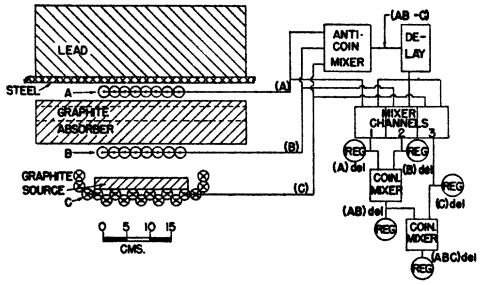

FIG. 1. Experimental arrangement. The geometry in the plane perpendicular to the paper can be inferred from the length of the counters, which is 35 cm.

2) that less than 0.03 count per hour can be due to radiation from 25-Mev electrons in our arrangement. Consequently, it may be seen from Table I that at least a substantial fraction of the electrons must have a range greater than 15 g/cm² of carbon. Therefore, we conclude that there are decay electrons having energies greater than 25 Mev and therefore that the 2-particle decay process (Eq. (1)), with a *unique* energy of about 25 Mev for the decay electron, is incompatible with our results.

We observe, however, that a *maximum* energy of about 50 Mev for the decay electrons would be consistent with the data of Table I.

* For one run a small thickness of iron was added on top of the graphite.

** The absorber for the decay particles, when placed between A and B, produces a negligible change in the number of mesons stopped in the graphite below B, so that the strength of the "source" of decay electrons is sensibly constant as indicated by the rate $(B)_{del}+(C)_{del}$.

[1] M. Conversi and O. Piccioni, Phys. Rev. **70**, 874 (1946).
[2] H. Bethe and W. Heitler, Proc. Roy. Soc. **A146**, 83 (1944).
[3] C. D. Anderson, R. V. Adams, P. E. Lloyd, and R. R. Rau, Phys. Rev. **72**, 724 (1947); R. V. Adams, C. D. Anderson, P. E. Lloyd, R. R. Rau, and R. C. Saxena, Rev. Mod. Phys. **20**, 334 (1948).
[4] W. Y. Chang, reported at the Am. Phys. Soc. Washington Meeting, April 1948; J. G. Retallack, Phys. Rev. **73**, 921 (1948); E. C. Fowler, R. L. Cool, and J. C. Street, Phys. Rev. **74**, 101 (1948); J. L. Zar, J. Hershkowitz, and E. Berezin, Phys. Rev. **74**, 111 (1948).
[5] O. Klein, Nature **161**, 897 (1948); J. A. Wheeler, reported at the Am. Phys. Soc. Washington Meeting, April, 1948.
[6] E. Fermi, Phys. Rev. **57**, 485 (1940); G. C. Wick, Ricerca Scient. **12**, 858 (1941); O. Halpern and H. Hall, Phys. Rev. **73**, 477 (1948).

The Self-Diffusion Coefficient of Nitrogen*

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AN approximation to the self-diffusion coefficient of nitrogen at room temperature has been determined, using a method originated by Ney and Armistead and previously applied to uranium hexafluoride[1] and methane.[2] This consisted of allowing nitrogen having 7.4-atom percent enrichment of N^{15}, supplied by the Eastman Kodak Company, to diffuse into normal nitrogen at the same temperature and pressure. Because of the chemical similarity and the small mass difference between the molecules $N^{14}N^{14}$ and $N^{14}N^{15}$, the coefficient of diffusion of the one into the other should be very nearly the same as the coefficient of self-diffusion of either.

The apparatus used consisted of two cylindrical copper bulbs, having volumes of 924 cm³ and 249 cm³, mounted on a common axis and connected through a copper tube and brass ground-joint stopcock, the tube and stopcock assembly having a uniform bore of 0.635 cm and an over-all length of 16.23 cm. In performing the diffusions heavy nitrogen was placed in one bulb and the normal gas in the other at the same temperature and pressure. After opening the connecting stopcock a continuous analysis of the concentration of $N^{14}N^{15}$ in the small bulb was performed with a 60° Nier-type mass spectrometer, the rate at which this concentration changed providing a means of evaluating the coefficient of diffusion. In order to obtain a relaxation time of about an hour and a half all diffusions were performed at room temperature and at pressures of from five to six cm of mercury.

In the kinetic theory of transport phenomena there is derived the relation $\rho D=\epsilon\eta$, where ρ is the density, D the coefficient of self-diffusion, η the coefficient of viscosity, and ϵ a constant related to the intermolecular forces. Taking ρ for nitrogen to be 1.2506×10^{-3} g/cm³ at 0°C and 760 mm of mercury pressure, and assuming the ideal gas law to hold, the mean of five diffusions referred to 20°C is: $(\rho D)_{20°C}=258\pm10$ micropoises. The precision measure assigned is the most probable cumulative error arising from errors in the measurement of the geometrical constants, pressure, and temperature, as well as instrument error.

Taking η at 20°C to be 174.7 micropoises,[3] it is found that $\epsilon=1.48$. If the nitrogen molecules be represented as point centers of repulsive force, Chapman and Cowling[4] compute that $\epsilon=1.44$, using the experimentally verified relation $\eta\propto T^{0.756}$. This theoretically determined figure agrees with the observed value within the limits of experimental error. This agreement between experiment and theory is of especial interest, since the values reported for ϵ for uranium hexafluoride,[1] methane,[2] and argon[5] show a departure from the simple theory and yet agree with each other within the limits of error. This unexpected result led at first to the suspicion that ϵ might have the same value for all gases, but the figure reported here does not support such a belief.

