# 5163, Homework Assignment 9
# due on Friday, 04/29/2022, at 6pm (to be uploaded to Canvas)

This homework set consists of four problems.

This homework assignment is based on the paper Phys. Rev. A **54**, 656 (1996) by W. Ketterle and N. J. van Druten.

Problem 1:
Fill in all the steps needed to get from Eqs. (1) and (2) to Eqs. (3), (4), and (6).

Problem 2:
What is being discussed in Eqs. (5), (7), and (8)? To address this question perform calculations as needed and provide a discussion. Be as specific as you can when converting the infinite sum to an integral.
Note that the density of state expression $\rho(E)$ given in the paper contains a typo. The units should be $1/energy$; thus,

$$\rho(E) = \frac{\left(\frac{E}{\hbar\omega}\right)^2}{2\hbar\omega}. \tag{1}$$

Problem 3:
Write a little code that allows you to reproduce Figs. 1(a) and 1(b) for $N = 100$. If you use a cutoff in any of the infinite sums, you are encouraged to make sure that your results are converged with respect to the cutoff.
This can be done fairly straightforwardly in Mathematica. Before you start setting this up on the computer, write down clearly on a piece of paper what the steps are that you want to implement (unless you have a clear idea of what you want the computer to do for you, you cannot "teach" the computer to accomplish the task).

Problem 4:
This problem builds on the tools developed in Problem 3.
For $N = 100$, plot the fugacity and the chemical potential as a function of $T/T_c^0$.