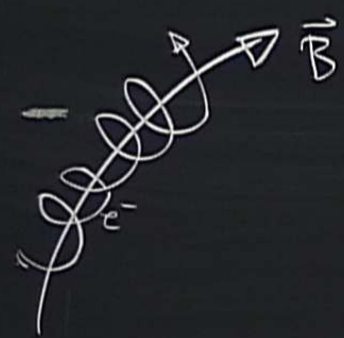
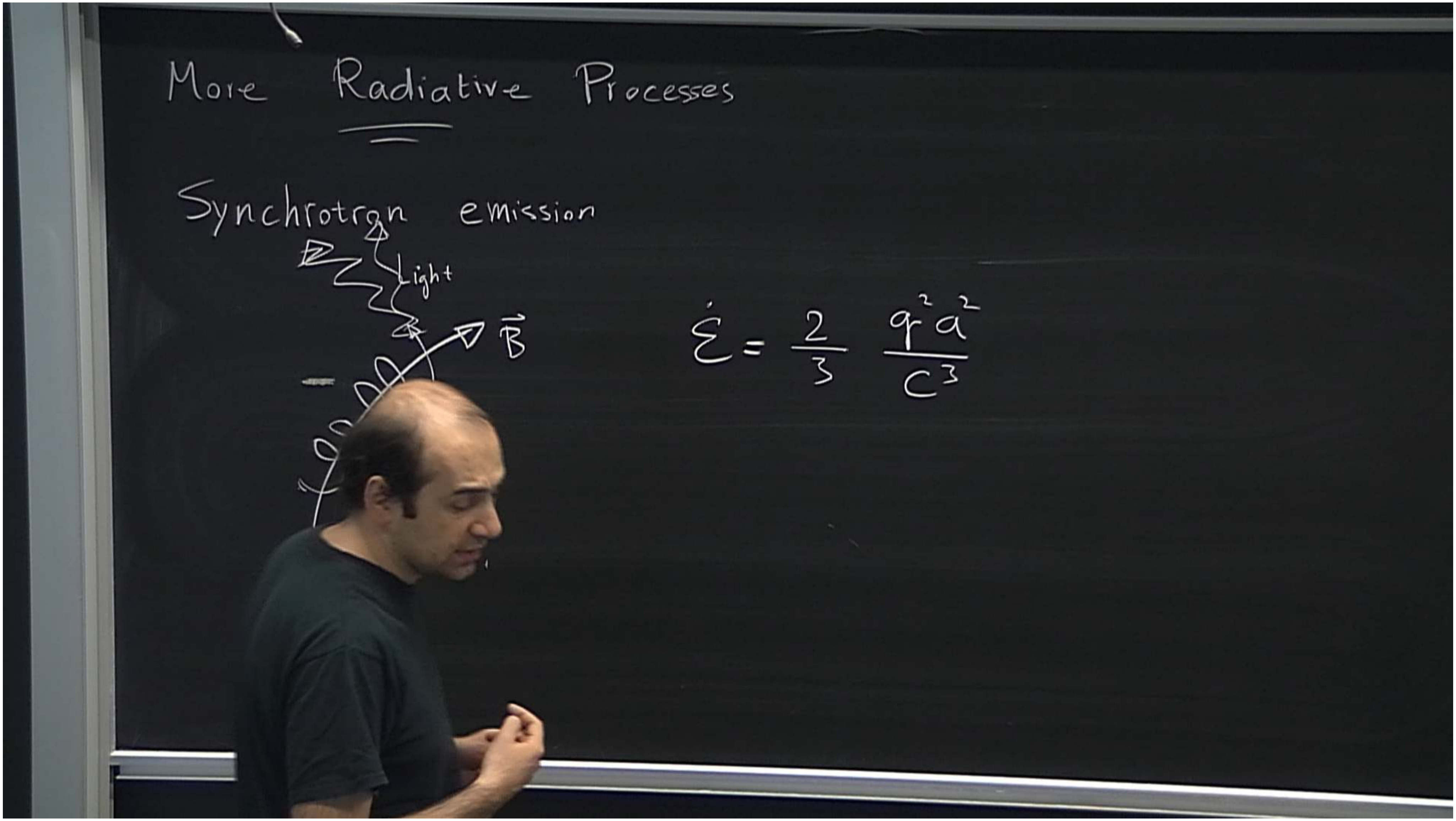
More Radiative Processes

