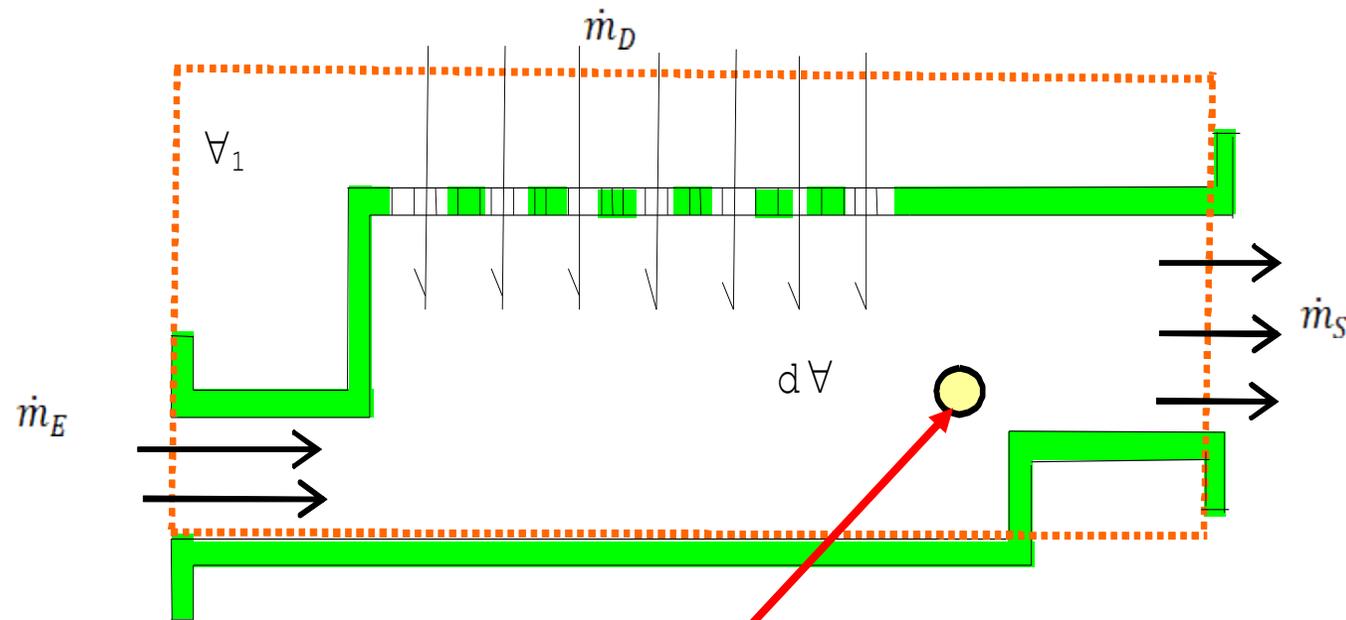


PQI 3203: FENÔMENOS DE TRANSPORTE I

Balço de massa diferencial

Mecânica dos Meios Contínuos – Hipótese do Contínuo



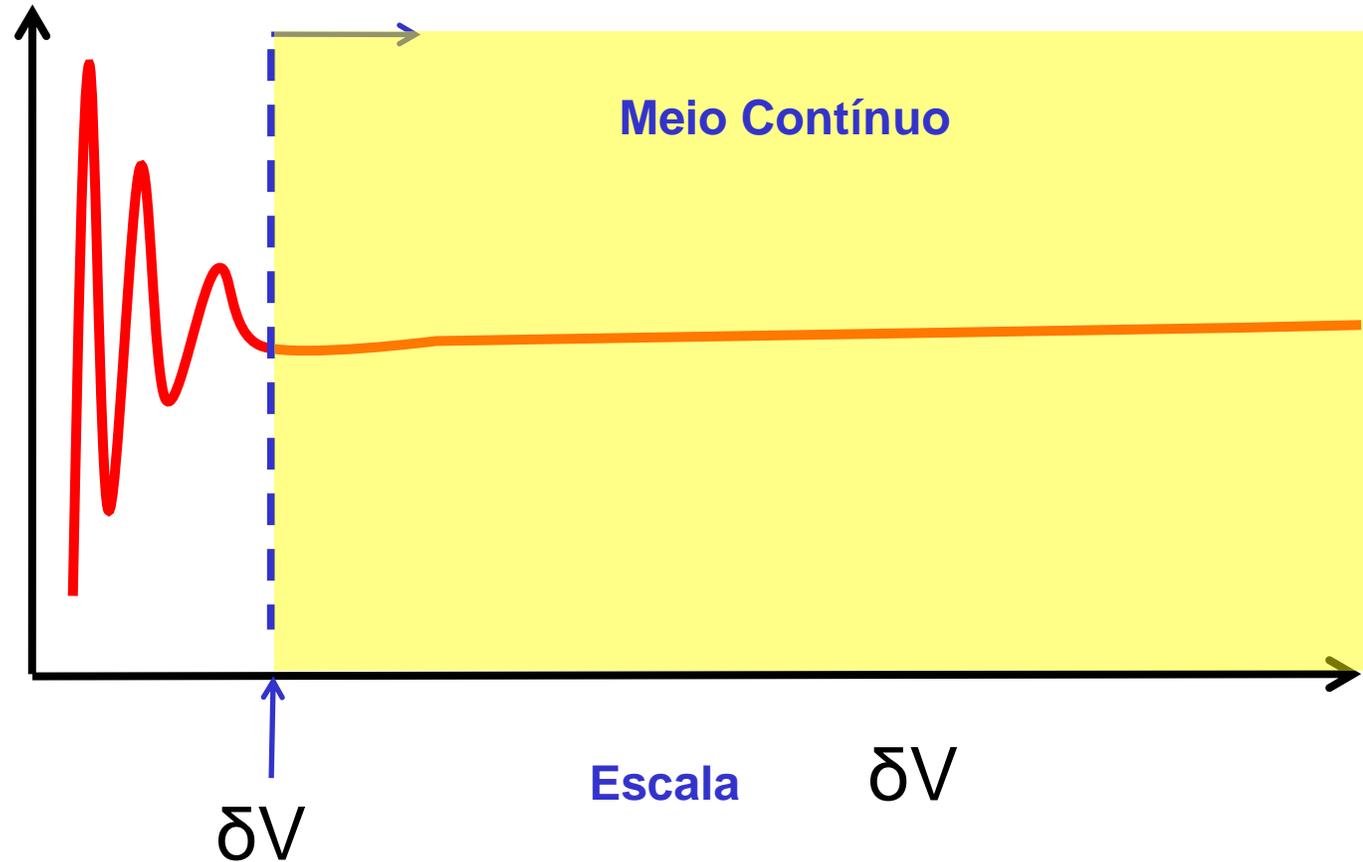
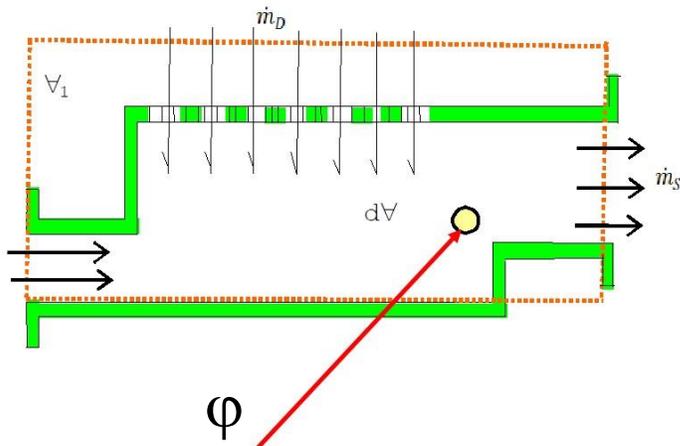
$\varphi, \dots, P, T, \vec{V}$

