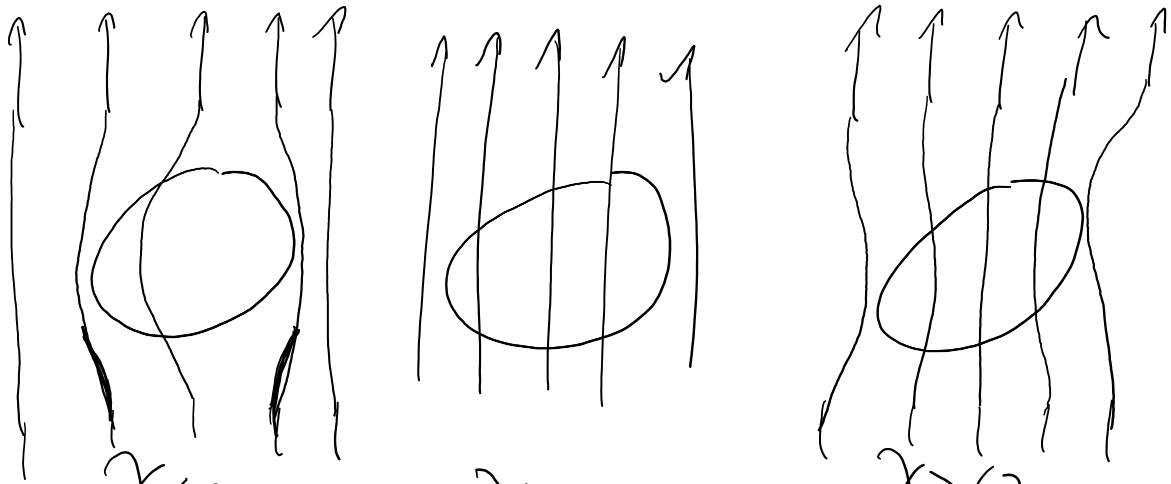
magnetische Eigenschaften

$$\vec{B} = \mu_0 (\vec{H} + \vec{M}) \qquad \vec{M} = \frac{\sum \vec{\mu}_m}{V} = \chi_m \vec{H}$$

$$= \mu \mu_0 \vec{H} \qquad \mu = 1 + \chi_m$$

$\chi_m > 0$ Paramagnet

$\chi_m < 0$ Diamagnet



$\chi < 0$ $\qquad$ $\chi = 0$ $\qquad$ $\chi > 0$

$E_{pot} = -\vec{\mu}_m \cdot \vec{B}$ makroskopisch $\frac{E_{pot}}{V} = -\vec{M} \cdot \vec{B}$

$$\vec{F} = -\vec{\nabla} E_{pot} = \vec{\nabla}(\vec{M} \cdot \vec{B}) \cdot V$$

$$= V \vec{\nabla}(\chi_m \vec{H} \cdot \vec{B}) = V \vec{\nabla}\left(\frac{\chi_m}{\mu \mu_0} \vec{B}^2\right)$$

$$F_z \sim \chi_m B_z \cdot \partial B_z$$

∂z

Paramagnetische Substanzen

$\vec{m}_m$ permanentes Dipolmoment

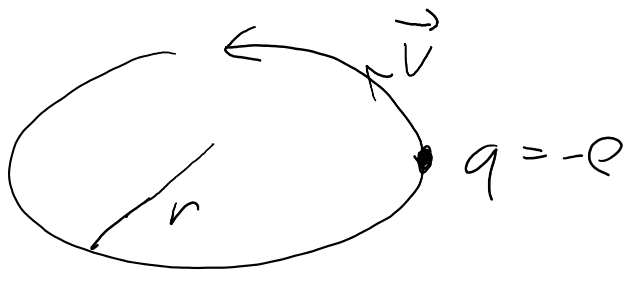
$$\vec{M} = \frac{\sum \vec{m}_m}{V} \qquad E_{pot} = -\vec{m}_m \vec{B}$$

totale Ausrichtung: $$\vec{M} = n \cdot \vec{m}_m \underbrace{\left(e^{-\frac{\vec{m}_m \vec{B}}{kT}} - e^{+\frac{\vec{m}_m \vec{B}}{kT}} \right)}_{\frac{2 \vec{m}_m \vec{B}}{kT}}$$

$$\vec{M} = \frac{2 n \vec{m}_m^2}{kT} \mu_0 \vec{H} \qquad \chi_m \sim \frac{1}{T}$$

$\hookrightarrow \chi_m$

mikroskopische / atomare Kreisströme



$$\vec{m}_m = I \vec{A} = -\frac{e}{T} \pi r^2 \vec{n} = -\frac{e v}{2\pi r} \pi r^2 \vec{n} = -\frac{e}{2} v r \vec{n}$$

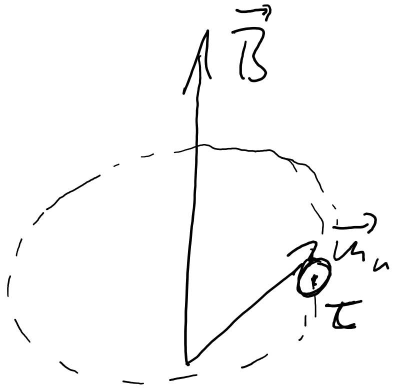
$$= -\frac{e}{2m_e}\,\vec{r} \times \vec{v} m_e = -\frac{e}{2m_e}\cdot\vec{L}$$

im Bohrmodell: $\vec{\mu}_m = -\frac{e}{2m_e}\hbar$

Planck'sche Konstante "h quer"

$\hbar \simeq 10^{-34}$ Js

Magnetisches Moment im $\vec{B}$-Feld



$$\vec{\tau} = \vec{\mu}_m \times \vec{B}$$

$$\vec{\tau} = \frac{d\vec{L}}{dt} \sim \frac{d\vec{\mu}_m}{dt}$$

$$\frac{e}{2m}|\vec{L}|\cdot|\vec{B}| = \omega_L|\vec{L}|$$

$$\omega_L = \frac{e}{2m}|\vec{B}|$$ Larmor-Frequenz