# Pure Rotational Spectra of HNCS in the Far Infrared: Ground State Analysis

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The pure rotational spectrum of HNCS was recorded under high resolution by a Michelsontype Fourier transform infrared spectrometer in the far-infrared region; also, some high-J submillimeter-wave transitions (e.g.,  $J=91 \leftarrow 90$ ) near 1 THz were observed with the precision of microwave spectroscopy using a high-frequency backward wave oscillator. Effective molecular parameters have been determined for each  $K_a$  substate of HNCS up to  $K_a=7$ , for DNCS up to  $K_a=6$ , for HNC<sup>34</sup>S up to  $K_a=5$ , and for some  $K_a$  substates of HN <sup>13</sup>CS and H <sup>15</sup>NCS, by fitting the available microwave and millimeter-wave transitions simultaneously. The centrifugal distortion resonance has been clearly observed in HNCS and analyzed by a second-order perturbation treatment. © 1995 Academic Press. Inc.

#### I. INTRODUCTION

Among the molecules exhibiting significantly bent structure, isothiocyanic acid, HNCS, is known as the molecule which manifests most strongly the character of molecular quasilinearity (1, 2). The quasilinearity parameter  $\gamma_0 = 0.69$  of this molecule is comparable in magnitude to that of fulminic acid, HCNO, which is closer to the linear limit with  $\gamma_0 = -0.65$ . For the bent limit, the value  $\gamma_0$  assumes +1, and -1 for the linear limit. The molecule HNCS has a fairly large electric dipole moment both in the a and b directions; e.g., for DNCS, both components of the dipole moment have been determined experimentally as  $\mu_a = 1.67(3)$  and  $\mu_b = 1.08(15)$  D (3). Similar values for the dipole moment components are expected to hold for HNCS.

Due to the relative size and direction of the dipole moment, the pure rotational spectrum of this type of molecule is a hybrid spectrum. It consists of a superposition of strong parallel ( $\mu_a$  dipole transitions) and perpendicular ( $\mu_b$  dipole transitions) structures. Since the magnitude of the rotational constants,  $A \gg B \approx C$ , HNCS exhibits very strong a-type spectra ( $\Delta K_a = 0$ ); transitions are therefore found in the microwave (MW), millimeter-wave, and submillimeter-wave (mmW) regions, and strong b-type rotational spectra extend throughout the far-infrared (FIR) region. The perpendicular spectrum is dominated by conspicuous Q branches.

The MW and mmW spectra of this molecule were intensively studied by Yamada and co-workers in 1970s, see, for example, Ref. (4); they reported the  $r_s$  structure in 1980 (5). They have analyzed the transitions of the parallel band together with the perpendicular pure rotational spectra in the FIR region and obtained a fairly complete set of molecular parameters. The FIR spectra were measured by Krakow *et al.* (6) using a large grating spectrometer with resolutions between 0.25 and 0.5 cm<sup>-1</sup>.

The molecular structure was determined from the ground state rotational constants of the various isotopomers, i.e., HNCS, DNCS, H<sup>15</sup>NCS, HN<sup>13</sup>CS, and HNC<sup>34</sup>S; the

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HNC angle was found to be 131.7°, and the NCS skeleton, which had been believed to be linear, was discovered to be bent, with an angle of 173.8°.

In the present study, we have remeasured the pure rotational spectra of HNCS both in the FIR by high-resolution Fourier transform and in the terahertz region with microwave techniques. In the FIR region, the present recordings are of much higher resolution  $(0.00185 \text{ cm}^{-1})$  than that of Krakow *et al.*, and consequently have higher precision  $(0.05 \times 10^{-3} \text{ cm}^{-1})$  based on the use of the Bruker FTIR spectrometer at Giessen. For the first time, the conspicuous Q branches are partially resolved, revealing details not seen before. Portions of the newly recorded perpendicular spectra near the prominent Q branches are reproduced in Fig. 1.

The newly obtained FIR data contain nearly the complete set of b-type transitions  $(\Delta K_a = 1)$  up to  $K_a = 7 \leftarrow 6$ , with which we have been able to determine precise term values for the high- $K_a$  states. However, because of effects of the quasilinearity of the molecule and partly because of the centrifugal distortion resonance (7), the line positions of high- $K_a$  rotational levels could not be reproduced by the effective rotational Hamiltonian for asymmetric tops containing a polynomial extension to the higher order terms.

The effect of the centrifugal distortion resonance between the ground state and the  $v_5 = 1$  state is clearly observed in the presently recorded FIR spectra and has been analyzed by a second-order perturbation treatment, yielding the interaction constant.

In addition, some a- and b-type transitions have been recorded in the submillimeterwave region near 1 THz, as shown in Fig. 2, using the new Cologne terahertz spectrometer. The frequency positions of the new submillimeter-wave lines are also included in the analysis, together with the available MW and mmW data.

A portion of the data presented in this paper has been used for determining the quasilinear bending potential by the semirigid-bender model (8); the potential hump at the linear position has been found to be about 1000 cm<sup>-1</sup>, and the energy levels of the excited bending states with  $v \ge 2$  have been predicted to be above the potential hump.

## II. EXPERIMENTAL PROCEDURES

The high-resolution Fourier transform spectrometer (Bruker IFS-120) at Giessen was employed to record the interferogram for the region from 28 to 350 cm<sup>-1</sup>. For the present measurements in the FIR region, we used an Si bolometer detector at 4.2 K, a mylar beamsplitter of 12  $\mu$ m thickness, an Hg lamp as the FIR radiation source, and polyethylene windows. The cell was a 3-m-long Duran glass tube, which was filled with 15 Pa of the sample vapor. The sample of HNCS was prepared by heating a mixture of KSCN and KHSO<sub>4</sub>, and purified by low-temperature distillation. The 229 interferograms were coadded, and the achieved resolution was 0.00185 cm<sup>-1</sup>, which is better than that in the previous work of Krakow *et al.* (6) by a factor of more than 100. Boxcar apodization and eightfold zero-filling was applied for plotting the spectrum and for measuring the line-center positions.

