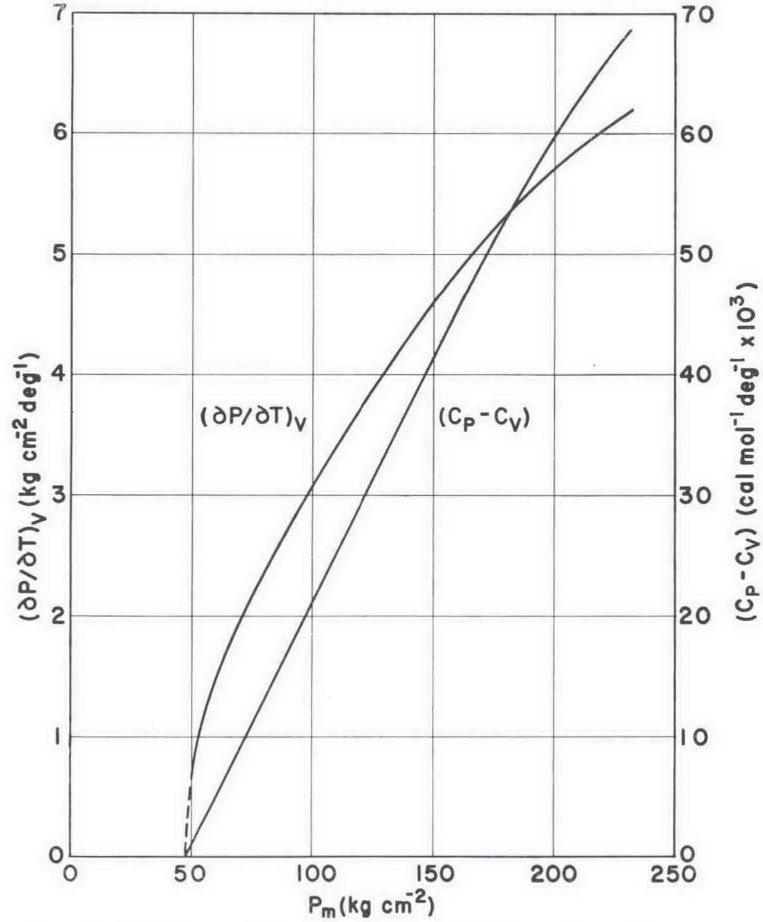

FIG. 10. $(\partial P/\partial T)_V$ and $(C_P - C_V)$ for fluid He^3 along the melting curve.

lowest accessible mean temperature for the present α_f measurements. It is seen that the curve of Fig. 5 intersects the melting curve at 47 kg/cm^2 in good agreement with the extrapolations made in Figs. 4 and 10. Temperatures where $\alpha_f = 0$, derived from pressure-volume-temperature data by Brewer and Daunt (*28*) and Sherman and Edeskuty (*29*), are in general agreement with the measurements of Fig. 5.

The slopes, $(\partial \alpha_f/\partial T)_P$ and $(\partial \beta_f/\partial P)_T$, decrease with increasing melting pressure as shown in Figs. 6 and 7, respectively. From the thermodynamic formulas,

$$(\partial C_P/\partial P)_T = -T(\partial^2 V/\partial T^2)_P = -TV[\alpha^2 + (\partial \alpha/\partial T)_P] \tag{7}$$

and the data given above for fluid He^3, it can be seen that C_P decreases with increasing pressure in the vicinity of the melting curve. Gutsche (*30*) and Jones and Walker (*31*) reported a similar variation for H_2 and A, respectively.

Equation (5) combined with the thermodynamic relation,

$$\frac{dP_m}{dT_m} = \left[\left(\frac{\partial P}{\partial V}\right)_T\right]_m \frac{dV_m}{dT_m} + \left[\left(\frac{\partial P}{\partial T}\right)_V\right]_m, \tag{8}$$

leads to

$$\beta_f = \alpha_f \frac{dT_m}{dP_m} - \frac{1}{V_f}\frac{dV_f}{dP_m}. \tag{9}$$

For He^3 at low pressures, the values of β_f calculated from Eq. (9) compare reasonably well with those measured directly (Fig. 4), deviating by +27 percent at $P_m = 50$ kg/cm^2 and by −2 percent at $P_m = 225$ kg/cm^2. At 3555 kg/cm^2, the calculated β_f is 7.4×10^{-5} cm^2/kg.

The theory of melting for metals that was advanced by Bonfiglioli *et al.* (*32*) predicts that $\alpha_s T_m$ is constant for a given crystal type. Unfortunately, available data are restricted to melting pressures of ∼1 atmos but for face-centered-cubic, body-centered-cubic, and hexagonal-closest-packed metals of widely varying melting temperature, $\alpha_s T_m$ appears to be ∼0.06. Above the anomalous region where α_f shows a maximum, the present results for fluid He^3 (and He^4) indicate that values of $\alpha_f T_m$ rise rapidly with P_m then approach constancy around 0.05–0.06 at high melting pressures. The empirical deduction from the present work that $\alpha_s = 0.75\alpha_f$ indicates that the expansion of the solid along the melting curve follows closely that of the fluid and implies a constant value of 0.04–0.05 for $\alpha_s T_m$ at high pressures. It is interesting to compare the ratio $\alpha_s/\alpha_f = 0.75$ for He^3 and He^4 with the ratios 0.70 and 0.77 for Na and K, respectively, measured by Bridgman (*33*) at $P_m = 1$ kg/cm^2.

Values of V_s can be calculated from the present measurements of V_f and ΔV_m. For He^3 the ratio V_f/V_s was found to be constant and equal to 1.044 with a maximum deviation of only 0.4 percent over the full pressure range studied.[4] Therefore $(1/V_f)(dV_f/dP_m) = (1/V_s)(dV_s/dP_m)$ which, with Eq. (8) and the ratio $\alpha_s/\alpha_f = 0.75$, leads to the following equations for He^3:

$$\beta_s = 0.75\alpha_f \frac{dT_m}{dP_m} - \frac{1}{V_f}\frac{dV_f}{dP_m}, \tag{10}$$

and

$$\Delta\beta = \beta_f - \beta_s = 0.25\alpha_f(dT_m/dP_m). \tag{11}$$

[4] For He^4 the ratio of V_f/V_s varied monotonically from 1.066 at $P_m = 35$ kg/cm^2 to 1.044 at $P_m = 3555$ kg/cm^2.