Phys 114 **Week 10: Amy's reading advice** **2021**

My observations about reading this week: Schroeder *or* **B&B** might be the one-stop reading, if that's all you have time for this week. If you read B&B, Sections 30.1 and Appendices C.4 and C.5 are skippable.

1. **Schroeder sections 7.2, 7.4 and 7.5** might be your first choice, if you like his style of being gentle and tutorial, and giving a lot of background without focusing so much on mathematical aspects.

• **7.2** is a has a low key, super clear path from the Grand canonical ensemble to the FD and BE partition function and occupation numbers for a single energy state. Fig. 7. shows FD, BE and MB occupation numbers a function of a single particle energy, ε, with μ and kT clearly marked.

• **7.4** is everything I'd want you to know, and more, about the photon gas, Blackbody radiation and its application to astrophysics.

• **7.5** has 5 1/2 pages that tell you all you need to know to extend our model of vibrating solid atoms from the Einstein to the Debye model.

2. What can B&B add (or **subtract** ;-o)**?**

• **Ch. 23:** treats photon gas and black body radiation. It might confuse you by rederiving results with new notation. For example the **Stefan-Boltzmann constant** σ which gives us *Power radiated per unit area* $= uc/4 = \sigma T^4$ looks different from Schroeder, until you realize they are using $\hbar$ not h. Footnote 12 on p. 270 uses h and agrees with Schroeder. Phew!

• Not a topic of homework this week, but good stuff is:

- Section 23.3: **Kirchoff's law**, that the absorbtivity/emissivity of an object is a universal function that depends only on temperature.
- Section 23.8: relations between the **Einstein A and B coefficients** for spontaneous and stimulated emission and absorption of photons by atoms. The last two come from the atom being bathed in photons of the right energy to make the transition.

• **Ch. 24:** is a fine treatment of the Einstein vs. Debye solids. I particularly like Fig. 24.3 which shows how Einstein gets the specific heat wrong for low temperatures. I apologize for confusion that comes from different notations. For example, B&B call the Debye temperature Θ_D. Your other books call it T_D.

• **Ch. 29:** starts with a gentle review about quantum wave functions and the statistics of identical quantum particles. Later sections just repeat what you'd read in the other books by deriving the **distribution function** *f(E)*. **Notation alert:** *f(E)* is just another name for the expected occupation number $\bar{n}(E)$.

• **Appendix C.4** gives a name to integrals, and values which show up when we calculate thermal properties of Bosons. While you can just do these **Bose integrals** numerically, it is cool to know that Eq. (C.30) gives you exact values via the **Reimann zeta** and **Gamma functions**.

• **Appendix C.5** is more relevant next week than this one. Because photons have $\mu = 0$, they have fugacity $z=1$. So to do Black Body calculations, we don't need the awesome power of the **polylogarithm**, $Li_n(z)$ for arbitrary z. Next week, we'll do bosons that have μ nonzero, as well as fermions, and the polylogarithm will apply to both.

• **Section 30.1** is another one that will come back to be useful next week, when we continue to study gasses of bosons and fermions. It teaches us how to derive the grand potential for boson or fermion gasses. From this, we find *N* and *E*. Example 30.2 gives the comforting result that when the chemical potential is large and negative, we get back to familiar, semiclassical gas results.

3. What can G&T reading add? Honestly, not much. It might confuse you with a third notation. They don't give a lot of love to the photon gas or Debye solid. If you really want to read more for enrichment I'd go to the extra reading by Leff on photon vs. matter gasses, linked to our Moodle site.