

ionised carboxylic group appears at $1,622\text{ cm}^{-1}$. The absorption in this region indicates that the resonance of carboxylate ion is preserved in the complex and that metal to oxygen band must, therefore, be essentially ionic in character.

The strong band appearing at 935 cm^{-1} in the uranyl complex has been assigned to the stretching vibration of the uranyl ion. In other crystalline uranyl compounds, this vibration has been found to occur between $900\text{--}950\text{ cm}^{-1}$,^{11,12} typically near 920 cm^{-1} .

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MICROWAVE SPECTRUM OF 2-CYANOPYRIDINE

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THE microwave spectrum of 2-cyanopyridine (Fig. 1) has been investigated in the frequency range 8 to 18 GHz using a conventional 100 KHz Stark modulated microwave spectrometer.¹ Since the molecule has a very low vapour pressure at dry ice temperature, the spectrum was observed at room temperature. The pressure was maintained around 5 microns for most of the measurements. The molecule exhibits a rich spectrum with a line every 10 to 15 MHz. Most of the lines are broad and have observable quadrupole splittings.

The molecule was assumed to be planar. Using the pyridine ring dimensions as reported by Bak *et al.*² and taking the values of $d_{cc} = 1.419\text{ Å}^3$ and $d_{cN} = 1.158\text{ Å}^3$, the rotational constants come out to be $A = 5868.96\text{ MHz}$, $B = 1658.16\text{ MHz}$ and $C = 1292.88\text{ MHz}$ with the asymmetry parameter $\kappa = -0.8404$. The spectrum was generated with these constants. Assignment of transitions was little difficult as Stark patterns were not clear for the lines expected to be of low J transitions and also because of the large number of lines. So the method adopted for the identification of the spectra was as follows: Based on intensity considerations and unresolved low J Stark patterns, lines were assigned to different transitions. A combination of four frequencies were chosen (in principle, any number of frequencies can

