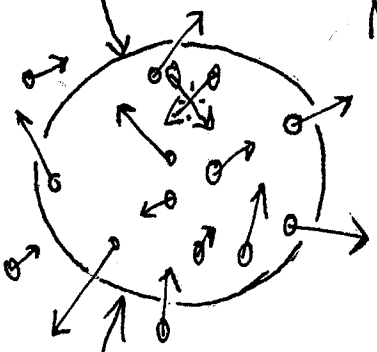
"FLUID PARCEL"

A small volume that keeps the same mass and moves (and deforms) with the fluid



Note: individual molecules pass across parcel boundary — gives rise to molecular diffusion

Volume V, mass m } parcel density $= \frac{m}{V}$

- much larger than mean free path (still tiny!)

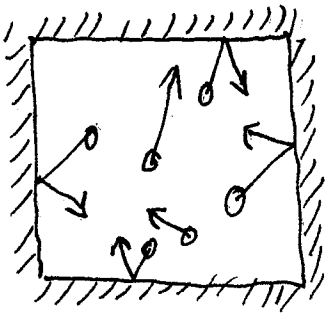
Considering all the parcels that make up a fluid, we can define the continuous density field:

$$\text{DENSITY} \equiv \frac{\text{mass}}{\text{unit vol.}} = \rho(\underset{\sim}{x}, t) \qquad [\text{kg m}^{-3}] \quad \text{scalar field}$$

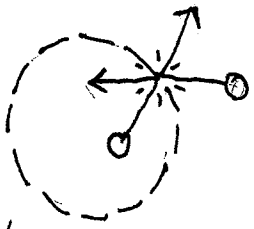
"defined as" "rho" $\underset{\sim}{x} = (x, y, z)$

PRESSURE

- the compressive force on a fluid parcel due to molecular collisions
- Consider a gas inside a box
- elastic collisions push out on box ∴ walls of box push in on the gas



- Same concept applies to a fluid parcel



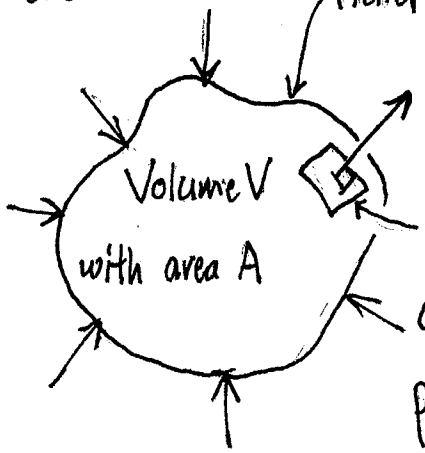
Considering this for all fluid parcels we can define the pressure field:

$$\text{PRESSURE} \equiv \frac{\text{normal compressive force}}{\text{unit area}} = p(\underset{\sim}{x}, t)$$

$$\left[\frac{kg\ m}{s^2}\frac{1}{m^2} = \frac{N}{m^2} = Pa \text{ "Pascal"}\right] \quad \text{scalar field}$$

★ Spatial variation of the pressure field exerts a force on fluid parcels

General case:



at any point on the surface pressure exerts a force $-p\hat{n}\,dA$

... this is a <u>vector</u> because we have defined <u>what area</u>, and hence <u>what direction</u> the pressure is acting on

Total force on the parcel due to pressure is

$$\underset{\sim}{F} = \int_A -p\hat{n}\,dA$$