The line positions were calibrated by selected water lines (9) recorded simultaneously as impurity lines, which yielded a precision of  $0.05 \times 10^{-3}$  cm<sup>-1</sup> for the line-center determination. The accuracy of the line positions thus obtained is limited by that of the water lines used as standards.

A few submillimeter-wave transitions of both a- and b-type have been recorded for the main isotopomer HNCS using a submillimeter backward wave oscillator (BWO) made in Russia (10). The output of the BWO (typically 1-10 mW of power) was phase locked to the harmonics of a millimeter-wave synthesizer (KVARZ, Nizhnii

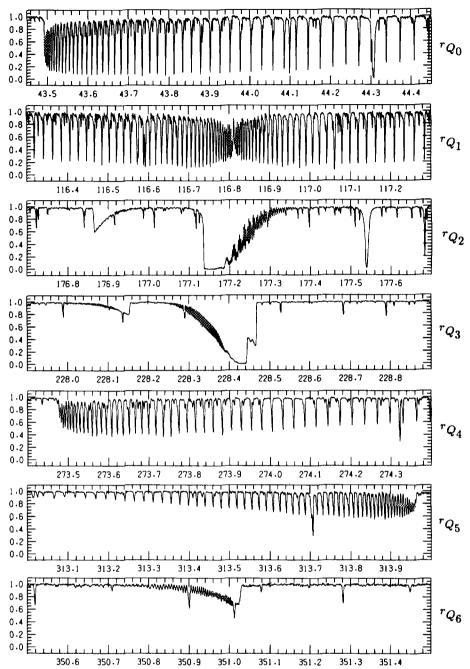


FIG. 1. The observed  ${}^{\prime}Q_{Ka}$  transitions of HNCS are reproduced for  $K_{a}^{\prime\prime}=0$  to 6. The magnitude and direction of the degrading changes with increasing  $K_{a}$  quantum number. These anomalous changes in the Q-branch patterns with  $K_{a}$  excitation are mainly due to the centrifugal distortion resonance. The effects of quasilinearity are superimposed (see text).

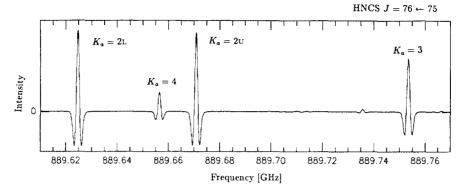


Fig. 2. A portion of the observed submillimeter-wave spectra of HNCS is reproduced; the a-type transition of  $J = 76 \leftarrow 75$  with its associated  $K_a$  components near 900 GHz are shown. The  $K_a = 0$  and the  $K_a = 1$  doublets are too far apart in frequency to be shown here.

Novgorod) oscillating around 100 GHz. The spectra have been digitally recorded with a frequency step of 90 or 100 kHz.

## III. SPECTRA AND ASSIGNMENTS

Assignments of the ground state lines were easily performed, because the recorded spectra exhibit a typical b-type rotational spectrum of a near-prolate symmetric top with a large rotational constant A. Strong  ${}^{r}Q_{K_{a}}$  transitions were clearly observed in the regions reported previously by Krakow et al. (6) for  $K_{a}^{"}=0$  to 4.

We have extended the assignments up to  $K_a'' = 6$ . The observed seven Q branches assigned to the ground vibrational state are reproduced in Fig. 1. Associated P- and R-branch transitions were also easily identified.

The principal structure of a perpendicular pure rotational spectrum is well characterized by standard asymmetric rotor theory. For a near-prolate asymmetric-top molecule such as HNCS ( $\kappa = -0.99993$ ), b-type  $^\prime Q_0$  transitions shift the line positions toward higher wavenumbers for increasing J. The  $^\prime Q_1$  branch beautifully exhibits the expected K-type doubling, caused by the inertial asymmetry of the molecule. With increasing J quantum number, the  $^\prime Q_1$ -branch lines are split, forming an ascending and a descending branch, depending on the wavenumber. For all other  $^\prime Q_{K_a}$  branches, i.e., those with  $K_a \ge 2$ , the effect of inertial asymmetry recedes and is hardly recognized at the resolution of the FTIR spectrometer.

For the regular case of a near-prolate asymmetric rotor, the expected  ${}^{\prime}Q_{K_a}$ -branch pattern for  $K_a^{\prime\prime} \ge 2$  is expected to be determined to first order by the effect of centrifugal distortion, i.e., the influence of size and sign of the parameter  $D_{JK}$ . Thus the degrading of all higher- $K_a$  Q branches ( $K_a^{\prime\prime} \ge 2$ ) is expected to be the same. For positive  $D_{JK}$  and for increasing J-quantum number, the line positions shift to lower wavenumbers, whereas for negative  $D_{JK}$ , the reverse is expected to hold. The standard case with positive  $D_{JK}$  is observed for HSSH (11). However, for HNCS, the degrading and thus the J pattern of the individual Q branches is far from being that simple, as can be seen in Fig. 1, where we present a composition of all Q branches up to  $K_a = 7 \leftarrow 6$ . With increasing  $K_a$ , the direction and amount of Q-branch degradation shift several times. These anomalies are an unambiguous indication of the centrifugal distortion resonance proposed by Yamada (7) for HNCO, as discussed in Section V below.

In addition to the large number of lines arising from excited bending vibrational states of HNCS, which will be reported in a forthcoming paper, we have identified

several isotopomer spectra. Among those are the ground state lines of DNCS commencing with  $K_a = 2 \leftarrow 1$  to  $K_a = 6 \leftarrow 5$ , lines of HNC<sup>34</sup>S from  $K_a = 1 \leftarrow 0$  to  $K_a = 5 \leftarrow 4$ , and lines of HN<sup>13</sup>CS and H<sup>15</sup>NCS for  $K_a = 3 \leftarrow 2$ . All are observed in natural abundance, except for the D isotopomer which was enriched accidentally by exchange of D on the cell walls. Some of the Q branches assigned to these isotopomers are reproduced in Fig. 3.

