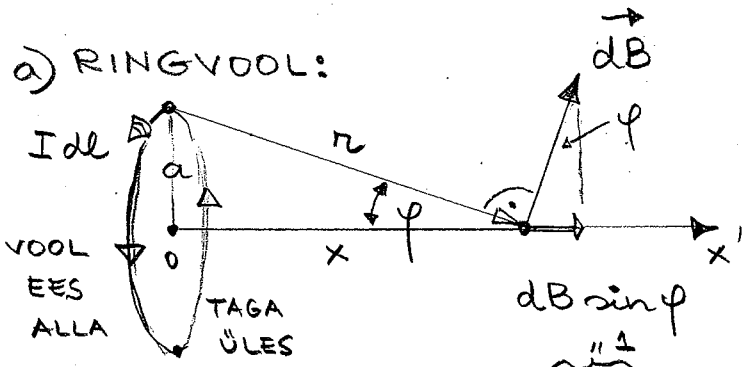
MAGNETVÄLJA VEKTORIAALNE SUPERPOSITSIOON

a) RINGVOOL:



VAAKUM: ($\mu = 1$)

BIOT'-SAVART': $dB = \frac{\mu_0 I\, dl \sin\theta}{4\pi r^2}$

$$B_x(x) = \oint_{\text{ÜLE RINGJUHTME}} \frac{\mu_0 I\, dl \sin\theta \sin\varphi}{4\pi r^2} = \frac{\mu_0 I}{4\pi r^2} \oint_{2\pi a} dl \underbrace{\frac{a}{r}}_{\sin\varphi} =$$

($\sin\theta = 1$)

$$= \frac{\mu_0 I}{4\pi r^2} 2\pi a \cdot \frac{a}{r} = \frac{\mu_0 I a^2}{2r^3} = \frac{\mu_0 I a^2}{2(a^2+x^2)^{3/2}} \quad (*)$$

RINGI TSENTRIS ($x=0$, $a=r$):

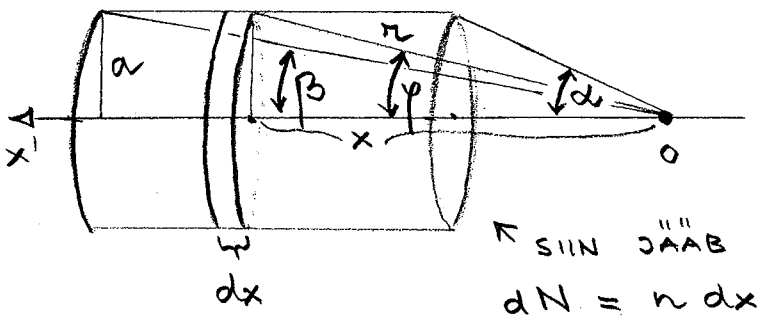
$$B(0) = \frac{\mu_0 I a^2}{2a^3} = \frac{\mu_0 I}{2a}$$

Aines: $B = \mu_0 \mu \frac{I}{2a}$

ja $H = \frac{1}{\mu_0 \mu} B = \frac{I}{2a}$

(H ÜHIKU $1 \triangleq \frac{A}{m}$ DEF.)

b) SOLENOID: N JUHTMEKEERDU



↖ SIIN JÄÄB VAHEMIKKU dx

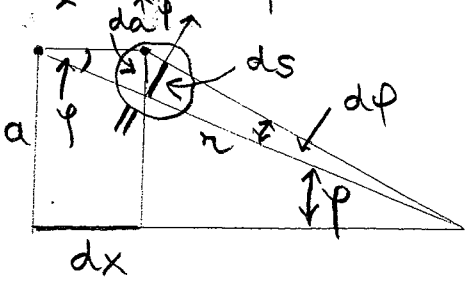
ISELOOMUSTAB KEERDUDE TIHEDUS: $n = \frac{N}{\ell}$ (KEERDUDE ARV / PIKKUS)

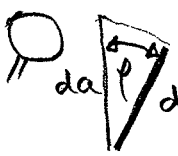
$dN = n\,dx$ KEERDU, MIS TEKITAVAD

$$dB = \frac{\mu_0 n dx\, I a^2}{2r^3}$$ PUNKTIS 0

$\frac{a}{x} = \tan\varphi$; $x = \frac{a}{\tan\varphi}$

VAJA LEIDA $\frac{dx}{d\varphi} = \frac{d}{d\varphi} \underbrace{\cot\varphi}_{x/a} \cdot a$





