Camada equivalente aplicada ao processamento e interpretação de dados de campos potenciais

Vanderlei C. Oliveira Jr.

2016

Anomalia de Campo Total (parte B)

Vanderlei C. Oliveira Jr.

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Campo principal

$$\mathbf{B}_i = B_i \hat{\mathbf{B}}_i$$

Campo crustal

$$\mathbf{T}_i = \mathbf{F}_i + \mathbf{B}_i$$

Campo total

$$F_i \gg B_i$$

Condição observada na prática

$$\Delta T_i = T_i - F_i$$

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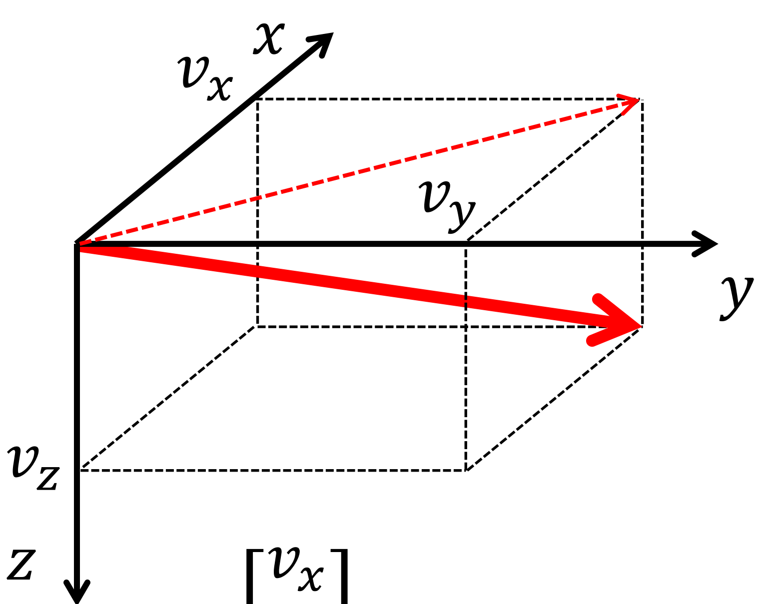

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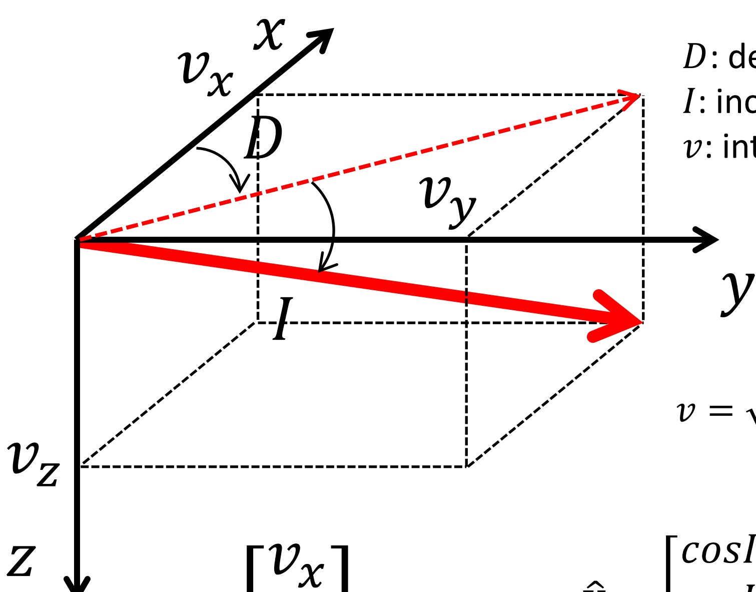

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(por exemplo, IGRF)

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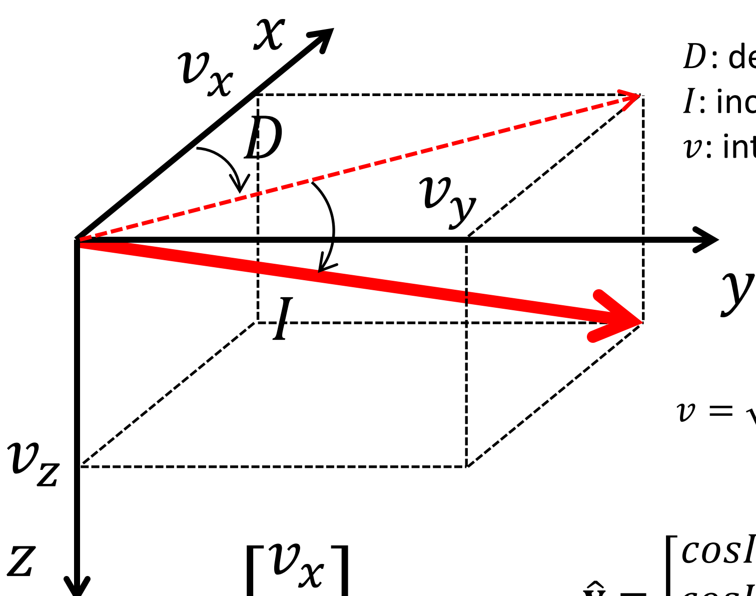

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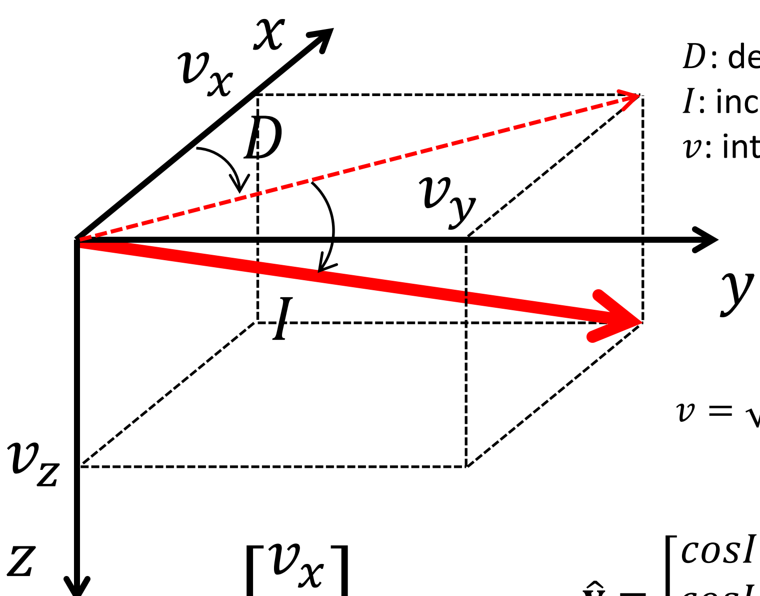

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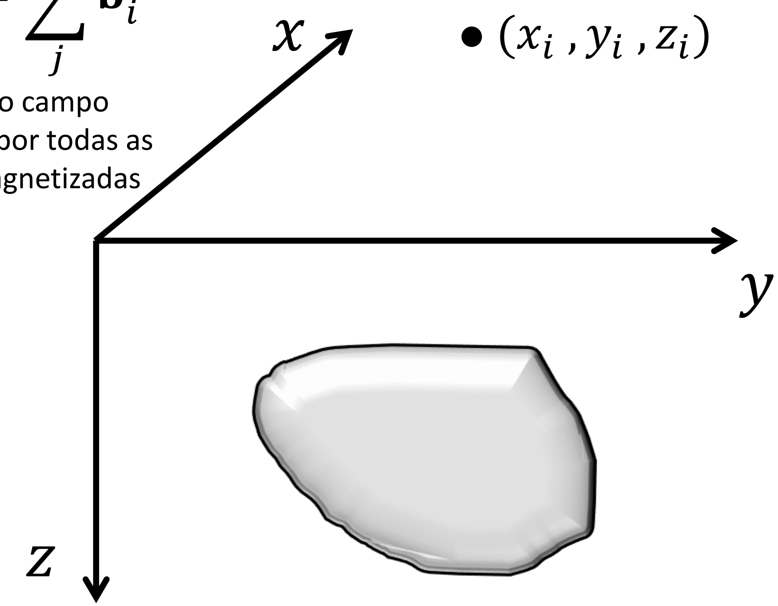
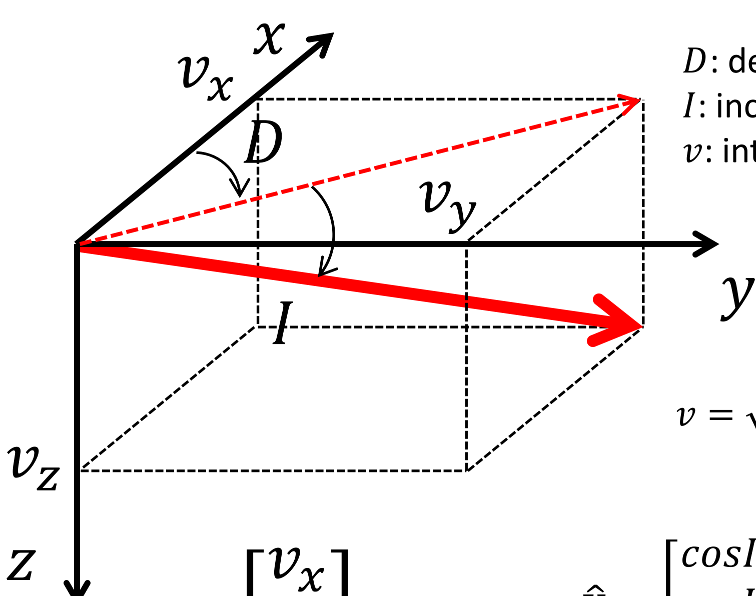


