PHYSICS 140B W26 : STATISTICAL PHYSICS
HW ASSIGNMENT #3

(1) For ideal Fermi gases in $d = 1$, 2, and 3 dimensions, compute at $T = 0$ the average fermion speed.

(2) Consider a two-dimensional gas of fermions which obey the dispersion relation

$$\varepsilon(\boldsymbol{k}) = \varepsilon_0\Big((k_x^2 + k_y^2)\,a^2 + \tfrac{1}{2}(k_x^4 + k_y^4)\,a^4\Big) \ .$$

Sketch, on the same plot, the Fermi surfaces for $\varepsilon_{\rm F} = 0.1\,\varepsilon_0$, $\varepsilon_{\rm F} = \varepsilon_0$, and $\varepsilon_{\rm F} = 10\,\varepsilon_0$.

(3) Obtain numerical estimates for the Fermi energy (in eV) and the Fermi temperature (in Kelvins) for the following systems:

(a) conduction electrons in silver, lead, and aluminum

(b) nucleons in a heavy nucleus, such as ^{200}Hg

(4) Consider a three-dimensional Fermi gas of $S = \frac{1}{2}$ particles obeying the dispersion relation $\varepsilon(\boldsymbol{k}) = A\,|\boldsymbol{k}|^4$.

(a) Compute the density of states $g(\varepsilon)$.

(b) Compute the molar heat capacity.

(c) Compute the lowest order nontrivial temperature dependence for $\mu(T)$ at low temperatures. *I.e.* compute the $\mathcal{O}(T^2)$ term in $\mu(T)$.