Magnetické pole

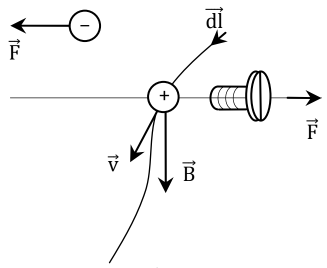
$$\vec{D} = \varepsilon_0.\varepsilon_r.\vec{E}; \quad \vec{F} = \frac{1}{4\pi\varepsilon}.\frac{Q_1.Q_2}{r^2}; \quad \oiint \vec{D}.\overrightarrow{dS} = Q; \quad \mathrm{div}\vec{D} = \rho; \quad \vec{E} = \frac{1}{4\pi\varepsilon}.\frac{Q}{r^2}.\overrightarrow{r_0}$$

$$\vec{B} = \mu_0\mu_r.\vec{H} \qquad \oiint \vec{B}.\overrightarrow{dS} = 0 \quad \mathrm{div}\vec{B} = 0$$

Lorencova síla

$\vec{F} = Q.\left(\vec{v} \times \vec{B}\right) \quad [B] = T$

$$[B] = \frac{F}{Q.v} = \frac{N}{C.m.s^{-1}} = \frac{kg.m.s^{-2}}{C.m.s^{-1}} = \frac{kg.s^{-2}}{A} = T$$

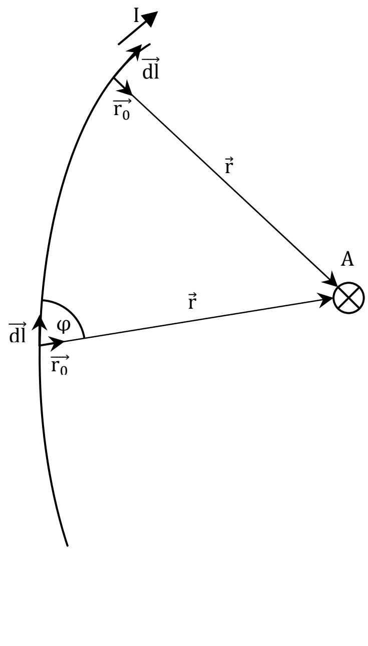


$$dQ.\vec{v} = dQ.\frac{\overrightarrow{dl}}{dt} = \frac{dQ}{dt}.\overrightarrow{dl} = I.\overrightarrow{dl}$$

$$\vec{F} = \int_l I.\left(\overrightarrow{dl} \times \vec{B}\right)$$

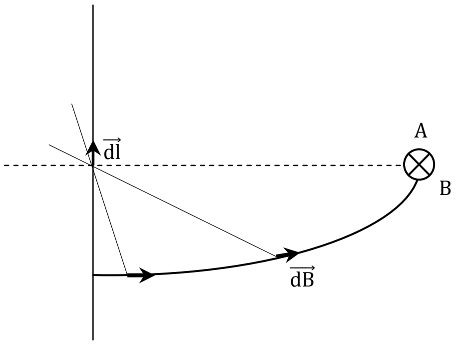
$F = I.l.B$
$F = Q.v.B$ – rovný vodič, I=konst., B homogenní

Biol-Savertův zákon

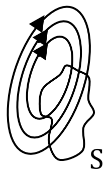


$$\overrightarrow{dB} = \frac{\mu_0}{4\pi}.\frac{I}{r^2}.\overrightarrow{dl} \times \overrightarrow{r_0}$$

$$\left|\overrightarrow{dl} \times \overrightarrow{r_0}\right| = dl.1.\sin\alpha$$



