2.9.1 Heat capacity for solids: Einstein- and Debye-model

We will repeat the details of this discussion in a later chapter. Here we will just show some experimental findings which can be well understood within the Debye model and partly within the easier Einstein model.

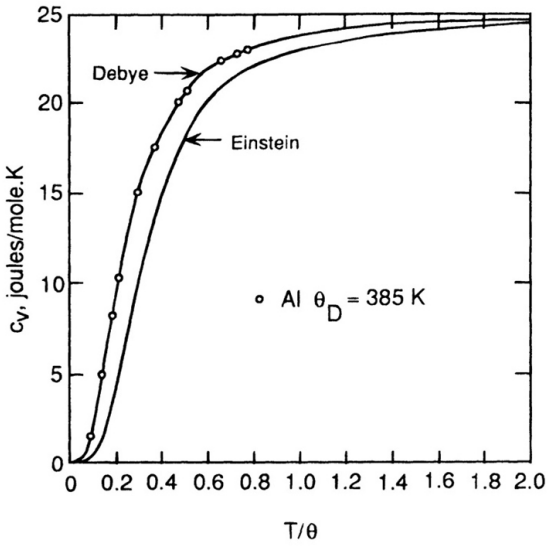

Figure 2.6: Comparison of measured C_V data and results using the Debye and Einstein model.

- The Einstein model assumes $3N$ oscillators each with the frequency ν. The capacity related to the vibrational energy is found to be

$$C_{vib} = 3R\frac{\left(\frac{\Theta}{T}\right)^2 \exp(\Theta/T)}{(\exp(\Theta/T)-1)^2} \quad \text{with} \quad \Theta = \frac{h\nu}{k} \tag{2.25}$$

- The Debye model assumes $3N$ oscillators each with the frequency ν. The capacity related to the vibrational energy is found to be

$$C_{vib} = 9R\frac{T^3}{\Theta_D^3}\int_0^{\Theta_D/T} \frac{x^4\, e^x}{(\exp(x)-1)^2}\, dx$$
$$\text{with} \quad x = \frac{h\nu}{kT} \quad \text{and} \quad \Theta_D = \frac{h\nu_{max}}{k} \tag{2.26}$$
$$\text{For} \quad T \ll \Theta_D: \qquad C_{vib} = \frac{12\pi^4 R}{5}\frac{T^3}{\Theta_D^3}$$
$$\text{For} \quad T \gg \Theta_D: \qquad C_{vib} = 3R$$

Fig. 2.6 shows a comparison between measured heat capacity data and corresponding points using the Debye and the Einstein model. Obviously the Debye model allows for a very good description of the measured data.