**Static Dielectric**

We’ll take a look at a variety of thermal properties…

**Thomas-Fermi model calculation of χirr(q)**

We want to calculate the response of the charge distribution to a time-independent potential.



So we use a semi-classical approximation. We assume that the thermodynamic distribution function of the electrons can be given semi-classically by,



Then the electron distribution would be (maybe see Stat Mech folder/Classical NESM RTA),



The unperturbed charge density would be [well technically the unperturbed charge density is zero thanks to the background crystal lattice – this is the unperturbed *electron* density]:



which is independent of r we’ll note. And we can find the linear response [n(r) is the perturbed electron density and n(0)(r) could be said to be the fixed crystal lattice density, so the difference could indeed be called the net perturbed density],



where n(μ) is the fermionic particle number function. From the stat mech file, this is:



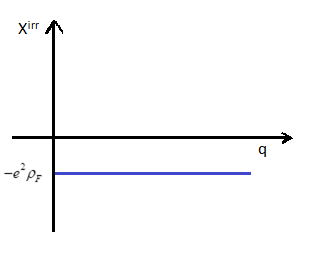
If we fill in the low T approximation, we get:



So,



where ρF is the density of states at the Fermi surface in 3D. Plugging the latter result for qTF2 back into χirr makes it work out to simply χirr = -e2ρF. Plotted below:



[why do we get induced charge if we even have φ(r) = const (which corresponds to no net force)? Because we are increasing the chemical potential, which draws in more charge. But if we do this calculation, with the restriction that N = constant (and thereby adjust μ accordingly to -φ(r)), then we’ll get ρind = 0 in the φ(r) = const. case.