P502 **Midterm (part I)** **Nov. 2, 2022**

NAME:

Q1. (6 points) Give the typical values for the listed quantities in simple metals. (Use appropriate units.)

$v_F =$ $\epsilon_F =$ $k_F =$

$T_F =$ $r_s =$ $\lambda_{\rm TF} =$

Q2. (6 points)

a) In the Sommerfeld model how does c_v depend on T?

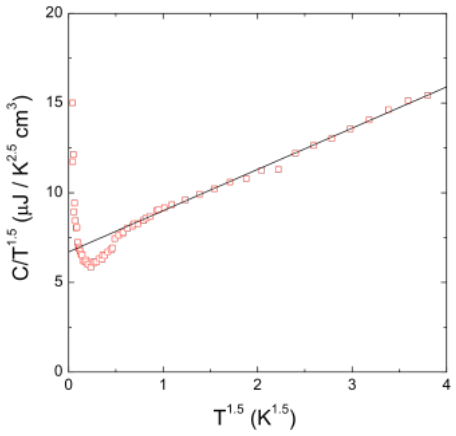
b) In the interacting electron gas in what limit one expects formation of a Wigner crystal?

c) In one sentence summarize the Landau argument for superfluidity in liquid ^{4}He.

Q3. (5 points) Write down the second-quantized Hamiltonian for a system of N bosons described by

$$H = \sum_j \frac{\mathbf{p}_j}{2m} + \frac{1}{2} V_0 \sum_{i \neq j} \delta(\mathbf{r}_i - \mathbf{r}_j).$$

Q4. (3 points) The figure below shows measured specific heat in a certain 3-dimensional crystalline solid. Based on this data determine if the solid is most likely to be (i) a metal, (ii) an insulating ferromagnet, or (iii) an insulating antiferromagnet. Give a brief explanation of your reasoning.



Q5. (5 points) Magnon density of states in a d-dimensional ferromagnet goes as $D(\omega) \propto \omega^{(d-2)/2}$. Find the T dependence of the specific heat. [This requires a short calculation.]