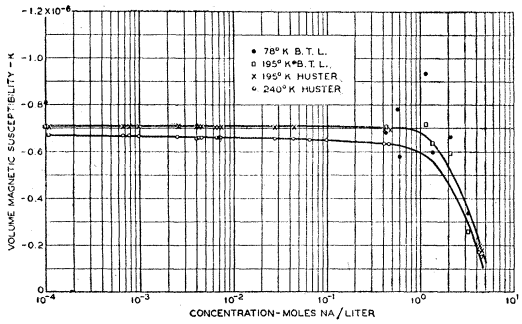

FIG. 1. Volume magnetic susceptibility in c.g.s. units of sodium in liquid ammonia *versus* concentration of solution.

The persistent current experiment is quite unsatisfactory, since cracking in the sample at the time of cooling may alter the result. A number of laboratories[3] have reported completely negative results, although Hodgins[4] found a perceptible indication in four experiments out of a total of one hundred and fifteen trials.

It appeared to us that a quantitative measurement of the magnetic susceptibility would be more significant in detecting superconductivity, since small cracks do not affect the results. A perfect superconductor has a volume diamagnetic susceptibility equal to $1/4\pi$ or 0.0795. Normal diamagnetic materials have values of 1×10^{-6} or less, whereas "alloy" superconductors have intermediate values.

The solutions were prepared by distilling ammonia from a sodium solution into the dried Pyrex tube. A calculated amount of sodium, contained in a 3-mm i.d. glass tube, was suspended in the ammonia. After solution was complete, the glass tube was removed and the container closed with a ground glass joint. After the magnetic measurement was made, the solution was poured into a beaker to evaporate, and the amount of sodium present was determined by titration with 0.429N sulfuric acid, using methyl orange as an indicator. The analysis usually checked very well with the calculated concentration.

The Gouy method, as modified by Freed and Sugarmann[5] for low temperature work, was used in making the susceptibility measurements. Weighings were made with and without the magnetic field (usually 4000 gausses, although weaker fields were tried) while the sample was suspended in dry nitrogen at the specified temperatures. The solutions were contained in closed Pyrex tubes 25 centimeters in length and 0.65 centimeters in internal diameter. In each case the solutions were quick-cooled from 240 degrees Kelvin (the boiling point of ammonia) by plunging into a flask of liquid nitrogen. For measurements at 195 degrees Kelvin they were subsequently warmed in a bath of dry ice and toluene. The results are presented in Fig. 1 where the volume magnetic susceptibility, K, in c.g.s. units is plotted *versus* the concentration of the solution. For comparison purposes, the measurements of Huster[6] on sodium in liquid ammonia solutions at 195 and 240 degrees Kelvin are given. Although we claim no greater accuracy than ±25 percent for our data, it is seen that the results at 195 check those of Huster and that quick cooling to 78 degrees Kelvin produces no appreciable increase in the diamagnetic susceptibility. The data indicate that if any of our sample is superconducting, the amount is not greater than 1 part in 10,000 by volume.

As a check on the persistent current effect, samples similar to those described by Ogg[1] were prepared between closely spaced microscope slides. These were plunged rapidly into a Dewar flask containing liquid nitrogen, situated in a magnetic field of 1500 gausses. The cells were then quickly transferred to a second liquid nitrogen bath near which a magnetometer capable of detecting a magnetic field of 10^{-5} gauss was situated. Four trials using approximately normal solutions all gave negative results.

[1] R. A. Ogg, Phys. Rev. **69**, 243 (1946); R. A. Ogg, *ibid.* **70**, 93 (1946).
[2] R. A. Ogg, Phys. Rev. **70**, 443 (1946).
[3] H. A. Boorse, D. B. Cook, R. B. Pontius, and M. W. Zemansky, Phys. Rev. **70**, 92 (1946); J. G. Daunt, M. Desirant, K. Mendelssohn, and A. J. Birch, *ibid.* 219. Luigi Guilotto and Alberto Gigli, *ibid.* **71**, 211 (1947).
[4] J. W. Hodgins, Phys. Rev. **70**, 568 (1946).
[5] S. Freed and N. Sugarmann, J. Chem. Phys. 11, 354 (1943).
[6] E. Huster, Ann. d. Physik **33**, 477 (1938).

The Determination of the Self-Diffusion Coefficient of Methane

E. B. WINN AND E. P. NEY
Rouss Physical Laboratory, University of Virginia, Charlottesville, Virginia
May 27, 1947

THE self-diffusion coefficient of methane, not heretofore measured by direct experimental means, has been determined by a method similar to that developed by Ney and Armistead[1] and applied to uranium hexafluoride.

From kinetic theory one has the relation $\rho D=\epsilon\eta$, where ρ is the density of the gas, D its coefficient of self-diffusion, η its coefficient of viscosity, and ϵ a quantity which, according to molecular force law theory, varies from 1.200 to 1.543 depending upon the value of the force law exponent. Since the value of ϵ is uncertain, D can only be computed approximately. An experimental evaluation of ρD, however, enables one to arrive at a precise value for ϵ.

Seven diffusions of heavy methane, i.e., methane enriched in $C^{13}H_4$, into normal methane were performed, the rates of change of the concentrations of the two isotopes in the apparatus being determined by continuous analysis with a mass spectrometer. From these diffusions were obtained the values of ρD at 20°C shown in Table I.

Taking into consideration the precision with which the various factors entering into the computations could be ascertained, the final result is:

$$\rho D=146\pm4 \text{ micropoise at } 20°\text{C}.$$

TABLE I.

