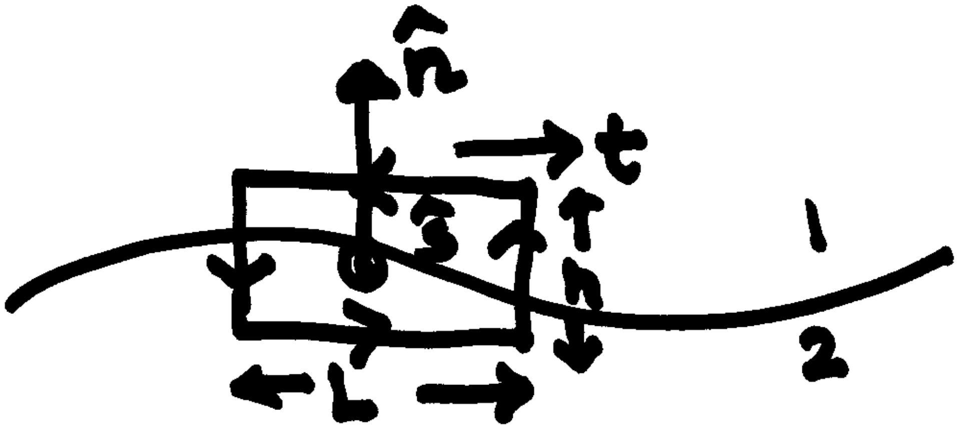
Prof D.K. Ghosh
Lec-26
10/10/11

$$B_{2n} = B_{1n}$$

$$\vec{\nabla}\cdot\vec{A} = 0 \Rightarrow \int \vec{A}\cdot d\vec{S} = 0$$

$$\boxed{A_{2n} = A_{1n}}$$



$\underline{h \ll L}$

$\underline{\hat{s}, \hat{t}, \hat{n}}$ right handed system.

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 I$$

$$= \mu_0 \int \vec{J} \cdot \hat{s} \cdot hL$$

$$= \mu_0 L \Big(\underbrace{\int \vec{J} dh}_{\vec{K}} \Big) \cdot \hat{s}$$

$$= \mu_0 L \vec{K} \cdot \hat{s} \,.$$

$$\hat{t} = \hat{n} \times \hat{s}$$

$$(\vec{B}_1 - \vec{B}_2) \cdot (\hat{s} \times \hat{n}) = \mu_0 \vec{K} \cdot \hat{s}$$

$$\boxed{\hat{n} \times (\vec{B}_1 - \vec{B}_2) = \mu_0 \vec{K}}$$

$$\boxed{\vec{B}_1 - \vec{B}_2 = \mu_0 \vec{K} \times \hat{n}}$$

$$\oint \vec{A} \cdot d\vec{l} = 0 \quad \text{as } h \to 0$$

A_t is continuous

$$\vec{B}_2 - \vec{B}_1 = \mu_0 \hat{n} \times \vec{K}$$

$$\vec{\nabla} \times (\vec{A}_2 - \vec{A}_1) = \mu_0 \hat{n} \times \vec{K}.$$

$$\hat{n} \times [\vec{\nabla} \times (\vec{A}_2 - \vec{A}_1)] = -\mu_0 \vec{K}.$$

$$\vec{J} = 0 \Rightarrow \vec{\nabla} \times \vec{B} = 0$$

$$\vec{B} = -\mu_0 \nabla \Phi_m$$

$$\vec{\nabla} \cdot \vec{B} = 0 \Rightarrow \nabla^2 \Phi_m = 0$$

Line Current

$$\vec{B} = \frac{\mu_0 I}{2\pi r}\hat{\varphi}$$

$$\nabla \Phi_m = \left(\hat{r}\frac{\partial}{\partial r} + \hat{\varphi}\underline{\frac{1}{r}\frac{\partial}{\partial \varphi}} + \hat{z}\frac{\partial}{\partial z}\right)\Phi_m$$