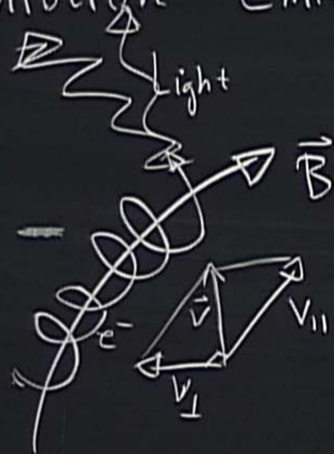
Synchrotron emission




More Radiative Processes
Synchrotron emission
Light
$\vec{B}$
$\dot{\mathcal{E}} = \frac{2}{3}\frac{q^2a^2}{c^3}$

More Radiative Processes

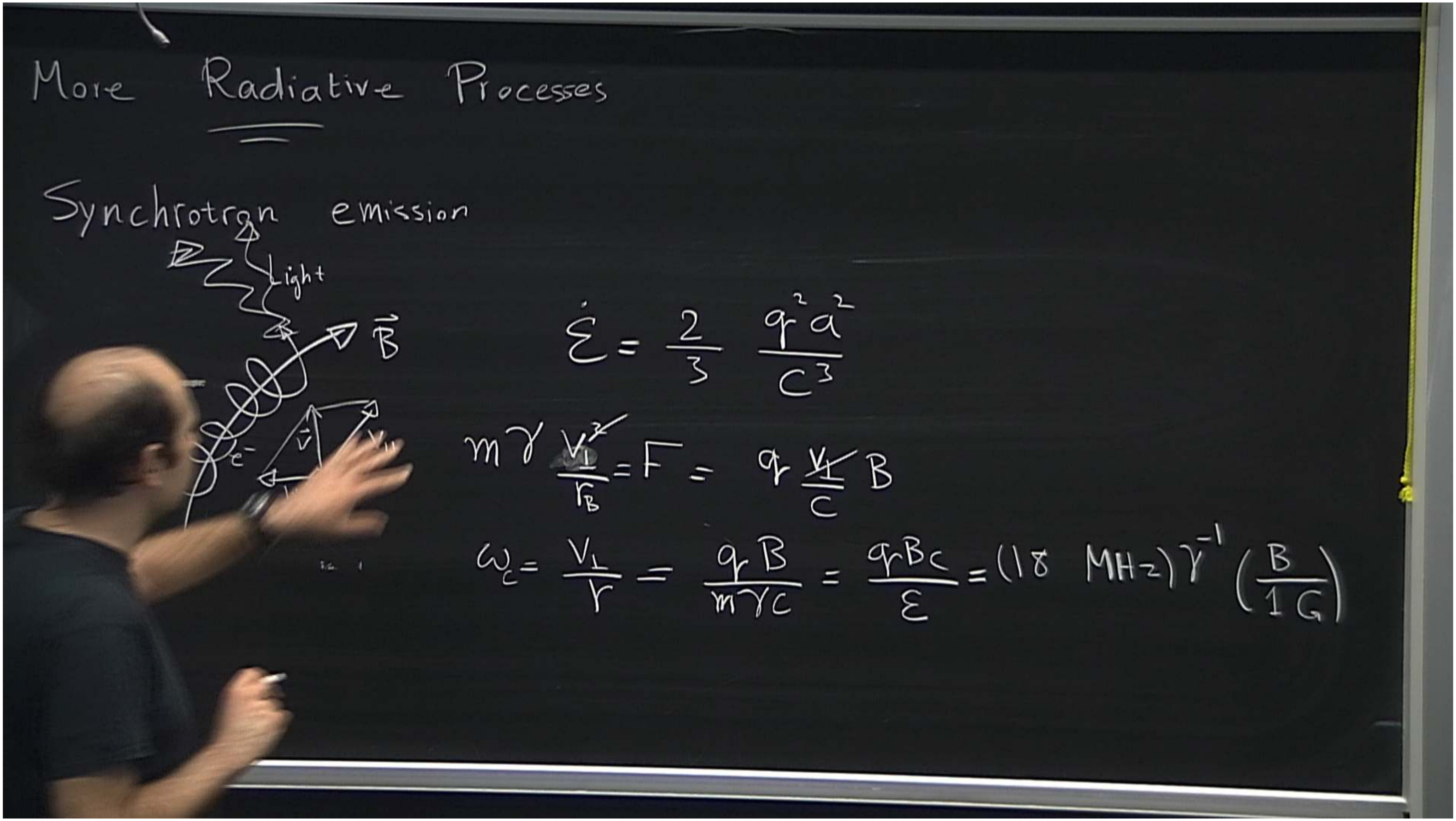
Synchrotron emission



$$\dot{\mathcal{E}} = \frac{2}{3}\,\frac{q^2 a^2}{c^3}$$

$$m\gamma\,\frac{v_{\perp}^2}{r_B} = F = q\,\frac{v_{\perp}}{c}\,B$$

$$\omega_c = \frac{v_{\perp}}{r} = \frac{qB}{m\gamma c} = \frac{qBc}{\mathcal{E}}$$


