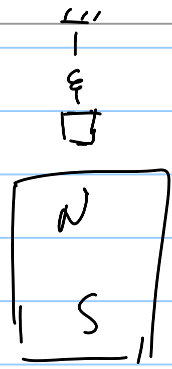
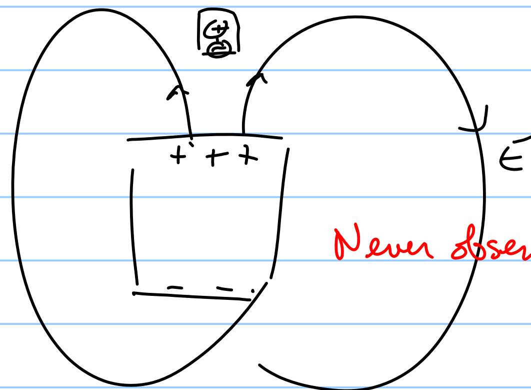
Lecture 38

Note Title 4/26/2006



weak attraction (thermal distribution)



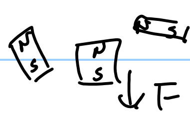
Never observe repulsion

all dipoles fix in direction of field
strong attraction

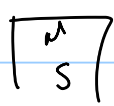
magnetic case (microscopic explan: atoms have orbital motion ⇒ mag dipole & electrons which have permanent mag dipole)

- weak attraction <u>paramagnetism</u>

each atom has net dipole moment (due to unpaired electrons)

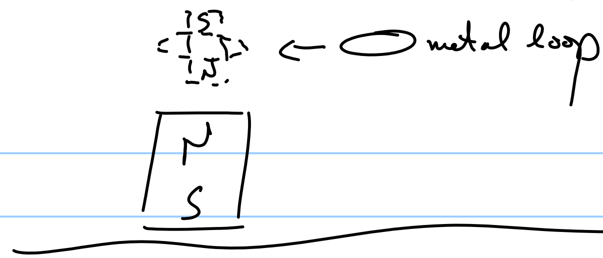


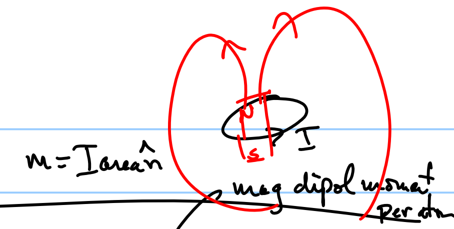
thermal dist.



- strong attraction if all mag dipole line up Ferromagnetism

- weak repulsion diamagnetism



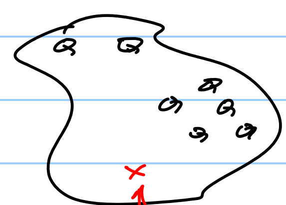


Dipole vector potential $\vec{A} = \frac{\mu_0}{4\pi}\frac{m \times \hat{r}}{r^2}$

Find fields ($\vec{A}$ & $\vec{B} = \vec{\nabla} \times \vec{A}$) for material that

$\frac{\text{mag dipol moment}}{\text{volume}}$ (given) $= \underline{M}(x,y,z)$

want to find $\vec{B}$ everywhere.



$$\frac{\mu_0}{4\pi}\int \frac{dm \times \hat{r}}{r^2} = \frac{\mu_0}{4\pi}\int \frac{\vec{\underline{M}} \times \hat{r}}{r^2}\, d\tau = \vec{A}_{net}$$

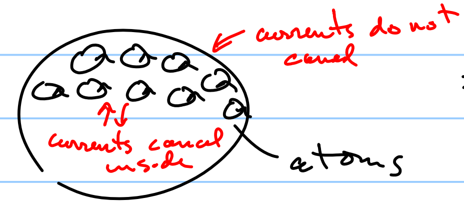
find $\vec{A}_{net}$ due to all the dipoles

$\vec{\nabla}\frac{1}{r} = \frac{\hat{r}}{r^2}$ + vector cal manipulations $\Rightarrow$

$$\vec{A}_{net} = \frac{\mu_0}{4\pi}\int \frac{1}{r}(\vec{\nabla} \times \vec{\underline{M}})\, d\tau + \frac{\mu_0}{4\pi}\oint \frac{1}{r}(\vec{\underline{M}} \times d\vec{a}) \qquad d\vec{a} = \hat{n}|d\vec{a}|$$

$$\uparrow$$
$$\vec{J}_{bound}$$

$$\uparrow$$
$$\vec{K}_b = \vec{M} \times \hat{n}$$
surface current



$$\vec{J}_b = \vec{\nabla} \times \vec{M} = 0$$
($\vec{M}$ = const)

$$\vec{M} = \text{Const}\ \hat{z}$$

$$\vec{K}_b = \text{const}\ \hat{z} \times \hat{r}$$
($\hat{r}$: $\hat{s}$; $\hat{z} \times \hat{r} = \hat{\varphi}$)

$$\vec{M} = kr\,\hat{z}$$
($kr = M_z$)

$$\vec{J}_b = \vec{\nabla} \times \vec{M} = -k\hat{\varphi}$$
$$\vec{K}_b = \vec{M} \times \hat{r} = kR\hat{\varphi}$$