PQI 3203: FENÔMENOS DE TRANSPORTE I

Mecânica dos Meios Contínuos – Hipótese do Contínuo

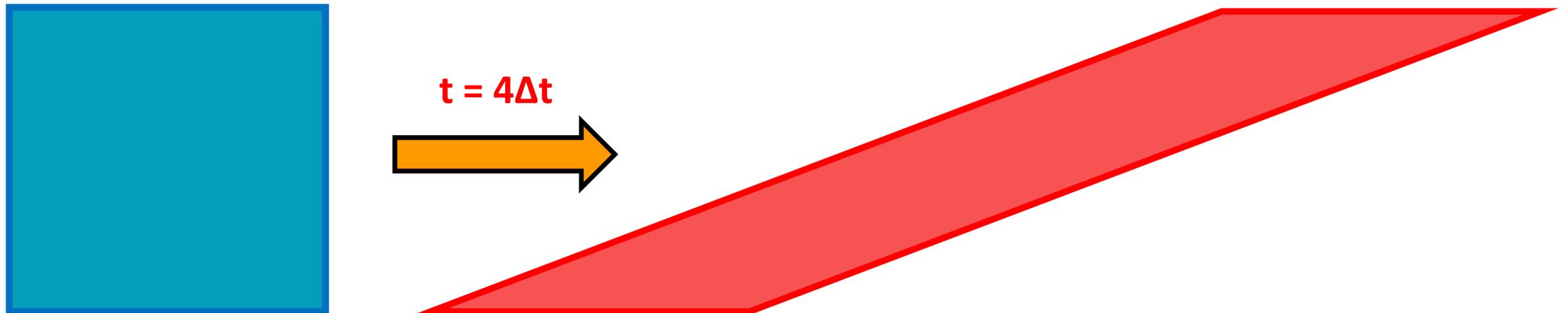
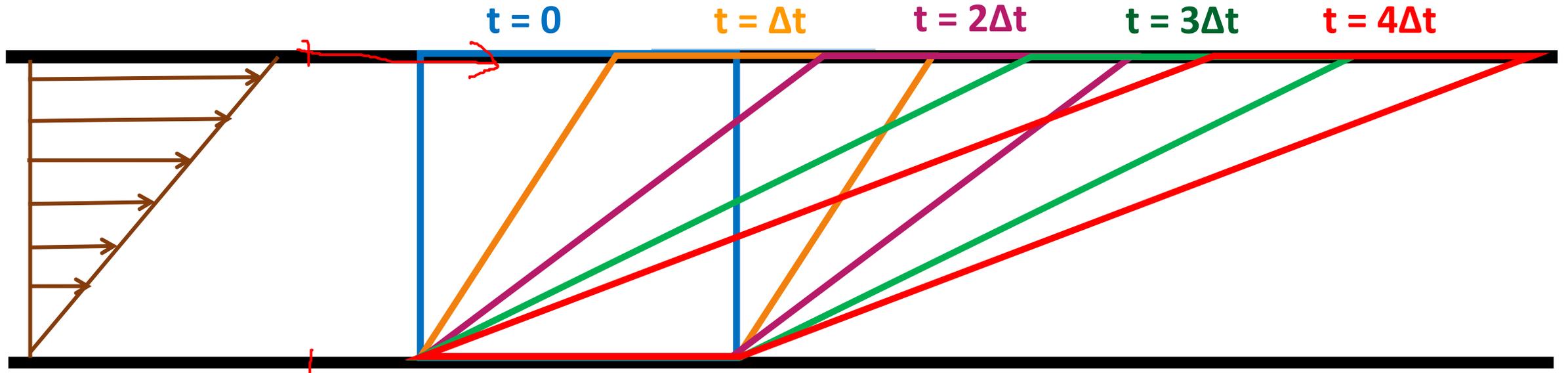
Propriedade

φ



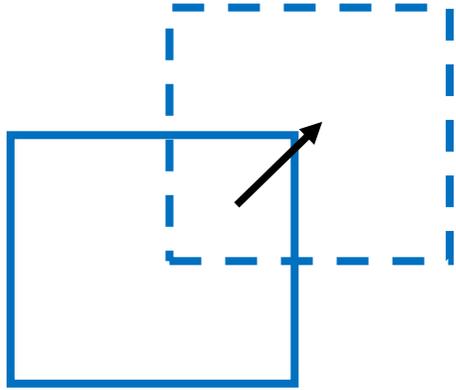
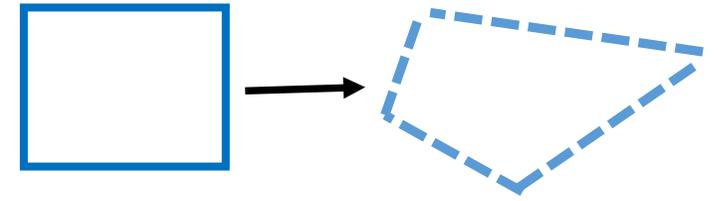
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Campo de velocidades - Deformação

