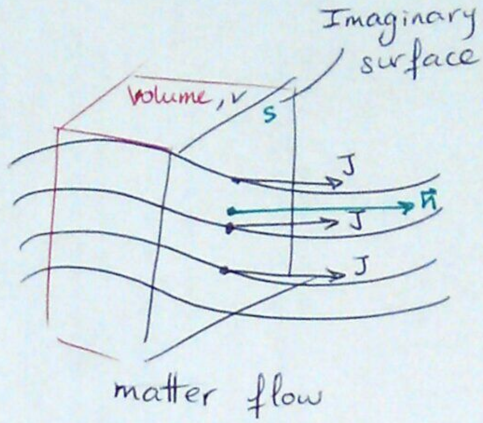
CONTINUITY EQUATION

$$\boxed{\frac{d\rho}{dt} + \underline{\nabla} \cdot \underline{J} = 0} \quad [A]$$



where ρ matter density

$\underline{J} = \rho \underline{v}$ current

$\underline{v}$ velocity of matter particles.

Over the volume:

① $$\int_V \frac{d\rho}{dt} dV = \frac{d}{dt} \int_V \rho \, dV \equiv \frac{d\,\text{MASS}}{dt}$$

This tells us how mass of the fluid changes in the volume.

② $$\int_V (\underline{\nabla} \cdot \underline{J}) dV \underset{\uparrow}{=} \int_S (\underline{J} \cdot \underline{n}) dS \equiv \text{flux of matter/particles passing through the surface S.}$$

Gauss' theorem

Therefore,

$$\boxed{\frac{d\,\text{MASS}}{dt} = -\int_S (\underline{J} \cdot \underline{n}) dS} \quad [B]$$

[A] & [B] are equivalent (one is the differenciated form and the other the integral form of the equation). However, from [B] it's easier to interpret that the <u>DIVERGENCE</u> of the current of particles means:

"The flux of particles flowing outwards the imaginary surface S is exactly equal to the amount of mass we lose in the volume V in some time t".