Microwave Absorption Spectrum of ND_3

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(Received October 10, 1952)

The main $J=K$ sequence of inversion lines of the ND_3 absorption spectrum were observed and measured between 1589 and 2540 Mc. Quantum numbers up to $J,K=18,18$ were assigned by the use of an approximate empirical formula.

THE investigation of the microwave absorption spectra of the deutero ammonias previously reported[1,2] has been extended. The isotopic analysis of 24 of the lines between 2 and 17 kMc showed[2] that the principal ground state ND_3 lines were to be expected below the 2080-Mc cut-off frequency of the S-band absorption cell[3] used previously. Accordingly a coaxial type Stark cell of novel design[4] was constructed to permit measurements as low as 900 Mc, currently the lowest frequency gas spectrometer reported. Table I lists both the frequencies of the main $K=J$ series of lines as measured to a precision of approximately 0.05 Mc, and the corresponding frequencies calculated according to the empirically determined approximate equation:

$$\nu=1595.69-7.155J(J+1)+10.03K^2, \quad (1)$$

based on the NH_3 type theoretical formula:

$$\nu=\nu_0-BJ(J+1)+AK^2. \quad (2)$$

Additional terms in higher powers of J and K are required to calculate the series of lines at high J,K numbers to the measurement precision. The table was discontinued at $J,K=12,12$ where these higher order terms begin to dominate the calculation. A number of additional lines were observed incidentally, but are not given in this preliminary Table, which have been discussed previously.[5] The identification of the proper peaks for the 1,1 and 2,2 lines is made uncertain by a combination of effects—the overlapping of the 1,1 and 2,2 quadrupole patterns, the recently reported[6] K doubling of the 1,1 line (and its quadrupole components), and an unfortunate waveguide resonance between 1580 and 1600 Mc. It is hoped to resolve this uncertainty with a modification of the apparatus and technique. Computation of both the molecular constants and higher order terms in the empirical formula awaits this investigation.

Previous theoretical predictions of ν_0 have varied from 1200[7] to 2000[8] Mc. A semi-empirical calculation of the constants in Eq. (1) is discussed elsewhere,[9] and confirms the experimental assignments listed in the table.

Other features of the spectra, such as the splitting of the 3,3 and 6,6 lines[10] have also been observed.

It is a pleasure to acknowledge the helpful discussions with Professor Charles H. Townes of Columbia University, consultant to the Microwave Standards Section of the National Bureau of Standards.

TABLE I. Frequencies of ND_3 inversion lines (Mc).

J,K	Measured	Calculated	J,K	Measured	Calculated
1,1	1589.10	1591.41	10,10	1815.37	1812
2,2	1591.72	1592.88	11,11	1872.43	1865
3,3	1599.53	1600.10	12,12	1937.31	1924
4,4	1612.99	1613.1	13,13	2010.57	
5,5	1631.82	1631.8	14,14	2092.32	
6,6	1656.18	1656.3	15,15	2183	
7,7	1686.46	1686.5	16,16	2285	
8,8	1722.85	1722.4	17,17	2403	
9,9	1765.80	1764.2	18,18	2540	

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