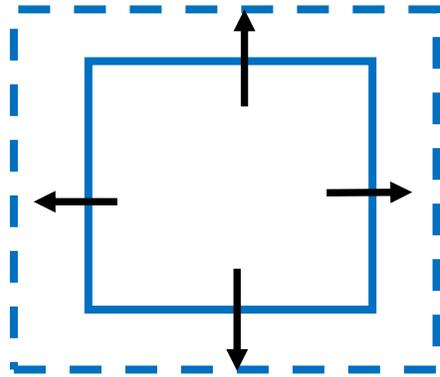


PQI 3203: FENÔMENOS DE TRANSPORTE I

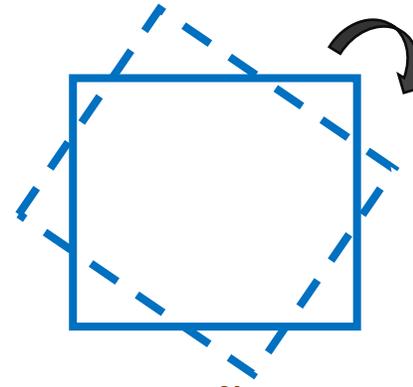
Campo de velocidades - Deformação



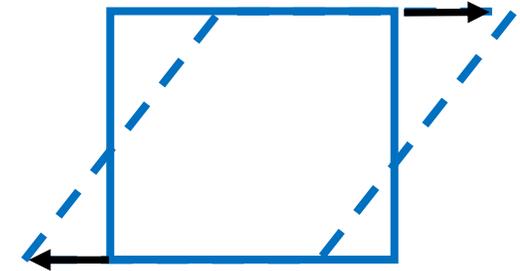
translação



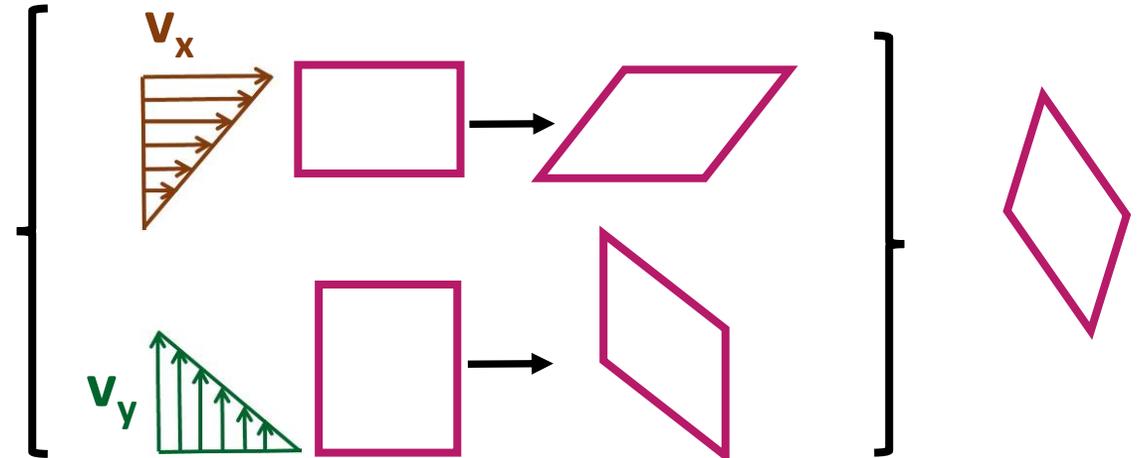
dilatação/contração



rotação

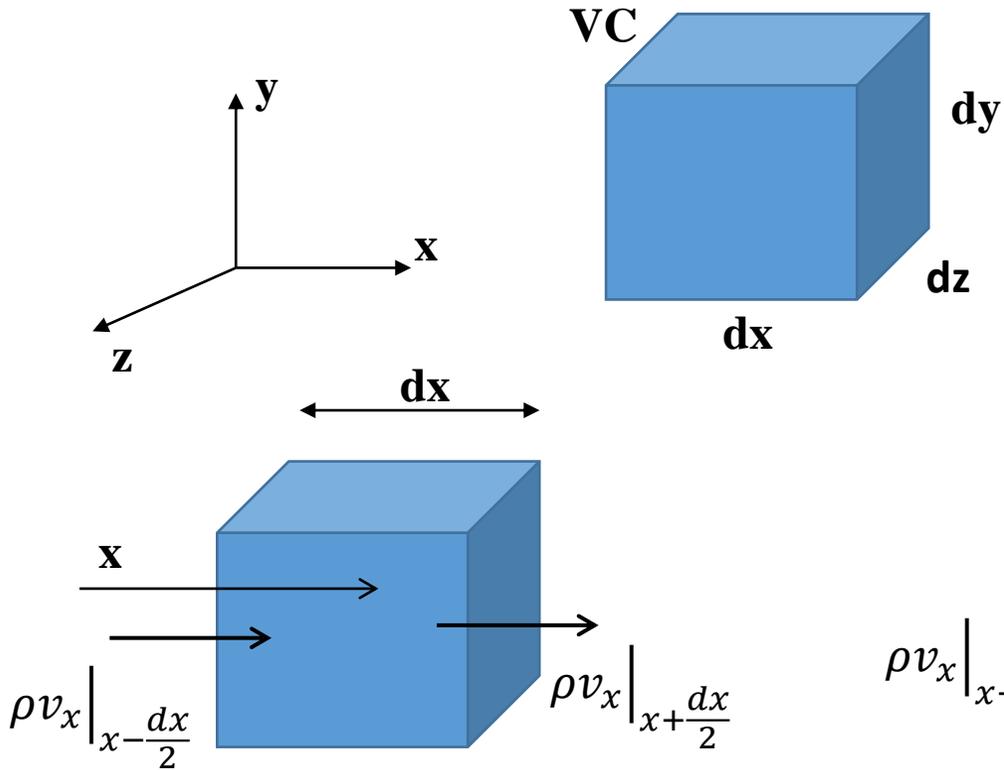


Cisalhamento simples



PQI 3203: FENOMENOS DE TRANSPORTE I

Balanço de massa microscópico



$$\left(\frac{\partial m}{\partial t}\right)_{VC} = \frac{\partial}{\partial t} \int_{VC} \rho dV = \left(\frac{\partial \rho}{\partial t}\right) dx dy dz$$

