**Phys 114** **Week 11: Amy's reading advice** **2021**

**My observations about reading this week:** This is one of those weeks where there is lots of repetition - which you don't need - among the books. All three do what is essentially the same derivation of low temperature properties of fermions. They all derive the phase transition to a Bose Einstein Condensate (BEC). Yikes!

For primary reading, G&T is very good though rather dull and mathy. Schroeder is also very good, has adequate math, and does his usual great job of explaining things in engaging ways.

I do advise rereading B&B section 30.1, C.4 and C.5 which were technically assigned last week

**Bottom line:** No harm in reading B&B 30.1 plus the rest of the assigned reading either from G&T or Schroeder. Then try the homework. Visit another book only if you have trouble with a problem that comes from that book.

**1. About B&B:**

•**I advise rereading section 30.1 which sets the stage for the math we are doing this week**. This plus sections **C.4 and C.5** provide a slick and concise way of talking about the integrals we need to understand to study bosons and fermions.

• It is almost too brief in its treatment of fermions. Also, Example 30.4 where the low temperature expansion is described might be the most intimidating among the three books.

• It is also brief in its treatment of bosons, but it does a lovely job of pulling off the argument about the BEC (Bose Einstein Condensation) phase transition, by appealing to the math of polylogarithms.

**2. About G&T:**

• It gives a **solid treatment of fermions at zero, low temperatures, and via a problem assigned, high temperatures**. It derives the behavior of all thermodynamic quantities we'd care about with temperature, including pressure (which B&B neglects) and bulk modulus, which

• It is **also solid on bosons**, including Bose Einstein Condensation (BEC). It derives the phenomenon; but sadly, it's not very exciting. It almost feels hand-wavy, in contrast to the solid math of B&B section 30.4.

**3. About Schroeder:**

• It gives us a welcome reminder of what it means to be a truly quantum gas, where the quantum volume is large compared with V/N.

• It gives us an unnecessary reminder about state counting to find $g(\varepsilon)$, the density of states.

• It gives us names to remember important quantities . E.g A quantum system is considered "degenerate" and P for a zero temperature fermi gas is the "degeneracy pressure".

• It gives us good pictures like Fig 7.14 showing the product of $g(\varepsilon)$ and $\bar{n}_{FD}(\varepsilon)$, to make the argument (that G&T only make in words) about why $\mu(T)$ decreases with T.

• It is probably the **best discussion of BEC**. I really like the "Real world examples" and the "Why does it happen" parts of section 7.6 .