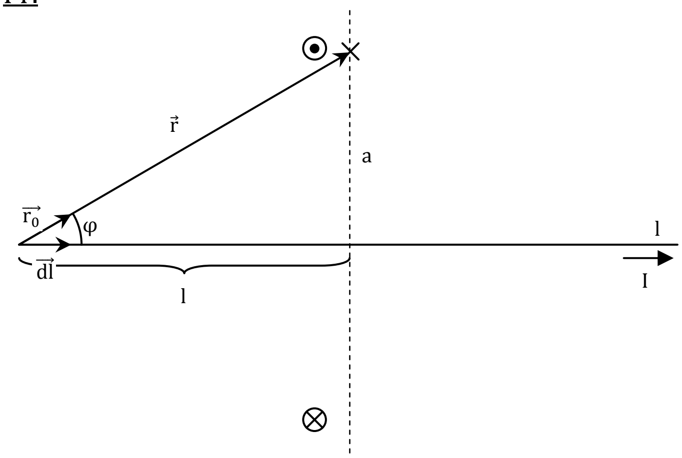
Pravidlo pravé ruky – palec ukazuje směr proudu a prsty pak ukazují směr mag. intenzity



$$\vec{B} = \int_l \vec{dB} = \int_l \frac{\mu_0}{4\pi} . \frac{I}{r^2} . \vec{dl} \times \vec{r_0}$$

$\varepsilon[\mathrm{F.m^{-1}}]$
$\mu[\mathrm{H.m^{-1}}]$

<u>Př.</u>



$$\vec{dB} = \frac{\mu_0}{4\pi} . \frac{I}{r^2} . \vec{dl} \times \vec{r_0}$$

$$\frac{a}{r} = \sin\varphi \Rightarrow r = \frac{a}{\sin\varphi}$$

$$\frac{l}{a} = \mathrm{cotg}\varphi \Rightarrow l = a.\mathrm{cotg}\varphi$$

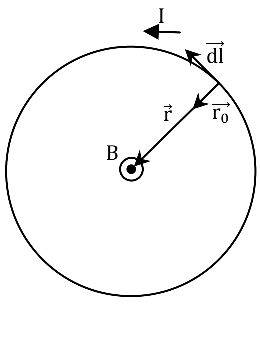
$$dl = a.(\mathrm{cotg}\varphi)'.d\varphi = a.\frac{1}{\sin^2\varphi}.d\varphi$$

$$dB = \frac{\mu_0}{4\pi} . \frac{I}{r^2} . dl.\sin\varphi = \frac{\mu_0}{4\pi} . I.\sin^3\varphi . dl = \frac{\mu_0}{4\pi} . \frac{I.\sin^3\varphi}{a^2} . a.\frac{1}{\sin^2\varphi} . d\varphi = \frac{\mu_0}{4\pi} . \frac{I}{a} . \sin\varphi$$

$$B = \int_l dB = \int_0^\pi \frac{\mu_0}{4\pi} . \frac{I}{a} . \sin\varphi . d\varphi = \frac{\mu_0}{4\pi} . \frac{I}{a} . \int_0^\pi \sin\varphi . d\varphi = \frac{\mu_0}{4\pi} . \frac{I}{a} . [-\cos\varphi]_0^\pi =$$

$$= \frac{\mu_0}{4\pi} . \frac{I}{a} . (-\cos\pi + \cos 0) = \frac{\mu_0}{4\pi} . \frac{I}{a}(1+1) = \boxed{\frac{\mu_0 . I}{2\pi a}}$$

<u>Př.</u>



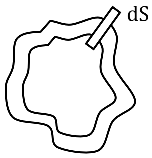
$$\vec{dl} \perp \vec{r_0}$$

$$|\vec{dl} \times \vec{r_0}| = dl.1.\sin\frac{\pi}{2} = dl$$

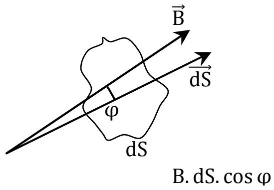
$$dB = \frac{\mu_0}{4\pi} . \frac{I}{r^2} . \vec{dl} \times \vec{r_0} = \frac{\mu_0}{4\pi} . \frac{I}{r^2} . dl$$

$$B = \int_l dB = \frac{\mu_0}{4\pi . r^2} . \int_l dl = \frac{\mu_0}{4\pi . r^2} . 2\pi r = \boxed{\frac{\mu_0 . I}{2.r}}$$