Considere o campo produzido pela j-ésima fonte magnética na posição (x_i, y_i, z_i)



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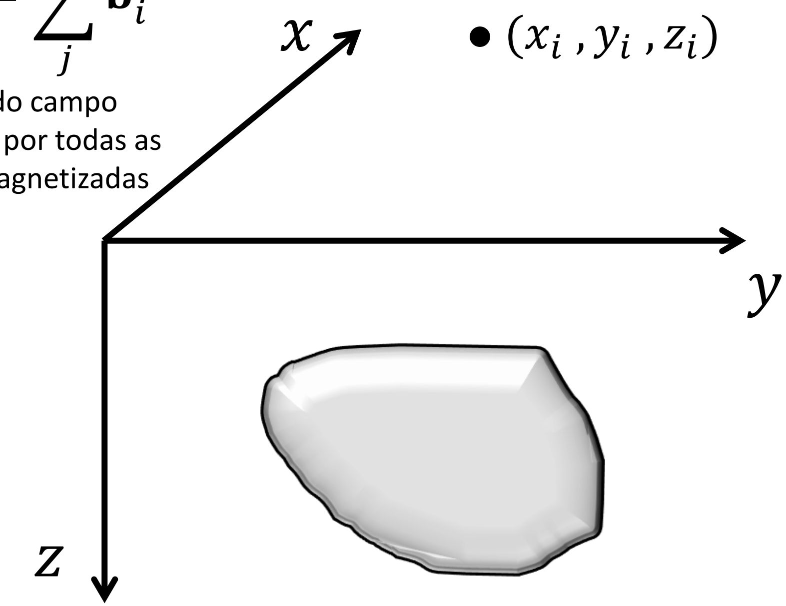
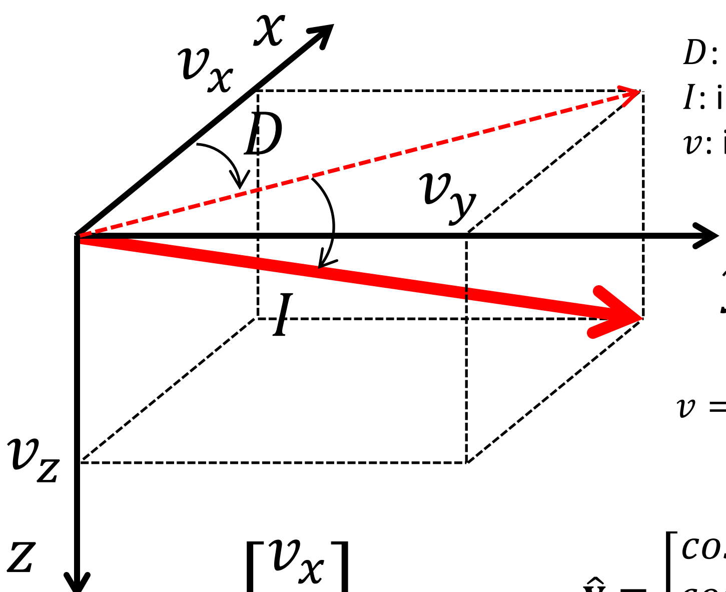


A indução magnética $\mathbf{b}_i^j$ é uma integral avaliada no volume da j-ésima fonte magnética



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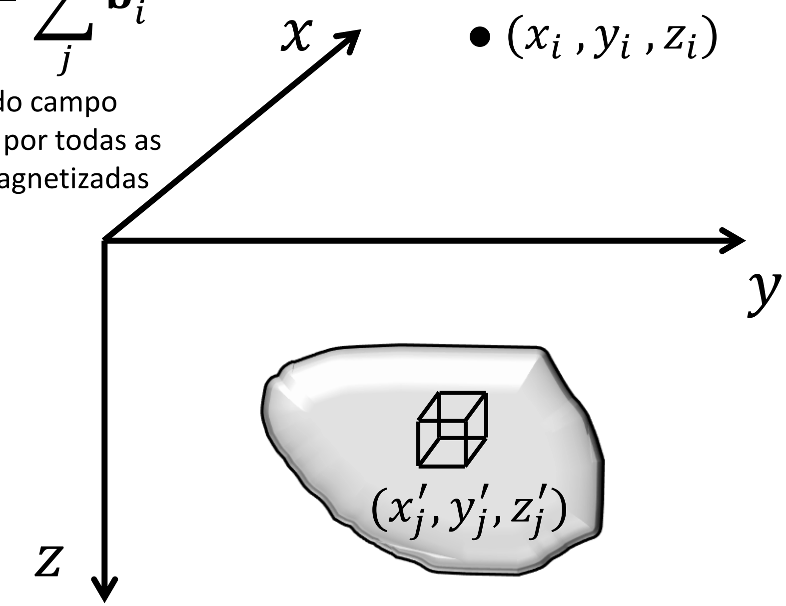

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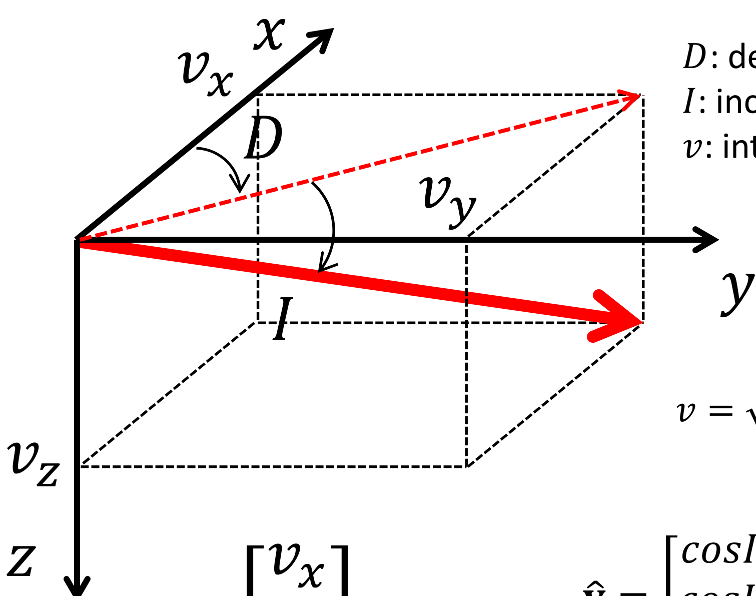
Anomalia de campo total

(x_j', y_j', z_j') são as coordenadas de
um elemento de volume $dxdydz$
dentro da j-ésima fonte



