Department of Physics, University of Maryland, College Park, MD 20742-4111

Physics 404 **HOMEWORK ASSIGNMENT #10** **Fall 2013**

The last, at last!!

Due date: Tuesday, Dec. 10 **Deadline:** Thursday, Dec. 12

1. (10) 7.61 Low-temperature heat capacity of liquid ^{4}He. You do not need to repeat the derivation for phonons; just cite the relevant results and where they are modified here. It is convenient to consider one mole of ^{4}He, i.e. $N = N_A$. Note that we do not use the fact that ^{4}He becomes a superfluid below about 2 K.

2. (10) 7.63 Thermal properties of a 2D material. Use the Debye model and generalize the calculation on p. 310 to two dimensions. Note the integrals in the middle of Appendix B. You do *not* need to do the computer plot of C(T); it looks qualitatively like its 3D counterpart. Just make clear what the low-temperature power-law behavior is and show that at high temperature you retrieve the equipartition result.

3. (10) 7.66 a,b,c Bose condensation of ^{87}Rb atoms. In part b), show that $k_B T_c \propto N^{2/3} \epsilon_0$ and find the proportionality constant. If you crank through part d) [not assigned], you would find that the ratio of N_0/N_1 is nearly 5 times as large as in part c).

4. (10) 7.70 a,b Heat capacity of gas of bosons. Compare your predicted value of $C_V(T_c)$ with that in Fig. 7.37. Note the result in part c).

5. (10) 7.71. Hints: Start with your result for $C_V(T)$ from the previous problem to find S(T). You should then find $F \propto -N\,(T/T_c)^{3/2}\,k_B T$ and $p \propto \lambda_T^{-3}\,k_B T$. (You must verify these results and find the prefactors.)