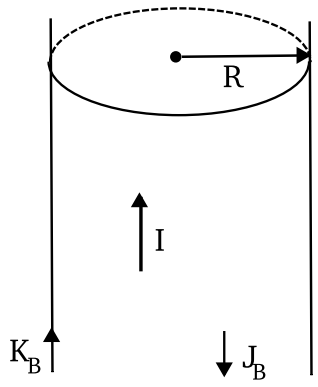
8.022 Lecture Notes Class 26 - 10/31/2006



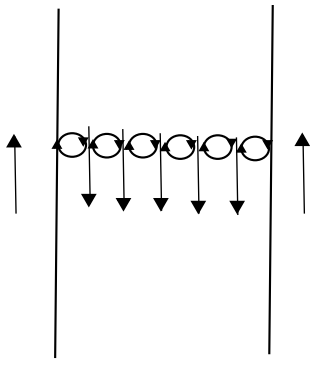
Long copper wire of radius R,
uniform current I
Find:

1. Direction of bound currents $\frac{\vec{J_B}}{|\vec{J_B}|}, \frac{\vec{k_B}}{|\vec{k_B}|}$
2. $\vec{H}$ inside
3. $\vec{H}$ outside

What's a bound current? One way: electrons in materials moving Current that cannot escape; property of material.

$$\oint \vec{H} \cdot d\vec{l} = I_{\text{freeenclosed}}$$

$$\begin{aligned} \vec{H} &= \quad \tfrac{I}{2\pi r} \\ \vec{J_B} &= \quad \vec{\nabla} \times \vec{M} \\ &= \vec{\nabla} \times (\tfrac{\vec{m}}{V}) ...? \end{aligned}$$



$\hat{J_B}$ is down because little circles of current cancel out inside to go down, on surface $\vec{k_B}$ goes up

1.

2. Well, H depends only on free current

Inside:

$$\oint \vec{H} \cdot d\vec{l} = I_{\text{freeenclosed}} \qquad \vec{\nabla} \times \vec{H} = \vec{J_{\text{free}}}$$

$$H = \frac{1}{2\pi r} \cdot I \cdot \frac{\pi r^2}{\pi R^2} = \frac{Ir}{2\pi R^2}\hat{\phi} \qquad \vec{H} = \frac{1}{\mu_0}\vec{B} - \vec{M}$$

3. Outside :

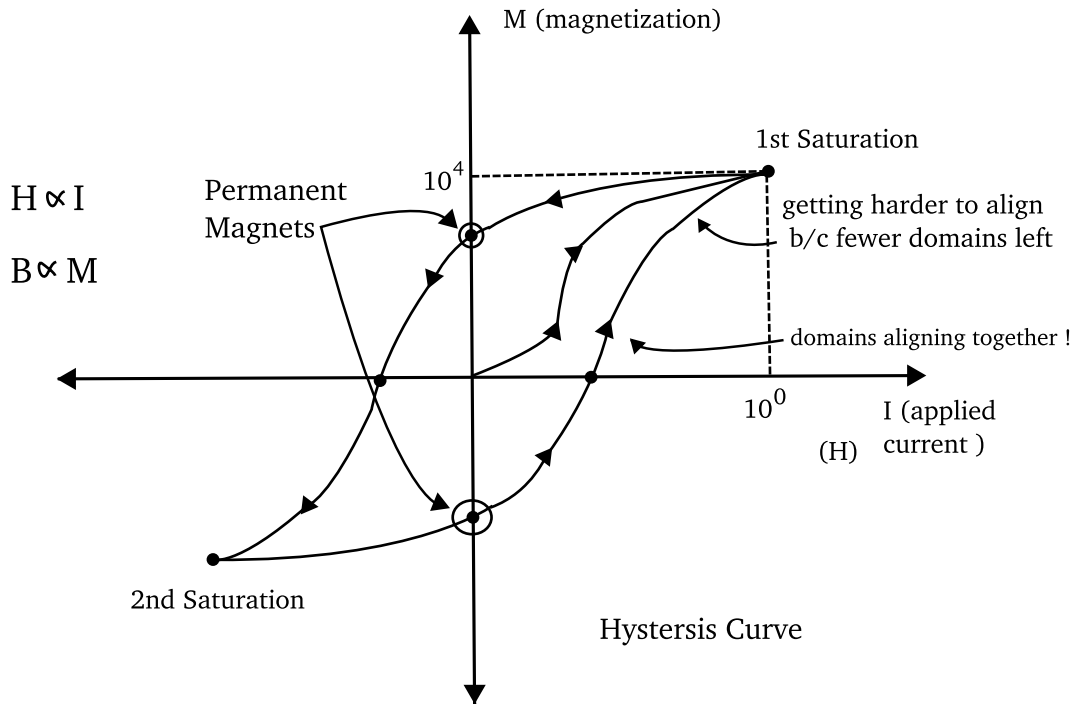
$$\oint \vec{H} \cdot d\vec{l} = I_{\text{freeenclosed}}$$

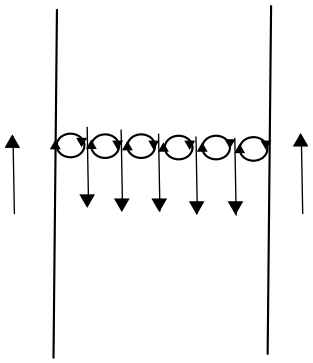
$$H = \frac{I}{2\pi r}\hat{\phi}$$

Ferromagnetism

- based on history
- aligns with itself
- rare - requires special electronic structure
- nonlinear

- Ferromagnetic domains align to external fields





We know this creates an $\vec{H}$, which is related to $\vec{M}$

Curie pt: $10^3 K$ (Ferro $\longrightarrow$ para)