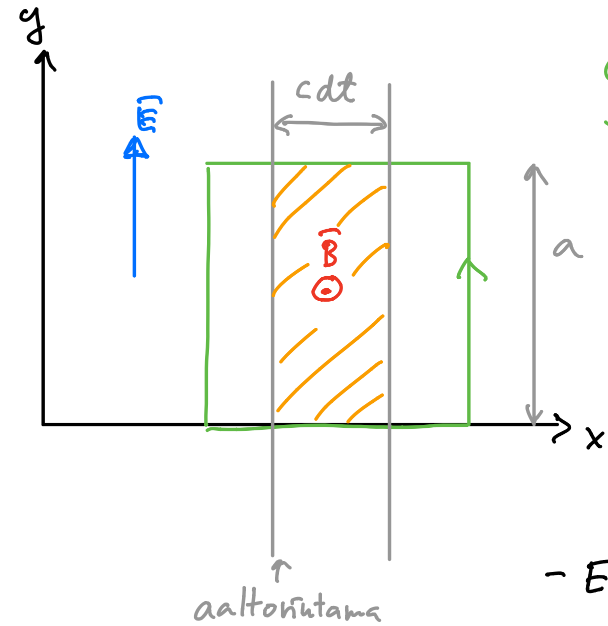


Faradayn laki

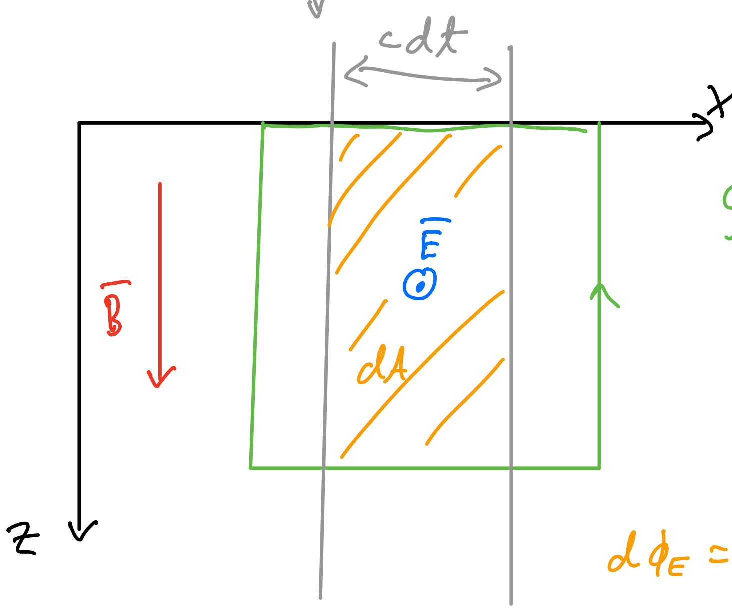
[s. 11]

$$\oint \bar{E}\cdot d\bar{l} = -Ea$$

$$= -\frac{d\phi_B}{dt}$$

$$\frac{d\phi_B}{dt} = B\frac{dA}{dt} = B\frac{acdt}{dt}$$

$$-Ea = -Bac \Rightarrow \boxed{E = cB}$$



Ampèren laki

[s. 12]

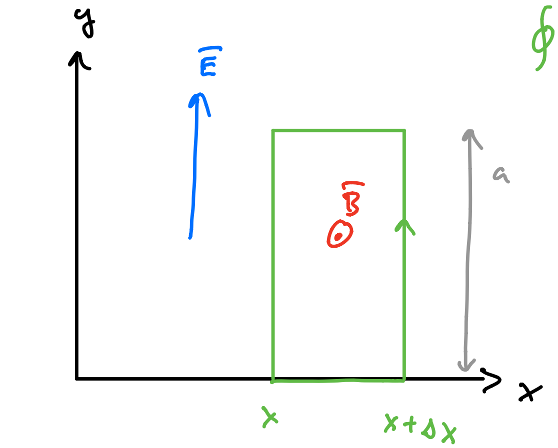
$$\oint \bar{B}\cdot d\bar{l} = Ba$$

$$= \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$$

$$d\phi_E = E\,dA = Eacdt$$

$$Ba = \mu_0\varepsilon_0 Eac \Rightarrow \boxed{B = \mu_0\varepsilon_0 c E}$$

$$\Rightarrow \boxed{c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}}$$



[s. 15]

