Phys635, MBQM I-Semester 2019/20, Tutorial 1, Tue 20.8.

Please sit in your assignment teams, two or three teams to a table (behave like Bosons, not like Fermions). Do the "Stages" in the order below. When all teams finished a stage, elect a student to present and explain on the board.

Stage 1 Let's try to sort out some questions about the material so far.

(i) List the main points of the material covered so far, try to agree on your table on what the essentials are.

(ii) Among those, each list three items you think you understood best, and three that you understood least.

(iii) Pair up, such that each of you explains to another student on the table one of those concepts, then swap. Ask us if unsure.

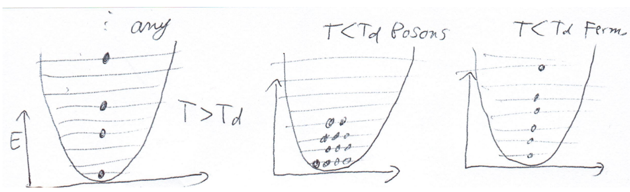
Stage 2 Why is quantum-many-body theory harder than classical many-body theory? Discuss on the table, write on the board.

(i) What information is needed to specify a classical state of N particles? A quantum state?

(ii) Invent a way to "quantify" the volume of that information? How does either scale as the number of particles gets larger?

(iii) In terms of the classification of many-body states seen in the lecture, which aspect is "causing the trouble"?

Stage 3 Let's chat about what to expect later in lecture. Consider the attached two diagrams for Bosons or Fermions in a harmonic trap. The temperature where it becomes important whether two particles can enter the same state or not, is called "degeneracy temperature" T_d.



(i) Why would it be <u>not</u> important for temperatures $T \gg T_d$?

(ii) Make a rough estimate of the degeneracy temperature. Discuss on the table, write on the board.

(iii) Suppose we are slowly reducing the temperature of the system. Discuss what might happen in the context of section 2.2.2 of the lecture.

Stage 4 Think about the numerical component of assignments. In the first assignment, we have seen an exemplary numerical solution of the TDSE for two coupled harmonic oscillators.

(i) What is conceptually different when you are solving this on a computer, compared to an analytical solution? Discuss on the table, write on the board.

(ii) How do you deal with the Laplacian?

(iii) How do you deal with the $\frac{\partial}{\partial t}$?

(iv) What can go wrong with either?