(For this purpose 4.2 °K is effectively the absolute zero [3]). The change in internal energy, ΔU_0, in altering the volume from V_1 to V_2 at 0 °K is given by:

$$\Delta U_0 = -\int_{V_1}^{V_2} p \, \mathrm{d}V .$$

b) The second step is then to derive from the $U_0 - V$ curve so obtained the relationship between the Debye temperature of the solid, θ_D^2, and the volume V. (Experiments [3] have shown that a Debye approximation is quite good for solid helium). To do this, it is assumed that $\theta_D^2 \propto \mathrm{d}^2 U_0/\mathrm{d}r^2$, where r is the interatomic distance [5]. To evaluate the constant of proportionality, one value of θ_D was taken from specific heat measurements [3].

c) Thirdly the Lindemann melting formula relating θ, V, and the melting temperature, T_m, is used to find T_m as a function of V. A value for the Lindemann constant for helium was taken from the work of DUGDALE and SIMON [3], which had already shown that the Lindemann melting formula was valid for solid helium throughout the range of their experiments (up to 3 000 atmospheres).

d) The last step is to use a Debye-Grüneisen model (*) of the solid to calculate the pressure corresponding to the volume, V, at the melting temperature. This gives the melting curve.

e) As a further check on the calculations, one can calculate the zero point energy ($(9/8) R\theta_D$) and subtract it from the internal energy. This gives the lattice energy, which may then be compared with that calculated from a suitable interatomic potential.

3. – The results.

The results are represented in Fig. 1 and 2. Fig. 1 shows the isochores (lines of constant volume) of solid helium calculated in the manner outlined above. It also shows the melting curve so derived: for comparison a melting curve based on experiment is also plotted. MILLS and GRILLY [6] have measured

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(*) By this is meant a solid in which (*a*) the specific heat at constant volume, for example, is a function of θ/T, where θ depends only on volume, and (*b*) the temperature dependence of C_V is given by the Debye function. The calorimetric experiments of Dugdale and Simon showed that this was approximately true of solid helium.