Phys 114 **Week 6: Amy's reading advice** **2021**

My observations about reading this week:

1. You can get the homework done with a modest amount of reading, shared between the two books, or even just read G&T.

Reading about **simulations can only be found in G&T Ch. 4**. However, there are some gems in B&B which I'll describe below.

2. B&B has a ton of great examples. Ones which I don't think G&T has:

- Isothermal atmosphere: Ch. 4.7
- Fusion in the sun must happen with tunneling, since $e^{-E/kT}$ is too tiny for it to happen via thermodynamics: Ch. 4.7
- Maxwell-Boltzmann velocity distribution give Doppler broadening of spectral lines: Ch. 5.3
- System with a finite number, N, of equally-spaced energy levels: Ch. 20.1
- Spin 1/2 paramagnet (which G&T Ch. 5 will do, but we'll get to it later ...) leading to "Curie's law": $\chi \sim 1/T$: Ch. 20.4
- A molecule with translations, rotations and vibrations: Ch. 20.1 and 21.6
- Brownian motion: Ch. 19.4

3. B&B organizes info that, while it exists in G&T, is concisely described. For example:

- A one-and-done treatment of Maxwell-Boltzmann and Maxwellian distributions: Ch. 5
- Equipartition and how it applies to heat capacities, C. There is an excellent emphasis on
  - "frozen" degrees of freedom ... which don't contribute to C if $kT << \Delta E$, a quantum energy step between two levels: Ch. 19
  - the "Schottkey anomaly" where C peaks because around that temperature, a new flock of states becomes accessible: Ch. 20
- Everything you could want to know about the Canonical ensemble's semiclassical ideal gas: Ch. 21

4. B&B has info that exists subtly in G&T, or would take a little deriving to get to from G&T. For example:

- Diatomic molecule rotation, both classically for equipartition argument: Ch. 19 and quantum mechanically: Chs. 20, 21
- Calculating thermodynamic quantities from Z: Ch. 20.2
- Showing us that even though (T,V,N) are the "natural variables" for Z and its free energy, F ... you can still calculate pressure P, enthalpy H, Gibbs free energy, G in the Canonical ensemble.
- Pulling together the idea that $Z(T,V,N) = (1/N!)\, Z_{trans} Z_{rot} Z_{vib}$ for a set of semiclassical, indistinguishable diatomic molecules

5. B&B has some notation and ways of thinking about concepts that may be helpful to you. For example:

- They call the deBroglie wavelength λ_{th}, and they introduce the 3 dimensional concept of the "quantum volume", $n_Q = \lambda_{th}^3$. In terms of n_Q, partition functions for the ideal gas are delightfully simple to write down: Ch. 21.2.
- Using deBroglie wavelength as shorthand, various thermo quantities for the ideal gas are much easier to express: Ch. 21.4
- There is an argument leading to g(k) dk in Ch. 21.1. I find it much less klunky than going through the variables n_x, n_y, n_z as G&T

in order to, e.g., find $\Gamma(E,V,N)$ in their Ch. 4. But it is happily these are equivalent. That is:

$$Z_1 = \int_0^\infty e^{-\beta E} g(E)\, dE = \int_0^\infty e^{-\beta E(k)} g(k)\, dk$$

where $E(k) = \frac{\hbar^2 k^2}{2m}$

B & B find $g(k)\, dk = \frac{V k^2}{2\pi^2}\, dk$

This agrees with expression using E:

$\boxed{g(k)\, dk = g(E)\, dE}$, with $dE = \frac{\hbar^2 k}{m}$

Q/ Where do we find $g(E)$?

A/ Look in G & T ch. 4 where we talked about microcanonical ensemble. There:

$$\Gamma(E) = \frac{V}{h^3}\frac{4\pi}{3}(2mE)^{3/2}$$

$$\Rightarrow g(E) \equiv \frac{d\Gamma(E)}{dE} = \frac{V 2\pi}{h^3}(2m)^{3/2} E^{1/2}$$