$$\oint \bar{E}\cdot d\bar{l} = -E_y(x,t)\,a + E_y(x+\Delta x,t)\,a$$

$$= -\frac{d\phi_B}{dt} = -\frac{\partial B_z(x,t)}{\partial t}\,a\,\Delta x$$

$$\Rightarrow \frac{E_y(x+\Delta x,t) - E_y(x,t)}{\Delta x} = -\frac{\partial B_z(x,t)}{\partial t}$$

$$\xrightarrow{\Delta x\to 0} \boxed{\frac{\partial E_y(x,t)}{\partial x} = -\frac{\partial B_z(x,t)}{\partial t}}$$

Smg aaltoyhtälö $E_y(x,t)$:lle tyhjiössä

$$\boxed{\frac{\partial^2 E_y}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 E_y}{\partial t^2}}$$

Yrite: $E_y = E_+ f(x-ct)$ [s. 18]

$$\frac{\partial^2 E_y}{\partial x^2} = E_+ f''(x-ct)$$

$$\frac{1}{c^2}\frac{\partial^2 E_y}{\partial t^2} = \frac{E_+}{\cancel{c^2}}\cancel{(-c)^2} f''(x-ct) = \frac{\partial^2 E_y}{\partial x^2} \qquad \text{OK.}$$

$$\bar{S} = \frac{1}{\mu_0} \bar{E} \times \bar{B} = \frac{1}{\mu_0} \hat{j} E_{max} \cos(kx - \omega t) \times \hat{k} B_{max} \cos(kx - \omega t)$$

$$= \hat{i} \frac{E_{max} B_{max}}{\mu_0} \underbrace{\cos^2(kx - \omega t)}_{\frac{1}{2}(1 + \cos(2kx - 2\omega t))} \qquad [s. 26]$$

Luentodemo (s. 36)

1. Sijoitetaan annettu yrite $E_y(x,t) = E_0 e^{-k_c x} \cos(k_c x - \omega t)$ yhtälöön:

$$\frac{\partial E_y}{\partial x} = E_0 (-k_c) e^{-k_c x} \cos(k_c x - \omega t) + E_0 e^{-k_c x} (-k_c) \sin(k_c x - \omega t)$$

$$= -k_c E_0 e^{-k_c x} [\cos(\dots) + \sin(\dots)]$$

$$\frac{\partial^2 E_y}{\partial x^2} = (-k_c)^2 E_0 e^{-k_c x} [\cos(\dots) + \sin(\dots)]$$

$$- k_c E_0 e^{-k_c x} [-k_c \sin(\dots) + k_c \cos(\dots)]$$

$$= E_0 k_c^2 e^{-k_c x} 2 \sin(k_c x - \omega t)$$

$$= \frac{\mu}{\rho} \frac{\partial E_y}{\partial t} = \frac{\mu}{\rho} E_0 e^{-k_c x} \omega \sin(k_c x - \omega t)$$

$$\Rightarrow \quad 2 k_c^2 = \frac{\omega \mu}{\rho} \quad \Rightarrow \quad \boxed{k_c = \overset{+}{(-)} \sqrt{\frac{\omega \mu}{2 \rho}}}$$

(yhtälö toteutuu, kun valitaan k_c näin.)

2. Johtavassa aineessa energia muuttuu lämmöksi i^2R-häviöiden takia $\Rightarrow$ Aallon amplitudi pienenee eksponentiaalisesti.

3. Amplitudi tekijä $e^{-k_c x} = e^{-1}$, $x = \delta$

$$\Rightarrow \delta = \frac{1}{k_c} = \sqrt{\frac{2S}{\omega\mu}} \approx \underline{\underline{1{,}33\,\mu m}}$$