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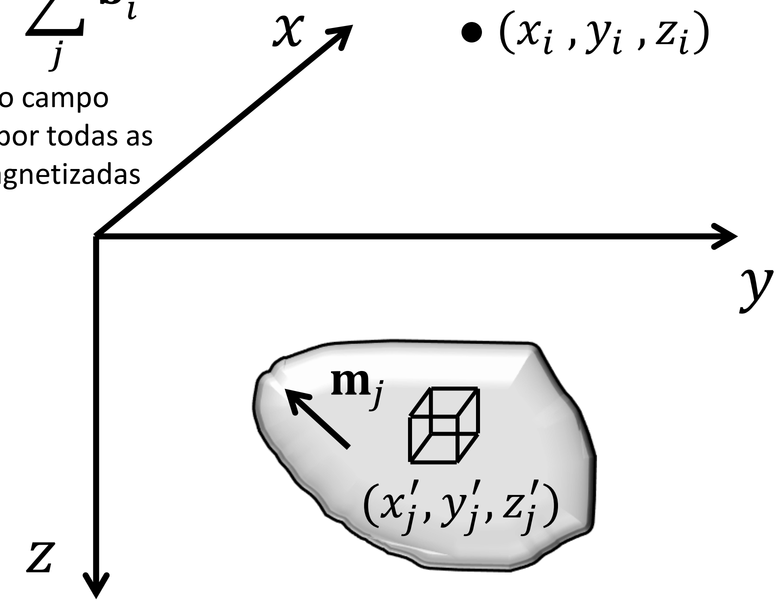

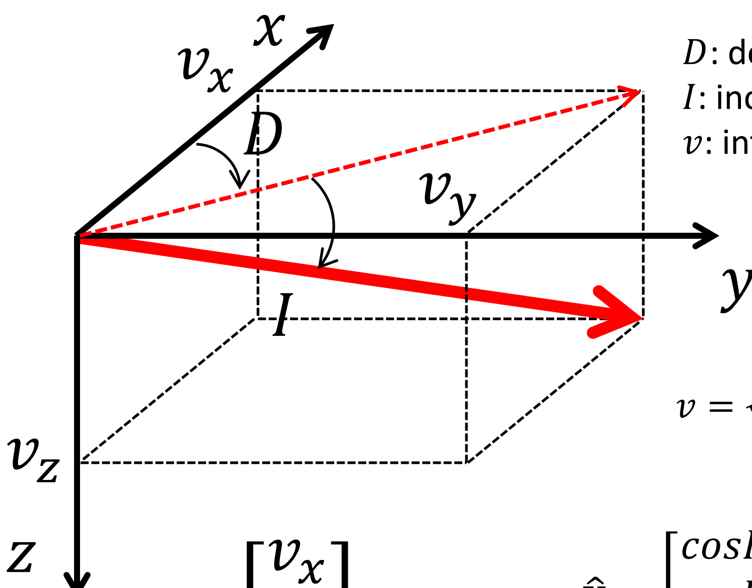

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Vetor unitário

(x_j', y_j', z_j') são as coordenadas de um elemento de volume $dxdydz$ dentro da j-ésima fonte

Considere uma que a j-ésima fonte tenha magnetização com direção constante

$$\mathbf{m}_j = m_j \hat{\mathbf{m}}_j$$

$$\mathbf{F}_i = F_i \hat{\mathbf{F}}_i$$

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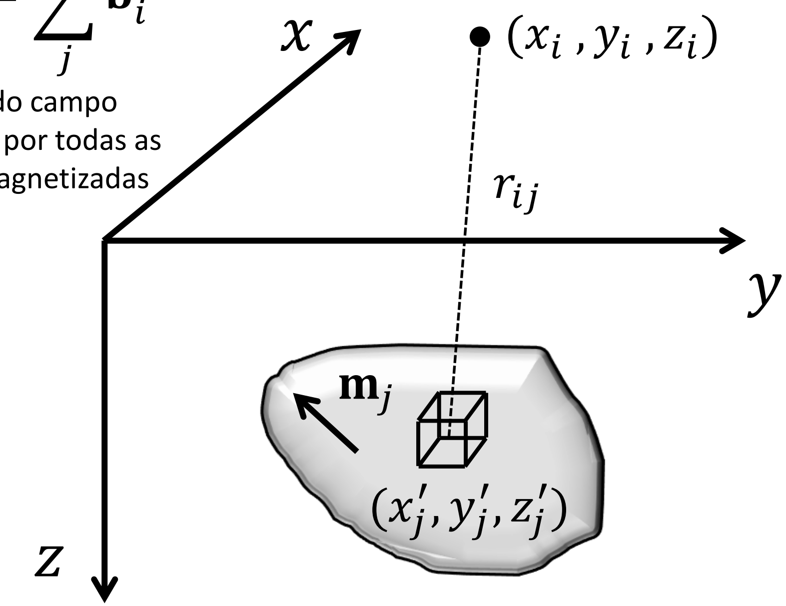

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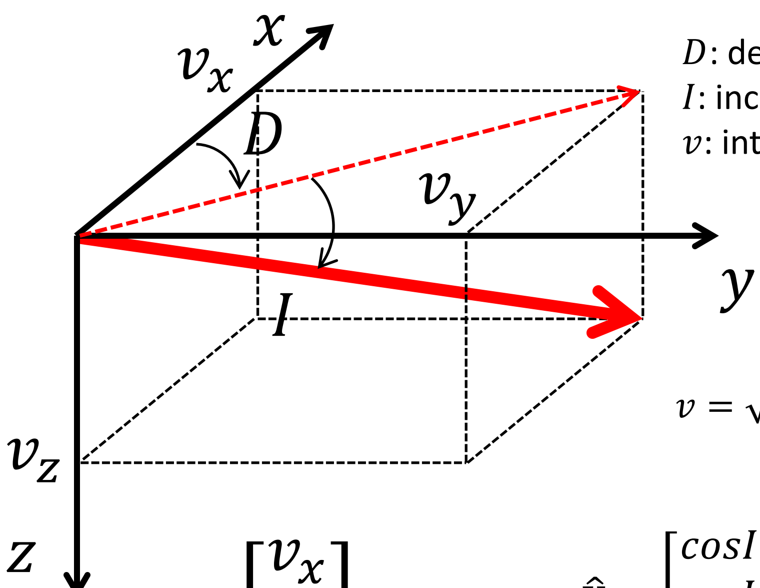
$$\Phi_i^j = \iiint_{v_j} m_j \frac{1}{r_{ij}} dv_j$$

A integral é avaliada
no volume da fonte

$$r_{ij} = \sqrt{\left(x_i - x_j'\right)^2 + \left(y_i - y_j'\right)^2 + \left(z_i - z_j'\right)^2}$$



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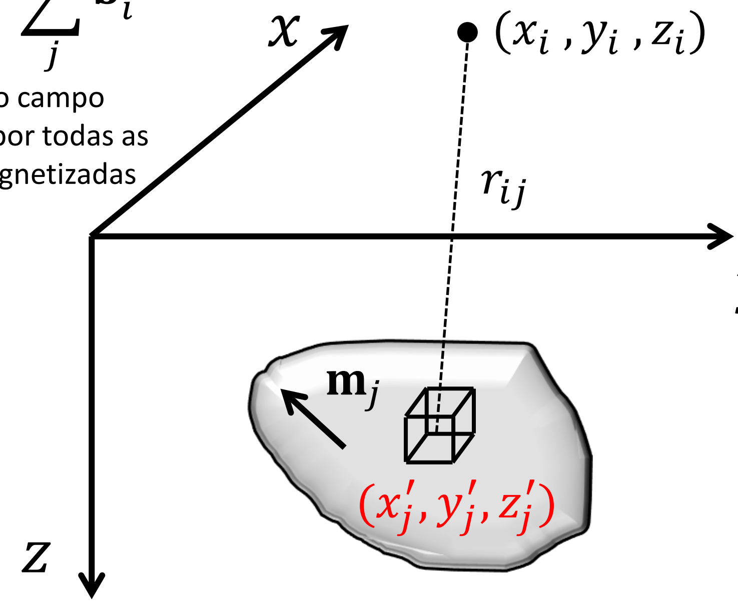