$\iint \vec{D}.\vec{dS} = Q$



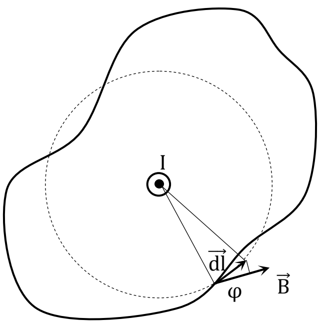
$\iint_S \vec{B}.\vec{dS} = \phi$ [Wb]

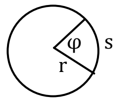


mag. indukční tok

Ampérův zákon

$\oiint_S \vec{D}.\vec{dS} = Q$





$\varphi = \frac{s}{r}$

$d\varphi . r = dl . \cos\varphi$

$$\oint_l \vec{B}.\vec{dl} = \oint_l B.dl.\cos\varphi = \int_0^{2\pi} B.r.\cos\varphi = \int_0^{2\pi} \frac{\mu_0 . I}{2\pi r}.r.d\varphi = \int_0^{2\pi} \frac{\mu_0 . I}{2\pi}.d\varphi = \frac{\mu_0 . I}{2\pi}.\int_0^{2\pi} d\varphi = \frac{\mu_0 . I}{2\pi}.2\pi =$$

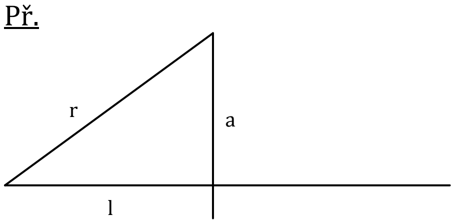
$$= \mu_0 . I \qquad B = \frac{\mu_0 . I}{2\pi r}$$

$$\boxed{\oint_l \vec{B}.\vec{dl} = \mu_0 . I}$$

$\vec{B} = \mu_0 . \mu_r . \vec{H}$

$$\oint_l \mu_0 . \mu_r . \vec{H}.\vec{dl} = \mu_0 . \mu_r . I \Rightarrow \oint \vec{H}.\vec{dl} = I \Rightarrow \oint \vec{H}.\vec{dl} = \sum I -$$ součet proudů v ploše

Př.

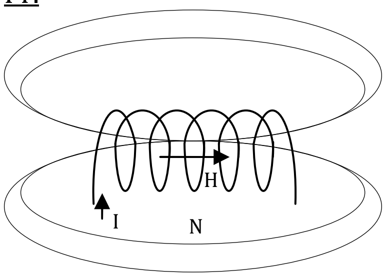


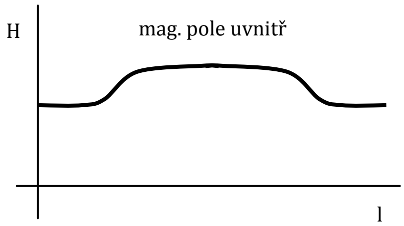
$\vec{H} \parallel \vec{dl} \Rightarrow B = \frac{\mu_0 . I}{2\pi a}$

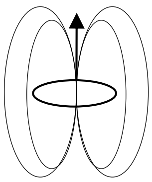
$$I = \oint_l \vec{H}.\vec{dl} = \oint_l H.dl = H.\int_l dl = H.2\pi.a$$

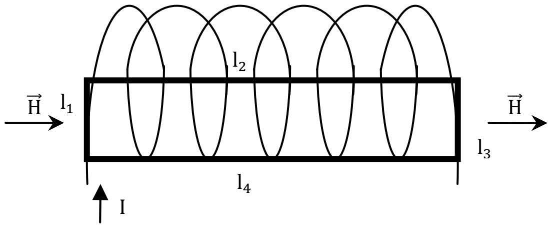
$$I = H.2\pi.a \Rightarrow H = \frac{I}{2\pi.a} \Rightarrow B = \frac{\mu_0.I}{2\pi.a}$$

