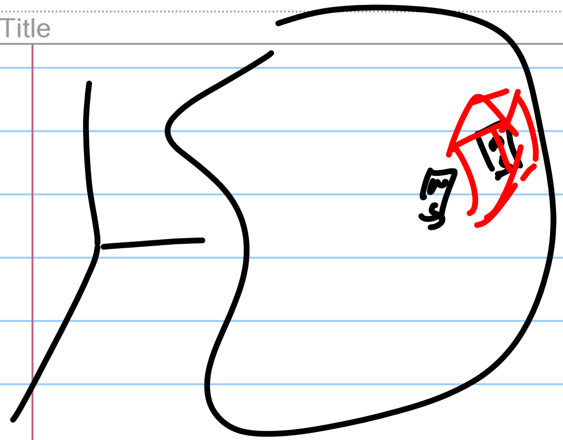
$\nearrow d\vec{A}$

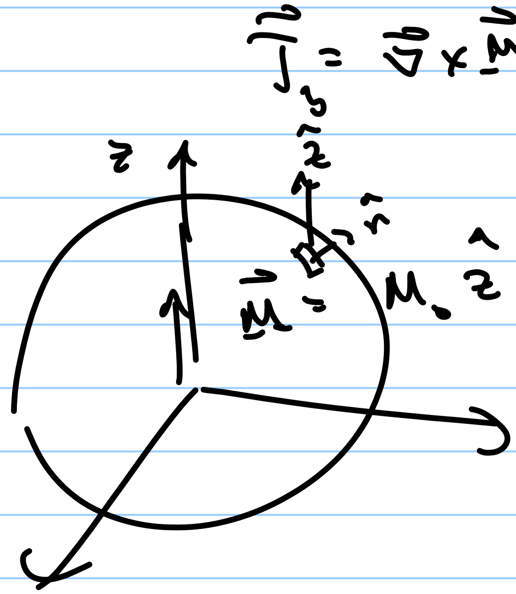
Note Title 4/21/2008



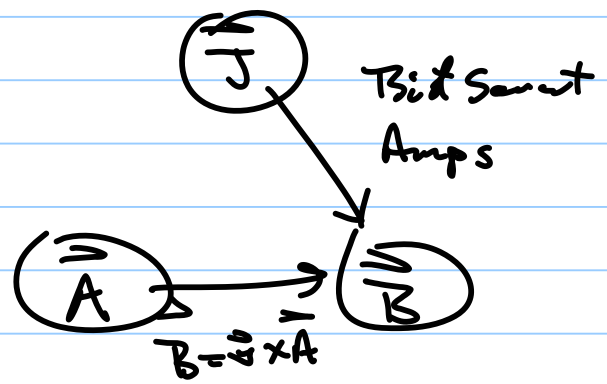
$$\vec{A}_{dipole} = \int d\vec{A}$$

$$= \frac{\mu_0}{4\pi} \int \frac{\vec{J}\, d\tau}{r}$$

$$\vec{J}_b = \vec{\nabla} \times \vec{M} \qquad \vec{K}_b = \vec{M} \times \hat{n}$$



What is $\vec{B}$ for ball bearing with this $\vec{M}$?

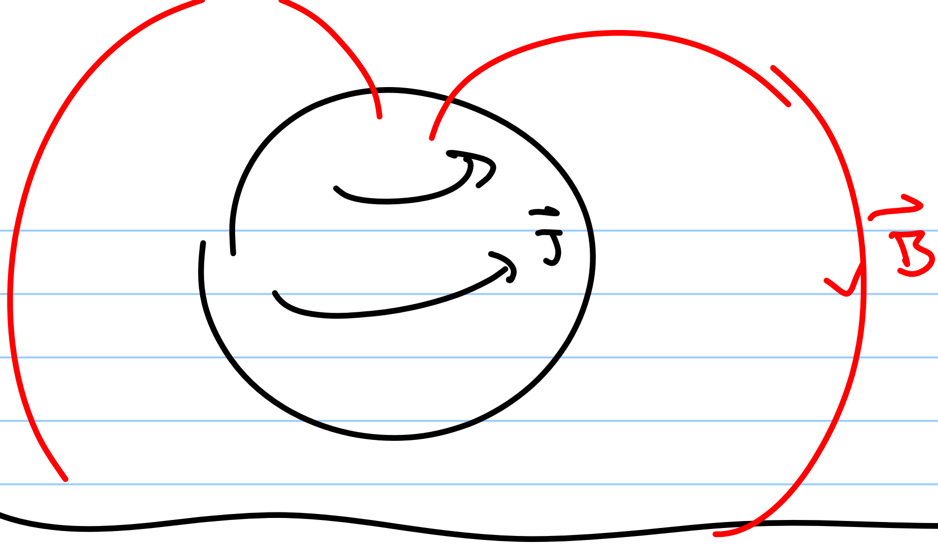


$$\vec{J}_b = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 0 & 0 & M_0 \end{vmatrix} = \phi$$

