tude of the oscillations increased by approximately seven times (the oscillations were barely noticeable at 4.2°K). The amplitude of the oscillations was quite sensitive to the quality of the single crystal. That the specimens used in the experiments differed in quality was evidenced by the fact that up to ~ 15 harmonics of cyclotron resonance were observed in the specimen with $D_1 = 0.47$ mm, but only ~5 in the sample with $D_2 = 0.39$ mm. Accordingly, in the second sample the amplitude of the oscillations was two orders of magnitude lower, thus accounting in particular for the smaller number of experimental points on the curve of Fig. 2 pertaining to this sample. Together with the temperature-dependence data, this indicates that the attenuation of the waves depends strongly on the mean free time of the electrons.

The existence of the described magnetoplasma waves in bismuth and their main properties are in qualitative agreement with the SHB theoretical premises, except for one fact. As indicated above, the conditions for wave excitation are optimal when $\mathbf{H} \parallel \mathbf{J}$, whereas according to SHB $\mathbf{E} \perp \mathbf{H}$; these relations are compatible only when $\mathbf{E} \perp \mathbf{J}$ which, generally speaking, does not take place. In addition, the analysis in [3] was made for quadratic dispersion, which does not hold for bismuth [2-6]. For the same reason, a quantitative comparison of the experimental results and the calculations based on the SHB theory cannot be illustrative. It will be rational to carry out such a comparison following an exact calculation of the real spectrum of the carriers in bismuth in accordance with the theory of Abrikosov and Fal'kovskiĭ [6].

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[1] Khaĭkin, Mina, and Édel'man, JETP **44**, 2190 (1963), Soviet Phys. JETP **17**, 1470 (1963).

[2] Khaĭkin, Fal'kovskiĭ, Édel'man, and Mina, JETP **45**, No. 12 (1963) (in press), Soviet Phys. JETP, in press.

[3] Smith, Hebel, and Buchsbaum, Phys. Rev. **129**, 154 (1963).

[4] Khaĭkin, Mina, and Édel'man, JETP **43**, 2063 (1962), Soviet Phys. JETP **16**, 1459 (1963).

[5] M. S. Khaĭkin, PTÉ No. 3, 95 (1961).

[6] A. A. Abrikosov and L. A. Fal'kovskiĭ, JETP **43**, 1089 (1962), Soviet Phys. JETP **16**, 769 (1963).

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MEASUREMENT OF THE SPECIFIC HEAT C_v OF OXYGEN NEAR THE CRITICAL POINT

A. V. VORONEL', Yu. R. CHASHKIN, V. A. POPOV, and V. G. SIMKIN

Institute of Physico-technical and Radio Measurements

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A logarithmic temperature dependence of the specific heat C_V of argon was previously observed [1] near the critical point. To check whether this is a general phenomenon, we measured C_V of oxygen near its critical point ($T_c = 154.565$°K, $\rho_c = 0.408$ g/cm^3). The choice of oxygen was dictated by its relative availability in pure form and by the proximity of its critical temperature to that of argon, making the previously developed measurement procedures [2,3] usable.

The oxygen was obtained by decomposition of chemically pure $KMnO_4$, with strict adherence to the methodological instructions of [4,5], so that a purity not worse than 99.99% could be expected.

The dependence of the specific heat of oxygen on the temperature was measured in the region of transition from the heterogeneous system to the homogeneous system at constant volume, differing from critical by ~ 0.5 per cent (the curve was measured twice at densities 0.408_3 and 0.408_5 g/cm^3, with different batches of oxygen). The width of the temperature interval reached ~ 0.04°K.

The data obtained are shown in Fig. 1. They are

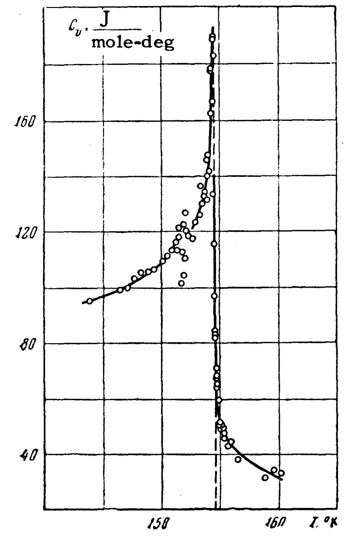

FIG. 1. Temperature dependence of C_v of oxygen at $\rho \sim \rho_c = 0.408$ g/cm^3.

also plotted on a semi-logarithmic scale in Fig. 2. It is clearly seen that the logarithmic dependence of the specific heat begins at a distance ~ 1° to the left and to the right of the transition point, showing once more the need for using very narrow temperature intervals in the measurements. The time necessary to attain equilibrium near T_c reaches 3—4 hours if the liquid is simultaneously mixed.