<u>Př.</u>





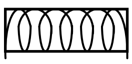




$$N.I = \oint \vec{H}.\vec{dl} =$$

$$= \underbrace{\int_{l_1} \vec{H}.\vec{dl}}_{H.dl.\cos\frac{\pi}{2}=0} + \int_{l_2} \vec{H}.\vec{dl} + \underbrace{\int_{l_3} \vec{H}.\vec{dl}}_{0} +$$

$$+ \underbrace{\int_{l_4} \vec{H}.\vec{dl}}_{0} = H.\int_{l_2} dl = H.l$$



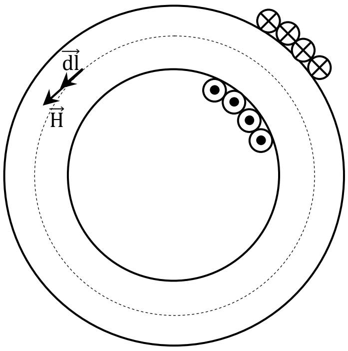
platí pro oblast těsně vedle cívky

$$\oint \vec{H}.\vec{dl} = 0$$

H=0

$$\boxed{H.l = N.I \Rightarrow H = \frac{N.I}{l}}$$

<u>Př.</u> Toroid (anuloid)



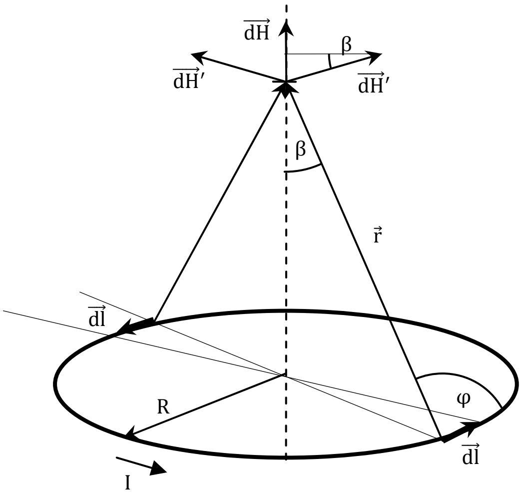
$$\int \vec{H}.\vec{dl} = N.I$$

$$\int H.dl = N.I$$

$$H.\int dl = N.I$$

$$H.2\pi r = N.I \Rightarrow \boxed{H = \frac{N.I}{2\pi r}}$$

Př.



$$\overrightarrow{dH} = \frac{1}{4\pi}.\frac{I}{r^2}.\overrightarrow{dl} \times \overrightarrow{r_0}$$

$$dH' = \frac{I}{4\pi r^2}.dl.1.\sin\alpha$$

$$dH = 2.dH'.\sin\beta$$

$$\sin\beta = \frac{R}{r}$$

$$r = \sqrt{R^2 + Z^2}$$

$$H = \frac{1}{2}.\oint dH = \frac{1}{2}.\oint 2.dH' \sin\beta = \oint dH' \sin\beta = \oint \frac{I}{4\pi r^2}.dl.\sin\beta = \oint \frac{I}{4\pi r^2}.dl.\frac{R}{r} = \oint \frac{R.I}{4\pi r^3}.dl =$$

$$= \oint \frac{R.I}{4\pi.(R^2 + Z^2)^{\frac{3}{2}}}.dl = \frac{R.I}{4\pi(R^2 + Z^2)^{\frac{3}{2}}}.\oint dl = \frac{R.I.2\pi r}{4\pi(R^2 + Z^2)^{\frac{3}{2}}} = \frac{R^2.I}{2.(R^2 + Z^2)^{\frac{3}{2}}}$$