Coulombs lov

$$\vec{E} = \frac{Q}{4\pi\epsilon_0}\frac{\hat{R}}{R^2}$$

⇓

Gauss lov

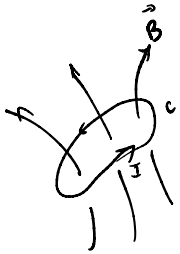
$$\oint_S \vec{E}\cdot d\vec{S} = \frac{Q_{in}}{\epsilon_0}$$

symmetri

$$\nabla\cdot\vec{E} = \frac{\rho}{\epsilon_0}$$

Biot-Savarts lov

$$\vec{B} = \oint_C \frac{\mu_0}{4\pi}\frac{I d\vec{l}\times\hat{R}}{R^2}$$



⇓

Amperes lov

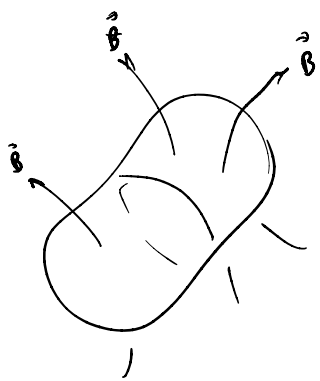
$$\oint_C \vec{B}\cdot d\vec{l} = \mu_0 I_c$$



Gaus lov $\vec{B}$-felt?

$$\oint_S \vec{B}\cdot d\vec{S} = 0$$

$$\nabla\cdot\vec{B} = 0$$



TEST

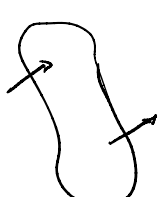
Kan disse være magnetfelt?

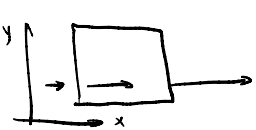
a) $\vec{B} = B_0\hat{x}$

b) $\vec{B} = \frac{B_0}{a}\times\hat{x}$

c) $\vec{B} = (-y,x)\frac{B_0}{a}$

d) $\vec{B} = (x,y)\frac{B_0}{a}$



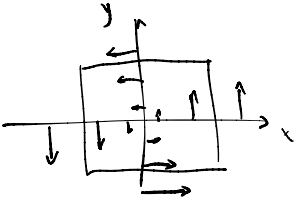


a) $\nabla\cdot\vec{B} = \frac{\partial B_0}{\partial x} + \frac{\partial 0}{\partial y} + \frac{\partial 0}{\partial z} = 0$

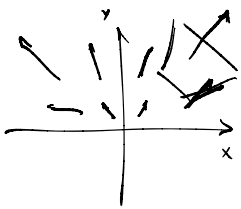
b) $\nabla\cdot\vec{B} = \frac{\partial\left(\frac{B_0 x}{a}\right)}{\partial x} + \dots = \frac{B_0}{a}$

c) $\vec{B} = (z, y, x)\,\frac{B_0}{a}$

$\nabla \cdot \vec{B} = \frac{B_0}{a}(0+0+0)$

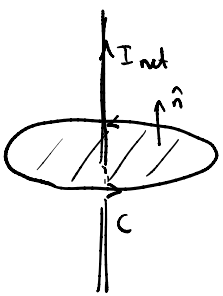


d) $\vec{B} = (x, y)\,\frac{B_0}{a}$



Ampere lov

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I_{net}$$



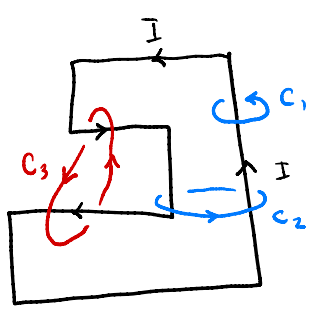
- C må vere lukket
- I_{net} : netto strøm

$$I_{net} = \int_S \vec{J} \cdot d\vec{S}$$

Stokes teorem

$$\oint_C \vec{B} \cdot d\vec{l} = \int_S \nabla \times \vec{B} \cdot d\vec{S} = \int_S \mu_0 \vec{J} \cdot d\vec{S} \qquad \nabla \times \vec{B} = \mu_0 \vec{J}$$

