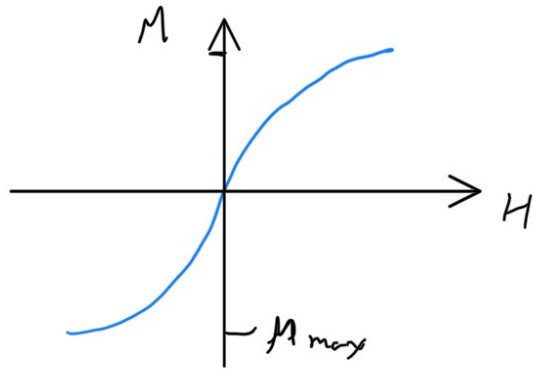


Ferro magnetismo: Efeito coletivo \rightarrow acoplamento de dipolos

gerando domínios magnéticos

Baixa histerese \rightarrow blindagem e confinamento do campo

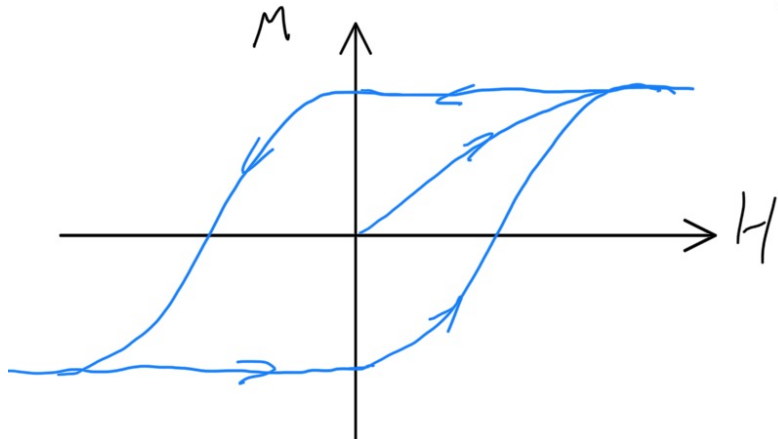


$$\vec{B} = \mu_0 (\vec{H} + \vec{M})$$

\Rightarrow aumento do Fluxo

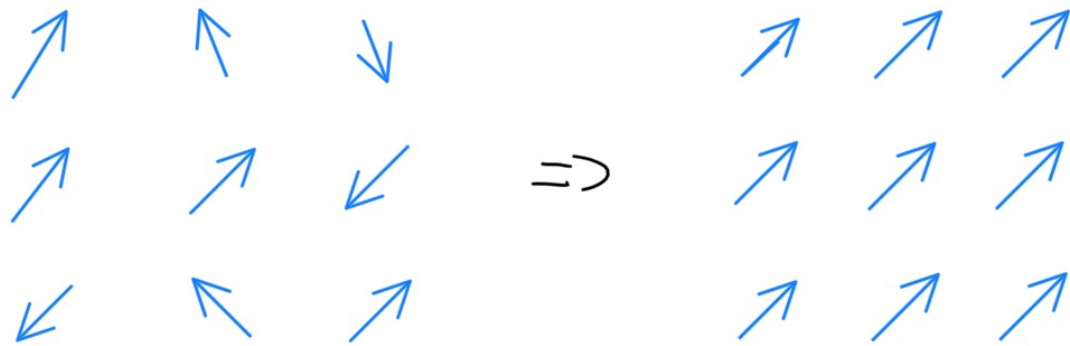
$$\phi = L \cdot I \rightarrow \text{aumento da indutância}$$

Alta histerese \rightarrow ímãs permanentes



Origem: Acoplamento spin-spin: $H = - \sum_{ij} J \langle \vec{S}_i \cdot \vec{S}_j \rangle$