$$\vec{K}_b = \underset{\underset{\underbrace{\hat{z} \times \hat{n}}}{\uparrow}}{\vec{M}} \times \underset{\uparrow}{\hat{n}} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & M_0 \\ \sin\theta\cos\phi & \sin\theta\sin\phi & \cos\theta \end{vmatrix} =$$

$$|\hat{z}||\hat{r}| \sin\theta\, \hat{\phi}$$

$$\begin{matrix} \shortparallel & \shortparallel \\ 1 & 1 \end{matrix}$$



Biot Savart

Amps Law

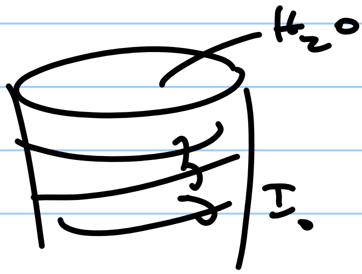
$$\vec\nabla\times\vec B = \mu_0 J$$

$$\nabla\times\Big(\underbrace{\frac{\vec B}{\mu_0} - \vec M}_{\vec H}\Big) = \vec J_f$$

$$\vec J = \vec J_f + \vec J_{bound}$$

$$\vec J_{bound} = \nabla\times\vec M$$

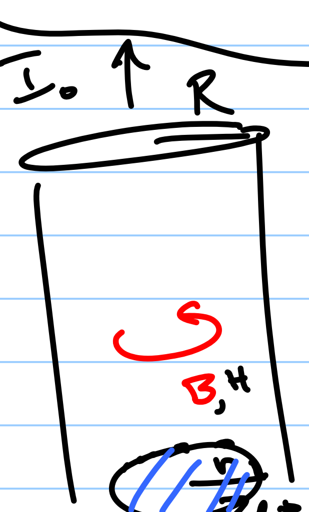
$$\oint \vec H\cdot d\vec l = I_{f,enclosed}$$



1st find H then linear material

$\vec M = \chi_m \vec H$ then put H in

$$\vec H = \frac{\vec B}{\mu_0} - \vec M \Rightarrow \underbrace{\mu_0(1+\chi_m)}_{\mu}\vec H = \vec B$$



copper wire find B inside copper

Principle: $\oint \vec H\cdot d\vec l = I_{f,encl}$

direction of H

$$\oint \vec H\cdot d\vec l = \oint H\,dl\,\underbrace{\cos\phi}_{1} = H\oint dl = H\,2\pi r$$

$$I_{encl,f} = \int \vec{J}_f \cdot d\vec{a} = \frac{I_0}{\pi R^2}\pi r^2 = H\, 2\pi r$$

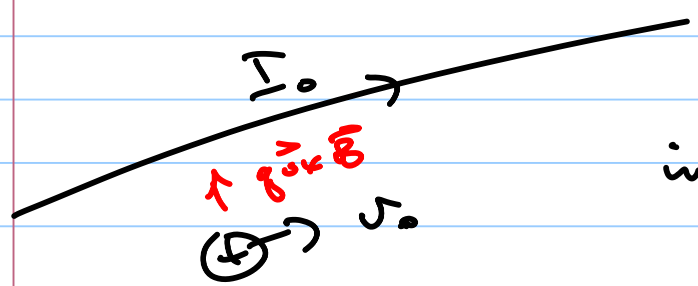
$$\vec{J}_f = \frac{I_0}{\pi R^2}$$

$$H = \frac{I_0}{\pi R^2}\,\frac{\cancel{\pi} r^{\cancel{2}}}{2\cancel{\pi}\cancel{r}}$$