Experimentally determined values of ϵ for various gases are listed in Table I, which, with the addition of the result for nitrogen, is reproduced from a paper by Hutchinson[5] and illustrates the as yet unexplained behavior of this quantity.

Amdur[6] has already pointed out that the molecular model assumed by Chapman and Cowling may be incomplete, it being more appropriate to represent the interactions as a sum of both repulsive and attractive forces.

TABLE I. Reported values of ϵ.

Gas	Temperature, °C	ϵ
H_2	20	$1.37_0\pm0.003$
	−188	1.32 ±0.06
	−252.8	1.28 ±0.02
Ne	20	$1.27_8\pm0.006$
A	22	1.31 ±0.01
Kr	20	1.30 ±0.06
Xe	20	1.24 ±0.06
CH_4	20	1.33
UF_6	30	1.31
N_2	20	1.48

Furthermore, the temperature variation of the coefficient of viscosity by itself does not supply reliable information as to the nature of the attractive force, so that no final conclusions regarding the force field of the nitrogen molecule should be drawn from this work alone.

The writer would like to express his thanks to Dr. E. P. Ney for suggesting the problem and for valuable discussions in the initial stages of the project.

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[1] E. P. Ney and F. C. Armistead, Phys. Rev. **71**, 14 (1947).
[2] E. B. Winn and E. P. Ney, Phys. Rev. **72**, 77 (1947).
[3] M. Trautz and R. Zink, Ann. d. Physik **7**, 427 (1930).
[4] S. Chapman and T. G. Cowling, *The Mathematical Theory of Non-Uniform Gases* (Cambridge University Press, Teddington, 1939), p. 172.
[5] F. Hutchinson, Phys. Rev. **72**, 1256 (1947).
[6] I. Amdur, Phys. Rev. **72**, 642 (1947).

Erratum: The Radial Dependence of the Tensor Force in the Deuteron

[Phys. Rev. **74**, 145 (1948)]

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IN the above article, on page 149, Eq. (33) should read

$$\langle J_1(r)\rangle_{Av} \geq \gamma \langle J_2(r)\rangle_{Av}.$$

Cloud-Chamber Observations of the Decay of Tritium

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August 5, 1948

THE introduction of a small amount of tritiated water[1] into a cloud chamber operating at atmospheric pressure, thus providing a weakly radioactive vapor in the chamber, has enabled us to observe a significant number of beta-particle tracks from the decay of $_1H^3$. The chamber had a diameter of 9 cm; and photography was non-stereoscopic, using an optical system with a 4-mm depth of focus. The photographs were measured at a magnification of 10.83 diameters, and only those tracks were recorded which were entirely in focus. 1565 tracks were acceptable, and the differential distribution of the lengths of their projections is shown in Fig. 1. Although all photographs were searched very carefully for very short tracks, we cannot be sure that the distribution as shown is accurate for projections smaller than 0.5 mm.

In view of the preliminary nature of this investigation, and of the uncertainties in available data relative to straggling and to the energy-range relation, it seems possible to reach only limited conclusions from Fig. 1. Apart from the fact that the data do not indicate any highly unusual form for the energy distribution, it is possible to report only that the maximum track length was observed to be 4.12 mm (referred to dry air at 15°C and 760-mm pressure). An application of Alper's[2] energy-range relation, as extrapolated to higher energies concordantly with Wilson's,[3] indicates an energy of 11 ± 1 kev as the corresponding maximum energy for the tritium beta-particles. The uncertainty in the 4.12-mm measured range leads to a corresponding undertainty in the maximum-energy determination, but it is considerably less than the ±1 kev attributed to the uncertainties in the energy-range relation.

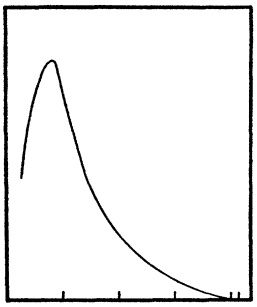

FIG. 1.

[1] The authors are indebted to the Carnegie Institution (DTM), and particularly to Drs. M. A. Tuve and P. H. Abelson and Mr. W. D. Whitehead of that Institution, for the gift of tritiated water.
[2] T. Alper, Zeits. f. Physik **76**, 172 (1932).
[3] C. T. R. Wilson, Proc. Roy. Soc. **A104**, 1 (1923).

Cloud-Chamber Observation on Low Energy Portion Ra*E* Beta-Spectrum

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SINCE measurements of the low energy behavior of continuous beta-spectra of Ra*E* have been somewhat contradictory, it seems that cloud-chamber measurements might provide significant new information. We have made cloud-chamber measurements of this spectrum using Ra*E* deposited on a collodion film having a thickness of about 0.15 micron, and have observed 716 tracks. The diameter of the cloud chamber was 9 cm and the effective depth of focus was about 4 mm; only those tracks were used which were entirely in focus. Tracks were photographed non-stereoscopically and measured according to the method of Petrova,[1] in which the projection of the track in the photographic plane is determined; all data were reduced to 15°C and 760 mm Hg. Corrections were applied to compensate for the change in effective solid angle with projected length of track. A second series of 262 tracks was obtained by using a source deposited electrolytically on a platinum wire, to exhibit the effects of a massive source support.

The data are shown as differential distributions in Fig. 1, indicating the intensity of each spectrum as a function of the "projected range." It is clear from this figure that the energy distribution of the Ra*E* beta-particles seems to vanish at zero (or some small energy); this result has not been reported by earlier workers,[2] presumably because of instrumental difficulties at very low energies.