## IV. ASYMMETRIC ROTOR ANALYSIS

Watson's S-reduced Hamiltonian up to sextic centrifugal distortion terms (12),

$$\hat{H}_{\text{rot}}^{S} = \frac{1}{2} \left( \tilde{B}_{x}^{(S)} + \tilde{B}_{y}^{(S)} \right) \hat{J}^{2} + \left\{ \tilde{B}_{z}^{(S)} - \frac{1}{2} \left( \tilde{B}_{x}^{(S)} + \tilde{B}_{y}^{(S)} \right) \right\} \hat{J}_{z}^{2}$$

$$- \Delta_{J} \hat{J}^{4} - \Delta_{JK} \hat{J}^{2} \hat{J}_{z}^{2} - \Delta_{K} \hat{J}_{z}^{4} + H_{J} \hat{J}^{6} + H_{JK} \hat{J}^{4} \hat{J}_{z}^{2} + H_{KJ} \hat{J}^{2} \hat{J}_{z}^{4} + H_{K} \hat{J}_{z}^{6}$$

$$+ \left\{ \frac{1}{4} \left( \tilde{B}_{x}^{(S)} - \tilde{B}_{y}^{(S)} \right) + d_{1} \hat{J}^{2} + h_{1} \hat{J}^{4} \right\} (\hat{J}_{+}^{2} + \hat{J}_{-}^{2})$$

$$+ (d_{2} \hat{J}^{2} + h_{2} \hat{J}^{4}) (\hat{J}_{+}^{4} + \hat{J}_{-}^{4}) + h_{3} (\hat{J}_{+}^{6} + \hat{J}_{-}^{6}), \quad (1)$$

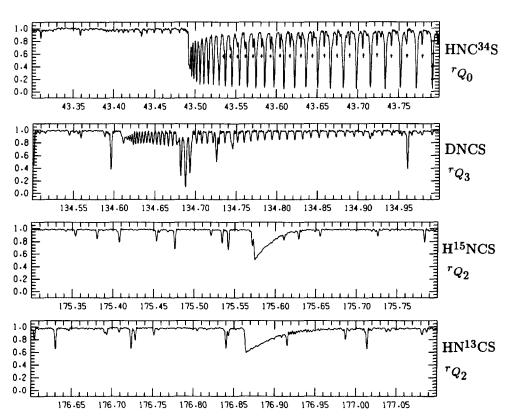


FIG. 3. Observed  ${}'Q_{k_a}$  transitions of the less abundant isotopomers. From the top down, the  ${}'Q_0$  lines of HNC<sup>34</sup>S (marked with arrows) are superimposed on the main species HNCS. The weak Q-branch lines appearing toward lower wavenumbers from the band head near 43.49 cm<sup>-1</sup> of HNCS are tentatively assigned to HN<sup>13</sup>CS. The  ${}'Q_3$  lines of DNCS resolved in high J, the unresolved  ${}'Q_2$  branch of H1<sup>15</sup>NCS, and the unresolved  ${}'Q_2$  branch of HN<sup>13</sup>CS are degraded to the blue, which also is a manifestation of the centrifugal distortion resonance and the molecular quasilinearity.

TABLE I
Spectroscopic Parameters of HNCS Determined in the Present Study Using a Watson-Type Hamiltonian<sup>a</sup>

	HNCS	HNC <sup>34</sup> S	DNCS	
Ā	1362.78424(22)	1361.4687(40)	707.58837(27)	GHs
В	5883.462561(38)	5744.83221(38)	5500.43872(19)	MHz
C	5845.611119(38)	5708.73722(41)	5445.22481(19)	MHz
$D_J$	1.1938893(66)	1.14357(36)	1.09142(29)	kHs
$\mathbf{D}_{JK}$	-1.025240(30)	-1.01693(22)	-1.33344(15)	MHz
$\mathbf{D}_{K}$	59.33048(27)	57.5857(16)	12.94876(24)	GHz
$\mathbf{d}_1$	-13.78247(73)	-11.27(34)	-34.5575(51)	Ηz
$\mathbf{d_2}$	-4.94248(89)	-7.00(27)	-7.89(13)	Нв
$H_J$	-0.04964(47)	0.0 (fix)	0.0(fix)	Hз
$H_{JK}$	2.1215(31)	-0.61(12)	3.874(31)	Нs
$H_{KJ}$	-185.088(16)	-183.232(88)	-120.444(64)	kHz
$H_K$	6.716261(62)	6.05540(25)	1.067222(51)	GHz
$L_{44}$	0.7231(15)	-0.1106(70)	0.372(19)	Нs
$L_{26}$	-16.5450(23)	-16.414(11)	-10.6936(98)	kHz
$L_K$	464.2044(60)	365.358(17)	67.0713(46)	MHz
S <sub>46</sub>	0.08109(19)	0.0(fix)	0.0180(17)	Ηz
$S_{28}$	-0.530570(84)	-0.52645(39)	-0.49860(57)	kHz
$S_K$	17.20156(28)	10.53850(54)	2.39195(20)	MHz
$T_{48}$	0.0024576(71)	0.0 (fix)	0.000327(41)	Hв
$T_{2,10}$	0.0(fix)	0.0 (fix )	-0.00851(11)	kHz
$\mathbf{T}_{K}$	0.3144865(60)	0.1128311(60)	0.0428815(43)	МНв
$U_K$	2.213011(47)	0.0 (fix )	0.298038(33)	kHz

a) The numbers in parentheses represent one standard deviation.