More Radiative Processes
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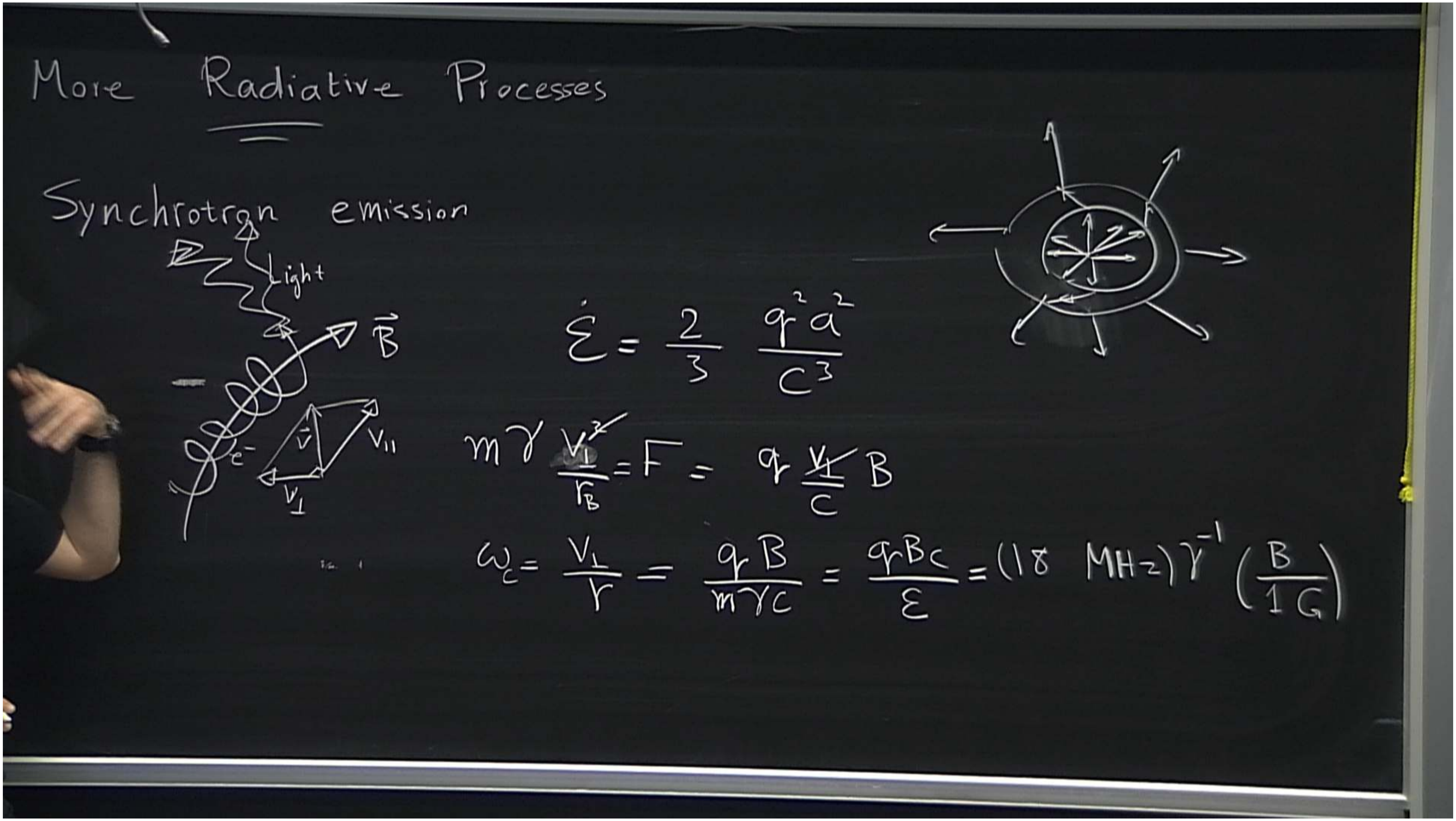
More Radiative Processes
Synchrotron emission
Light
$\vec{B}$
e^-
$\vec{v}$
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More Radiative Processes

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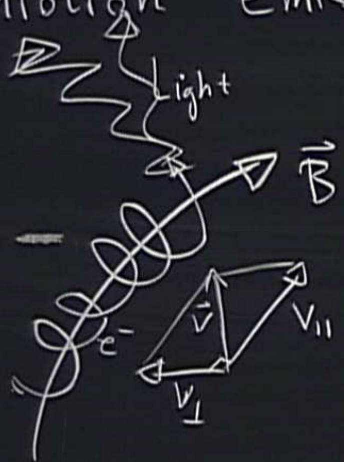