Pressure (cm Hg)	Temp. (°C)	ρD at 20°C (micropoise)
6.16	19.2	145
6.02	20.7	138
5.15	21.4	145
6.18	23.5	147
6.24	23.8	156
6.18	24.0	147
6.30	24.7	145
		Average 146 micropoise

Taking the coefficient of viscosity of methane at 20°C to be 109.7 micropoise, it is seen that $\epsilon=1.33$.

It is known that the variation of η with temperature for molecules repelling each other as the inverse nth power of their separation is

$$\eta \propto T^s$$

where, as shown by Rayleigh,[2]

$$s=(n+3)/(2(n-1).$$

If η is plotted as a function of T for the various values listed in the International Critical Tables for methane, it is found that s is very nearly unity. This then gives $n=5$, which results in a value of 1.543 for ϵ, according to an expression derived by Chapman and Cowling.[3] This is a wider divergence from our value than can be explained by experimental error. It should also be pointed out that because of the large thermal diffusion effect one would expect $n>5$ and an ϵ in better agreement with the value reported here.

A possible significant result of this work lies in the fact that the value of 1.33 for ϵ in the case of methane agrees within the limits of our precision with the value of 1.31 found for uranium hexafluoride. No conclusions can as yet be drawn regarding this agreement; however, further work is being undertaken to evaluate the self-diffusion coefficients of a number of gases, from which it is hoped that the true nature of ϵ may be established. An important case to be investigated is that of ammonia at room temperature, which has been shown by Watson and Woernley[4] to exhibit a reversal of the thermal diffusion effect and hence should have an $\epsilon \simeq 1.54$.

We wish to express our thanks to Professor A. O. C. Nier, of the University of Minnesota, for his kindness in supplying the sample of heavy methane used in this experiment.

[1] E. P. Ney and F. C. Armistead, Phys. Rev. **71**, 14 (1947).
[2] Rayleigh, Proc. Roy. Soc. **A66**, 68 (1900).
[3] S. Chapman and T. G. Cowling, *Mathematical Theory of Non-Uniform Gases* (The Macmillan Company, New York, 1939), p. 172.
[4] W. W. Watson and D. Woernley, Phys. Rev. **63**, 181 (1943).

Magnetic Dipole Fields in Unstrained Cubic Crystals

L. W. McKeehan
Sloane Physics Laboratory, Yale University, New Haven, Connecticut
June 6, 1947

LUTTINGER and Tisza[1] have recently made use of a few of the calculated values published some time since[2] under the above title. They mentioned discrepancies which tended to cast general doubt upon the accuracy of the earlier calculations. After correspondence, which clarified the exact character of these discrepancies, a check with the original work-sheets disclosed two misprints in Table II of the 1933 publication which now, therefore, requires the following corrections:

The numbers −2.13651 and 29.36734, appearing several times each in column 9 of Table II on page 916, should have been, respectively, −2.16351 and 29.36374.

This brings the values newly computed by Luttinger and Tisza into satisfactory agreement with what was done in 1933.

TABLE I. Additions to Table II of reference 2.

Column 1	*2*	*3*	*7*	*9*
(S)	100	1/4 1/4 0	4.18879	16.51841
			0	31.52037
			0	0
		0 1/4 1/4	4.18879	−20.47045
			0	0
			0	0
		1/4 1/4 1/2	4.18879	0.52690
			0	2.59919
			0	0
		1/2 1/4 1/4	4.18879	11.51257
			0	0
			0	0

A further computation has been made of the values of h_i at two points, not on the boundary of a dipole domain, which are of interest from the new viewpoint. In the notation of the 1933 paper these new values may be added to its Table II in the form given in Table I.

The components of a characteristic function $\mathbf{S}(\mathbf{r})$ in the notation of Luttinger and Tisza may be found by subtracting entries in column 7 from the corresponding entries in column 9. Care has to be taken to transpose the symbols in columns 2 and 3 and to change the order of entries in columns 7 and 9 to take care of the direction of dipole axes which may be assumed. Thus for dipoles parallel to the Z-axis, the newly computed entries give

$$S_z(0,\ 1/4,\ 1/4)=16.51841-4.18879=12.32962$$
$$S_y=(0,\ 1/4,\ 1/4)=31.52037-0=31.52037$$
$$S_y(1/2,\ 1/4,\ 1/4)=2.59919-0=2.59919.$$

While not affecting the most recent comparison of results, it is desirable to point out two further mistakes in the 1933 paper. In Eqs. (13)–(17) on page 919, a negative sign should precede each symbol h, e.g., h_{iit2}. In the description of Fig. 1, on page 914, r_2 and r_3 should be transposed, so that the equations in the parentheses will read $r_1=r_3=-1$, $r_2=1$.

[1] J. M. Luttinger and L. Tisza, Phys. Rev. **70**, 954 (1946).
[2] L. W. McKeehan, Phys. Rev. **43**, 913 (1933).

Ultrasonic Absorption from 75 to 280 Mc/sec.*

Robert A. Rapuano
Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts
May 23, 1947

MEASUREMENTS of ultrasonic absorption in liquids at frequencies up to 100 Mc/sec. have been reported in the literature. The present note is a preliminary report of absorption measurements between 75 Mc/sec. and 280 Mc/sec. The pulse-echo method[1] has been adapted for this work by the use of a solid acoustic delay line.

Acoustic echoes are received from a reflector placed in the path of an ultrasonic beam set up in fluid which is contained in a tank. Attenuation is determined by measuring, with a calibrated attenuator, the amplitude of the received echo as a function of the separation of the reflector and transducer. The transducer is an x-cut quartz crystal