Research Notes

the value of α is negative, corresponding to a positive 'internal pressure'. For ³He, on the other hand, the value of α is positive and this corresponds to a negative internal pressure. It is of interest to see how this result fits in with the theoretical treatment of solid helium.

In an attempt to account for the properties of substances in which the role of zero-point energy is important, the present writer put forward the following differential equation for the Debye Θ value (Domb 1952):

$$\Theta = 0.4109 \frac{h}{k} \left[\frac{\phi''(r)}{m} + \frac{9}{8} \frac{R}{m} \frac{d^2 \Theta}{dr^2} \right]^{1/2} \qquad \dots \dots (2)$$

where $\phi(r)$ is the lattice energy per particle, and *m* the mass of the particles. This equation was rewritten by Dugdale and MacDonald (1954) as an equation for the internal energy at absolute zero E_0 in the form

$$E_0 = \phi(r) + a \left(\frac{d^2 E_0}{dr^2}\right)^{1/2} \qquad \dots \dots (3)$$

where a is a constant inversely proportional to $m^{1/2}$ which represents the effect of zero-point energy. Dugdale and MacDonald put forward an approximate solution in closed form when $\phi(r)$ is a Mie-Lennard-Jones 6-10 potential, and this solution has a number of interesting physical properties.



The internal energy E_0 at absolute zero plotted as a function of volume, for various values of a (see equation (3)).

The form of E_0 as a function of volume for varying a is shown in the figure. As a increases the minimum is pushed out and the potential well becomes shallower until, for a particular critical value a_c , E_0 ceases to have a minimum. It seems that ⁴He with a positive internal pressure corresponds to a value of $a < a_c$, whereas ³He corresponds to $a > a_c$. For ⁴He the solid phase could exist under atmospheric pressure, but the liquid phase is more stable; for ³He, however, the solid phase could not exist.

The accuracy of the solution of Dugdale and MacDonald in the region of applicability to ⁴He and ³He, and the dependence of the solution on the form of intermolecular potential are being investigated by M. E. Fisher and I. J. Zucker at King's College.

ormion bands are considerably probably due to the fact that in rules all of the same size, while all almost certainly take place. und the theory suggests that the

ongosed with ultra-violet light cours, the absorption band in After this treatment the crystal listed work) obtained a similar a the full output of the mercury

ctagulation of the silver nuclei, to inger wavelengths in both served. A shape effect may be

i changes taking place during is being made at present, and eparting the shape and size of

ne throughout this work, and culations from the Mie theory, Clemical Industries Limited

Rog_ Soc. A, 238, 568.

drigen Isotopes

er Lindon

56

termined the melting curves serve range. For ⁴He their ts at Simon and his colla-953 and on fitting the data

.....(1)