and 10^7 for well and atmospheric helium, respectively. In a private communication Dr. Alvarez has indicated that owing to difficulties in shimming the cyclotron and to the fact that different detecting devices were used for He^3 and He^4 in their work, it is possible that their absolute determination of the He^3 abundance might be in error. However, since the same experimental arrangements were used for air and well helium, their relative He^3 concentrations should be correct. Our relative concentrations are in good agreement with their values, and since at present we see no reason to doubt our absolute determinations, it appears that He^3 is approximately ten times as abundant as has been assumed heretofore.

Helium from different geological sources including radioactive minerals will be investigated in further studies.

While the problem of concentrating He^3 from natural sources remains a formidable one, the higher value for the abundance brings it closer to reality. Also since measurements are in the range of a good mass spectrometer, the results of concentration processes can be evaluated.

The mass spectrometer used in this investigation was built from a grant from the Graduate School. This research was made possible through a grant from the Research Corporation.

[1] In a preliminary report in the Bulletin of the American Physical Society, Vol. 21, No. 6, November 29, 1946 we gave 6×10^6 for this ratio.

[2] L. W. Alvarez and R. Cornog, Phys. Rev. 56, 613 (1939); 56, 379 (1939).

The Hyperfine Structure of the Microwave Spectrum of Ammonia and the Existence of a Quadrupole Moment in N^{14} *

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Good[1] has reported the existence of a hyperfine structure for many of the lines of the inversion spectrum of ammonia, $N^{14}H_3$, which falls in the microwave region near 1.25 cm. This feature had not been predicted theoretically. Of the possible explanations, the interaction of a quadrupole moment of the N^{14} nucleus with the electrical field of the other charges in the molecule seems the most likely and has been widely discussed. Another possibility, magnetic spin-spin interaction of the nuclei, is theoretically of too small a magnitude and does not fit in other ways.

Table I. Hyperfine structure spacings in $N^{14}H_3$ in megacycles/sec. from the central line.

JK	$\Delta\nu$	$\Delta\nu'$	JK	$\Delta\nu$	$\Delta\nu'$
11	0.60	1.57	33	1.72	2.34
22	1.30	2.05	44	1.91	2.48

(all values ±0.05)

Table II. Calculated and observed ratios.

	$\Delta\nu_{JK}/\Delta\nu_{11}$		$\Delta\nu'_{JK}/\Delta\nu'_{11}$		$\Delta\nu'_{JK}/\Delta\nu_{JK}$	
JK	obs.	calc.	obs.	calc.	obs.	calc.
11					2.62	2.50
22	2.17	2.14	1.31	1.33	1.58	1.56
33	2.87	2.78	1.49	1.50	1.36	1.35
44	3.18	3.18	1.58	1.60	1.30	1.26

In order to test the quadrupole hypothesis, a quantum-mechanical treatment of the interaction has been carried out and the results compared with accurate measurements of the hyperfine structure spacings.

The equations, the derivation of which will be published separately, are as follows for the frequency difference between the central line and each of the four satellites:

$$h\Delta\nu=\pm(\tfrac{3}{16})Q(\partial^2 V/\partial z^2)\{1-[3K^2/J(J+1)]\}[(J+1)/(2J+3)],$$

$$h\Delta\nu'=\pm(\tfrac{3}{16})Q(\partial^2 V/\partial z^2)\{1-[3K^2/J(J+1)]\}[J/(2J-1)],$$

in which Q is the so-called nuclear quadrupole moment' $\langle\rho(3z^2-r^2)\rangle_{\mathrm{Av}}$ and J and K are the total angular momentum and axial angular momentum quantum numbers for the rotation of the molecule. V is the electrostatic potential at the nitrogen nucleus owing to the charges outside that nucleus. Z is along the symmetry axis. These formulas assume that the molecule is of the symmetrical top type, that the spin of the N nucleus is unity, and that the magnetic couplings of the nuclei are negligible.

The hyperfine structure for the (J, K) 11, 22, 33, and 44 lines of $N^{14}H_3$ was measured with an apparatus using a wave guide absorption cell and a sweeping technique in which the carrier was frequency modulated, so that sidebands are produced which cause images of the central absorption line to be displayed. These are compared in frequency with the satellite lines. The results are given in the Tables I and II. Since the absolute values of Q and $\partial^2 V/\partial z^2$ are not known, only ratios of splittings can be predicted theoretically.

It is seen that the agreement is excellent. Furthermore no hyperfine structure has been detected for $J=3$, $K=2$, for which the theory predicts zero splitting, or for higher J values, for which a further theoretical treatment predicts a lower relative intensity for the satellites.

Since N^{15} is reported[2] to have a nuclear spin of $\frac{1}{2}$ units, it should not show this effect. Therefore a sample of ammonia containing 60 percent N^{15} was prepared from ammonium nitrate procured from the Eastman Kodak Laboratory and its inversion spectrum examined in a simple wave guide absorption apparatus similar to that used by Hershberger.[3] Lines ascribed to $N^{15}H_3$ were found at 24560(77), 23928(66), 23686(11, 10), 23406(55), 23049(44), 22769(33), 22640(22) megacycles, the probable quantum numbers being given in parenthesis. Although the hyperfine structure of the $N^{14}H_3$ lines 11, 22, 33, and 44 was clearly observed with the same sample of ammonia, no hyperfine structure was seen on the $N^{15}H_3$ lines.

We therefore conclude that the hypothesis that the hyperfine structure of $N^{14}H_3$ is caused by a quadrupole interaction is strongly supported by several types of observations.

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[1] W. E. Good, Phys. Rev. 70, 213 (1946).

[2] R. W. Wood and G. H. Dieke, J. Chem. Phys. 6, 908 (1938).

[3] W. D. Hershberger, J. App. Phys. 17, 495 (1946). J. E. Walter and W. D. Hershberger, J. App. Phys. 17, 814 (1946).