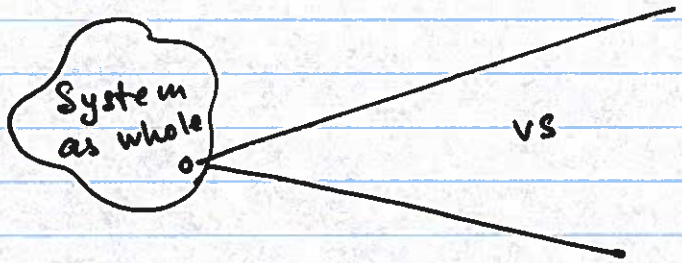
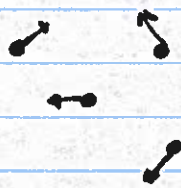
Macro vs micro description of the world

Macro



Micro



Combination of individual atoms/molecules

	Temperature	T
	Pressure	P
	Volume	V
Mass	Density	ρ [kg/m^3]
	Molar density	
	# of moles	n

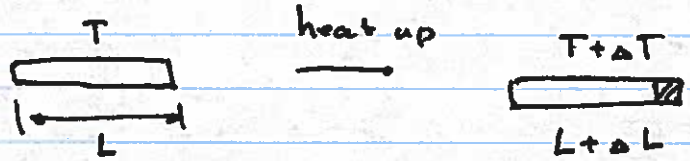
Number of atoms/mol.
Velocity distribution
atomic/molecular mass
motional degrees of freedo
inter-molecular interaction

Thermodynamics
more phenomenological
Macro world has the arrow of time

statistical mechanics
more ab-initio
Micro world is time-reversible

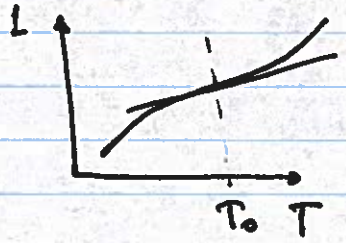
Interaction b/w particles make mieroscopic description more complicated, so for solids and liquids we tend to use phenomenological description

Thermal expansion



$$\frac{\Delta L}{L} = \alpha \Delta T$$

α – coefficient of linear expansion



slope $= \frac{dL}{dT} = \alpha$ around T_0

For liquids / isotropic solids $V \to V + \Delta V$

$$\frac{\Delta V}{V} = \beta \cdot \Delta T$$

β – coefficient of volume expansion

- Typically $\beta \approx 3\alpha$

$V = L^3$ $\quad V + \Delta V = (L+\Delta L)^3 = L^3 + 3\Delta L \cdot L^2 + \cancel{3(\Delta L)^2 \cdot L} + \cancel{(\Delta L)^3}$ small if $\Delta L \ll$

$L^3 = V^{\frac{3}{3}}$ $\quad 3\Delta L L^2 = 3V \frac{\Delta L}{L}$

$$\Delta V = 3V \frac{\Delta L}{L} = 3V \cdot \alpha \Delta T = (3\alpha) V \cdot \Delta T$$

Since the change in length / volume depends only on temperature difference, it does not matter if T is expressed in Kelvins or Celcius degrees, since

$1C = 1K$