TABLE I. Gamma-ray spectra of Ga^{72}.

Ga^{72} beta-groups Energy	Intensity	Ga^{72} gamma-rays Energy	Intensity
3.15 Mev	9.5 to 20%	2.51	26%
2.52 Mev	8 to 18.5%	2.21	31.5%
0.955 Mev	32%	1.87	7.5%
0.64 Mev	40%	(1.60)	(4.5%)
		1.05	4.5%
		0.84	100%
		0.68	2%
		0.63	18.5%

1.87-Mev line fits well between the levels of Ge^{72} at 3.35 Mev and 1.47 Mev, while the sum of the other three lines, $0.68+1.05+1.60=3.33$, is very close to the difference between the 3.35-Mev level of Ge^{72} and the ground state. However, the intensity of the 0.68 line appears to be much too small to be in a sequence with the 1.05-Mev line and probably the 1.60-Mev line, even allowing for rather large uncertainty in intensity measurements.

The 0.68 line was found by means of its conversion electrons which appear in about 0.5 percent of the disintegrations. The gamma-ray line intensity is so small as to be very difficult to measure. It would appear, however, that the conversion coefficient was between 10 and 50 percent which, for such a high energy and such a low atomic number, would indicate a metastable level with a considerable half-life. The decay period of the beta-ray spectrum and conversion line differs inappreciably from 14.1 hours, indicating that the delay of the line is not longer than a few hours at most.

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[1] C. E. Mandeville, Phys. Rev. 64, 147 (1943).
[2] L. C. Miller and L. F. Curtiss, Phys. Rev. 70, 983 (1946).
[3] A. Wattenburg, Phys. Rev. 71, 497 (1947).
[4] Siegel and Glendenin, Rev. Mod. Phys. 18, 513 (1946).
[5] E. C. Barker, Phys. Rev. 72, 167 (1947).

Stark Spectrum of HDO*

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THE $5_{3,3;0}$–$5_{3,2;1}$ rotation line of HDO[1] has been measured in the 1.25-cm region at a frequency of 22,307.67 ±0.05 mc/sec. The Stark spectrum of this line was studied in a wave-guide cell by use of equipment and methods that have been described previously.[2–4] Five components were detected, but only three of them were measured. Line breadths were of the order of 250 kc/sec. and, qualitatively, intensities followed theoretical predictions, i.e., proportional to M^2.

In Fig. 1 is plotted the experimental data for the three Stark components that were measured. The data may be fitted with the formula:

$$\Delta\nu = 9.00E^2M^2\times 10^{-8}\ \text{mc/sec.},$$

where E is measured in volts per cm and M is the magnetic quantum number, $|M|\leq 5$.

In deriving this equation theoretically, the calculation

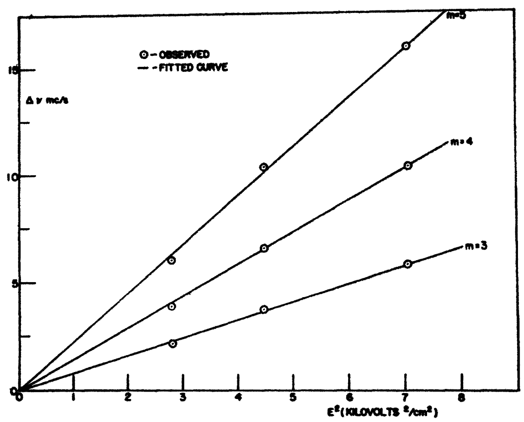

FIG. 1. HDO Stark pattern.

turned out to be considerably more straightforward than expected for an asymmetric rotor. Most of the energy denominators in the second-order terms of conventional perturbation theory are in the infra-red and can be neglected in comparison with the line $5_{3,3;0}$–$5_{3,2;1}$. The largest neglected term corrects the simplified formula in two ways: (*a*) The entire Stark pattern is shifted toward the undisturbed line by an amount about 2.5 percent of its total width. (*b*) The term in M^2 is increased by about 2 percent. The contribution of all the other terms is negligible. For HDO, $K=-0.7$ so that in calculating the direction cosine matrix elements an additional approximation was made by using the symmetric rotor wave functions without further transformation. This approximation involves an error of less than 2 percent of the total Stark pattern width. The resulting theoretical formula is:

$$\Delta\nu = \frac{\mu^2E^2\sin^2\delta M^2}{h^2(\nu_{5,1}-\nu_{5,0})}\frac{1}{50},$$

where: μ = dipole moment in e.s.u.-cm, δ = angle between ellipsoid of inertia and dipole moment = 20°38′,[5] E = applied electric field in e.s.u./cm, ν = frequency in c.p.s.

By using the dipole moment of $H_2O(1.84\times 10^{-18}$ e.s.u.-cm),[6] the above equation becomes

$$\Delta\nu = 9.56\times 10^{-8}E^2M^2\ \text{mc/sec.},$$

which is to be compared with the experimental formula.

The agreement is reasonable since, in fact, the dipole moment of HDO can only be approximated by that of H_2O. Using the experimental formula, the value of the dipole moment of HDO obtained, is:

$$\mu = 1.78\pm 0.06\times 10^{-18}\ \text{e.s.u.-cm}.$$

Errors in field strength constitute about 1.5 percent of the indicated error.

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[1] C. H. Townes and F. R. Merritt, Phys. Rev. 70, 558 (1946).
[2] Golden, Strandberg, Wentink, and Hillger, Phys. Rev. 73, 92 (1948).
[3] R. H. Hughes and E. B. Wilson, Jr., Phys. Rev. 71, 562 (1947).
[4] B. P. Dailey, Phys. Rev. 72, 84 (1947).
[5] G. W. King, R. M. Hainer, and P. C. Cross, Phys. Rev. 71, 433 (1947).
[6] See, for example, "Tables of electric dipole moments," Tech. Report No. II, Laboratory for Insulation Research, Massachusetts Institute of Technology.