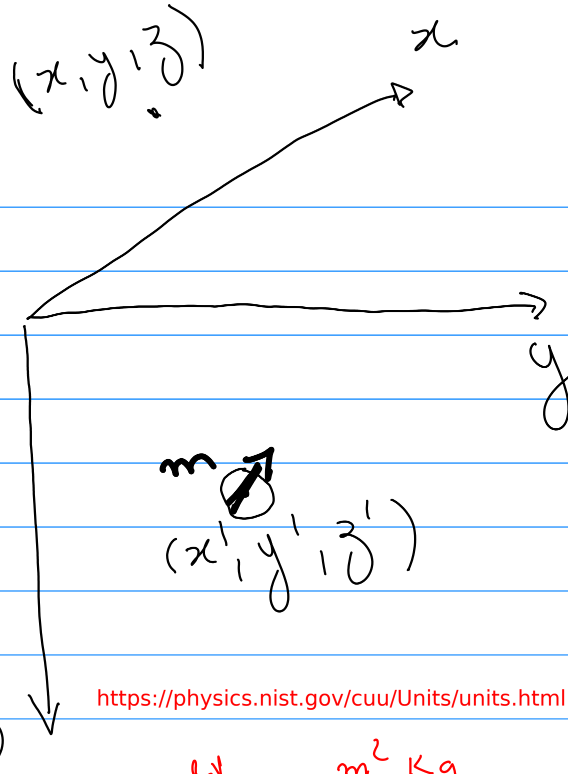
Dipolo



$$\mathbf{B}(x,y,z) \; ?$$

condições magnetostáticas
(ausência de corrente elétrica)

https://physics.nist.gov/cuu/Units/units.html

HENRY $\quad H = \dfrac{m^2\,Kg}{s^2\,A^2}$

TESLA (T)

potencial magnético escalar

$$V(x,y,z) = -C_m \, \boldsymbol{\nabla}\frac{1}{r}^{T} \mathbf{m} \qquad \left[10^9 \frac{H\,A}{m}\right] = \left[10^9 \, m \frac{Kg}{s^2 A}\right] = \left[10^9\,T\,m\right]$$

$$\mathbf{r} = \begin{bmatrix} x - x' \\ y - y' \\ z - z' \end{bmatrix} \qquad r = \left[(x-x')^2 + (y-y')^2 + (z-z')^2\right]^{1/2}$$

$$\boldsymbol{\nabla}\frac{1}{r} = \begin{bmatrix} \partial_x \frac{1}{r} \\ \partial_y \frac{1}{r} \\ \partial_z \frac{1}{r} \end{bmatrix} \qquad \left[\frac{1}{m^2}\right]$$

$$\mathbf{m} = m\,\hat{\mathbf{m}}$$

$$\hat{\mathbf{m}} = \begin{bmatrix} \cos I' \cos D' \\ \cos I' \sin D' \\ \sin I' \end{bmatrix}$$

$$C_m = 10^9 \frac{\mu_0}{4\pi} \quad \frac{H}{m}$$

m = volume x intensidade de magnetização total

$[m^3]$ $\quad$ $[A/m]$

$$\boldsymbol{\nabla}\frac{1}{r} = \frac{-1}{r^3}\mathbf{r}$$

indução magnética

$$\mathbf{B}(x,y,z) = -\nabla V(x,y,z) = -\begin{bmatrix} \partial_x V \\ \partial_y V \\ \partial_z V \end{bmatrix}$$

$$-\partial_x V = -\partial_x \left[-c_m \left(\partial_x \frac{1}{r} m_x + \partial_y \frac{1}{r} m_y + \partial_z \frac{1}{r} m_z \right) \right]$$

$$\partial_x \frac{1}{r} = -\frac{1}{\cancel{2}} \frac{\cancel{2}(x-x')}{r^3} = -\frac{(x-x')}{r^3}$$

$$\partial_y \frac{1}{r} = -\frac{y-y'}{r^3} \qquad \partial_z \frac{1}{r} = -\frac{z-z'}{r^3}$$

$$\nabla \frac{1}{r} = \frac{-1}{r^3} \mathbf{r}$$

$$\partial_{xx} \frac{1}{r} = \left(-1 \cdot \frac{1}{r^3} \right) + -(x-x')\left(-\frac{3}{2}\right) \frac{1}{r^5} 2(x-x')$$

$$= \frac{3(x-x')^2}{r^5} - \frac{1}{r^3}$$

$$\partial_{xy} \frac{1}{r} = -(y-y')\left(-\frac{3}{2}\right) \frac{1}{r^5} 2(y-y')$$

$$= \frac{3(x-x')(y-y')}{r^5}$$

$$-\partial_x V = Gm \left[\partial_{xx}\frac{1}{r} \quad \partial_{xy}\frac{1}{r} \quad \partial_{xz}\frac{1}{r} \right] m$$

$$-\partial_y V = Gm \left[\partial_{xy}\frac{1}{r} \quad \partial_{yy}\frac{1}{r} \quad \partial_{yz}\frac{1}{r} \right] m$$

$$-\partial_z V = Gm \left[\partial_{xz}\frac{1}{r} \quad \partial_{yz}\frac{1}{r} \quad \partial_{zz}\frac{1}{r} \right] m$$

Ex $\partial_{xy}\frac{1}{r} = \partial_{yx}\frac{1}{r}$

Ex $\partial_{xx}\frac{1}{r} + \partial_{yy}\frac{1}{r} + \partial_{zz}\frac{1}{r}$

Ex $\partial_x\frac{1}{r} = -\partial_{x'}\frac{1}{r}$