Stat Mech (PHYS 370) Guide 10

Fall 2024 v2.0

This week will be devoted to the Fermi-Dirac distribution and degenerate Fermi gasses. We'll explore the surprising way "simple counting" dominates the structure of white dwarf (and neutron) stars. We'll also ooch the temperature up from $T = 0$ with the Sommerfeld expansion.

Reading:
Chapter 7 section 7.2 - 7.3

Problems: (Due on Thursday November 21 at the beginning of class)

(1) Show that at high speeds (or momentum) the relativistic energy is

$$E = \sqrt{(pc)^2 + m^2c^4} \simeq pc + \frac{1}{2}\frac{m^2c^3}{p}$$

(2) 7.11 Fermion occupation at room temperature, as compared to chemical potential μ.

(3) 7.16 (3 pts.) Counting for fermions, the Fermi-Dirac distribution, and finding μ. Use Mathematica to run the fit in part (c)

(4) 7.19 Are electrons in copper a degenerate electron gas? To help you get started here are the numbers: it has a density of 8.93 g/cm^3 atomic mass of 63.5 g/mol. Assume each copper atom gives one conduction electron. The bulk modulus of Cu is 123 GPa. Compare this to what you find.