has been extended as described by Yamada and Klee (13) to higher order by adding the following terms:

$$\hat{H}' = -L_J \hat{J}^8 - L_{62} \hat{J}^6 \hat{J}_z^2 - L_{44} \hat{J}^4 \hat{J}_z^4 - L_{26} \hat{J}^2 \hat{J}_z^6 - L_K \hat{J}_z^8 + S_J \hat{J}^{10} + S_{82} \hat{J}^8 \hat{J}_z^2 + S_{64} \hat{J}^6 \hat{J}_z^4 + S_{46} \hat{J}^4 \hat{J}_z^6 + S_{28} \hat{J}^2 \hat{J}_z^8 + S_K \hat{J}_z^{10} - T_{48} \hat{J}^4 \hat{J}_z^8 - T_{2,10} \hat{J}^2 \hat{J}_z^{10} - T_K \hat{J}_z^{12} + U_K \hat{J}_z^{14}.$$
 (2)

TABLE II Effective Parameters of HNCS for Each  $K_a$  State<sup>a</sup>

	$E_0(K)$ in $cm^{-1}$	B(K) in MHs	D(K) in kHz	H(K) in 10 <sup>-3</sup> H
0	· · · · · · · · · · · · · · · · · · ·	5864.536839(38)	1.231063(11)	0.06729(83)
1L	43.49202307(32)	5855.930542(35)	1.1890110(27)	
1U	43.492043(38)	5874.856064(49)	1.2165438(39)	
2L	160.302810(38)	5866.600022(62)	1.194855(12)	-0.02950(84)
2U	160.302807(33)	5866.599768(66)	1.167576(12)	-0.14356(81)
3	337.440421(43)	5867.352796(51)	1.1869585(47)	
4	565.885009(56)	5866.555459(79)	1.171847(33)	-0.1523(32)
5	839.356395(89)	5876.3946(19)	1.21436(31)	
6	1153.32958(12)	5870.3269(30)	1.18880(57)	
7	1504.36319(17)	5868.5608(64)	1.1980(17)	

a) The numbers in parentheses represent one standard deviation. The conversion factor is 1 cm<sup>-1</sup>= 29979.2458 MHz.

TABLE III

Effective Parameters of DNCS for Each  $K_a$  State<sup>a</sup>

F	$E_0(K)$ in $cm^{-1}$	B(K) in MHz	D(K) in kHs	H(K) in 10 <sup>-3</sup> Hz
0		5472.83086(16)	1.23306(25)	0.6906(61)
1L	23.0215651(48)	5460.25079(15)	1.08916(27)	
1U	23.0215626(47)	5487.85804(15)	1.15860(27)	
2L	88.551077(26)	5476.80463(20)	1.10005(34)	
2U	88.551027(26)	5476.80489(19)	0.97396(32)	
3	191.066163(31)	5480.10362(19)	1.05902(32)	
4	325.673266(40)	5483.37740(23)	1.06310(36)	
5	488.481145(50)	5486.28029(29)	1.06986(44)	
6	676.431109(92)	5488.4926(41)	1.0114(15)	

a) The numbers in parentheses represent one standard deviation.

The conversion factor is  $1 \text{ cm}^{-1} = 29979.2458 \text{ MHs}$ .

Since HNCS is very nearly a prolate symmetric top,  $\kappa = -0.99993$ , all off-diagonal terms higher than quadratic in the power of J were not required in the present study.

The wavenumber positions of the *b*-type lines determined in the present study were analyzed together with the new terahertz spectra and the previously reported MW and mmW line positions (3-5). Since the  $K_a = 5$  levels are strongly perturbed by the centrifugal distortion resonance, as mentioned earlier, the least-squares fit using the above Hamiltonian was carried out for lines limited to  $K_a < 5$ . For higher- $K_a$  lines, only a single line of the lowest *J* for each subband was retained in the fit, as was done previously by Yamada *et al.* (4, 5). In this way, one obtains the  $K_a$ -dependent parameters for predicting the subband origins, without being deceived by the perturbation. The molecular parameters thus obtained are listed in Table I for HNCS, HNC <sup>34</sup>S, and DNCS. Most of the higher order centrifugal distortion correction terms introduced into the above Hamiltonian serve only as fitting parameters with appropriately little physical significance. Nevertheless, the rotational constants A, B, and C determined in this way are reliable for structure calculations. The rotational constant A of HNC <sup>34</sup>S has been determined for the first time, and that of DNCS has been revised significantly. Otherwise, the constants are in agreement with previously reported values (5).

TABLE IV Effective Parameters of HNC<sup>34</sup>S for Each  $K_a$  State<sup>a</sup>

E	$_{0}(K)$ in $cm^{-1}$	B(K) in MHz	D(K) in kHz	H(K) in 10-	<sup>-3</sup> Hz L(K) in 10 <sup>-6</sup>
<u> </u>		5726.78389(13)	1.17611(24)		
۱L	43.491934(47)	5718.60902(11)	1.13827(22)		
1U	43.491954(54)	5736.65796(12)	1.16408(24)		
2L	160.308920(59)	5728.83456(27)	1.13066(89)	7.34(63)	-1.12(12)
2U	160.308655(59)	5728.83403(27)	1.12388(89)	-11.18(62)	1.60(11)
3	337.461131(63)	5729.60674(12)	1.13560(21)		
1	565.930138(76)	5728.87747(17)	1.12259(26)		
5	839.43605(12)	5738.1038(50)	1.1584(17)		

a) The numbers in parentheses represent one standard deviation. The conversion factor is  $1 \text{ cm}^{-1} = 29979.2458 \text{ MHz}$ .