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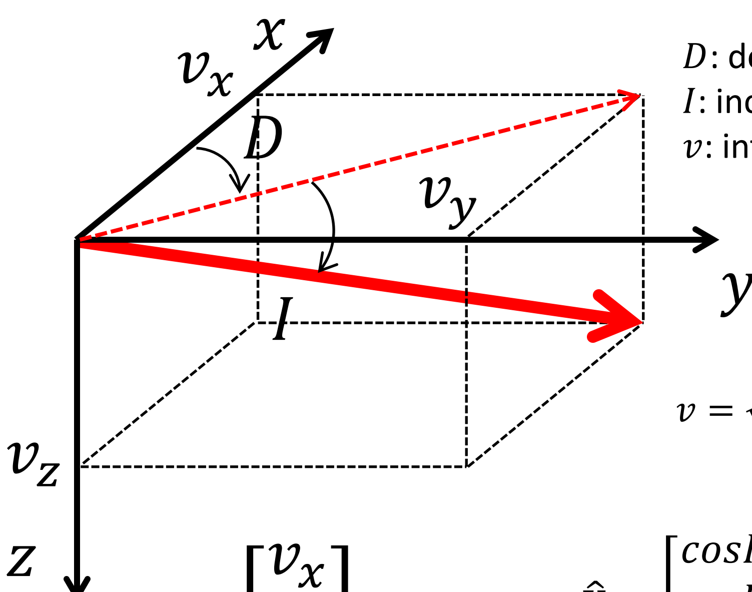
Variáveis de integração



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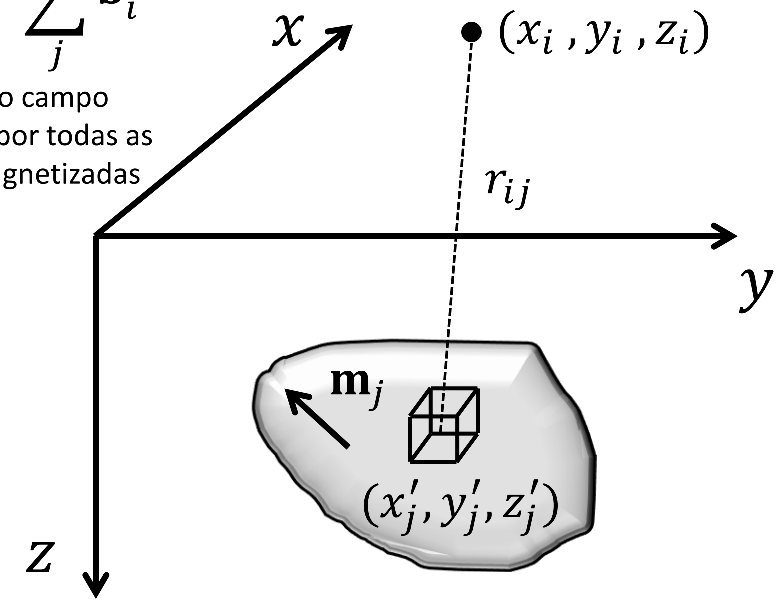

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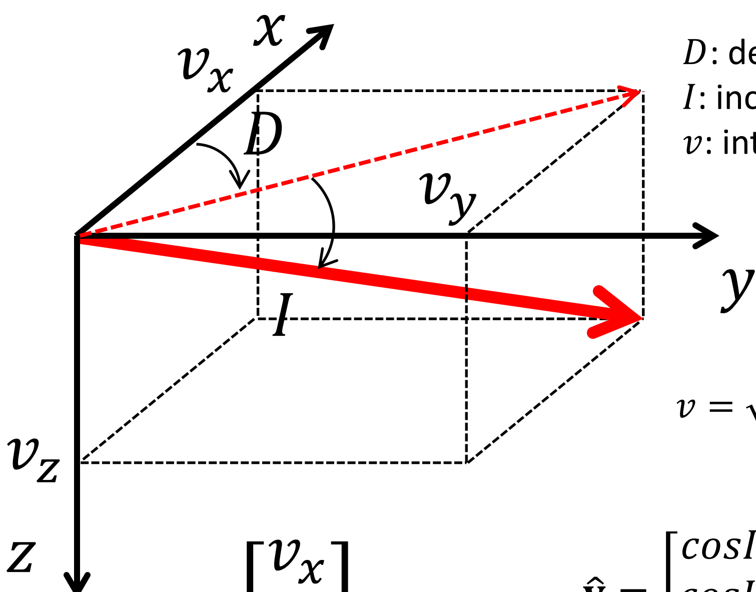

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$$\mathbf{b}_i^j = \kappa_m\, \mathbf{M}_i^j\, \hat{\mathbf{m}}_j \qquad \kappa_m = 10^9 \frac{\mu_0}{4\pi}$$

$$\mathbf{M}_i^j = \begin{bmatrix} \partial_{xx}\Phi_i^j & \partial_{xy}\Phi_i^j & \partial_{xz}\Phi_i^j \\ \partial_{xy}\Phi_i^j & \partial_{yy}\Phi_i^j & \partial_{yz}\Phi_i^j \\ \partial_{xz}\Phi_i^j & \partial_{yz}\Phi_i^j & \partial_{zz}\Phi_i^j \end{bmatrix}$$

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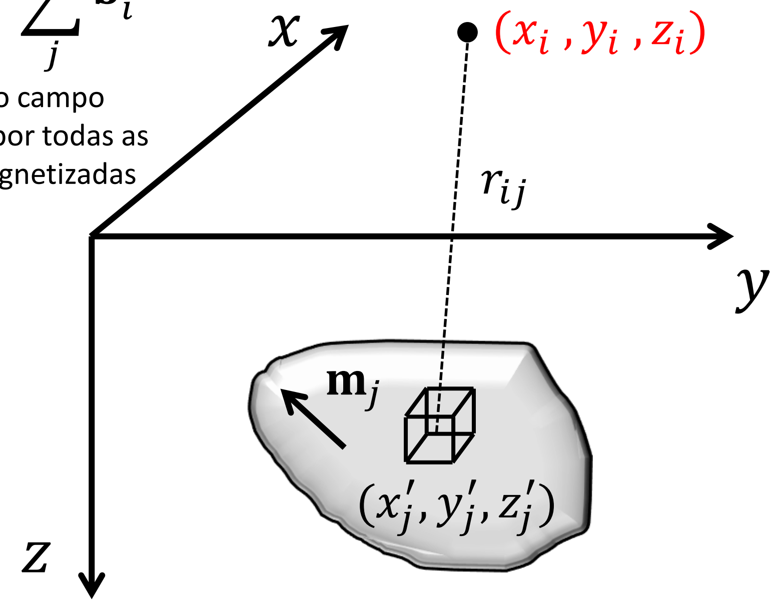

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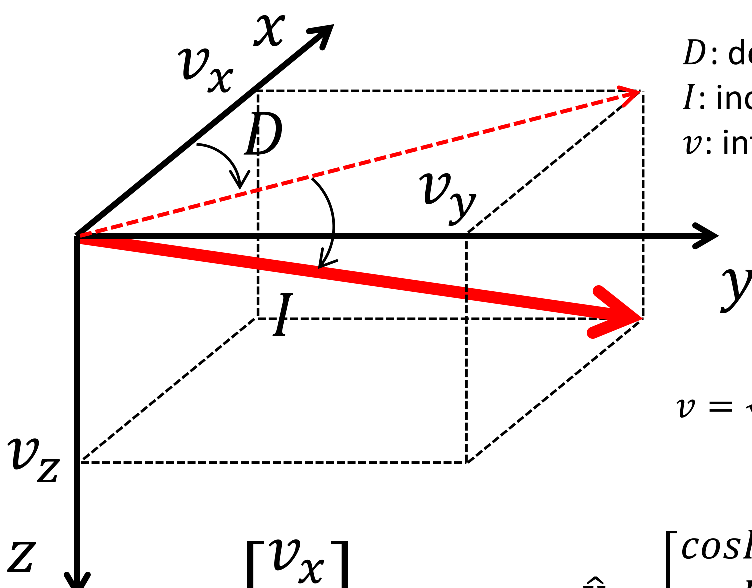