$$B = \mu H = \mu_0(1+\chi_m)\frac{I_0}{\pi R^2}\,\frac{r}{2}$$

Check $\chi_c \to 0$ B same without material

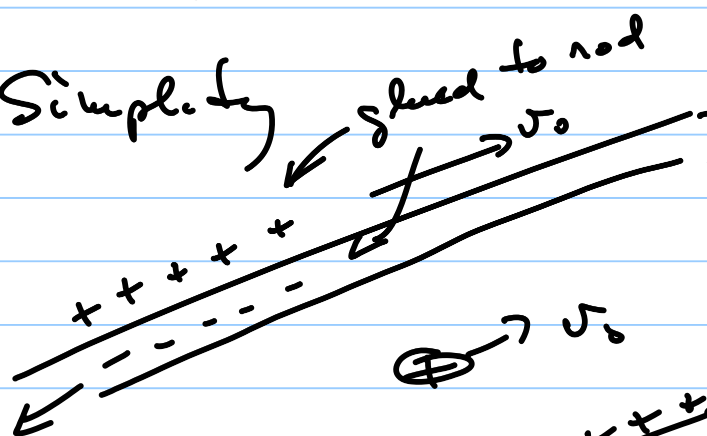
$I_0 \to 0$ $B \to 0$



in frame of $\oplus$ $v = 0$

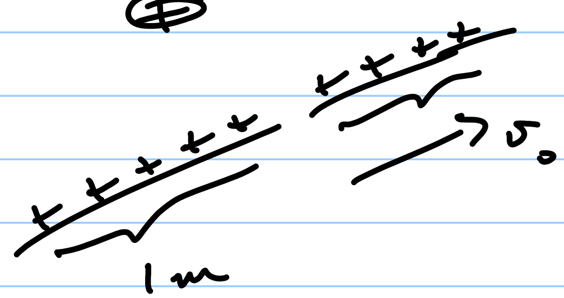
$q\,\vec{v}\times\vec{B} = 0$

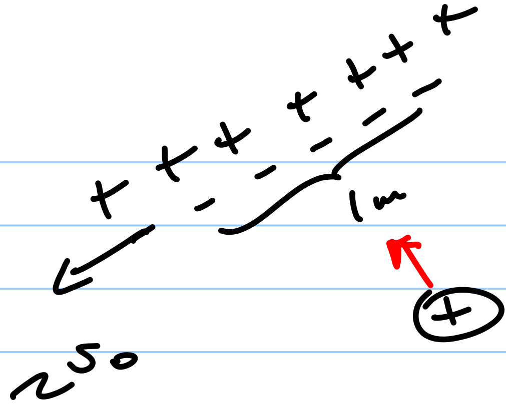
Simplify



$I_0 = \lambda_0 v$ charge density when wire is at rest

$\frac{\text{Coul}}{m}\,\frac{m}{s} = \frac{\text{Coul}}{s}$





100 charges on meter stick

$L \to L_0\sqrt{1-v^2/c^2}$

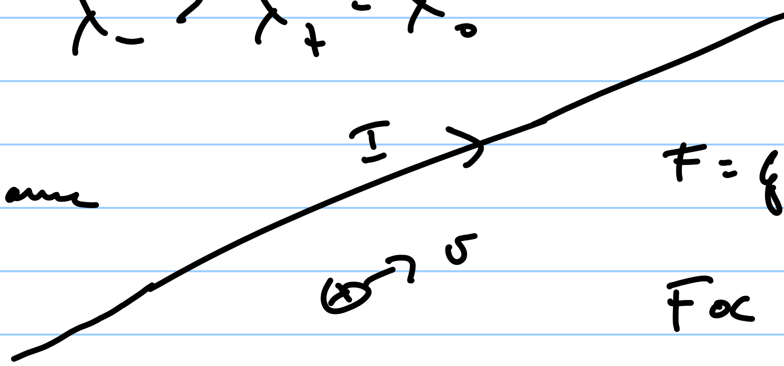
$$\lambda_- = \frac{\lambda_0}{L} = \frac{\lambda_0}{L_0\sqrt{1-v^2/c^2}}$$

$$\lambda_- > \lambda_+ = \lambda_0$$

$$\oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_0$$

$$B\, 2\pi r = \mu_0 I_0$$

Lab frame



$$F = qvB = qv\frac{\mu_0 I_0}{2\pi r}$$

$$F \propto \frac{v I_0}{r} \propto \frac{v^2}{r}$$

frame of charge

$$F = qE$$

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{enc}}{\epsilon_0}$$

$$E\, 2\pi r \cancel{L} = \underbrace{\left(\lambda_0 - \frac{\lambda_0}{\sqrt{1-v^2/c^2}}\right)}_{\lambda_0 - \lambda_0\left(1+\frac{1}{2}v^2/c^2+\cdots\right) \approx -\frac{\lambda_0}{2}\frac{v^2}{c^2}} \cancel{L}\,\frac{1}{\epsilon_0}$$

$$\Rightarrow qE = \frac{\lambda v^2}{2c^2}\,\frac{q}{2\pi r} = F \propto \frac{v^2}{r}$$