$ds = r\,d\varphi$; $\cos\varphi = \frac{ds}{da}$

$\tan\varphi = \frac{da}{dx} = \frac{a}{x}$ $\quad r\,d\varphi = da\cos\varphi = \frac{a}{x} dx \cos\varphi = dx \sin\varphi$

$$d(\cot\varphi) = \frac{dx}{a} = -\frac{r\,d\varphi}{\underbrace{\sin\varphi}_{dx}\, a} = -\frac{d\varphi}{\sin\varphi \underbrace{\frac{a}{r}}_{\sin\varphi}} = -\frac{d\varphi}{\sin^2\varphi}$$

kui $dx > 0$, siis $d\varphi < 0$

$$dB = \frac{1}{2}\mu_0 nI\left(-\frac{1}{\sin^2\varphi}\right)\underbrace{\frac{a^3}{r^3}}_{\sin^3\varphi}\,d\varphi = -\frac{1}{2}\mu_0 nI\sin\varphi\,d\varphi$$

JA

$$B = \int_\alpha^\beta \underbrace{\left(-\frac{1}{2}\mu_0 nI\right)}_{\text{KONSTANT}}\sin\varphi\,d\varphi = \frac{1}{2}\mu_0 nI\left(\cos\beta - \cos\alpha\right)$$

$$\int(-\sin\varphi)\,d\varphi = \cos\varphi$$

KUI ON PIKK JA PEENIKE SOLENOID, $(a \ll \ell)$, SIIS SOLENOIDI SEES $\beta \to 0$ ja $\alpha \to \pi$, seega

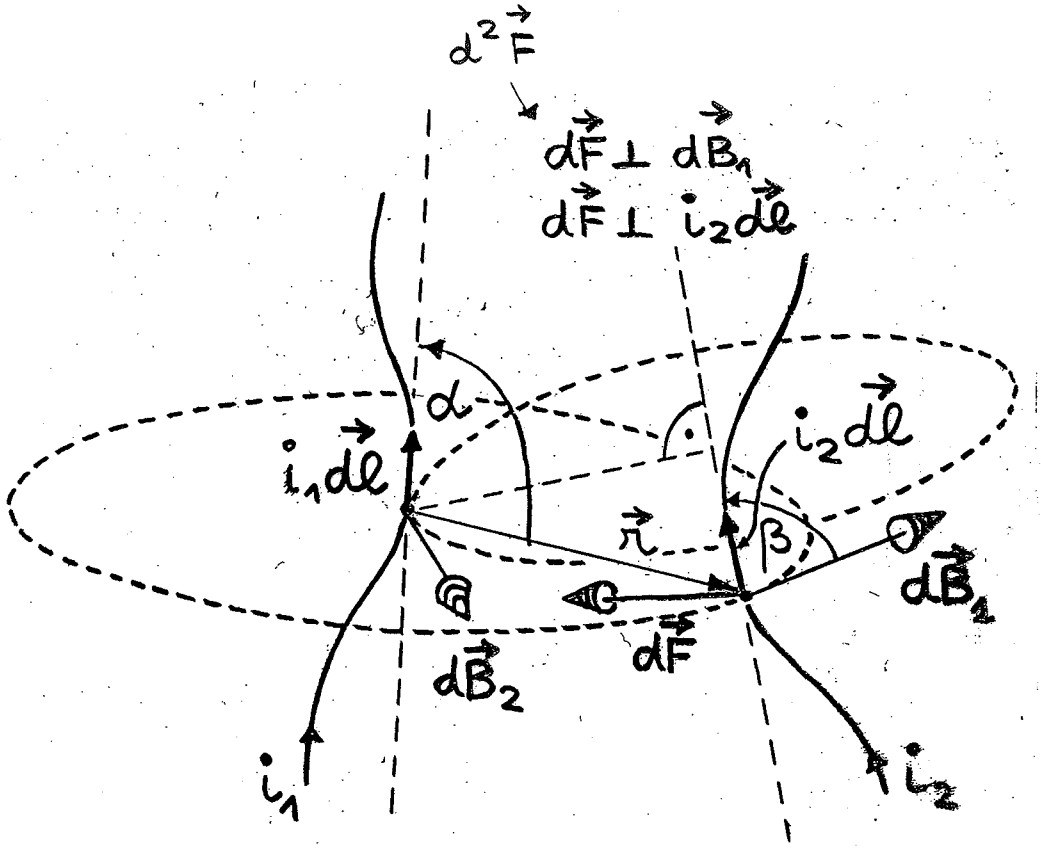
$$B_{SOL.} = \frac{1}{2}\mu_0 nI\left[\cos 0 - \underbrace{\cos\pi}_{-1}\right] = \mu_0 nI$$

$1+1=2$

AINES

$$B_{SOL} = \mu\mu_0 nI$$

JA $H_{SOL} = nI$



BIOT'-SAVART'

$$dB_1 = \frac{\mu\mu_0}{4\pi}\frac{i_1 d\ell}{r^2}\sin\alpha \quad \text{(B.-S.!)}$$

$$d^2F = dB_1 \cdot i_2 d\ell \sin\beta \quad \text{(Ampére)}$$