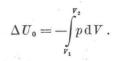(For this purpose 4.2 °K is effectively the absolute zero [3]). The change in internal energy, ΔU_0, in altering the volume from V_1 to V_2 at 0 °K is given by:

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

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, $\theta_D^{\prime}$, 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 $\theta_D^{\prime} \propto \mathrm{d}^2 U_0/\mathrm{d}r^2$, 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 3000 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.