Leva ao alinhamento de spins



→ Surgimento de domínios magnéticos com fronteiras

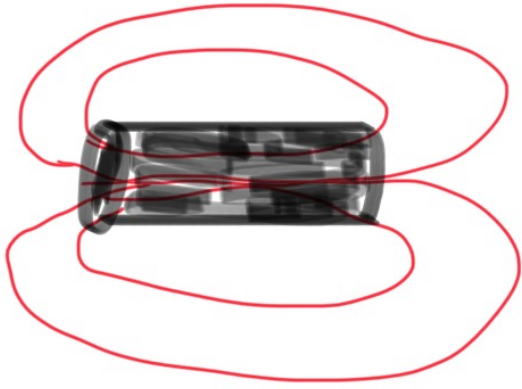
Magnet	preparation	B_r (T)	H_{ci} (kA/m)	$B \cdot H_{max}$ (kJ/m ³)	T_C (°C)
Nd ₂ Fe ₁₄ B	sintered	1.0–1.4	750–2000	200–440	310–400
Nd ₂ Fe ₁₄ B	bonded	0.6–0.7	600–1200	60–100	310–400
SmCo ₅	sintered	0.8–1.1	600–2000	120–200	720
Sm(Co,Fe,Cu,Zr) ₇	sintered	0.9–1.15	450–1300	150–240	800
Alnico	sintered	0.6–1.4	275	10–88	700–860
Sr-ferrite	sintered	0.2–0.4	100–300	10–40	450
Iron (Fe) bar magnet	annealed	?	800 ^[8]	?	770 ^[9]

Curie temperatures for some crystalline ferromagnetic materials^{[6][7]}

Material	Curie temp. (K)
Co	1388
Fe	1043
Fe ₂ O ₃ ^[a]	948
FeOFe ₂ O ₃ ^[a]	858
NiOFe ₂ O ₃ ^[a]	858
CuOFe ₂ O ₃ ^[a]	728
MgOFe ₂ O ₃ ^[a]	713
MnBi	630
Ni	627
Nd ₂ Fe ₁₄ B	593
MnSb	587
MnOFe ₂ O ₃ ^[a]	573
Y ₃ Fe ₅ O ₁₂ ^[a]	560
CrO ₂	386
MnAs	318
Gd	292
Tb	219
Dy	88
EuO	69

a. ^{a b c d e f g} Ferrimagnetic material

Correntes induzidas: (eddy currents)

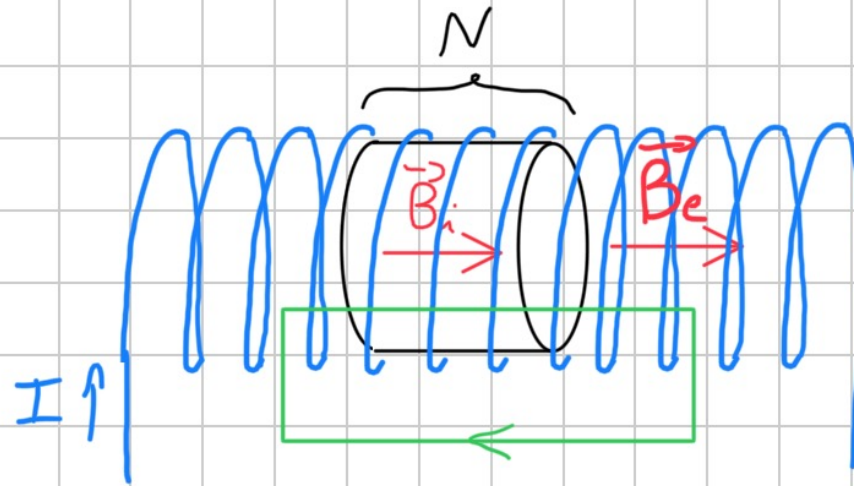
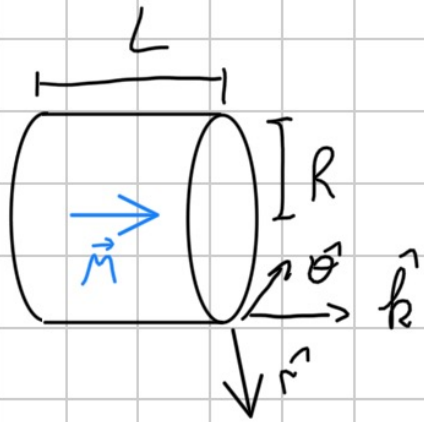


Ao aproximar, as correntes induzidas se opõem ao campo e se dissipam pela resistência do meio