TEST



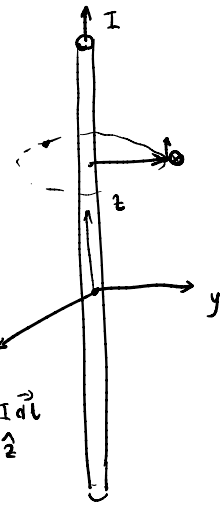
I_1

I_2

I_3

Ampers lov:

$$\oint_C \vec{B} \cdot d\vec{l} = \mu_0 I$$



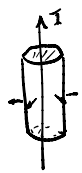
Symmetri-betraktning

$$\vec{B} = B_r(r,\varphi,z)\hat{r} + B_\varphi(r,\varphi,z)\hat{\varphi} + B_z(r,\varphi,z)\hat{z}$$

$\vec{B}$ er normal på $I d\vec{l}$ dus på $\hat{z}$

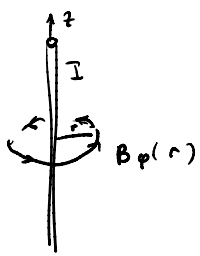
Biot-Savarts lov

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I d\vec{l} \times \hat{R}}{R^2} \Rightarrow B_z = 0$$



Divergensen til $\vec{B}$ er null.

$$\oint_S \vec{B} \cdot d\vec{S} = 0 \Rightarrow B_r = 0$$



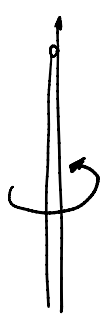
Ampers lov

velger lur kurve C

$$\oint_C \vec{B} \cdot d\vec{l} = \oint_C B_\varphi(r)\, dl = B_\varphi(r) \oint_C dl$$

$$= B_\varphi(r) \cdot 2\pi r = \mu_0 I$$

$$B_\varphi(r) = \frac{\mu_0 I}{2\pi r}$$



Polarisering

$\vec{E} \longrightarrow \vec{P}$

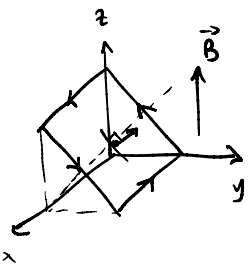


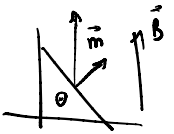
Magnetisering





TEST





$\vec{\tau}$

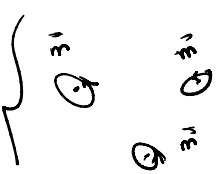
$\Sigma \vec{F} = 0$

$\vec{F} = Q\vec{v} \times \vec{B}$

$d\vec{F} = Id\vec{l} \times \vec{B}$

$\vec{\tau} = \vec{m} \times \vec{B}$, $\vec{m} = I\vec{S}$

$\vec{M}$: magnetisering $\Leftarrow$



Elektrisk felt

$\oint \vec{E} \cdot d\vec{S} = \frac{Q}{\epsilon_0}$

$\Downarrow$

$\oint \vec{D} \cdot d\vec{S} = \frac{Q_{fri}}{\epsilon_0}$

$\epsilon \vec{E} = \vec{D}$ $(\epsilon_0 \vec{E} + \vec{P})$?

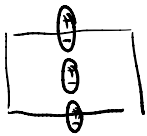
Magnetisk systemer

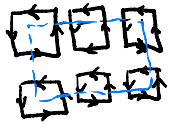
$\oint \vec{B} \cdot d\vec{l} = \mu_0 I$

$\oint \vec{H} \cdot d\vec{l} = I_{fri}$

$\vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M}$

Bundne strømmer





$$I_{b,c} = \int_S \nabla \times \vec{M} \cdot d\vec{S} = \int_S \vec{J}_b \cdot d\vec{S}$$

$$\vec{J}_B = \nabla \times \vec{M}$$

Magnetiske materialer

$$\vec{M} = \chi_m \vec{H} \quad \text{(For lineær materialer)}$$

$$\vec{B} = \mu_0(\vec{H} + \vec{M}) = \mu_0(1 + \chi_m)\vec{H} = \mu_0 \mu_r \vec{H}$$

Diamagnetiske : $\mu_r < 1$

Paramagnetiske : $\mu_r > 1$

Ferromagnetiske : $\mu_r >> 1$