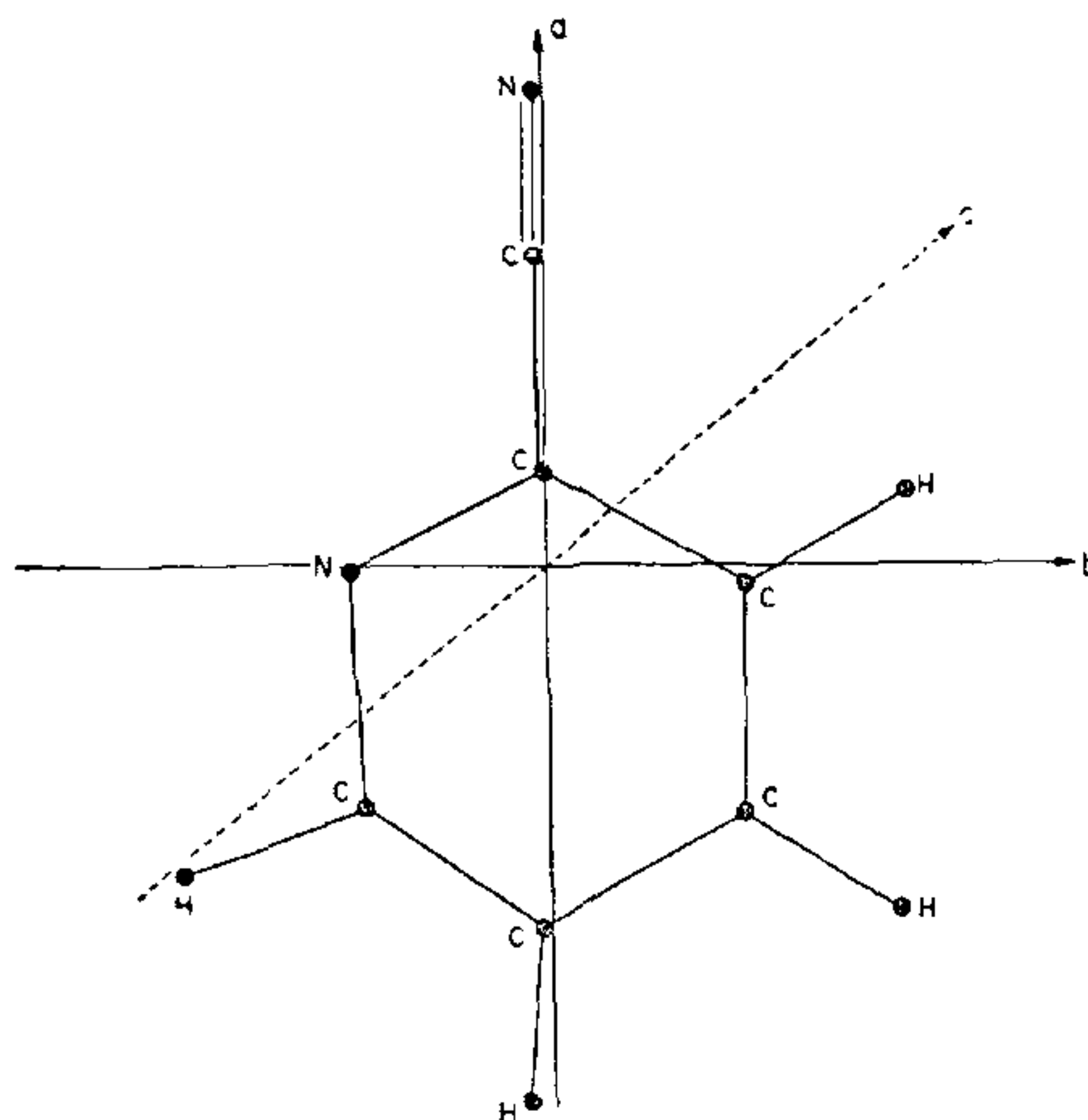


FIG. 1. 2-Cyanopyridine

be chosen for this purpose) and a matrix of the type

$$\nu_i = [\Delta \langle P_{z_i}^2 \rangle]A + [\Delta \langle P_{y_i}^2 \rangle]C + [\Delta \langle P_{x_i}^2 \rangle]B$$

was set up. Pierce's⁴ computer program which calculates the rotational spectra from the given A , B and C was modified.⁵ This program identifies the chosen combination of frequencies

TABLE I

Transition	$\nu_{\text{obs.}}$ (MHz)	$\nu_{\text{obs.}} - \nu_{\text{calc.}}$ (MHz)
3 (0, 3) - 2 (0, 2)	8478.41	+0.21
3 (1, 2) - 2 (1, 1)	9060.91	+0.17
3 (2, 2) - 2 (2, 1)	8558.00	-0.37
4 (0, 4) - 3 (0, 3)	11214.20	+0.21
4 (1, 4) - 3 (1, 3)	10385.34	+0.18
4 (1, 3) - 3 (1, 2)	12055.75	-0.06
4 (2, 2) - 3 (2, 1)	11591.55	-0.24
5 (0, 5) - 4 (0, 4)	13881.10	-0.01
5 (1, 5) - 4 (1, 4)	13323.70	+0.15
5 (2, 3) - 4 (2, 2)	14600.80	-0.11
5 (4, 2) - 4 (4, 1)	14308.00	+0.01
6 (0, 6) - 5 (0, 5)	16478.20	-0.13
6 (1, 6) - 5 (1, 5)	15943.70	+0.09
6 (2, 5) - 5 (2, 4)	17025.75	-0.22
6 (2, 4) - 5 (1, 5)	11119.70	-0.21
7 (1, 6) - 7 (0, 7)	10848.56	-0.07
8 (2, 6) - 8 (1, 7)	11197.20	-0.01
9 (2, 7) - 9 (1, 8)	11702.65	-0.20
11 (3, 8) - 11 (2, 9)	17502.30	-0.37
12 (2, 10) - 12 (1, 11)	15580.21	+0.13
12 (3, 9) - 12 (2, 10)	16979.15	-0.17
14 (3, 11) - 14 (2, 12)	16873.86	+0.02

TABLE II

Rotational constants and moments of inertia of
2-cyanopyridine

$A = 5836.756 \pm 0.014$ MHz	$I_A = 86.585$ amu \AA^2
$B = 1598.219 \pm 0.004$ MHz	$I_B = 316.213$ amu \AA^2
$C = 1254.460 \pm 0.004$ MHz	$I_C = 402.865$ amu \AA^2
$X_c = -0.84996$	$\Delta = I_C - I_A - I_B = 0.067$ amu \AA^2

Conversion factor : 505376 MHz amu \AA^2 .

and determines the new values of A, B and C obtained by solving the matrix by the method of least squares. In the next iteration, the coefficients of A, B and C are calculated from their new values. Iterations are continued till the difference between the two consecutive sets of rotational constants do not exceed a preset limit. In this case, a limit of 0.01 MHz had been set. The entire spectra of the molecule are generated from the values of rotational constants obtained this way. This is subsequently compared with the observed frequencies. Any number of sets could be tested at a time.

The assignment of the spectrum thus obtained has been confirmed by the usual Q line plot. Further confirmation is provided by observing the Stark patterns of low J lines predicted by these constants and the relative intensities of other lines.

The observed and calculated frequencies are listed in Table I. Table II gives the molecular constants that give the best fit to the spectra.

The evaluation of dipole moment, quadrupole coupling constants and centrifugal distortion constants are in progress and will be published later.

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BIOLOGY TEACHERS' HANDBOOK*

THIS publication is a production of the Biological Sciences Curriculum Study (BSCS), USA. The BSCS was established in 1958 for the improvement of biological education at all levels. As a co-operative enterprise between the biological and educational communities, the BSCS has produced a variety of materials used at both the secondary and collegiate levels. The single most important factor in making these materials reach the students

is the teacher. Hence the BSCS also brings out carefully planned handbooks to act as guidelines to biology teachers. With modal methodologies and resource materials added, such handbooks might also serve in the training of teachers.

The first U.S. edition of this Handbook was published in 1963 and the second U.S. edition in 1970 at \$ 8.95. This book is now made available as a less expensive Wiley Eastern Reprint. The Indian publication is timely as there is an awareness in the country now to teach bioscience as an integrated course from high school onwards.

* *Biology Teachers' Handbook*, Second Edition. Supervisor Evelyn Klinckman. (Wiley Eastern Private Ltd., Publishers, J. 41, South Extension I, New Delhi-49), 1971. Pp. xv + 692, Price Rs. 32.