TABLE V

Molecular Parameters of HN<sup>13</sup>CS and H<sup>15</sup>NCS

Determined for  $K = 3 \leftarrow 2$  Transitions

	HN <sup>13</sup> CS	$\mathrm{H}^{15}\mathrm{NCS}$	Unit
$\overline{\nu_0(3\leftarrow 2)}$	176.86456(21)	175.574085(74)	cm <sup>-1</sup>
B(2)	5847.81479(53)	5672.36476(28)	MHz
B(3)	5848.59164(58)	5672.78762(19)	MHs
D(2)	1.1470(23)	1.0935(14)	kHz
D(3)	1.1795(12)	1.10090(36)	kHz
H(2)	-1.59(28)	-7.6(22)	$10^{-3}~\mathrm{Hz}$

a) The numbers in parentheses represent one standard deviation. The conversion factor is 1 cm<sup>-1</sup>= 29979 2458 MHz

The Watson-type effective Hamiltonian is not appropriate for high- $K_a$  transitions of HNCS, because of the effect of quasilinearity and the influence of the centrifugal distortion resonance. Thus, in the present study, we have determined the spectroscopic parameters for each  $K_a$  substate, given individually in those cases where the K-type doublings are resolved (for  $K_a = 1$  and 2). Thus, the well known energy expression for linear molecules has been employed using K in place of  $K_a$ ,

$$E(J, K, \gamma) = E_0(K) + B(K, \gamma)J(J+1) - D(K, \gamma)J^2(J+1)^2 + H(K, \gamma)J^3(J+1)^3 - L(K, \gamma)J^4(J+1)^4,$$
 (3)

where the energy contribution of the K rotation is represented by  $E_0$ , and B is the effective rotational constant. The D, H, and L terms are the centrifugal distortion corrections for the given K substate, and  $\gamma$  is the index for the K doublet (U for upper, L for the lower component). The K-doublet index  $\gamma$  is omitted if no doubling is observed.

The parameters determined by the least-squares fits are collected in Tables II–V for HNCS, DNCS, HNC $^{34}$ S, HN $^{13}$ CS, and H $^{15}$ NCS, respectively. The experimental line positions of the main isotopomer are listed in Table VI together with the observed – calculated values. For the other isotopomers, such a list is available from the authors upon request. The newly measured a- and b-type submillimeter-wave lines near 1 THz are summarized in Table VII.

## V. CENTRIFUGAL DISTORTION RESONANCE

Figure 4 illustrates the  $K_a$  dependence of the effective rotational constant B thus determined. In this figure, the average of the B values for the K doublets is used in the cases  $K_a = 1$  and 2. This figure suggests a typical avoided crossing of energy levels in a resonance system between  $K_a = 4$  and 5. The ground state  $K_a$ -rotational energy terms are plotted in Fig. 5 together with those of the lowest three excited bending vibrations. Locations of the levels of the three excited states have been determined from the presently recorded spectra by assigning lines of the excited states and several forbidden transitions between the vibrational states, which will be presented in a forthcoming paper.

The centrifugal distortion resonance proposed by Yamada (7) couples the rotational levels of the ground state (gs) with those of the lowest excited vibrational state ( $v_5$  =

<sup>&</sup>lt;sup>2</sup> Also on deposit in the Editorial Office of this journal.

TABLE VI

Observed Line Positions of HNCS in cm<sup>-1</sup> Measured by FTIR Spectroscopy<sup>a</sup>