Se a resistência é nula a corrente permanece! ✓

⇒ Supercondutores bloqueiam o campo
 \vec{B} dentro de supercondutores é nulo! ✓

Lembrando da questão de fixação:

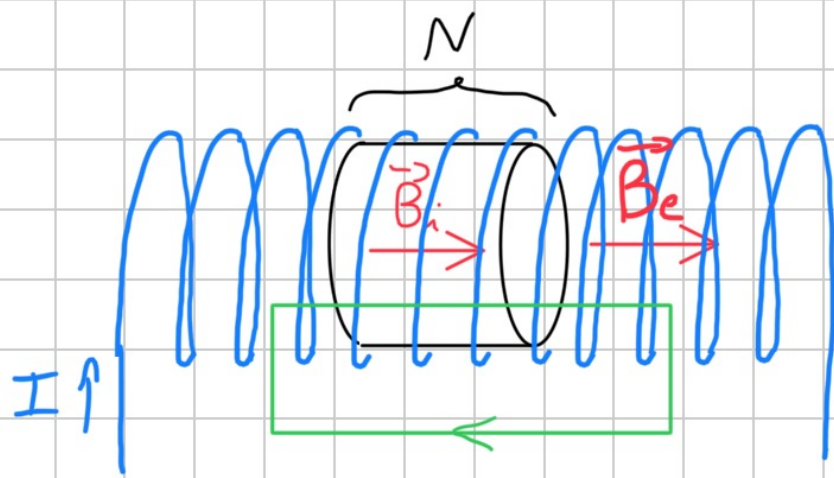


$$H = \frac{NI}{l} \rightarrow \text{lei de Ampère} \rightarrow \text{Loop}$$

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

$$H_i = H_e = NI/l$$

$$H \cdot l = N \cdot I$$



$$B_i = \mu H = \mu_0 (1 + \chi) H \quad B_e = \mu_0 H \quad \rightarrow \text{descontinuidade?}$$

\rightarrow transição!

$$M = \chi_m H = \chi_m \cdot \frac{NI}{l} \quad \vec{M} = M \cdot \hat{k}$$

Normal ao cilindro $\hat{n} = \hat{r}$ $\hat{r} \times \hat{\theta} = \hat{k} \Rightarrow \hat{k} \times \hat{r} = \hat{\theta}$

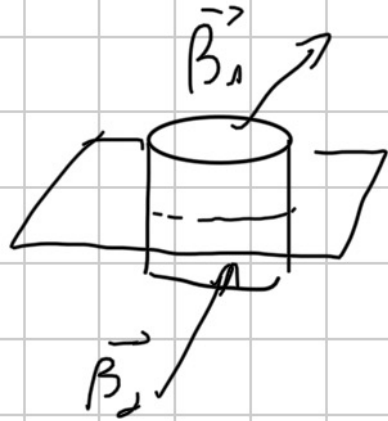
Corrente de superfície: $\vec{K}_m = \vec{M} \times \hat{n} = M \hat{k} \times \hat{r} = M \cdot \hat{\theta}$

$K_m = \chi_m \cdot \frac{NI}{l} \rightarrow$ o meio sobre põe um campo como

um segundo solenóide de corrente $\chi_m I$

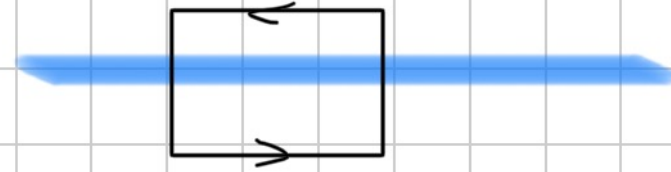
Interface : $\nabla \cdot \vec{B} = 0$

$$\nabla \times \vec{H} = \vec{J}$$



$$\vec{B}_1 \cdot \vec{n}_1 = \vec{B}_2 \cdot \vec{n}_2$$

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



$$H_{1\parallel} = H_{2\parallel}$$

$$\frac{B_{1\parallel}}{\mu_1} = \frac{B_{2\parallel}}{\mu_2}$$

Linhas de campo

$$B_{2\parallel} = \frac{\mu_2}{\mu_1} B_{1\parallel} ; B_{2n} = B_{1n}$$