Letters to the Editor

Temperature Dependence of Viscosity of Liquid Argon

N. F. ZHDANOVA
Khar'kov State University
(Submitted to JETP editor July 10, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) **31**, 724-725
(October, 1956)

THIS work continues the investigation of the temperature dependence of the viscosity of elementary liquids at constant density[1,2]. The object of our investigation is liquid argon. The method and apparatus to measure the viscosity coefficient at constant density were described previously[2].

The measured temperature dependence of the viscosity of liquid argon at constant density (in the range from 90 to 270°K) is shown graphically in Fig. 1, in which the ordinate represents the fluidity in cgs units, and the abscissa the absolute temperature. Curve *a-a* shows the temperature dependence of the fluidity of argon in equilibrium with its vapor pressure. The Table lists the experimental data corresponding to curve *a-a*. The family of curves $\varphi(T)$ at ρ = const, obtained for argon, is very similar to an analogous family of curves previously obtained for nitrogen[2].

Two types of curves are obtained, depending on how the viscosity (fluidity) varies with temperature at constant density. At high densities the fluidity of argon increases with temperature; at low temperatures, to the contrary, the fluidity of argon diminishes with increasing temperature. It should be noted that in both argon and nitrogen the character of the temperature dependence of viscosity changes at approximately the same value of relative liquid density ($\rho/\rho_k \approx 2$). One can assume that the character of the temperature dependence of the viscosity of nitrogen and argon (and perhaps also of other elementary liquids) changes at a density close to $2\rho_k$ because of the change in the mechanism of viscosity. The liquid mechanism of viscosity predominates at $\rho > 2\rho_k$, while the gas mechanism predominates at $\rho < 2\rho_k$.

Figure 2 shows a family of isothermal viscosity curves for argon obtained by calculation from the data of Fig. 1. The abscissa represents the density of the substance in g/cm^3, the ordinate the viscosity ($\times 10^6$) in cgs units. It is evident from Fig. 2 that argon viscosity depends monotonically on its density. The isothermal curves for argon intersect each other and intersect the equilibrium curve in approximately one point, at a liquid density nearly equal to $2\rho_k$.

Results of an investigation of the viscous properties of strongly compressed argon at a temperature above 0° have recently been published[3]. In

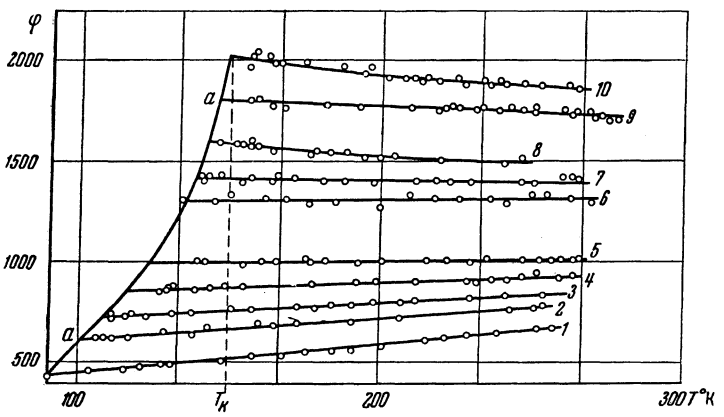

FIG. 1. Temperature dependence of fluidity of liquid argon in equilibrium with its vapor pressure; *1* – ρ = 1.37 g/cm^3; *2* – 1.31 g/cm^3; *3* – 1.22 g/cm^3; *4* – 1.16 g/cm^3; *5* – 1/10 g/cm^3; *6* – 1.02 g/cm^3; *7* – 0.95 g/cm^3; *8* – 0.88 g/cm^3; *9* – 0.78 g/cm^3; *10* – 0.70 g/cm^3.