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As derivadas são
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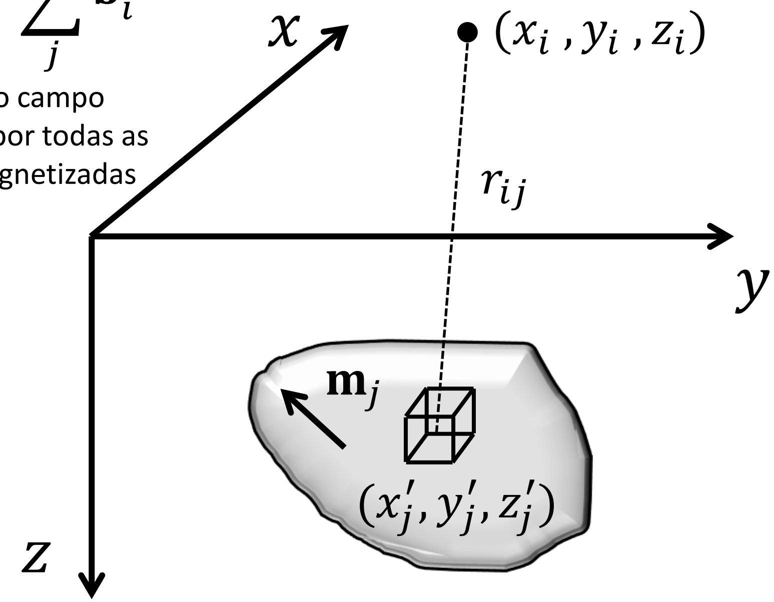

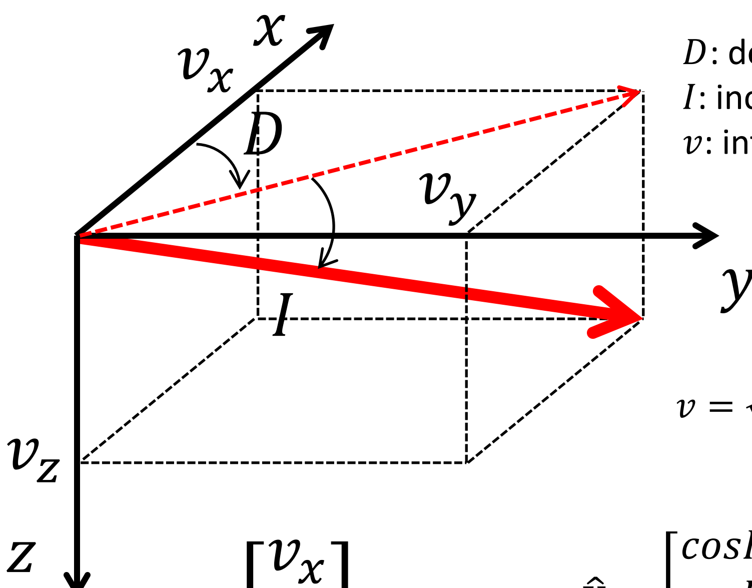

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Tente calcular os elementos desta matriz!

$$\boxed{\mathbf{M}_i^j = \begin{bmatrix} \partial_{xx}\Phi_i^j & \partial_{xy}\Phi_i^j & \partial_{xz}\Phi_i^j \\ \partial_{xy}\Phi_i^j & \partial_{yy}\Phi_i^j & \partial_{yz}\Phi_i^j \\ \partial_{xz}\Phi_i^j & \partial_{yz}\Phi_i^j & \partial_{zz}\Phi_i^j \end{bmatrix}}$$

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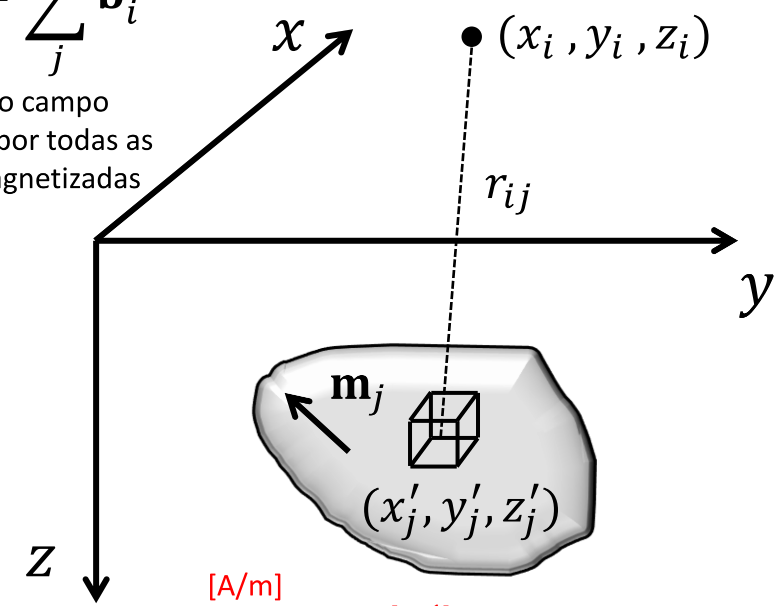

$$\underset{[\text{A m}]}{\Phi_i^j} = \iiint_{v_j} \overset{[\text{A/m}]}{m_j} \, \overset{[\text{m}^{-1}]}{\frac{1}{r_{ij}}} \, dv_j$$

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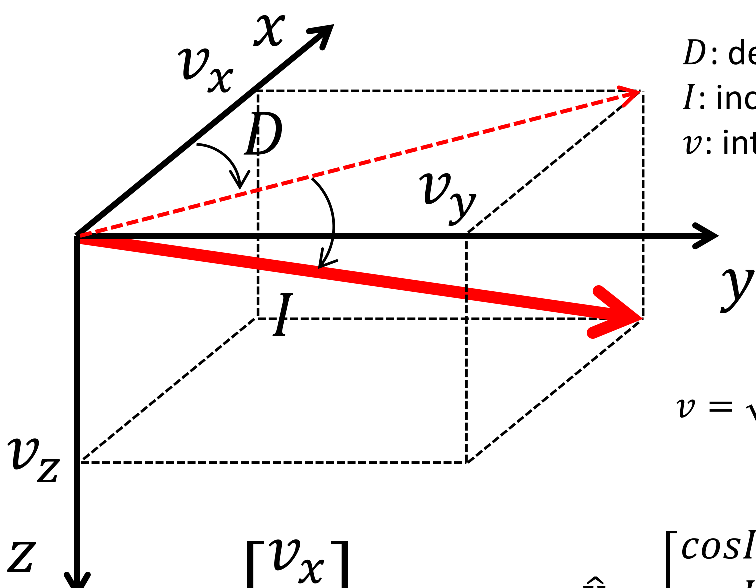
$$\underset{[\text{m}]}{r_{ij}} = \sqrt{\left(x_i - x'_j\right)^2 + \left(y_i - y'_j\right)^2 + \left(z_i - z'_j\right)^2}$$

$$\underset{[n\text{T}]}{\mathbf{b}_i^j} = \underbrace{\kappa_m \, \mathbf{M}_i^j}_{\substack{[10^9\text{H/m}][\text{A/m}] \\ n\text{T}}} \widehat{\mathbf{m}}_j$$

$$\underset{[10^9\text{H/m}]}{\kappa_m} = 10^9 \overset{[\text{H/m}]}{\frac{\mu_0}{4\pi}}$$

Converte
T para nT

$$\mathbf{M}_i^j = \begin{bmatrix} \partial_{xx}\Phi_i^j & \partial_{xy}\Phi_i^j & \partial_{xz}\Phi_i^j \\ \partial_{xy}\Phi_i^j & \partial_{yy}\Phi_i^j & \partial_{yz}\Phi_i^j \\ \partial_{xz}\Phi_i^j & \partial_{yz}\Phi_i^j & \partial_{zz}\Phi_i^j \end{bmatrix}$$



