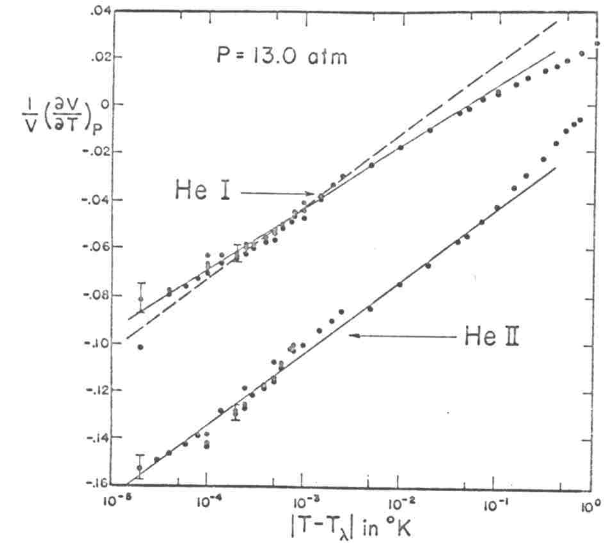


FIG. 6. Logarithmic plot of $\alpha_P$ (in $deg^{-1}$) at 13 atm close to the transition. The numerical data for the points at all pressures are available in tabulated form in the Ph.D. thesis of Elwell (Ref. 11). The dashed line is drawn parallel to the lower solid line.

We have found that the relation

$$P_\lambda(\text{atm}) = 0.0497 - 64.6X^{1.342} + 120X, \qquad (5)$$

where $X = T_\lambda(\text{SVP}) - T_\lambda(P)$ and $T_\lambda(\text{SVP}) = 2.173\,12$°K, is an excellent fit to all our data. This equation indicates that the limiting slope is −120 atm/°K. Since the slope according to Eq. (5) varies strongly very close to the lower triple point, this limiting slope is probably too high. More data within 0.5 m°K of the triple point will clarify this question. The temperature of the lower λ point is about 1 mdeg K higher than that listed in the $He^4$ *1958* vapor-pressure tables, but this difference is still within the limits of the calibration uncertainty and does not affect noticeably the slopes of the thermodynamic quantities along the λ line (Table VII). Kierstead[20] has recently completed an article on the λ line in which he presents new determinations of his own of the shape of the transition line and in which he reviews the work of other authors including our data presented elsewhere[8] and here. Therefore we confine our discussion to a few comments on the current state of knowledge. In general there is good agreement (to within 1 mdeg) on the location of the transition at all pressures, so that except in the low-pressure limit where $(dP/dT)_\lambda$ is changing rapidly there is basic agreement on the pressure derivative of the transition. Kierstead has taken the most extensive data of any of the investigators below 3 atm down to the upper limit of our high-resolution data, and we feel that in this range his data are most to be relied on. However, our high-resolution data at very low pressures indicate that the limiting slope is somewhat greater in magnitude than the value he obtains. Because of this, we prefer our simpler form, Eq. (5) excluding perhaps the portion within 0.5 m°K of the lower triple point. We have found no such simple relation that gives a satisfactory fit to the molar volume curve, but we have found that the straight-line value for the slope at low pressures is 45.5±0.5 cm³/mole °K, and this is in excellent agreement with the value of 47.6 cm³/mole calculated by Barmatz.[21]

A representative plot of the thermal expansion coefficient data is shown in Fig. 6. Here the 13-atm data are plotted as a function of $|T-T_\lambda|$ on a semilogarithmic

TABLE VII. Temperature derivatives of the λ line.

| $T$ (°K) | $(dP/dT)_\lambda$ atm/°K | $(dV/dT)_\lambda$ cm³/mole deg |
|---|---|---|
| 1.800 | −58.5 | 6.10 |
| 1.850 | −61.5 | 6.58 |
| 1.900 | −65.2 | 7.54 |
| 1.950 | −67.4 | 9.1 |
| 2.000 | −72.5 | 11.1 |
| 2.050 | −77.0 | 13.8 |
| 2.100 | −85.0 | 18.9 |
| 2.150 | −94.6 | 29.7 |
| 2.160 | −100[a] | 35.6 |
| 2.170 | −108[a] | 42.5 |
| 2.172 | −111[a] | 44.0 |
| 2.173 | −114[b] | 45.5[b] |
| | −120[a] | |

[a] From the fit to Eq. (5).
[b] From linear fit to the points of Run II in Table VI.

[20] H. A. Kierstead, Phys. Rev. (to be published).

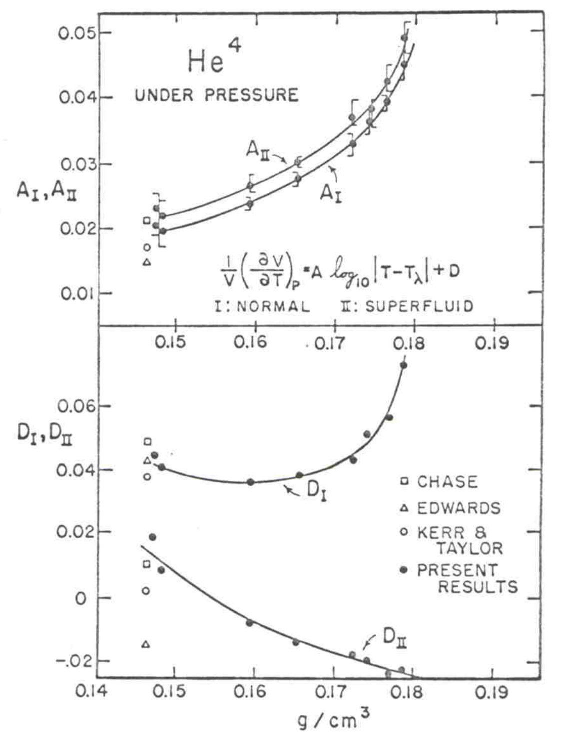


FIG. 7. The parameters $A$ and $D$ (in $deg^{-1}$) of the logarithmic plot for $\alpha_P$ as a function of density along the transition and comparison with results of other authors at saturated vapor pressure.

[21] M. Barmatz, thesis, University of California, 1966 (unpublished).