$$\left(\frac{\partial m}{\partial t}\right)_{VC} = d\dot{m}_e - d\dot{m}_s$$

$$\rho v_x \Big|_{x-\frac{dx}{2}} = \rho v_x - \left(\frac{\partial \rho v_x}{\partial x}\right) \frac{dx}{2}$$

$$\rho v_x \Big|_{x+\frac{dx}{2}} = \rho v_x + \left(\frac{\partial \rho v_x}{\partial x}\right) \frac{dx}{2}$$

$$f(x) = f(x_0) + \left(\frac{\partial f}{\partial x}\right) (x - x_0)$$

$$f\left(x + \frac{dx}{2}\right) = f(x) + \left(\frac{\partial f}{\partial x}\right) \left(x + \frac{dx}{2} - x\right)$$

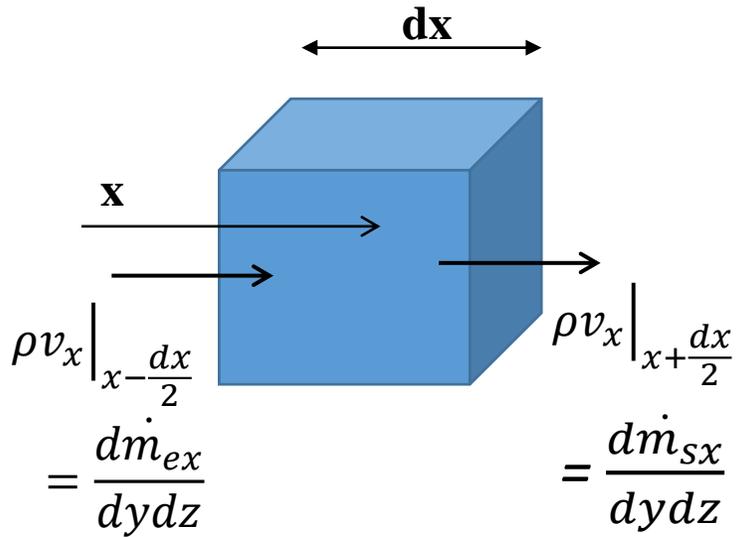
$$f\left(x + \frac{dx}{2}\right) = f(x) + \left(\frac{\partial f}{\partial x}\right) \left(\frac{dx}{2}\right)$$