The slight anomaly at T ~ 152°K is apparently connected with the special properties of oxygen (see, for example, [6]). Several series of measurements made on both specimens confirmed its presence, but further experiments are needed to determine more precisely and to explain the character of the anomaly.

Figure 2 shows clearly that C_V of oxygen tends to infinity near the critical point like $C_V \sim \ln(T - T_c)$. The jump in the specific heat at the critical point is $\Delta C_V = 98.3$ J/mole-deg and is very close to the jump for argon. The slope of the curve is close to the corresponding slope of the argon curve. The table lists the numerical values of the specific heat of oxygen in the direct vicinity of the critical point (ΔT in degrees is the width of the temperature interval).

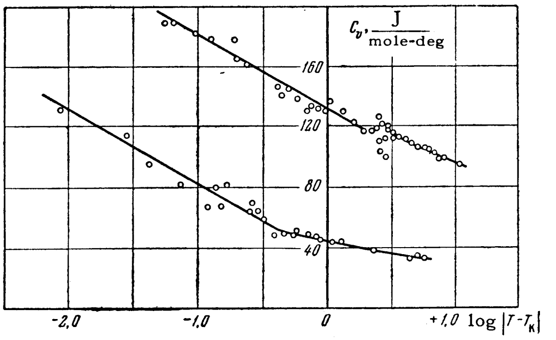

FIG. 2. Dependence of C_V of oxygen on log | T − T_c |.

T, °K	ΔT	C_v, $\frac{\text{J}}{\text{mole-deg}}$	T, °K	ΔT	C_v, $\frac{\text{J}}{\text{mole-deg}}$
152.39	0.185	118,8	154.61	0.136	97.2
152.68	0,185	117,6	154.64	0.222	82,3
152.97	0.178	123,3	154.69	0,083	68,3
153.26	0.171	130.0	154,70	0.052	80,8
153,54	0.164	136.2	154.71	0,070	68.5
153.59	0.121	130,3	154,72	0.072	81.7
153.72	0.119	132.8	154.81	0,073	65.3
153,83	0.166	133.8	154.83	0,057	71.2
153.85	0,120	131,5	154,86	0.086	65.8
153.99	0.114	139.6	154.89	0.137	59.6
154.07	0,154	145,6	154.95	0.147	50.1
154.11	0.113	140.8	155.00	0.103	51.6
154.24	0,109	147.3	155.12	0.248	49.9
154,33	0.143	161.4	155,13	0.103	51.7
154.36	0,098	165,9	155.27	0.149	50,1
154,37	0.039	178,4	155.38	0,326	48.0
154.44	0.039	177.8	155,45	0.156	46.9
154.47	0.055	182.0	155.64	0,163	44.2
154,50	0.037	189.1	155,83	0.161	44,6
154.51	0,043	188,7	156,86	0,630	39,0
			158.91	0,696	32,8
154.57	0.042	132,9	159.60	0,525	34,5
154,59	0,055	115,7	160,14	0.535	33.3

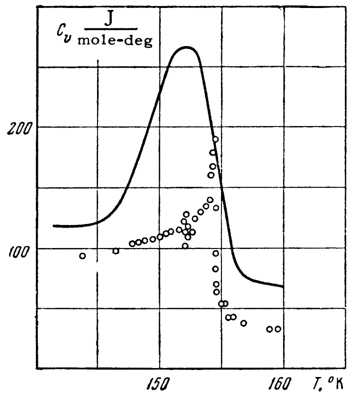

FIG. 3. Comparison of the experimental data of the authors (points) with the data of Hoge (continuous line).

The C_V dependence of oxygen near T_c differs sharply from that obtained by Hoge (continuous line on Fig. 3)[4], which can be attributed to the poor ratio of the calorimeter and specimen specific heats in his experiments (the oxygen specific heat was 5—10% of the measured quantity).

Thus, the experimental data on argon and oxygen lead to the conclusion that the logarithmic temperature dependence of the specific heat near the critical point is a thermodynamical fact.

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[1] Bagatskii, Voronel', and Gusak, JETP **43**, 728 (1962), Soviet Phys. JETP **16**, 517 (1963).

[2] Kostryukov, Alikhanyants, Samoĭlov, and Strelkov, ZhFKH (J. of Phys. Chem.) **28**, 650 (1954).

[3] A. V. Voronel' and P. G. Strelkov, PTE No. 6, 111 (1960).

[4] H. J. Hoge, J. of Research of NBS **44**, 321 (1950).

[5] M. P. Orlova, Dissertation, All-Union Res. Inst. of Synth. Leather, 1953.

[6] Henshaw, Hurst, and Pope, Phys. Rev. **92** 1229 (1953).

Translated by J. G. Adashko
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