Quiz Review

Identical particles vs Distinguishable Particles:

~~Bos~~

Identical particles:
- Bosons – Symmetric wavefunction
- Fermions – Antisymmetric wavefunction

Distinguishable particles: Direct product wavefunction

Consequences: 2 fermions cannot ~~be placed~~ have same wavefunction

Example problem:

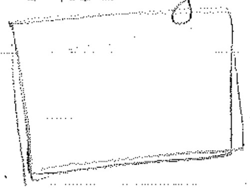
Three particles in 1D harmonic oscillator problem.
Determine ground state energy & degeneracy.

$E = (n + \tfrac{1}{2})\hbar\omega$ (ground)

Bosons: $3\hbar\omega$ ← Degeneracy: 1 (spinless)
Fermions: $6\hbar\omega$ ← Degeneracy: 1 (spinless)
Distinguishable: $3\hbar\omega$ Degeneracy (depends on spin)
(spin 0 : 1, spin $\frac{1}{2}$: 8)

spin $\frac{1}{2}$ fermions: $4\hbar\omega$ Degeneracy = 2

Closed system



definite ϵ

↳ gives accessible no. of microstates satisfying requirement of total energy ϵ.
(find all state)

Energy of sorts

example:

1spin: $\mathcal{H} = -mB$

$+B/2$ ——— $|\downarrow\rangle$

$-B/2$ ——— $|\uparrow\rangle$

$\epsilon = -\frac{B}{2}$ or $\epsilon = +\frac{B}{2}$

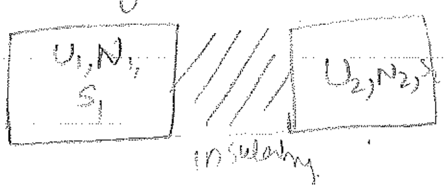
2spins: depending on distinguishability / bosonic / fermion different energies are allowed.

N spin problem discussed in class

$$g = \frac{N!}{N_\uparrow! \, N_\downarrow!}$$

Thermal Equillibrium, Entropy, Temperature

Consider 2 systems



Total energy : $U = U_1 + U_2$

Entropy : $S_1 + S_2$

Why? $g(N_1)$ accessible states in 1, $g(N_2)$ accessible states in 2

Total accessible states in combined system: $g(N_1)g(N_2)$

$\log g(N_1)g(N_2) = \log g(N_1) + \log g(N_2)$

$= S_1 + S_2$

Now bringing to thermal equilibrium

$$U = U_1 + U_2$$
$$= U_1' + U_2'$$

~~condu~~
thermal contact
(allows energy exchange)

Now what is the accessible states of whole system?

Now we know what it is when U_1' & U_2' are fixed

$$\longrightarrow \quad g(N_1, U_1')\, g(N_2, U_2')$$

When they are not, all the states must be allowed!

$$g(N, U) = \sum_{U_1'} g(N_1, U_1')\, g(N_2, U - U_1')$$

For large N_1 approx

$$g(N\,U) \approx \left(g(N_1, U_1')\, g(N_2, U - U_1') \right)_{max}$$

which gives you $g(N,U)$

[illegible] $g(N,U)$