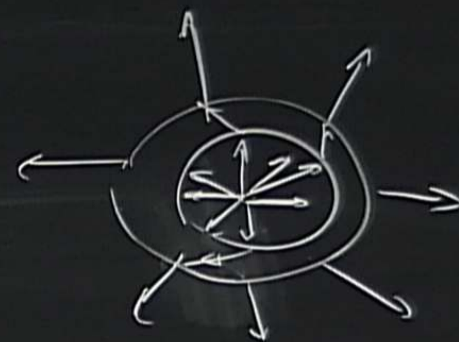

$$\dot{\mathcal{E}} = \frac{2}{3}\frac{q^2 a^2}{c^3}$$

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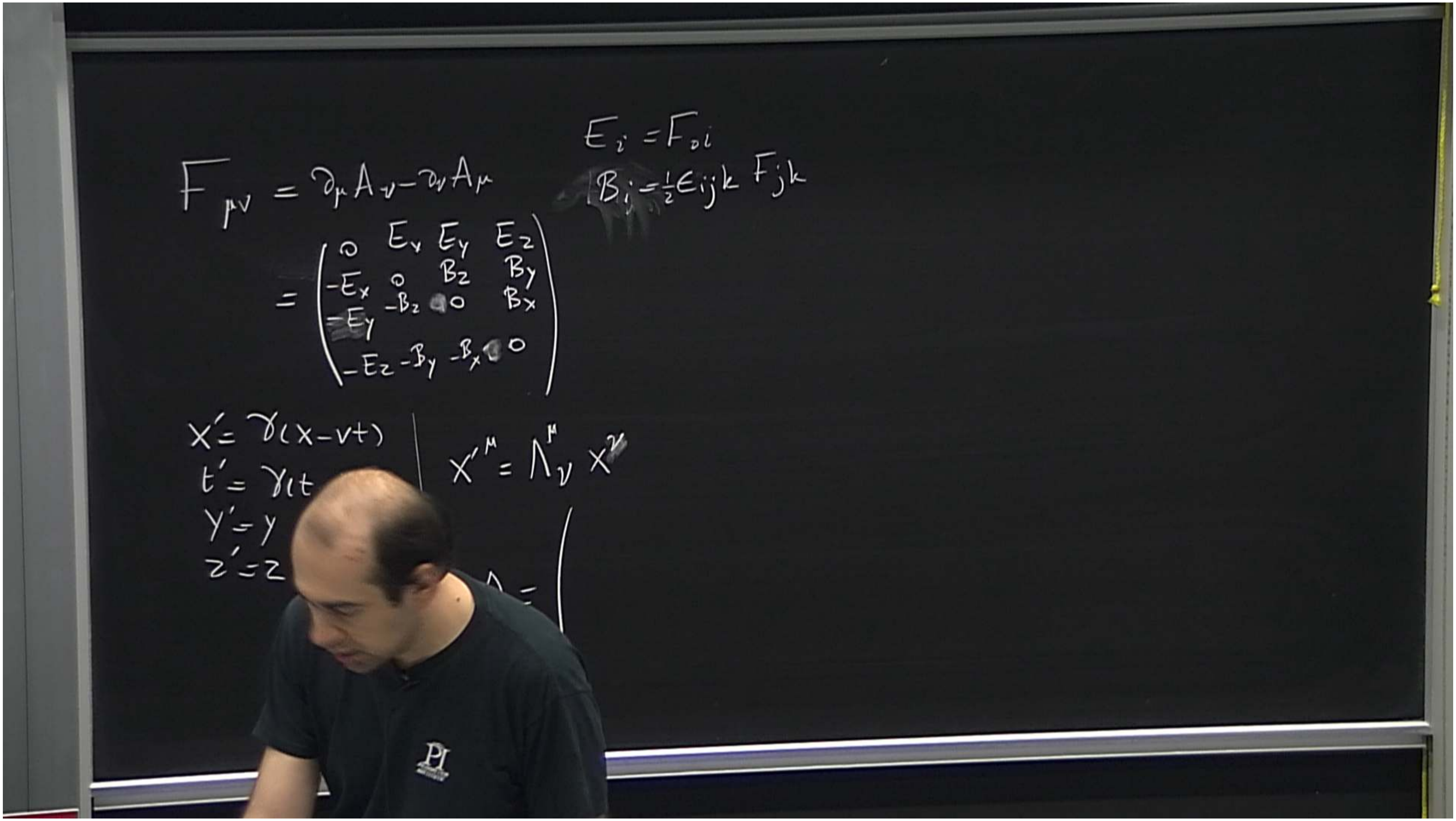
$E_i = F_{0i}$
$B_i = \frac{1}{2}\epsilon_{ijk} F_{jk}$
$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$
$= \begin{pmatrix} 0 & E_x & E_y & E_z \\ -E_x & 0 & B_z & B_y \\ -E_y & -B_z & 0 & B_x \\ -E_z & -B_y & -B_x & 0 \end{pmatrix}$
$x' = \gamma(x - vt)$
$t' = \gamma(t$
$y' = y$
$z' = z$
$x'^\mu = \Lambda^\mu{}_\nu x^\nu$
$\Lambda =$