Tr	ansition	Freq.	Δ	Transition	Freq.	Δ	Т	ransition	Freq.	Δ	Transition	Freq.	Δ
Qпр	(2, 0, 2)	43.49374		Qrp ( 72, 0, 72	45.31427	-1		11, 0, 11		2	Rrr (83, 0, 83)	74.27971	-12
Qrp Qrp	$\{3, 0, 3\}$	43.49616 43.49889	-1 -4	Prp ( 57, 0, 57	20.31946	.19	Rrr (	12, 0, 12 13, 0, 13	48.52562 48.90874	4	Qгр ( 70, 1, 69 )	115.48174	-4
Qпр	\ 5, 0, 5 \	43.50225	-12	Prp ( 56, 0, 56	20.74033		Rrr	14, 0, 14	49,29130	5	Qrp (69, 1, 68)	115.51812	
Qrp	{ 6, 0, 6 }	43.50650	ō	Prp (55, 0, 55	21.16114	28	Rrr	15, 0, 15	49.67325	4	Qrp (68, 1, 67)	115.55406	
Qnp	(7, 0, 7)	43.51123	-9	Prp { 54, 0, 54	21.58088	12	Rr	16, 0, 16	50.05462	4	Qrp (67, 1, 66)	115.58947	
Qпр	(8,0,8)	43.51683	0	Prp (53, 0, 53)	22.00022	3	Rr	17, 0, 17	50.43542	5	Qrp (66, 1, 65)	115.62444	
Qrp	(9, 0, 9)	43.52306	3	Prp (52, 0, 52	22.41907	-8	Rr	18, 0, 18	50.81560	3	Qrp (65, 1, 64)	115.65895	
Qrp (	10, 0, 10	43.52990	-1	Prp (51, 0, 51)	22.83773	11	Rr	19, 0, 19	51.19523	5	Qrp (64, 1, 63)	115.69286	
Qrp (	11, 0, 11	43.53753	4	Prp (50, 0, 50)	23.25572	11	Rrr I	20, 0, 20	51.57425	4	Qrp (63, 1, 62)	115.72652	
Qrp ( Qrp (	12, 0, 12 ) 13, 0, 13	43.54581 43.55470	-1	Prp (49, 0, 49) Prp (48, 0, 48)	23.67317 24.09028	12	Rrr   Rrr	21, 0, 21 22, 0, 22	51.95270 52.33056	5 6	Qrp (62, 1, 61) Qrp (61, 1, 60)	115.75963 115.79223	
Qub (	14, 0, 14	43.56437	2	Prp (47, 0, 47)	24.50674	6	Rr	23, 0, 23	52.70780	3	Qrp (60, 1, 59)	115.82443	
Qтр (	15, 0, 15	43.57475	7	Prp (46, 0, 46	24.92274	2	Rrr	24, 0, 24	53.08448	4	Qrp (59, 1, 58)	115.85606	
Qrp (	16, 0, 16	43.58567	-3	Prp (45, 0, 45	25.33838	11	Rrr	25, 0, 25	53.46057	4	Qrp (58, 1, 57)	115.88724	-4
Qrp (	17, 0, 17	43.59746	4	Prp (44, 0, 44)	25.75361	29	Rrr	26, 0, 26	53.83608	4	Qrp (57, 1, 56)	115.91793	-4
Qrp (	18, 0, 18 )	43.60989	7	Prp (43, 0, 43	26.16813	25	Rr	27, 0, 27	54.21101	6	Qrp (56, 1, 55)	115.94813	
Qrp (	19, 0, 19	43.62291	0	Prp (42, 0, 42)	26.58206	14	Rrr	28, 0, 28	54.58531	3	Qrp (55, 1, 54)	115.97787	
Qrp (	20, 0, 20	43.63671	1	Prp 41, 0, 41	26.99565	18	Brr.	29, 0, 29	54.95907	6	Qrp (54, 1, 53)	116.00707	
Qrp (	21, 0, 21 22, 0, 22	43.65120 43.66636	3	Prp (40, 0, 40) Prp (39, 0, 39)	27.40862 27.82114	11 10	Rrr Rr	30, 0, 30 32, 0, 32	55.33223	7 2	Qrp (53, 1, 52) Qrp (52, 1, 51)	116.03582 116.06406	
Qrp ( Qrp (	23, 0, 23	43.68219	-1	Prp (38, 0, 38	28.23317	11	Rr	33, 0, 33	56.44811	3	Qrp (51, 1, 50)	116.09180	
Qrp (	24, 0, 24	43.69877	3	Prp (37, 0, 37	28.64456	-1	Rrr	34, 0, 34	56.81891	3	Qrp (50, 1, 49)	116.11901	
Qrp (	25, 0, 25	43.71598	-1	Prp ( 36, 0, 36	29.05554	-2	Rrr	35, 0, 35	57.18918	9	Qrp (49, 1, 48)	116.14582	
Qrp (	26, 0, 26	43.73396	4	Prp ( 35, 0, 35	29.46596	-8	Rrr	36, 0, 36	57.55879	7	Qrp (48, 1, 47)	116.17197	-3
Qrp (	27, 0, 27	43.75257	3	Prp (34, 0, 34)	29.87605	6	Rrr	37, 0, 37	57.92779	4	Qrp (47, 1, 46)	116.19771	
Qrp (	28, 0, 28	43.77188	2	Prp ( 33, 0, 33	30.28546	4	Rrr	38, 0, 38	58.29627	7	Qrp (46, 1, 45)	116.22294	
Qrp (	29, 0, 29	43.79190	3	Pro 32, 0, 32	30.69435	2	Rir	39, 0, 39	58.66413	7	Qrp (45, 1, 44)	116.24767	
Qrp (	30, 0, 30 ) 31, 0, 31	43.81260	3	Prp (31, 0, 31)	31.10263	-8 8	Rr	40, 0, 40	59.03138	4 6	Qrp (44, 1, 43)	116.27182	
Qrp ( Qrp (	31, 0, 31 ) 32, 0, 32 )	43.83401 43.85609	2	Prp (30, 0, 30) Prp (29, 0, 29)	31.51065 31.91798	9	Rr	41, 0, 41 42, 0, 42	59.39809 59.76423	9	Qrp (43, 1, 42) Qrp (42, 1, 41)	116.29550 116.31871	
Qrp {	33, 0, 33	43.87889	3	Prp ( 28, 0, 28	32.32474	5	Rrr	43, 0, 43	60.12971	5	Qrp (41, 1, 40)	116.34133	
Qrp (	34, 0, 34	43.90237	3	Prp (27, 0, 27)	32.73097	2	Rrr	44, 0, 44	60.49466	7	Qrp (40, 1, 39)	116.36345	
Qrp (	35, 0, 35	43.92673	21	Prp (26, 0, 26)	33.13673	6	Rrr	45, 0, 45	60.85903	8	Qrp (39, 1, 38)	116.38506	
Qrp (	36, 0, 36	43.95141	2	Prp ( 25, 0, 25 )	33.54198	12	Rrr	46, 0, 46	61.22276	5	Qrp (38, 1, 37)	116.40620	
