1 Statistical description of systems of particles

Essential ingredients:

1. state of the system:
   - single spin-1/2 particle. $\uparrow, \downarrow$
   - a bunch of spin-1/2 particles. $\uparrow\uparrow\downarrow \dots$
   - a simple 1D Harmonic Oscillator: $E = (n + 1/2)\hbar\omega$, with states $|n\rangle$
   - a bunch of 1D HO: $|n_1, n_2, \dots, n_N\rangle$
2. Statistical ensemble: Instead of a simple experiments, we consider an exsemble of many exps.
3. Basic postulate about a priori probabilities (relative prob of finding the system in any of its accessible states)
4. Calculate probabilities

Example: 3 spin-1/2

State	Spin	Energy	$\Omega(E)$	$y_k = \uparrow, \downarrow$
$\uparrow\uparrow\uparrow$	3/2	$-3\mu H$	1	$\Omega(-\mu H, \uparrow)$
$\uparrow\uparrow\downarrow$	1/2	$-\mu H$	3	
$\uparrow\downarrow\uparrow$				
$\downarrow\uparrow\uparrow$				
$\uparrow\downarrow\downarrow$	-1/2	μH	3	
$\downarrow\uparrow\downarrow$				
$\downarrow\downarrow\uparrow$				
$\downarrow\downarrow\downarrow$	-3/2	$3\mu H$	1	

Table 1: Energy levels of 3 spin-1/2 particles

System: *isolated*: energy cannot change *equilibrium*: prob of finding the system in any one accessible state is constant in time

A fundamental postulate:

$\boxed{\text{An isolated system in equilirbium is equally likely to be in any of its accessible states}}$

In calculating probabilities, e.g., isolated system with energy in range $[E, E + \delta E]$
$\Omega(E)$: total number of states of the system in this range
$\Omega(E, y_k)$: in this energy range and some other property y_k where the probability of having this property is

$$P(y_k) = \frac{\Omega(E, y_k)}{\Omega(E)}$$

Density of states (DOS)

$$\Omega(E) = w(E)\mathrm{d}E, \quad w(E) \sim E$$

where $w(E)$ is the density of states.