$$E_i = F_{0i}$$

$$B_i = \frac{1}{2}\epsilon_{ijk} F_{jk}$$

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu = \begin{pmatrix} 0 & E_x & E_y & E_z \\ -E_x & 0 & B_z & B_y \\ -E_y & -B_z & 0 & B_x \\ -E_z & -B_y & -B_x & 0 \end{pmatrix}$$

$$F'^{\alpha\beta} = \Lambda^{\alpha}{}_{\mu} \Lambda^{\beta}{}_{\nu} F^{\mu\nu}$$

$$\left.\begin{aligned} x' &= \gamma(x+vt) \\ t' &= \gamma(t+vx) \\ y' &= y \\ z' &= z \end{aligned}\right\} \quad x'^{\mu} = \Lambda^{\mu}{}_{\nu} x^{\nu}$$

$$\Lambda = \begin{pmatrix} \gamma & \gamma v & 0 & 0 \\ \gamma v & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

$$= \begin{pmatrix} 0 & E_x & E_y & E_z \\ -E_x & 0 & B_z & B_y \\ -E_y & -B_z & 0 & B_x \\ -E_z & -B_y & -B_x & 0 \end{pmatrix}$$

$$E_i = F_{0i}$$

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$$\Lambda F \Lambda = \begin{pmatrix} \gamma & \gamma v & 0 & 0 \\ \gamma v & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & B & 0 \\ 0 & -B & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} \gamma & \gamma v & 0 & 0 \\ \gamma v & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$\vec{F} = q\left(\vec{E} + \cancel{\frac{\vec{v}}{c}} \times \vec{B}\right)$$

$$\vec{a}' = \frac{q\gamma v_\perp \vec{B}}{mc}$$

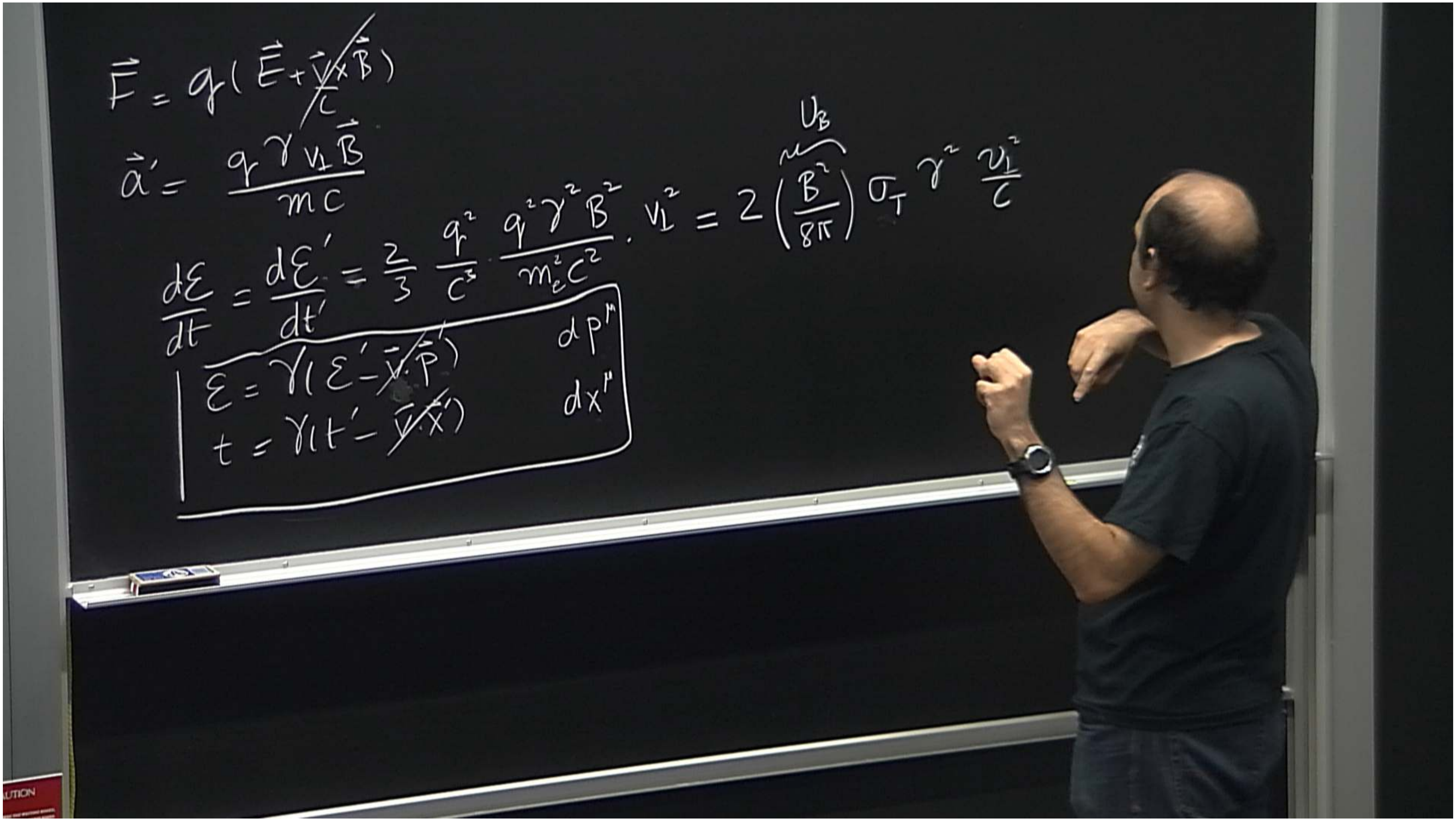
$$\frac{d\mathcal{E}}{dt} = \frac{d\mathcal{E}'}{dt'}$$