Qrp (	37, 0, 37	43.97695	- 1	Prp (24, 0, 24	33.94654	4	Rrr	47, 0, 47	61.58597	7	Qrp (37, 1, 36)	116.42677	
Qπ-(	38, 0, 38	44.00327	5	Prp (23, 0, 23	34.35067	6	Rrr	48, 0, 48	61.94857	7	Qrp ( 36, 1, 35 )	116.44684	
Qrp (	39, 0, 39 ) 40, 0, 40	44.03024 44.05788	6 4	Prp (22, 0, 22	34.75413	-4 8	Rrr   Rrr	49, 0, 49 50, 0, 50	62.31054 62.67222	1 25	Qrp (35, 1, 34)	116.46639	
Qrp (	41, 0, 41	44.08623	3	Prp (21, 0, 21) Prp (20, 0, 20)	35.15726 35.55971	5	Rrr	50, 0, 50 51, 0, 51	63.03293	10	Qrp (34, 1, 33) Qrp (33, 1, 32)	116.48537 116.50381	
Qrp (	42, 0, 42	44.11535	9	Prp (19, 0, 19	35.96156	-2	Rr	52, 0, 52	63.39321	10	Qrp (32, 1, 31)	116.52176	
Qrp (	43, 0, 43	44.14512	11	Prp (18, 0, 18	36.36296	ī	Rrr	53, 0, 53	63.75290	9	Qrp (31, 1, 30)	116.53927	
Qrp (	44, 0, 44	44.17549	2	Prp (17, 0, 17	36.76379	2	Rrr	54, 0, 54	64.11202	8	Qrp (30, 1, 29)	116.55617	
Qrp (	45, 0, 45	44.20661	-1	Prp (16, 0, 16)	37.16405	1	Rrr	55, 0, 55	64.47061		Qrp (29, 1, 28)	116.57247	7
Qrp (	46, 0, 46	44.23850	3	Prp ( 15, 0, 15	37.56384	8	Rrr	56, 0, 56		12	Qrp (28, 1, 27)	116.58826	
Qrp (	47, 0, 47	44.27106	3	Prp (14, 0, 14)	37.96299	7	Rir	57, 0, 57		11	Qrp (27, 1, 26)	116.60350	
Qrp (	48, 0, 48 49, 0, 49	44.30441 44.33829	12 5	Prp (13, 0, 13) Prp (12, 0, 12)	38.36157 38.75962	5 6	Rrr	58, 0, 58 59, 0, 59	65.54278 65.89907	10 14	Qrp ( 26, 1, 25 ) Qrp ( 25, 1, 24 )	116.61821	
Qrp (	49, 0, 49 50, 0, 50	44.37301	11	Prp (12, 0, 12) Prp (11, 0, 11)	39.15706	2	Rrr Rrr	60, 0, 60	66.25473	12	Qrp (25, 1, 24) Qrp (24, 1, 23)	116.63242 116.64613	
Qrp (	51, 0, 51	44.40831	5	Prp { 10, 0, 10	39.55398	2	Rrr	61, 0, 61	66,60982	11	Qrp (23, 1, 22)	116.65932	
Qrp (	52, 0, 52	44.44437	5	Prp (9, 0, 9)	39.95040	8	Rer	62, 0, 62	66.96432	ŝ	Qrp ( 22, 1, 21 )	116.67192	
Qrp (	53, 0, 53	44.48115	6	Prp (8, 0, 8)	40.34613	1	Rrr	63, 0, 63	67.31834	12	Qrp (21, 1, 20)	116.68401	
Qrp (	54, 0, 54	44.51860	3	Prp (7, 0, 7)	40.74139	4	Rrr	64, 0, 64	67.67168	8	Qrp ( 20, 1, 19 )	116.69543	
Qnp (	55, 0, 55	44.55670	-5	Prp (6, 0, 6)	41.13606	5	Rrr	65, 0, 65	68.02463		Qrp (19, 1, 18)	116.70655	
Qrp (	56, 0, 56	44.59566	3	Prp (5, 0, 5)	41.53023	12	Rr	66, 0, 66	68.37682	12	Qrp (18, 1, 17)	116.71697	
ޜ (	57, 0, 57 58, 0, 58	44.63528 44.67554	6	Prp (4, 0, 4) Prp (3, 0, 3)	41.92365 42.31663	2 4	Rer	67, 0, 67 68, 0, 68	69.07969	8	Qrp (17, 1, 16)	116.72687 116.73616	
Qrp ( Qrp (	58, 0, 58 59, 0, 59	44.07334	3	Prp (3, 0, 3) Prp (2, 0, 2)	42.70893	-4	Ren	68, 0, 68 69, 0, 69		22	Qrp (16, 1, 15) Qrp (15, 1, 14)	116.73616	
Qrp (	60, 0, 60	44.75831	7	, .p ( 2, 0, 2 )	74.10000		Rrr	70, 0, 70	69.78024	12	Qrp (15, 1, 14) Qrp (14, 1, 13)	116.75319	
Qrp (	61, 0, 61	44.80065	-i	Rrr (0, 0, 0)	43.88303	34	Rrr	71, 0, 71	70.12970	14	Qrp (13, 1, 12)	116.76079	
Qrp (	62, 0, 62	44.84384	5	Rrr (1, 0, 1)	44.27297	19	Rrr	72, 0, 72	70,47853	7	Qrp (12, 1, 11)	116.76796	
Qrp (	63, 0, 63	44.88768	5	Rrr (2, 0, 2)	44.66238	9	Rrr	73, 0, 73	70.82693	14	Qrp (11, 1, 10)	116.77457	12
Qrp (	64, 0, 64	44.93222	3	Rrr (3, 0, 3)	45.05126	3	Rrr	74, 0, 74	71.17466	9	Qnp (10, 1, 9)	116.78057	
Qrp (	65, 0, 65	44.97756	11	Rer (4, 0, 4)	45.43960	1	Rr	75, 0, 75	71.52192	12	Qnp (9, 1, 8)	116.78594	
Qrp (	66, 0, 66	45.02348	5	Rrr (5, 0, 5)	45.82741	4	Rrr	76, 0, 76	71.86887	40	Qrp (8, 1, 7)	116.79092	
Qrp (	67, 0, 67	45.07019	7	Rrr (6, 0, 6)	46.21458	1	Rrr	77, 0, 77	72.21472	12	Qrp (7, 1, 6)	116.79544	
Qrp (	68, 0, 68 69, 0, 69	45.11759   45.16574	7 10	Rer (7, 0, 7) Rer (8, 0, 8)	46.60127 46.98726	7 2	Rrr	78, 0, 78 79, 0, 79	72.56029	12 15	Qrp (6, 1, 5)	116.79910 116.80253	
Qrp (	70, 0, 70	45.16574 45.21444	-3	Rrr (9, 0, 9)	47.37273	3	Rrr	80, 0, 80	73.25028	61	Qrp (5, 1, 4) Qrp (4, 1, 3)	116.80233	
Qrp (													

