turbation methods.[5] The fine structure formula then assumes the following form

$$\{aK^2[J(J+1)]^{-1}+b+cf(J,K)\}C,$$

where a, b, and c are constants and $f(J,K)$ is a rather complicated function which takes into account the small departure from molecular symmetry. This expression can be fitted handsomely to the data presented in Coon's paper.[1] Indeed the leading (and dominant) term closely approximates his empirical formula, $a'(2K-J)$, for values of J and K large in comparison with their difference.

[1] J. Coon, J. Chem. Phys. **14**, 665 (1946).
[2] S. C. Wang, Phys. Rev. **34**, 249 (1929).
[3] E. C. Kemble, *Fundamental Principles of Quantum Mechanics*, see Section 48c, p. 394, on Van Vleck's method.
[4] H. M. Foley, Phys. Rev. **72**, 504 (1947).
[5] E. E. Witmer, Proc. Nat. Acad. **13**, 60 (1927).

On the Fine Structure in the Inversion Spectrum of Ammonia

R. S. HENDERSON
Department of Physics, Harvard University, Cambridge, Massachusetts
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SIMMONS and Gordy[1] report that interactions involving the nuclear quadrupole moment do not altogether account for the fine structure appearing in the inversion spectrum (microwave) of $N^{15}H_3$, and suggest that coupling of the nuclear dipole moment with the magnetic field set up by molecular rotation may be responsible for the discrepancies brought to light by their measurements.

A theoretical expression describing the effect of such coupling in molecules possessing a non-vanishing resultant of electron spins has recently been put forward by the writer.[2] This can be taken over bodily in dealing with cases where nuclear rather than electron spins interact with electronic orbital angular momenta. In the present instance one has only to replace S by I and add the resulting expression to the formula used by Simmons and Gordy in their calculations. Over and above terms representing quadrupole (or pseudoquadrupole) coupling, there then appears the following correction to the rotational energy

$$\{aK^2[J(J+1)]^{-1}+b\}[F(F+1)-J(J+1)-I(I+1)],$$

which owes its simple form to the fact that the ammonia molecule is symmetrical about an axis through the nitrogen atom.

The extent to which this improves the agreement between calculated and observed separations of satellites from their main lines is set forth in Table I. The columns list discrepancies between observed values of $\Delta\nu$ and $\Delta\nu'$, and those calculated with and without inclusion of the dipole term in the fine structure formula. It is seen that these can be reduced so that they compare in magnitude and scatter with experimental errors, estimated by Simmons and Gordy as ranging from ± 5 kc/sec. to ± 30 kc/sec.

Constants used in obtaining these figures were (mc/sec.):

$$eQ\partial^2 V/\partial z^2 = 4.10 \quad \text{with} \quad a=0.0057, \quad b=0.0011,$$

TABLE I.

		Discrepancies (kc/sec.)						Discrepancies (kc/sec.)			
		in $\Delta\nu$		in $\Delta\nu'$				in $\Delta\nu$		in $\Delta\nu'$	
J	K	New	Old	New	Old	J	K	New	Old	New	Old
1	1	−6	+3	+9	−6	8	8	−3	+42	−6	−75
2	2	+12	+25	+1	−24	9	9	−17	+34	+17	−58
3	3	+1	+17	0	−32	2	1	−11	+10	−8	−15
4	4	+13	+36	0	−40	4	3	−7	+22	−2	−30
5	5	+15	+43	−17	−63	5	4	−13	+20	+2	−34
6	6	+10	+42	−6	−63	6	5	−8	+30	+3	−43
7	7	−12	+28	−19	−80	7	6	−15	+28	+6	−47
						4	2			−22	−43

and

$$eQ\partial^2 V/\partial z^2 = 4.08$$

when the quadrupole term stands alone.

We wish to acknowledge the kind assistance of Professor Townes, at whose suggestion this work was undertaken.

[1] J. W. Simmons and W. Gordy, Phys. Rev. **73**, 713 (1948).
[2] Previous communication.

Distortion of Progressive Ultrasonic Waves*

J. C. HUBBARD, J. A. FITZPATRICK, B. T. KANKOVSKY, AND WILLIAM J. THALER
The Catholic University of America, Washington, D. C.
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THE subject of plane waves of sound of finite amplitude has received attention from the time of Riemann and was considered at some length by Rayleigh,[1] who predicted that, neglecting viscosity, the "crests of the velocity curve would gain continually on the troughs and must at last overtake them." R. D. Fay[2] has provided an analysis, including a consideration of the viscosity effect, and has shown that there is a gradual transfer of energy from lower to higher frequencies, so that a wave tends toward the distortion predicted by Rayleigh. Be-

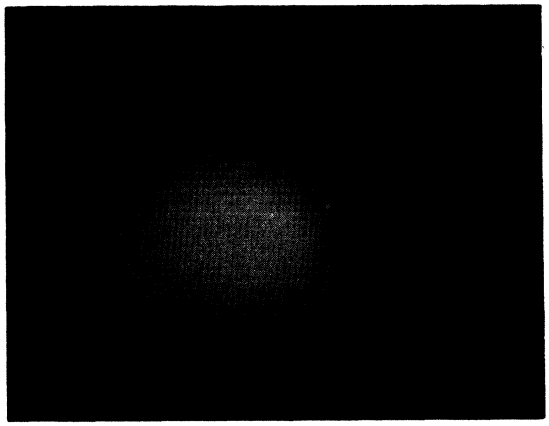

FIG. 1. Shadow photograph by collimated light of sound waves in air of frequency 405 kc/sec., at 27°C, the source being an x cut quartz plate with a peak voltage of 350 volts on the electrodes. Distortion of plane waves leaving the source is shown.