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Vetor unitário

$$\mathbf{F}_i = F_i \widehat{\mathbf{F}}_i$$

Campo principal
(por exemplo, IGRF)

$$\mathbf{B}_i = B_i \widehat{\mathbf{B}}_i$$

Campo crustal

$$\mathbf{T}_i = \mathbf{F}_i + \mathbf{B}_i$$

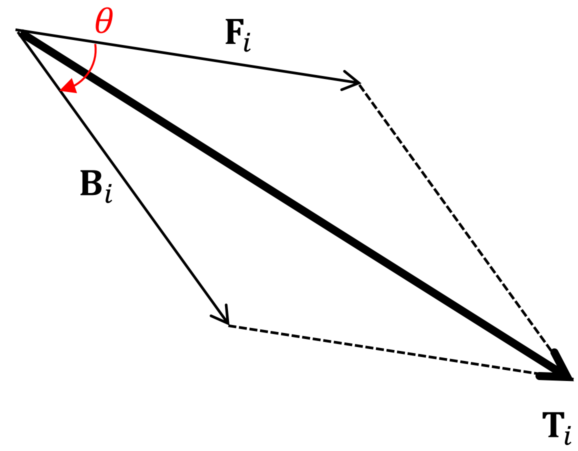
Campo total

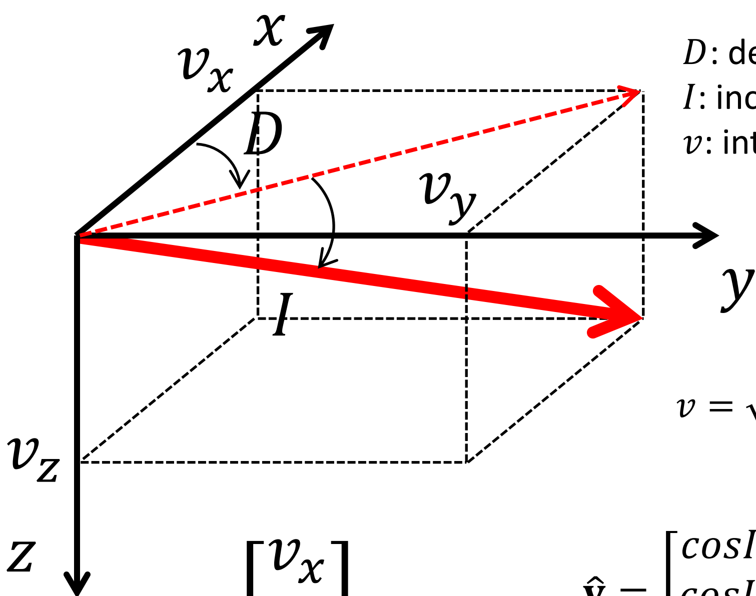
$$F_i \gg B_i$$

Condição observada
na prática

$$\Delta T_i = T_i - F_i$$

Anomalia de campo total





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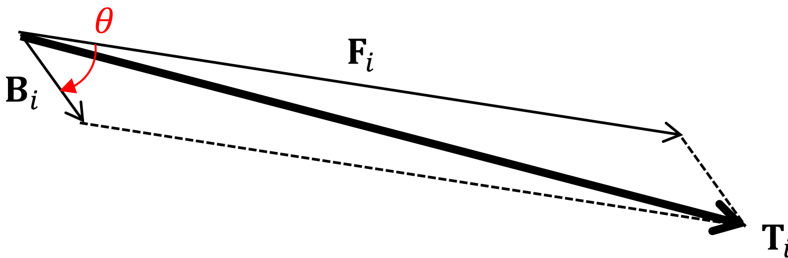

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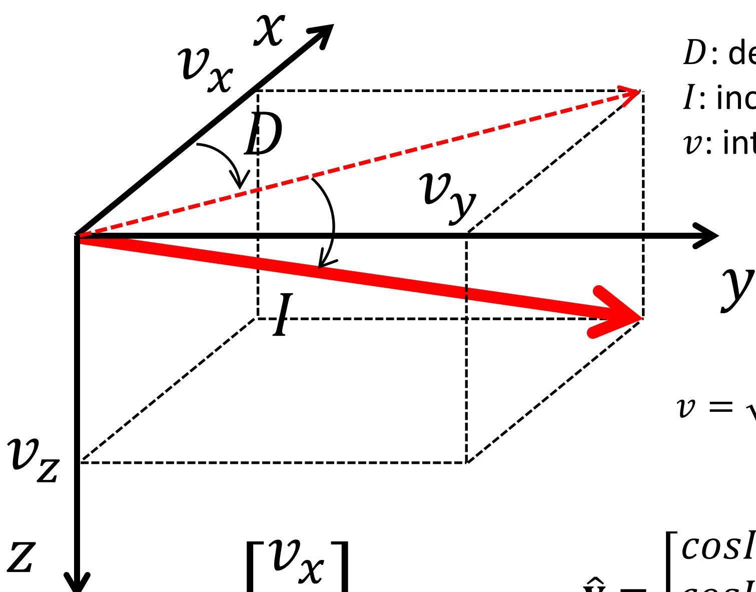

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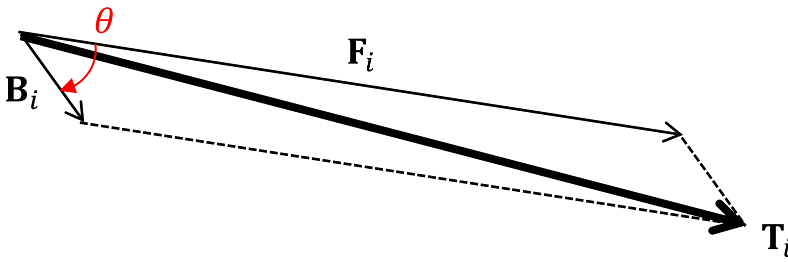

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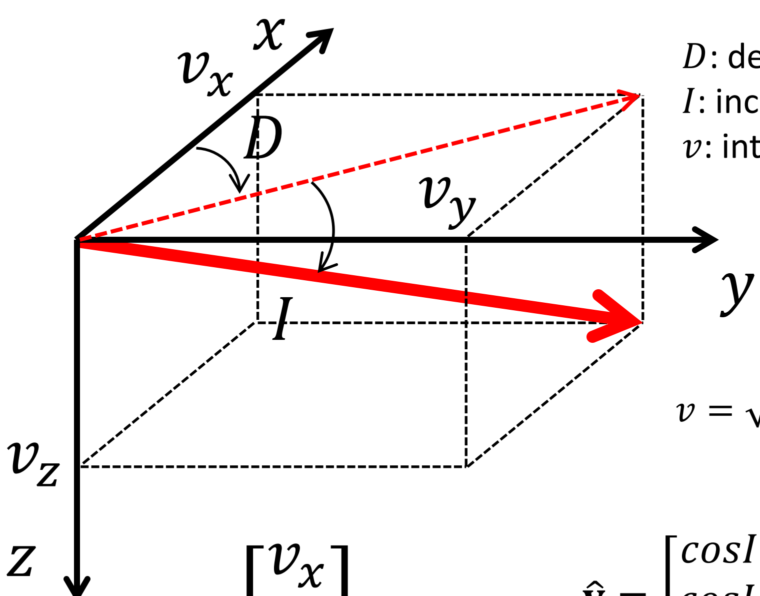

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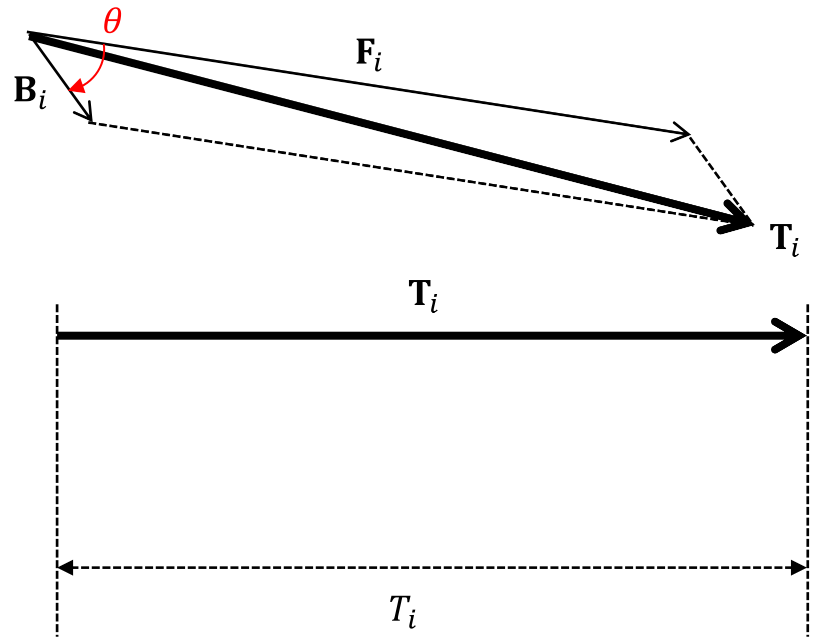

