Physics 540: Statistical Mechanics I

Read: LL 53-58
Problems to study: K.4 pr 3

“LL 1” means section 1 from Landau and Lifshitz book
“K.1 pr 2” means problem 2 from section 1 of Kubo’s book.

Homework 9

Exercise 1
Calculate quantum corrections to $c_p$, $c_p - c_v$, and to isothermal compressibility $\kappa \equiv -\frac{1}{V} \left( \frac{\partial V}{\partial P} \right)_T$ of a Boltzmann gas in the first order in $N/V$. Consider both Fermi and Bose statistics of elementary particles.

Exercise 2
Liquid He$^3$ has 46.2Å$^3$ volume per atom. Considering it an ideal Fermi gas, calculate its Fermi momentum, Fermi energy, and heat capacity $c_v$ at $T = 0.01K$. Compare $c_v$ to the classical ideal gas under the same conditions: explain the difference.

Exercise 3
A neutron star has a mass of 0.6 of that of the Sun and the radius of 15km. Assuming that neutrons near the surface form an ideal Fermi gas in the field of constant gravity, find
a) the height of the atmosphere,
b) the density as a function of height from the surface,
c) consider the effect of the non-zero temperature $T = 1keV$ on the atmosphere profile.