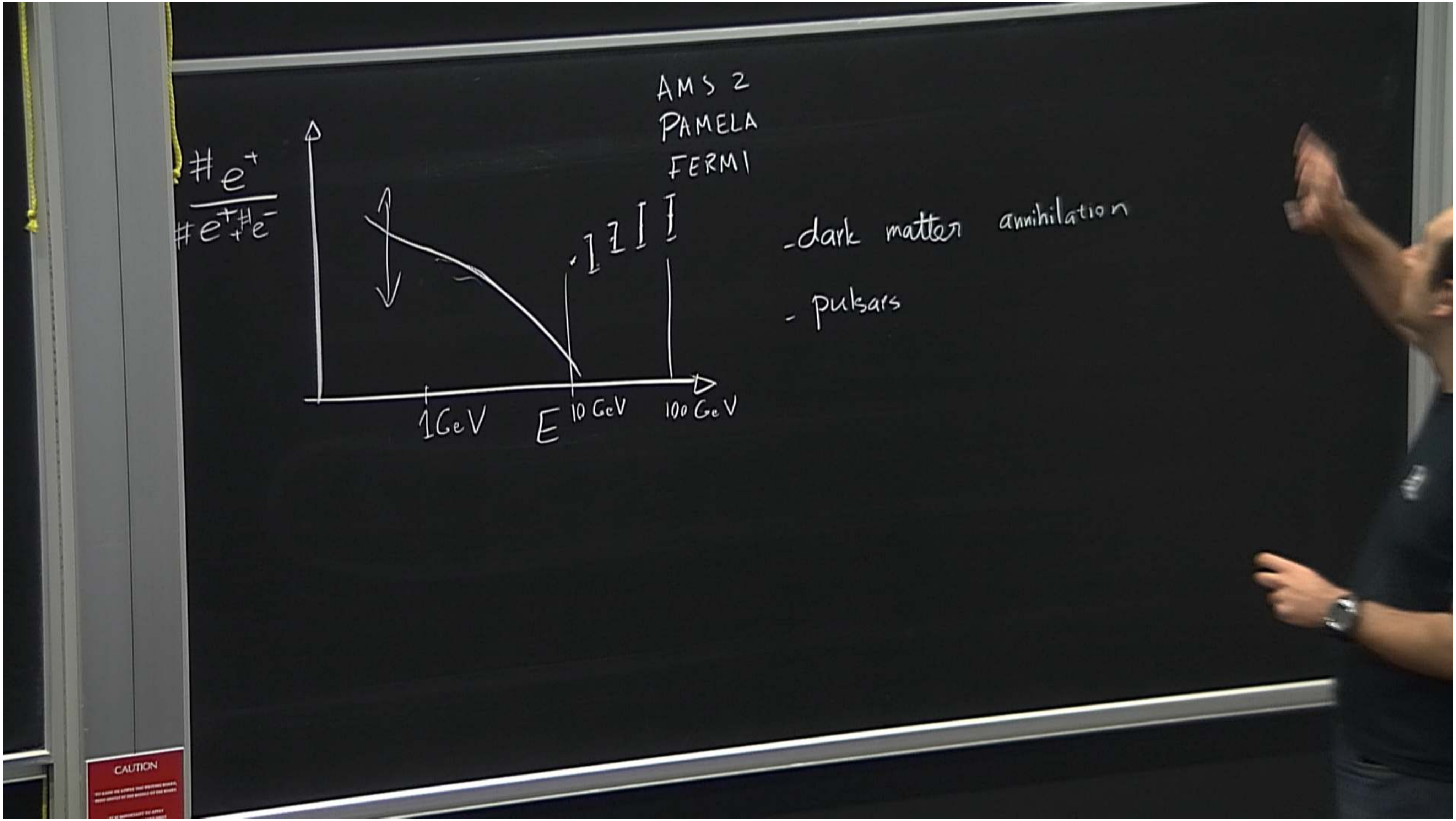
$$\mathcal{E} = \gamma(\mathcal{E}' - \cancel{\vec{v}\cdot\vec{p}'})$$