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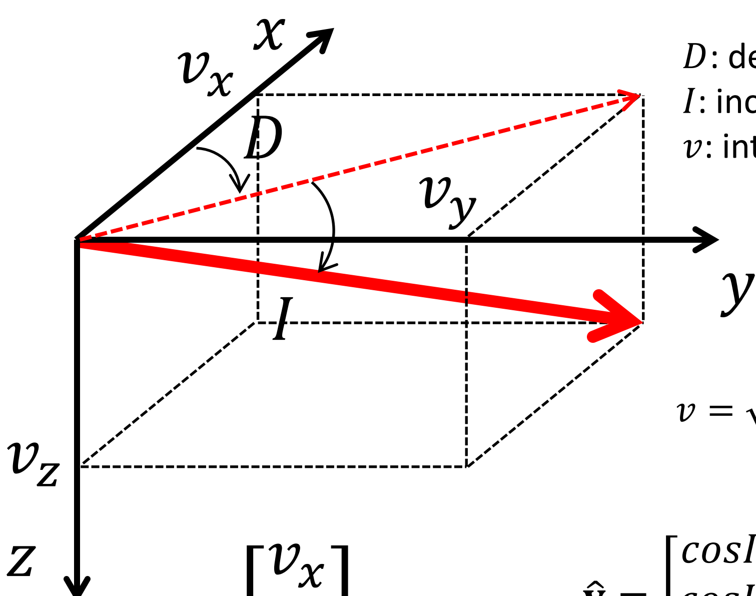

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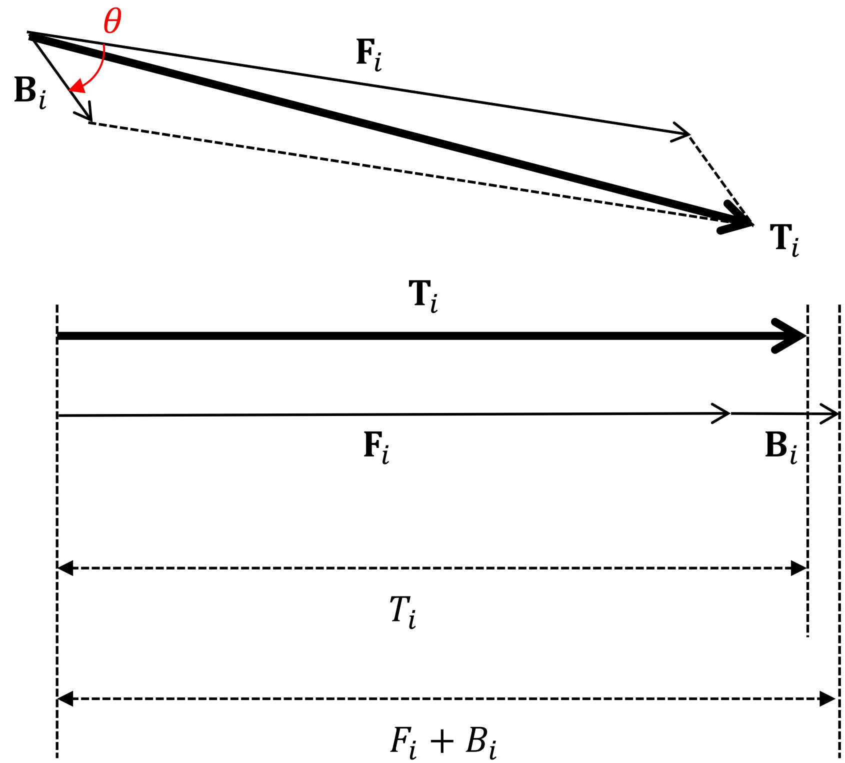
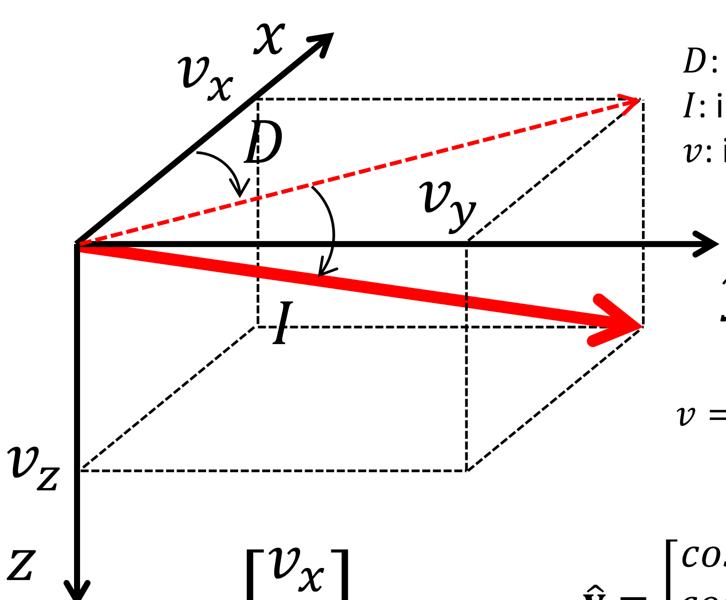


$$T_i \neq F_i + B_i$$



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Vetor unitário

Direção constante

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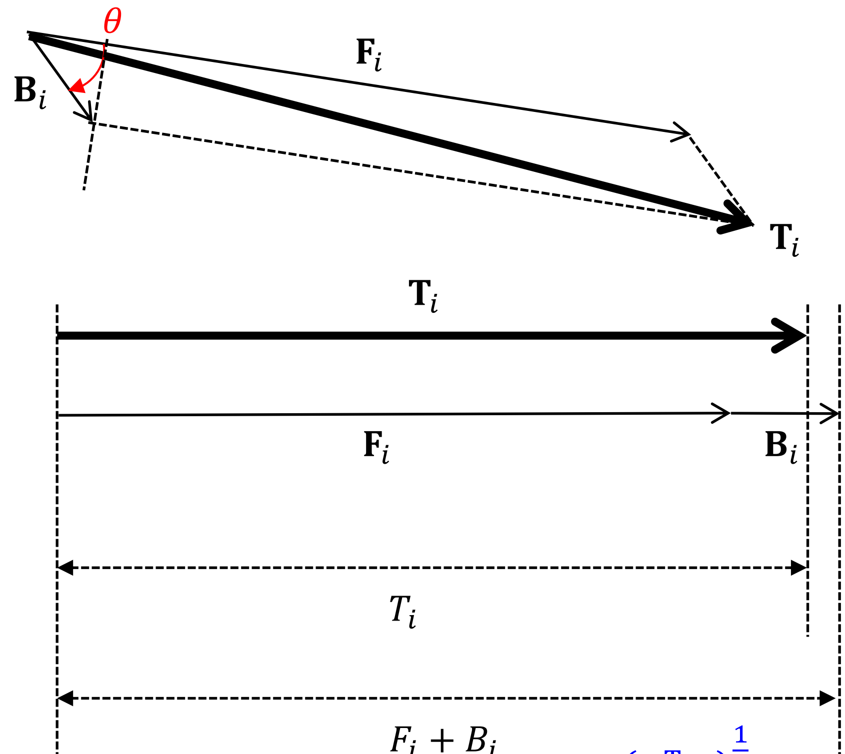

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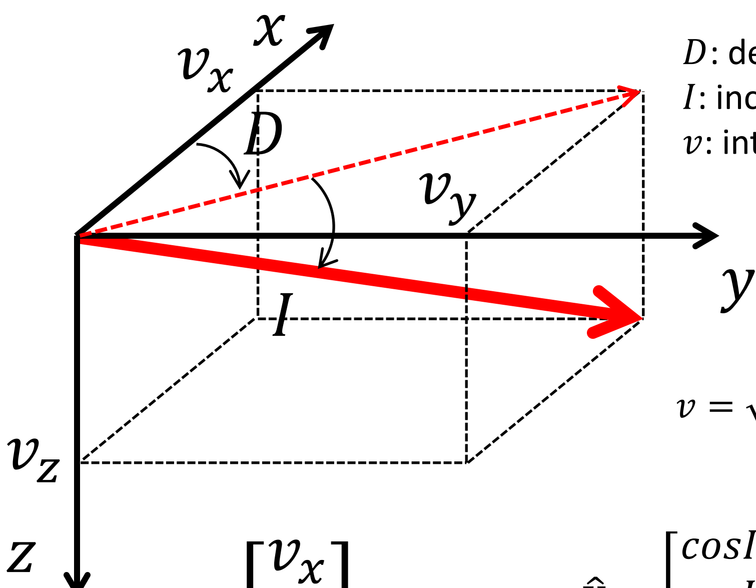

