Phys 771 Condensed Matter Physics Problem Set # 8

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Note: This homework focuses on quantum lattice vibrations. Classical lattice vibrations are left as a self study

- 1. Cosider a one-dimensional solid of N atoms. Use Einstein model to calculate the total energy (ε) and specific heat at constant volume (C_V). Discuss the high and low temperature limits. Use computer to plot $C_V/Nk_B vs T$ (set $T_E = 200K$ or any other number and see the effect).
- 2. Cosider a two-dimensional solid of N atoms. Use Debye model to calculate the single-particle density of states $D(\omega)$, Debye frequency ω_D , total energy ε , and specific heat at constant volume C_V . Discuss the high and low temperature limits. Use computer to plot $C_V/2Nk_B vs T$ (set $T_D = 200K$ or any other number and see the effect).
- 3. Cosider a one-dimensional solid of N atoms. Use Debye model to calculate the single-particle density of states $D(\omega)$, Debye frequency ω_D , total energy ε , and specific heat at constant volume C_V . Discuss the high and low temperature limits. Use computer to plot $C_V/Nk_B vs T$ (set $T_D = 200K$ or any other number and see the effect).
- 4. The following figure (figure 13.11 in textbook) represents the low temperature specific heat at constant pressure of both Sodium (Na) and Silver (Ag). Use the figure to estimate the Debye and Fermi temperatures of silver. Compare your values to those listed in tables 13.1 and 6.1 of textbook. (hint: use the following link to capture data from the figure, then plot the obtained data points and linear-fit them to find the slop and y-intercept https://web.eecs.utk.edu/ dcostine/personal/PowerDeviceLib/DigiTest/index.html)



Figure 1: