THE Q BRANCH OF 21^10-01^10 BAND OF N_2O

SHEN ZHIYE (沈之烨) AND LIU HUIFANG (刘蕙芳)
(*Dalian Institute of Chemical Physics, Academia Sinica*)

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The vibration-rotation spectra of N_2O are among the most thoroughly investigated IR spectra in the literature. Recently, the observation made by C. Amiot et al. gave molecular constants with great precision[1]. There is, however, no information yet on the Q branch of the 21^10—01^10 band.

Our measurements were made by using a Laser Analytics model LS-3 tunable diode laser source IR spectrometer. The principle and operation of the apparatus have been described elsewhere[2]. The gas cell was a multipass White cell with a path length set at 12m, and the N_2O pressure was 1.5 torr. The resulting spectra is shown in Fig. 1. The whole spectra obtained are composed of 4 regions. Between 2577.1 and 2578.8 cm^{-1}, 37 lines of the Q branch were observed, most of which were well separated, while a few lines were mutually overlapping. The half-width of any single line, about 0.006 cm^{-1}, was somewhat broader than the Doppler width.

The calculated and observed line positions are given in Table 1. For the calculation of line positions, the following formulae were used:

$$\begin{aligned}\nu_{c-d} &= \Delta\nu_0 + (B'_c - B''_d)J(J+1) - (D'_c - D''_d)[J(J+1)]^2 \\ &\quad + (H'_c - H''_d)[J(J+1)]^3, \\ \nu_{d-c} &= \Delta\nu_0 + (B'_d - B''_c)J(J+1) - (D'_d - D''_c)[J(J+1)]^2 \\ &\quad + (H'_d - H''_c)[J(J+1)]^3.\end{aligned}$$

The constants B, D, H's used here are those of Amiot et al. and are given in Table 2.

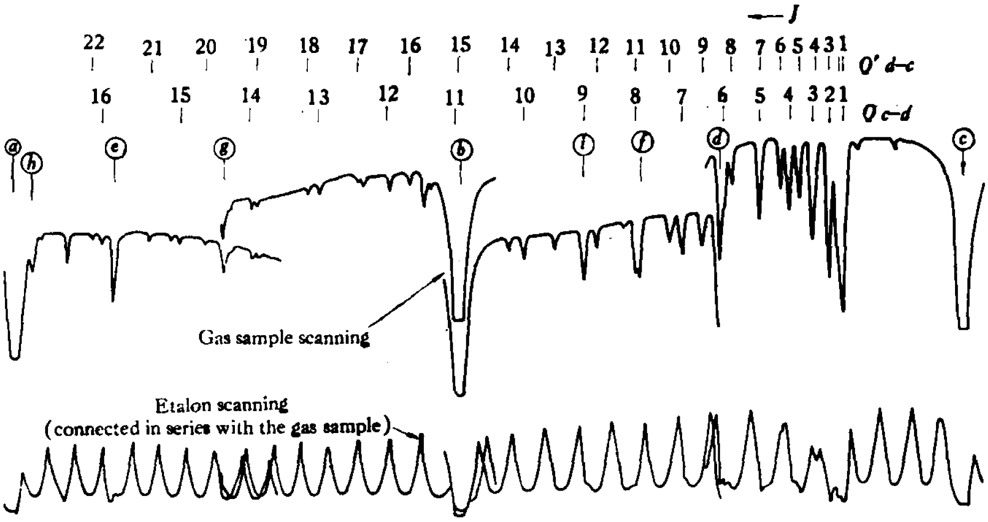

Fig. 1

Table 1

Calculated Value			Observed Value	$(C—O)\times10^{-3}$ (cm^{-1})
$Q(J)$ ($c-d$ band)	$Q'(J)$ ($d-c$ band)	Mean		
$Q(1)$ 2577.0774	$Q'(1)$ 2577.0811	0.0793	0.0803	—1
	$Q,(2)$ 0.0721	0.0721	0.0726	—0.5
$Q(2)$ 0.0609	$Q'(3)$ 0.0585	0.0597	0.0605	—0.8
$Q(3)$ 0.0361	$Q'(4)$ 0.0405	0.0383	0.0370	1.3
	Q')5) 0.0179	0.0179	0.0170	0.9
$Q(4)$ 0.0032		0.0032	0.0021	1.1
	$Q'(6)$ 2576.9908	0.9908	0.9895	1.3
$Q(5)$ 2576.9619	$Q'(7)$ 0.9592	0.9606	0.9607	—.1
	$Q'(8)$ 0.9231	0.9231	0.9225	0.6
$Q(6)$ 0.9124		0.9124	0.9107	1.7
	$Q'(9)$ 0.8825	0.8825	0.8854	—2.9
$Q(7)$ 0.8547		0.8547	0.8568	—2.1
	$Q'(10)$ 0.8374	0.8374	0.8391	—1.7
$Q(8)$ 0.7887	$Q'(11)$ 0.7878	0.7883	0.7901	—1.8
	$Q'(12)$ 0.7338	0.7338	0.7347	—0.9
$Q(9)$ 0.7145		(0.7158)	0.7165	—0.7
	$Q'(13)$ 0.6752	0.6752	0.6750	0.2
$Q(10)$ 0.6321		0.6321	0.6298	2.3
	$Q'(14)$ 0.6122	0.6122	0.6090	3.2
$Q(11)$ 0.5414	$Q'(15)$ 0.5447	—	—	—
	$Q'(16)$ 0.4728	0.4728	0.4775	4.7
$Q(12)$ 0.4425		0.4425	0.4455	—0.3
	$Q'(17)$ 0.3964	0.3964	0.3986	—2.2
$Q(13)$ 0.3354		0.3354	0.3357	—0.3
	$Q'(18)$ 0.3155	0.3155	0.3166	—1.1
	$Q'(19)$ 0.2303	0.2303	0.2306	—0.3
$Q(14)$ 0.2200		0.2200	0.2203	—0.3
	$Q'(20)$ 0.1406	0.1406	0.1428	—2.2
$Q(15)$ 0.0964		0.0964	0.0987	—2.3
	$Q'(21)$ 0.0465	0.0465	0.0461	0.4
$Q(16)$ 2575.9646		0.9646	0.9650	—0.4
	$Q'(22)$ 2575.9480	0.9480	0.9482	—0.2

Table 2

Some Spectral Constants of N_2O

Vibration State	B	D	H
$21^{1c}O$	0.4158451	1680.4×10^{-10}	3.4×10^{-13}
$21^{1d}O$	0.4169188	1685.9×10^{-10}	6.4×10^{-13}
$01^{1c}O$	0.4191775	1785.2×10^{-10}	—
$01^{1d}O$	0.4199695	1792.2×10^{-10}	—

$\Delta\nu_0$ for transition 21'0—01'0 = 2577.08563.

Several foreign lines that do not belong to the Q branch are also shown in Fig. 1. They are:

ⓐ $R(15)$, ⓑ $R(16)$ and ⓒ $R(17)$ of band 20°0—00°0,

ⓓ $P(13)$ and ⓔ $P(14)$ of the band 22^20—02^20,

ⓕ R (34) and ⓖ $R(33)$ of the band 30°0—10°0,

ⓗ $P(5)$ and ⓘ $P(4)$ of the band 22°0—02°0

Except for the line ⓘ overlapping with $Q(9)$ and the strong line ⓑ covering entirely $Q(11)$ and $Q'(15)$, all the remaining lines are well separated. Lines ⓓ, ⓕ, ⓖ and ⓔ are taken as the frequency standards in the four scan regions respectively. Following Amiot, the frequencies corresponding to the above 4 lines are:

ⓓ —2576.9055 cm^{-1};

ⓕ —2576.7951 cm^{-1};

ⓖ —2576.1742 cm^{-1};

ⓔ —2575.9856 cm^{-1}.

In Table 1, the greatest deviation between the calculated and measured line positions is shown to be about $4 \times 10^{-3}\text{cm}^{-1}$. A single line may be shifted by 0.004 cm^{-1} when measured in different regions. The source of error is due both to the nonlinearity of the laser scan and to the noncoincidence between the sample and etalon scans. On the other hand, we can see that any two adjacent lines always have approximately the same deviation, whether they are in the same band or not. This fact confirms the accuracy of Amiot's work.

REFERENCES

[1] Amiot, C. & Guelachvili, G., *J. Mol. Spectr.*, **59**(1976), 171—190.
[2] Nill, K. W., *Laser Focus*, **13** (1977),2: 32