PHY 410
HW# 11
Assigned: April 14, 2010: Due April 21, 2010

11.1 In the first observation of Bose-Einstein condensation with atomic hydrogen a gas of approximately 2×10^{10} atoms was trapped in a region and cooled until its density was 1.8×10^{14} atoms/cm^3.

(i) Why can we treat the Hydrogen atom as a boson?

(ii) What is the average distance between the hydrogen atoms at the above density

(iii) Calculate the condensation temperature T_E and compare to the measured value of 50 μK.

11.2 Calculate the condensation temperature for liquid helium-4 ^{4}He assuming that the atoms in the liquid can be treated as an ideal gas.(A physical justification for this is the large zero-point motion of the light He atoms). The mass density you can use is 0.145 g/cm^3. Compare this with the experimental value of 2.17K.

11.3 Find an expression for the entropy of a 3-dimensional ideal bose gas (mass m) confined in a volume V as a function of temperature τ in the region $0 < \tau < \tau_E$.

11.4 Problem 7.14 of the text. (Kittel and Kroemer)

11.5 Problem 8.1 of the text. (Kittel and Kroemer)