2. \[ G_1 = \frac{2\pi}{R_1 \cdot R_2 \cdot R_3} \quad \text{cyclic} \quad \Rightarrow \quad G_2 = 2\pi \frac{R_j \cdot R_k}{R_i' \cdot R_j' \cdot R_k'} \]

3. \( S(k) = \sum_j f_j e^{i \mathbf{k} \cdot \mathbf{r}_j} \)

(a) \( f_{cs}, f_{cl} \) are different

\[ S(k) = f_{cs} + f_{cl} e^{i(kx_{1/2} + ky_{1/2})} \]

3. \( S(k) = \sum_j f_j e^{i \mathbf{k} \cdot \mathbf{r}_j} \)

(a) Sometimes written with normalization factor. Either is ok.

(b) \( f_{cs}, f_{cl} \) are different

\[ S(k) = f_{cs} + f_{cl} e^{i(kx_{1/2} + ky_{1/2})} \]

5. \( \langle H \rangle = \int H(\varepsilon) f(\varepsilon) d\varepsilon \) where

- \( H(\varepsilon) \) is any function of \( \varepsilon \) that is smooth
- \( f(\varepsilon) = \left[ e^{-\beta(\varepsilon - \mu)} + 1 \right]^{-1} \) = Fermi-Dirac distribution fn.

(a) \( C_V = \frac{2}{3} k_B^2 T D(E_F) \) linear in \( T \)

(b) \( D(E_F) \) is DOS evaluated at \( E_F \).

(c) The classical gas has an energy of \( \frac{1}{2} k_B T \) for each degree of freedom. So each particle has

\[ \varepsilon = \frac{1}{2} M k_B T \] of energy. \( C_V^c = \frac{3}{2} k_B M / V \) (per unit volume).

Since on average \( D(\varepsilon) \sim 1/W \) bandwidth \( \approx \) a few eV,
\[ C_V^d \approx \frac{\pi^2}{3} k_B^2 \left( \frac{k_B T}{W} \right), \] and for a gas \( \frac{k_B T}{W} \ll 1 \).

This reduction is due to Pauli exclusion: only particles in states within \( \sim k_B T \) of \( E_F \) can be thermally excited.