PQI 3203: FENOMENOS DE TRANSPORTE I

Balanço de massa microscópico

$$\left(\frac{\partial m}{\partial t}\right)_{VC} = \frac{\partial}{\partial t} \int_{VC} \rho dV = \left(\frac{\partial \rho}{\partial t}\right) dx dy dz$$

$$\left(\frac{\partial m}{\partial t}\right)_{VC} = \dot{m}_e - \dot{m}_s = \left(\frac{\partial \rho}{\partial t}\right) dx dy dz$$



$$\frac{\dot{m}_{ex} - \dot{m}_{sx}}{dydz} = \rho v_x \Big|_{x-\frac{dx}{2}} - \rho v_x \Big|_{x+\frac{dx}{2}}$$

$$\frac{\dot{m}_{ex} - \dot{m}_{sx}}{dydz} = \rho v_x - \left(\frac{\partial \rho v_x}{\partial x}\right) \frac{dx}{2} - \rho v_x - \left(\frac{\partial \rho v_x}{\partial x}\right) \frac{dx}{2} = -\left(\frac{\partial \rho v_x}{\partial x}\right) dx$$

$$\dot{m}_{ex} - \dot{m}_{sx} = \left(\frac{\partial \rho}{\partial t}\right)_x dx dy dz = -\left(\frac{\partial \rho v_x}{\partial x}\right) dx dy dz$$

$$\dot{m}_{ey} - \dot{m}_{sy} = \left(\frac{\partial \rho}{\partial t}\right)_y dx dy dz = -\left(\frac{\partial \rho v_y}{\partial y}\right) dy dx dz$$

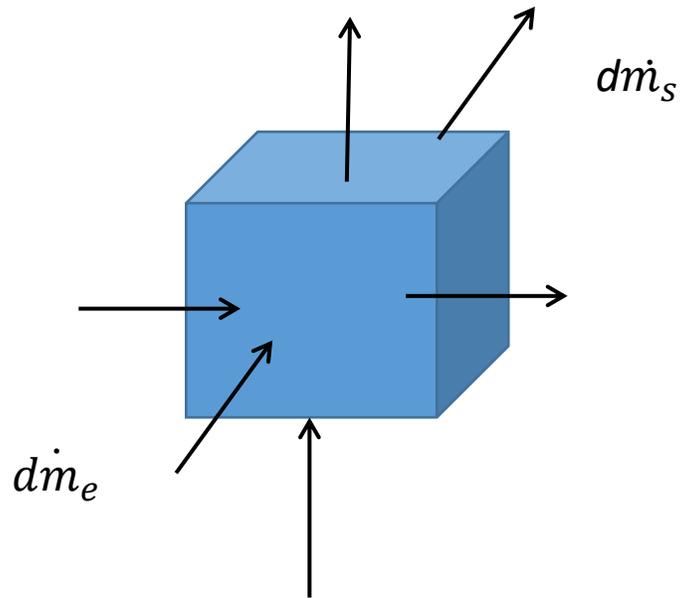
$$\dot{m}_{ez} - \dot{m}_{sz} = \left(\frac{\partial \rho}{\partial t}\right)_z dx dy dz = -\left(\frac{\partial \rho v_z}{\partial z}\right) dz dx dy$$

$$\dot{m}_e - \dot{m}_s = \left(\frac{\partial \rho}{\partial t}\right) dx dy dz = -\left(\frac{\partial \rho v_x}{\partial x} + \frac{\partial \rho v_y}{\partial y} + \frac{\partial \rho v_z}{\partial z}\right) dx dy dz$$

PQI 3203: FENÔMENOS DE TRANSPORTE I

Balanço de massa microscópico

$$d\dot{m}_e - d\dot{m}_s = \left(\frac{\partial \rho}{\partial t}\right) dx dy dz = - \left(\frac{\partial \rho v_x}{\partial x} + \frac{\partial \rho v_y}{\partial y} + \frac{\partial \rho v_z}{\partial z}\right) dx dy dz$$



$$\frac{\partial \rho}{\partial t} + \left(\frac{\partial \rho v_x}{\partial x} + \frac{\partial \rho v_y}{\partial y} + \frac{\partial \rho v_z}{\partial z}\right) = 0$$

$$\frac{\partial \rho}{\partial t} + \text{div}(\rho \vec{v}) = 0$$

$$\frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \vec{v}) = 0$$

Equação da continuidade