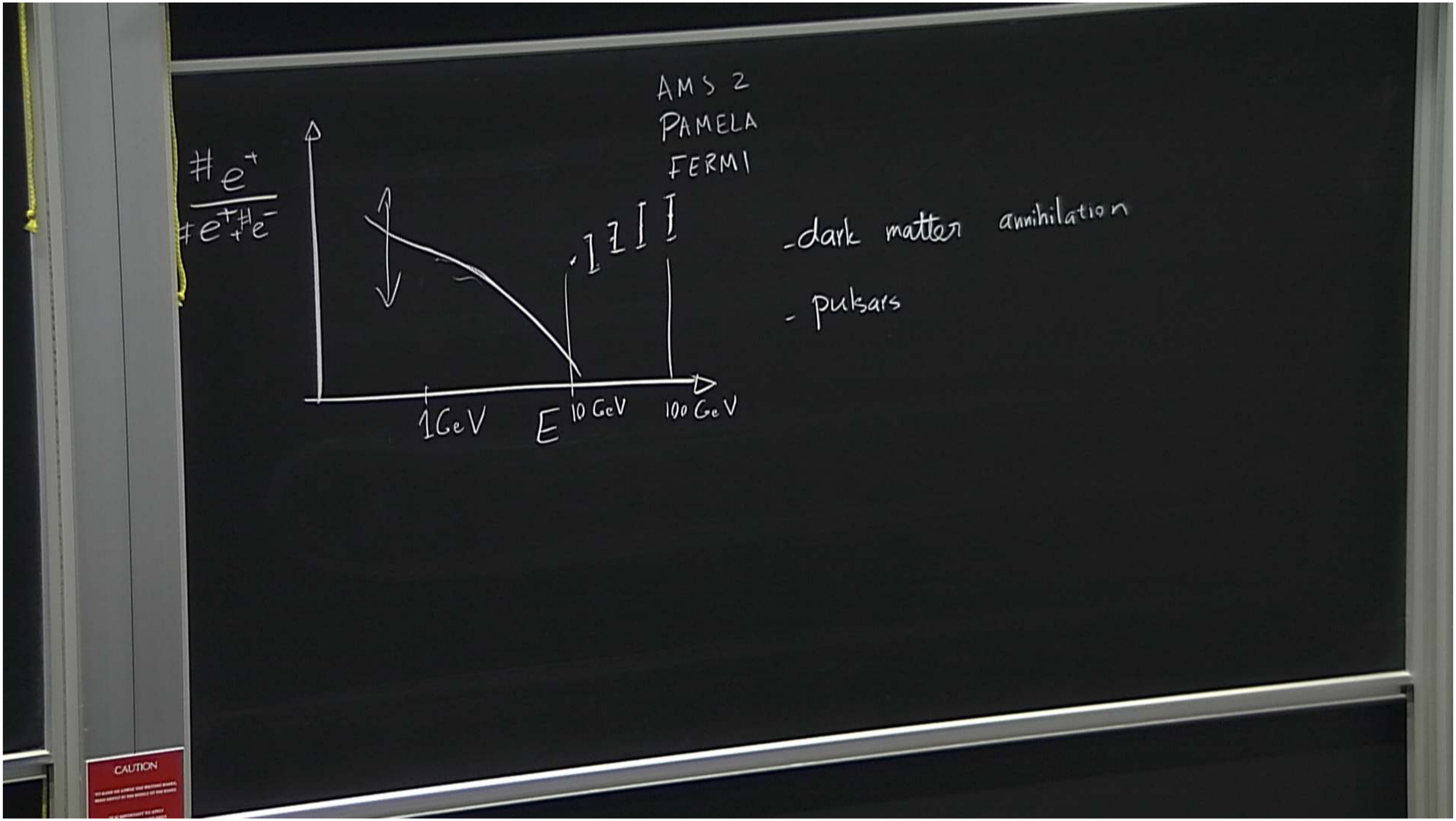
$$t = \gamma(t' - \cancel{\vec{v}\cdot\vec{x}'})$$