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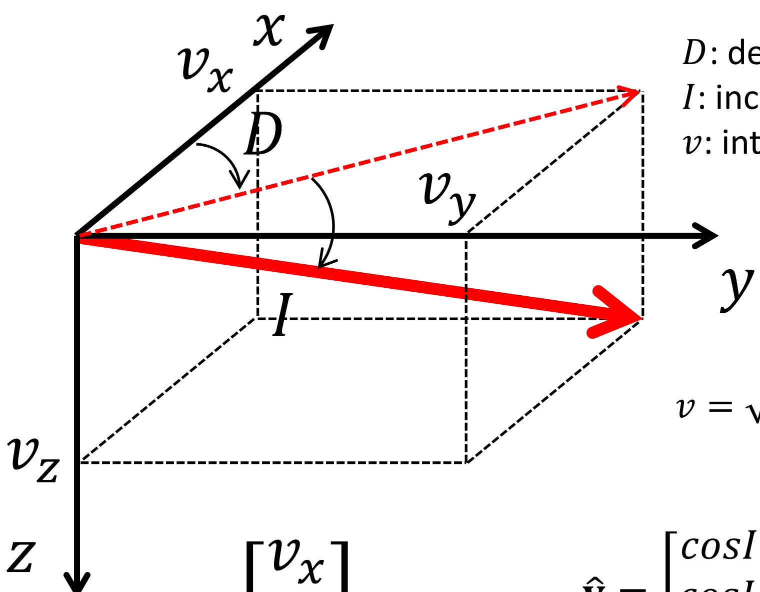

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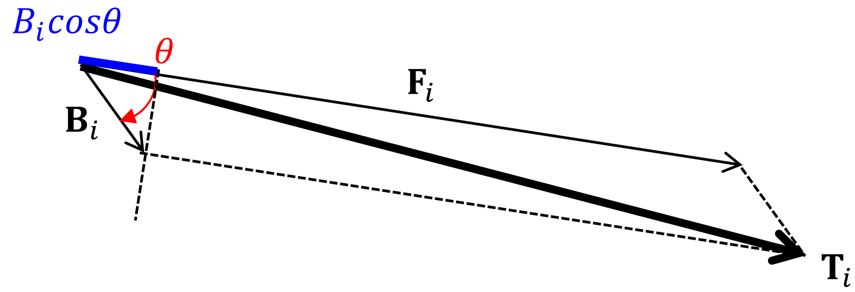

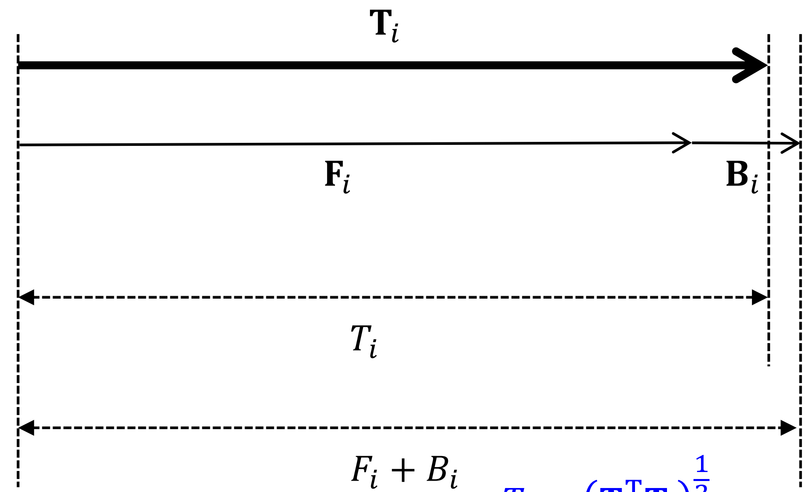

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Produto escalar

$$\boxed{\begin{aligned} \mathbf{v}^{\mathrm{T}}\mathbf{w} &= v_x w_x + v_y w_y + v_z w_z \\ &= v\ w\ cos\theta \end{aligned}}$$

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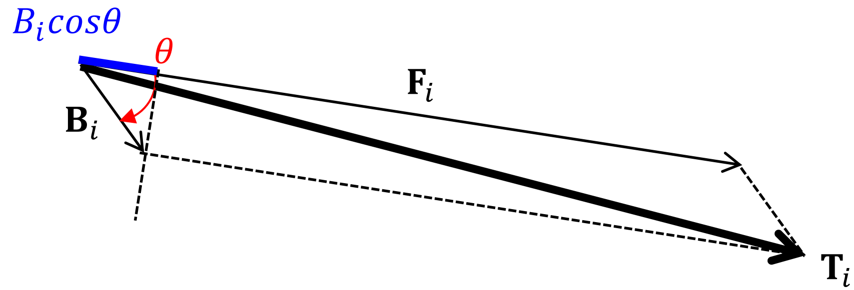

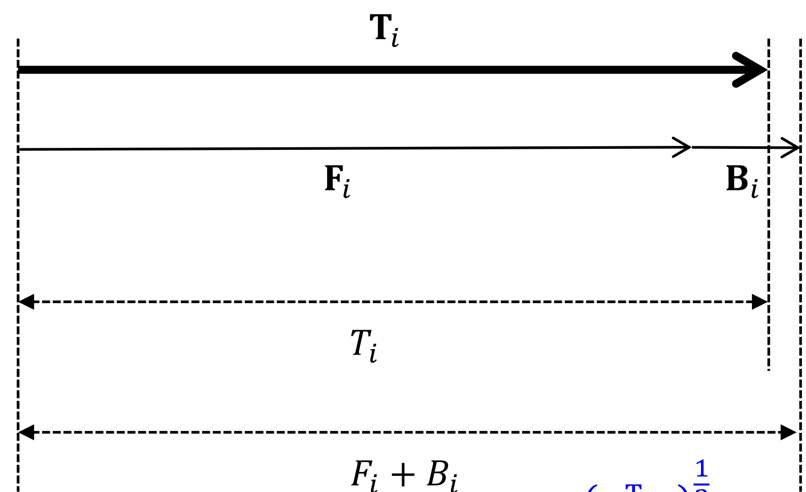

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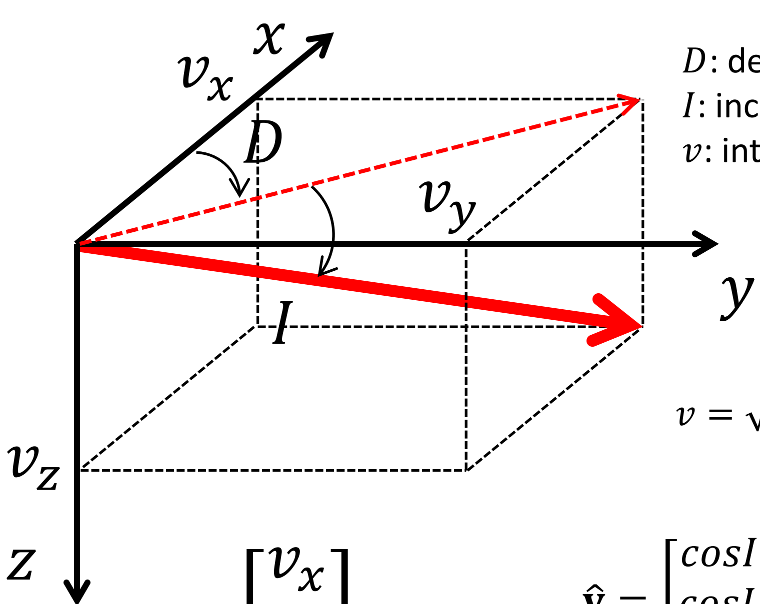

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Blakely (1996)
Langel e Hinze (1998)

Referências

- Blakely, R. J., 1996, Potential theory in gravity and magnetic applications: Cambridge University Press.
- Langel, R. A., e Hinze, W. J., 1998, The magnetic eld of the earth's lithosphere: The satellite perspective: Cambridge University Press.