Thermodynamics: study of macroscopic properties like pressure, temperature, heat flow, entropy

eg. $PV = nRT$

empirical - engineering?

Statistical Mechanics: study of many particles at once using averages, sums, etc.

microscopic

We can derive thermodynamics from stat. mech.

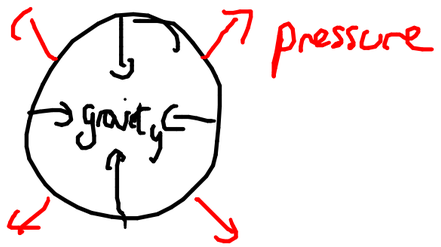
microscopic: individual pieces (grains of sand, cells, atoms, stars)

macroscopic: system in bulk (desert, organ, solid, galaxy)

Equilibrium

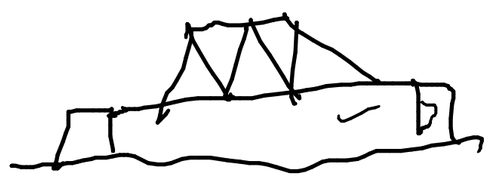
- in a star

forces balance one another



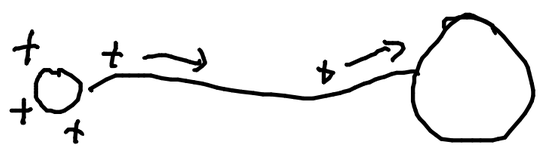
- static equilibrium — a bridge

forces & torques all balance



- electrostatic equilibrium

- charges will flow until all parts have the same potential



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equilibrium parameter : equal everywhere at equilibrium

Stable vs unstable equilibrium

~~if small perturbations do not cause~~

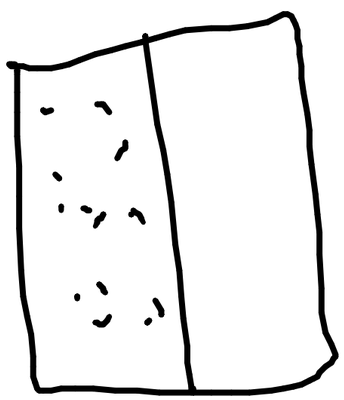
System returns to the same equilibrium state after a small perturbation, that is stable equilibrium

Systems not in equilibrium often approach stable equilibrium

time it takes to reach it is "relaxation time"

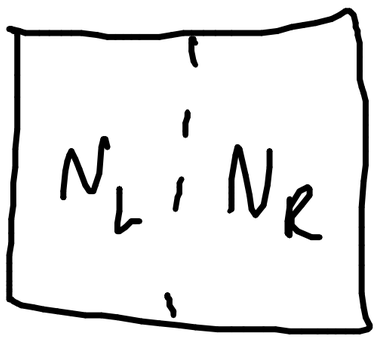
or... if it approaches exponentially $e^{-t/\tau}$

Diffusion or Diffusive Equilibrium



particles start on one side
move randomly without forces
eventually equal number of particles
on both sides

this is due to mathematics, not forces



particles that go $L \to R$
is proportional to N_L
particles that go $R \to L \propto N_R$

When $N_L > N_R$ more particles move $L \to R$
& $N_L \downarrow$ $N_R \uparrow$

& vice-versa

Until $N_L \simeq N_R$ flow rates are same.