$$dp^\mu$$

$$dx^\mu$$


$\vec{F} = q(\vec{E} + \cancel{\frac{\vec{v}}{c}\times\vec{B}})$
$\vec{a}' = \frac{q\gamma v_\perp \vec{B}}{mc}$
$\frac{d\mathcal{E}}{dt} = \frac{d\mathcal{E}'}{dt'} = \frac{2}{3}\frac{q^2}{c^3}\cdot\frac{q^2\gamma^2B^2}{m_e^2c^2}\cdot v_\perp^2 = 2\underbrace{\left(\frac{B^2}{8\pi}\right)}_{U_B}\sigma_T\gamma^2\frac{v_\perp^2}{c}$
$\mathcal{E} = \gamma(\mathcal{E}' - \cancel{\vec{v}\cdot\vec{p}'})$ dp^μ
$t = \gamma(t' - \cancel{\vec{v}\cdot x'})$ dx^μ


AMS 2
PAMELA
FERMI
$\frac{\# e^+}{\# e^+ + \# e^-}$
1GeV
E
10 GeV
100 GeV
- dark matter annihilation
- pulsars
CAUTION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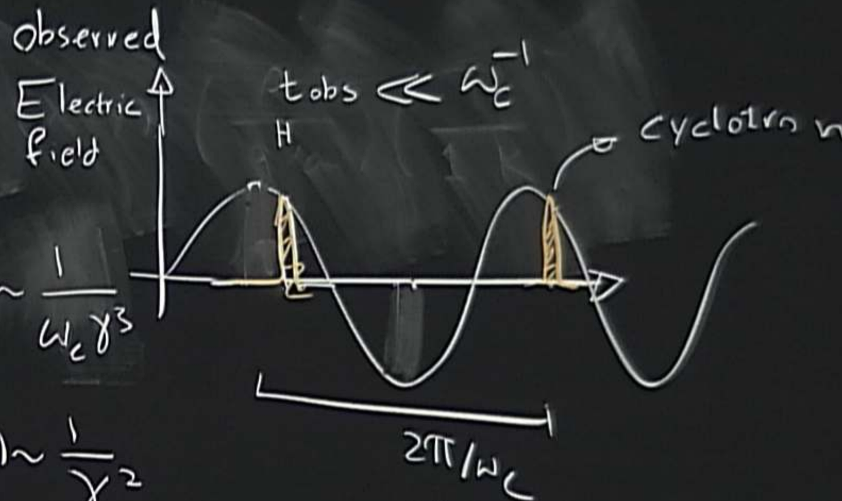
CAUTION

$$\theta \sim \frac{1}{\gamma} = \frac{mc^2}{\mathcal{E}}$$



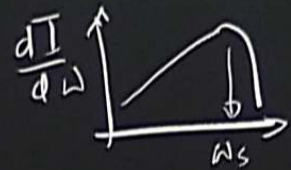
$$t_{obs} = \frac{\theta}{\omega}\left(1-\frac{v}{c}\right) \sim \frac{\theta}{\omega_c \gamma^2} \sim \frac{1}{\omega_c \gamma^3}$$

$$\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \approx \frac{1}{\sqrt{\left(1-\frac{v}{c}\right)\times 2}} \Rightarrow \left(1-\frac{v}{c}\right) \sim \frac{1}{\gamma^2}$$

$$\omega_{sync.} \sim \frac{1}{t_{obs}} \sim \gamma^3 \omega_c;$$

pitch angle

$$\omega_s = \frac{3}{2}\left(\frac{qB\sin\alpha}{mc}\right)\gamma^2 \sim 10^2\ \mathrm{MHz} = B(\mu G)\ \mathcal{E}^2(Ge$$



$$\frac{dI}{d\omega} = \frac{\sqrt{3}\, q^3 B}{2\pi m c^2} F\left(\frac{\omega}{\omega_s}\right)$$

$$F(\xi) = \xi \int_{\xi}^{\infty} K_{5/3}(z)\, dz$$

Bessel function

$$n(\mathcal{E}_e)\, d\mathcal{E}_e \propto \mathcal{E}_e^{-p}\, d\mathcal{E}_e$$

$$P_{tot}(\omega) \propto \omega^{-s}\, B^{1+s} \qquad p = 2s+1$$

self-abserption : $\alpha_\nu \propto \omega^{-\frac{1}{2}(p+4)}$