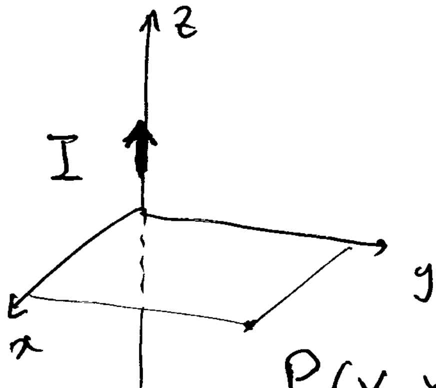
10-2 直線電流

$$\boxed{\mathbb{B} = \frac{\mu_0 I}{4\pi}\int \frac{d\mathbf{s}' \times (\mathbf{r}-\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|^3}}$$



P(X, Y, 0)

観測者 $\mathbf{r} = (X, Y, 0)$

$$\begin{cases} \mathbf{r}' = (0, 0, z') \\ d\mathbf{s}' = (0, 0, dz') \end{cases}$$

$$\mathbf{r}-\mathbf{r}' = (X, Y, -z')$$

$$d\mathbf{s}' \times (\mathbf{r}-\mathbf{r}') = (-Y dz', X dz', 0)$$

必ずこれを書くこと!!

$$B_x = \frac{\mu_0 I}{4\pi}\int_{-\infty}^{\infty} \frac{-Y dz'}{(X^2+Y^2+z'^2)^{\frac{3}{2}}} = \frac{-\mu_0 I}{4\pi}\left(\frac{2Y}{X^2+Y^2}\right)$$

$$\therefore B_x = -\frac{\mu_0 I}{2\pi}\frac{Y}{X^2+Y^2}$$

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同様に

$$B_y = +\frac{\mu_0 I}{2\pi}\frac{X}{X^2+Y^2}$$

$$\mathbb{B} = B_x \mathbb{e}_x + B_y \mathbb{e}_y$$

$$\begin{pmatrix} \mathbb{e}_r \\ \mathbb{e}_\theta \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}\begin{pmatrix} \mathbb{e}_x \\ \mathbb{e}_y \end{pmatrix}$$

$\therefore$

$$\mathbb{B} = (B_x \cos\theta + B_y \sin\theta)\,\mathbb{e}_r + (-B_x \sin\theta + B_y \cos\theta)\,\mathbb{e}_\theta$$

$$\begin{cases} B_x = -\dfrac{\mu_0 I}{2\pi}\dfrac{\cos\theta}{r} \\ B_y = \dfrac{\mu_0 I}{2\pi}\dfrac{\sin\theta}{r} \end{cases}$$

$$\therefore \boxed{\mathbb{B} = \frac{\mu_0 I}{2\pi}\frac{1}{r}\mathbb{e}_\theta}$$

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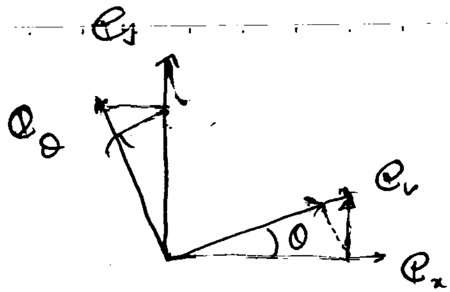

$$\begin{cases} e_r = e_x \cos\theta + e_y \sin\theta \\ e_\theta = e_y \cos\theta - e_x \sin\theta \end{cases}$$