TABLE

T°K	η, g/cm^{-1} sec^{-1}	φ, g^{-1}/cm/sec
84.25	0.00282*	355*
86.25	0.00262*	382*
86.90	0.00256*	391*
87.30	0.00252*	397*
90.0	0.00232	432
99.5	0.00162	618
111.0	0.00137	750
120	0.00116	862
127	0.00100	1000
133.5	0.00077	1300
138.7	0.00070	1430
143	0.00063	1590
147	0.00056	1790
149	0.00050	2000

* Values cited from work of N. S. Rudenko[4].

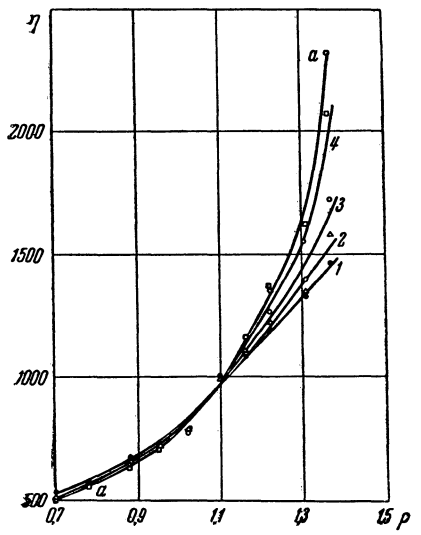

FIG. 2. Isothermal plots of argon viscosity vs. density. 1 – 260° K; 2 – 230° K; 3 – 200° K; 4 – 125° K.

our investigation, the viscosity coefficient of argon was measured at temperatures below + 18° C, and the results can therefore be compared only for a narrow temperature interval. Our results are nevertheless in good agreement with those of Ref. 3; the maximum discrepancy does not exceed 10%.

The temperature dependence of the viscosity of liquid argon at constant density in excess of $2\rho_k$ can be quite satisfactorily represented by an equation of the type $\eta = Ae^{U/T}$, where A and U are constants. A similar temperature dependence of viscosity was formerly obtained for nitrogen[2].

In conclusion, I must thank B. I. Berkin and N. S. Rudenko for supervising this work.

[1] B. I. Berkin and N. S. Rudenko, J. Exptl. Theoret. Phys. (U.S.S.R.) 20, 523 (1950).

[2] F. Zhdanova, J. Exptl. Theoret. Phys. (U.S.S.R.) 31, 14 (1956); Soviet Phys. JETP 4, 19 (1957).

[3] Michels, Botzen and Schurman, Physica 20, 1141 (1954).

[4] N. S. Rudenko, J. Techn. Phys. (U.S.S.R.) 18, 1123 (1948).

Translated by J. G. Adashko
156

The HDSe Microwave Spectrum

V. G. VESELAGO AND A. M. PROKHOROV
P. N. Lebedev Physical Institute
Academy of Sciences, USSR

(Submitted to JETP editor July 13, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) 31, 731
(October, 1956)

THE HDSe microwave spectrum was investigated with a radio spectroscope with electric molecular modulation.

Preliminary calculations called for two transitions to exist in the 9000 mc region: $2_{20}-2_{21}$ and $4_{31}-4_{32}$. An investigation of the spectrum in the 8400-9300 mc range disclosed two groups of six lines each, one for each of the selenium isotopes.

Study of the Stark effect of the observed lines disclosed that one group of lines corresponds to the $2_{20}-2_{21}$ transition, the other to the $4_{31}-4_{32}$ transition. The frequencies of the observed lines are given in the Table.

The frequencies were measured with the aid of a quartz multiplier. The measurement accuracy was ±0.1 mc. The frequencies of the Se^{74} lines were not measured, for this isotope occurs infrequently and its lines are of low intensity. In addition to observing the HDSe lines, we also observed two previously known[1] HDO lines, at 8577.7 and 8836.95 mc.

The intensity of the HDSe line reaches values of the order of 10^{-6} cm^{-1}. The HDO line at 8836.95 mc[2] was used to calibrate the spectroscope sensitivity.

The observed lines were used to calculate the frequencies of other possible transitions. Calculations called for a $9_{54}-9_{55}$ transition to exist in the vicinity of 14,000 mc. The lines corresponding to this transition were found, but a discrepancy on the order of 60 mc was found between