Specific Heat of a Metallic Solid

It is an experimental observation that for a solid the specific heat is

\[ c(T) = \gamma T + \alpha T^3 \]

This is usually emphasized graphically by plotting \( c(T)/T \) vs. \( T^2 \)

\[ c(T)/T = \gamma + \alpha T^2 \]

Our goal is to understand the \( \alpha T^3 \) contribution.

We will come back to \( \gamma T \) after discussing electron motion in a metal.
Specific heat definition

\[ C = \frac{d\langle E \rangle}{dT} \]

Increase \( T \)
e.g. particle, more fast, more KE

Alternate view \[ d\langle E \rangle = C \, dT \]

\( \frac{d\langle E \rangle}{dP} \)

\( \Delta P \)

\( \Delta V \)

How much energy in response to change in temperature?

Physics is full of response functions

\[ \chi = d\langle M \rangle / dB \]

Magnetic susceptibility

\[ d\langle M \rangle = \chi \, dB \]

\[ dJ = \sum dV \quad (\text{Conductivity} \; \Sigma = \frac{1}{R}) \]

\[ dJ = \Sigma \\, dV \]

At a phase transition the response function often diverges.

If a system is about to become a spontaneous magnet \( M \neq 0 \) even for \( B = 0 \) then \( \chi \) is enormous.
Specific heat of ideal gas?

\[ \langle E \rangle = \frac{3}{2} N k_B T \]

\[ C = \frac{3}{2} N k_B \quad (T \text{ independent constant}) \]

Basic principle/rule of statistical mechanics (Boltzmann)