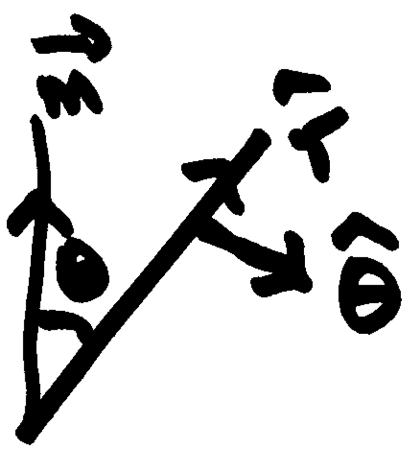
$$\frac{1}{r}\frac{\partial}{\partial \phi}\Phi_m = -\frac{I}{2\pi r}.$$

$$\Phi_m = -\frac{I}{2\pi}\varphi$$

Magnetic Dipole

$$\vec{B} = \frac{\mu_0}{4\pi}\left(-\frac{\vec{m}}{r^3} + \frac{3(\vec{m}\cdot\vec{r})\,\vec{r}}{r^5}\right)$$

$$= \frac{\mu_0}{4\pi}\left(\frac{2m\cos\theta}{r^3}\,\hat{r} + \frac{m\sin\theta}{r^3}\,\hat{\theta}\right)$$



$$= \frac{\mu_0}{4\pi}\left(\hat{r}\frac{\partial}{\partial r} + \hat{\theta}\,\frac{1}{r}\frac{\partial}{\partial \theta} + \hat{\varphi}\,\frac{1}{r\sin\theta}\frac{\partial}{\partial \varphi}\right) \times \left(-\frac{m\cos\theta}{r^2}\right)$$

$$\equiv -\mu_0\left(\frac{\vec{m}\cdot\hat{r}}{4\pi r^2}\right)$$

$$\boxed{\phi_m = \frac{\vec{m}\cdot\vec{r}}{4\pi r^3}}$$

$$= \frac{I}{4\pi} d\Omega$$

$$\oint B\cdot dl = -\mu_0 \int \vec{\nabla}\Phi_m \cdot \vec{dl}$$

$$= -\mu_0 \Delta\Phi_m. = \mu_0 I.$$

$$\boxed{\Delta\Phi_m = -I}$$

$$\phi_m = -\frac{I\Omega}{4\pi}$$

$$\vec{M} = \lim_{\Delta v \to 0} \frac{1}{\Delta v} \sum_i \vec{m}_i$$

Magnetization

$$\vec{A}(\vec{r}) = \frac{\mu_0}{4\pi} \int_{Vol} \frac{\vec{M}(\vec{r}\,') \times (\vec{r} - \vec{r}\,')}{|\vec{r} - \vec{r}\,'|^3} d^3r'$$

$$= \frac{\mu_0}{4\pi} \int_{Vol} \vec{M}(\vec{r}\,') \times \nabla' \frac{1}{|\vec{r} - \vec{r}\,'|} d^3r'$$

$$\nabla \times (\phi \vec{M}) = (\vec{\nabla}\phi) \times \vec{M} + \phi(\vec{\nabla} \times \vec{M})$$

$$\vec{A}(\vec{r}) = \frac{\mu_0}{4\pi}\int_{vol} -\nabla' \times \left(\frac{\vec{M}(r')}{|\vec{r}-\vec{r}'|^3}\right) d^3r'$$

$$+ \frac{\mu_0}{4\pi}\int_{vol} \frac{1}{|\vec{r}-\vec{r}'|}\left(\nabla' \times M(r')\right) d^3r'$$

$$= -\frac{\mu_0}{4\pi}\int_{Surface} \frac{\hat{n} \times \vec{M}(r')}{|\vec{r}-\vec{r}'|^3} dS'$$

$$+ \frac{\mu_0}{4\pi}\int_{vol} \frac{\nabla' \times \vec{M}(r')}{|r-r'|} d^3r'$$

$$\vec{J}_s(\vec{r}) = -\hat{n} \times \vec{M}(\vec{r})$$

$$\vec{J}_M(\vec{r}) = \nabla \times \vec{M}(r)$$

$$\vec{J}_D + \vec{J}_f = 0$$

$$\vec{J}_D = -\vec{J}_f$$