$$\boxed{\begin{aligned} cB_{MKS} &\longleftrightarrow B_{cgs} \\ \varepsilon_0 &\longleftrightarrow \frac{1}{4\pi} \\ \mu_0\varepsilon_0 &\longleftrightarrow \frac{1}{c^2} \end{aligned}}$$

同時に行う.

- **磁場の単位**

直線電流の作る磁場 $B = 2\dfrac{\mu_0}{4\pi} = \dfrac{I}{R}$

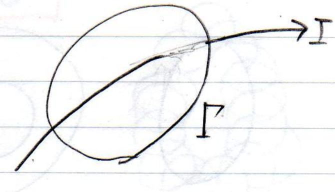
$$\left\{\begin{aligned} [I] &= A \\ [\mu_0] &= NA^2 \end{aligned}\right\} \quad [B] = NA^{-2}\cdot A\,m^{-1} = N/Am \equiv T \text{ (テスラ)}$$

$\boxed{B：磁束密度}$ $(1T = 10^4 \text{ gauss})$

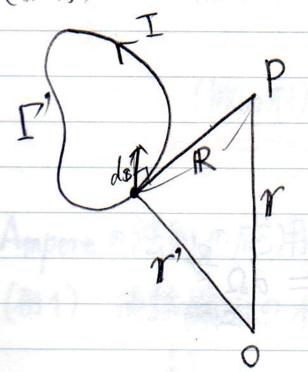
- **アンペールの法則.** (Biot-Savart の法則を一般化する)

$$\boxed{\oint_\Gamma \mathbb{B}\cdot d\mathbb{s} = \mu_0 I}$$

I：閉曲面を貫く電流.



(証明)



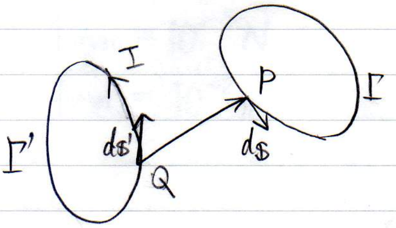
ds' が点Pにつくる磁場

$$d\mathbb{B} = \frac{\mu_0}{4\pi}\frac{I\,d\mathbb{s}'\times\mathbb{R}}{R^3}$$

Γ' により点Pにできる磁場 $\mathbb{B}(\mathbb{r})$

$$\mathbb{B}(\mathbb{r}) = \oint_{\Gamma'上} d\mathbb{B} = \frac{\mu_0}{4\pi}\oint_{\Gamma'}\frac{d\mathbb{s}'\times\mathbb{R}}{R^3}$$

(i) Γ が Γ' を よぎらない場合

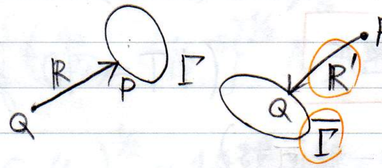


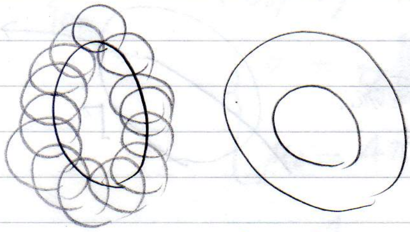
$$\oint_{\Gamma上} \mathbb{B}(r)\cdot ds = \frac{\mu_0}{4\pi}\int_{\Gamma上}\int_{\Gamma'上}\frac{(ds'\times \mathbb{R})\cdot ds}{R^3}$$

$$\left\{\begin{array}{l}(\mathbb{A}\times\mathbb{B})\cdot\mathbb{C} = -(\mathbb{A}\times\mathbb{C})\cdot\mathbb{B} \\ \text{さらに、} \ -\mathbb{R} = \mathbb{R}'\end{array}\right\}$$

$$\oint_{\Gamma} \mathbb{B}(r)\cdot ds = \left(\frac{\mu_0}{4\pi}\right)\int_{\Gamma}\int_{\Gamma'}\frac{(ds'\times ds)\cdot \mathbb{R}'}{R'^3}$$

$$= \left(\frac{\mu_0}{4\pi}\right)\int_{\Gamma'上}\int_{\Gamma上}\frac{(ds'\times ds)\cdot \mathbb{R}'}{R'^3}$$





ドーナツ状

$$ds'\times ds = dS$$

→ ドーナツの法線方向

$$\int_{\Gamma'上}\int_{\bar{\Gamma}上} ds'\times ds = \int_{D\,(\text{ドーナツの面上})} dS$$

$$\oint_{\Gamma上} \mathbb{B}(r)\cdot ds = \left(\frac{\mu_0}{4\pi}\right) I\int_D \frac{dS\cdot\mathbb{R}'}{R'^3}$$

$$= \left(\frac{\mu_0}{4\pi}\right) I\int_D d\Omega$$

$$\frac{dS\cos\theta}{R'^2} = d\Omega \quad \frac{\mathbb{R}'}{R'}$$

立体角

$$= \left(\frac{\mu_0}{4\pi}\right) I\cdot\left\{\begin{array}{ll}0 & (\text{Pがドーナツ面の外側}) \\ 4\pi & (\text{Pがドーナツ面の内側})\end{array}\right.$$