<sup>&</sup>lt;sup>a</sup>)Transitions are indicated by  $\Delta J$ ,  $\Delta K_a$ , and  $\Delta K_c$ , followed by the lower state quantum numbers J'',  $K''_a$ , and  $K''_c$  in parentheses. Capital P, Q, and R represent  $\Delta J = -1$ , 0, and +1, respectively. Lower case p, q, and r are used to indicate  $\Delta K_a$  and  $\Delta K_c$ . Observed line positions are listed in the column of "Freq.". The observed–calculated values are in the column of  $\Delta$  in the unit of  $10^{-5}$  cm<sup>-1</sup>.

1) with the selection rule  $\Delta K_a = \pm 1$ . As indicated in Fig. 5, the  $K_a = 4$  (gs) level is located slightly lower than the coupling partner of  $K_a = 3$  ( $v_5 = 1$ ). The  $K_a = 5$  (gs) level is very close to the  $K_a = 4$  ( $v_5 = 1$ ) level, but in this case the former level is

TABLE VI-Continued

Т	ransition	Freq.	Δ	Т	ransition	Freq.	Δ	7	ransition	Freq.	Δ	т	ransition	Freq.	Δ
Qrp	{ 2, 1, 2 }	116.81275		Qrp	( 74, 1, 74 )	118.77978		Prp	( 18, 1, 17 )	109.67283	3	Rrr		137.49849	5
Qπ	3, 1, 3	116.81503	-3	Qrp	75, 1, 75	118.83277 -		Prp	(17, 1, 16)	110.07395	-1	Rrr	( 55, 1, 54 )	137.85849	-4
Qrp Qrp	(4, 1, 4) (5, 1, 5)	116.81805 116.82128	15 -18	Q <sub>TP</sub> Q <sub>TP</sub>	( 76, 1, 76 ) ( 77, 1, 77	118.88646 - 118.94093 -		Prp Prp	( 16, 1, 15 ) ( 15, 1, 14 )	110.47452 110.87461	2	Rrr Rrr	( 56, 1, 55 ) ( 57, 1, 56 )	138.21801	-3 -2
Q'rp	\ 6, 1, 6 \	116.82583	10	Qrp	78, 1, 78			Prp	14, 1, 13	111.27413	ĩ	Rrr	(58, 1, 57)	138.93533	ő
Qтр	{7, 1, 7}	116.83084	12		( 10, 1, 70 )		• •	Prip	(13, 1, 12)	111.67313	2	Rrr	( 59, 1, 58 )	139.29308	-3
Qпр	(8, 1, 8)	116.83632	-9	Prp	( 85, 1, 84 )		-8	Prp	(12, 1, 11)	112.07160	3	Rrr	(60, 1, 59)	139.65028	-3
Qmp	(9, 1, 9)		-12 7	Prp	(83, 1, 82)	82.53283		Prp	( 11, 1, 10 )	112.46951	3	Rr	61, 1, 60	140.00693	-3
Qrp Qrp	( 10, 1, 10 ) ( 11, 1, 11 )	116.85000 116.85770	-6	Prp Prp	(81, 1, 80) (80, 1, 79)	83.39619 - 83.82766 -		Prp Prp	(10, 1, 9) (9, 1, 8)	112.86690 113.26375	4	Rr Rr	(62, 1, 61) (63, 1, 62)	140.36294 140.71816	-3 -28
Qrp	{ 12, 1, 12 }	116.86635	5	Prp	78, 1, 77	84.68896 -		Prp	8, 1, 7	113.66005	5	Rrr	64, 1, 63	141.07328	-5
Qrp	( 13, 1, 13 )	116.87560	5	Prp	77, 1, 76	85.11938	0	Prp	(7, 1, 6)	114.05580	4	Rrr	(65, 1, 64)	141.42762	- 2
Qтр	( 14, 1, 14 )	116.88555	3	Prp	(76, 1, 75)	85.54894 -		Prp	(6, 1, 5)	114.45101	4	Rrr	(66, 1, 65)	141.78132	-6
Qтр	( 15, 1, 15 )	116.89618	-1	Prp	75, 1, 74		25	Prp	$\{5, 1, 4\}$	114.84570	6	Rrr	(67, 1, 66)	142.13446	-7 -1
Qrp Qrp	( 16, 1, 16 ) ( 17, 1, 17 )	116.90761 116.91979	3 12	Prp Prp	(74, 1, 73) (73, 1, 72)	86.40690 - 86.83545	-9	Prp Prp	$\left\{ \begin{array}{ll} 4, & 1, & 3 \\ 3, & 1, & 2 \end{array} \right\}$	115.23975 115.63328	-1 -5	Rr Rr	(68, 1, 67) (69, 1, 68)	142.48710 142.83910	-1 -2
Qтр	18, 1, 18	116.93263	15	Prp	72, 1, 71		-2	тър	(3, 1, 2)	110.00020	-0	Rrr	70, 1, 69	143.19048	-7
Qтр	19, 1, 19	116.94607	7	Prp	71, 1, 70		12	Rrr	(1, 1, 0)	117.59361	64	Rrr	(71, 1, 70)	143.54131	-9
Qтр	(20, 1, 20)	116.96023	0	Prp	(70, 1, 69)		-8	Rrr	(2, 1, 1)	117.98349	25	Rrr	(72, 1, 71)	143.89156	-11
Qrp	(21, 1, 21)		-18	Prp	(69, 1, 68)		-4	Rrr	$\{3, 1, 2\}$	118.37302	6	Rrr	( 73, 1, 72 ) ( 74, 1, 73	144.24137	0
Qrp Qrp	( 22, 1, 22 ) ( 23, 1, 23 )	116.99065 117.00718	-17 0	Prp Prp	(68, 1, 67) (67, 1, 66)		-3 -4	Rrr	$\{4, 1, 3\}$ $\{5, 1, 4\}$	118.76219 119.15080	6	Rrr	( 74, 1, 73 ) ( 75, 1, 74 )	144.59046 144.93896	-3 -8
Qтр	24, 1, 24	117.02425	ŏ	Prp	66, 1, 65		12	Rrr	6, 1, 5		-12	Rrr	( 76. 1. 75 )	145.28699	-3
Qrp	(25, 1, 25)	117.04200	-4	Prp	(65, 1, 64)		15	Rrr	(7, 1, 6)	119.92632	4	Rrr	(77, 1, 76)	145.63440	-1
Qтр	( 26, 1, 26 )	117.06114	61	Prp	(64, 1, 63)		-8	Rrr	(8, 1, 7)	120.31327	5	Rrr	(78, 1, 77)	145.98121	-3
Qrp	( 27, 1, 27 ) ( 28, 1, 28 )	117.07974	-2	Prp	(63, 1, 62)		-1 -2	Rrr	(9, 1, 8) (10, 1, 9)	120.69962 121.08544	2 2	Rrr Rrr	(79, 1, 78) (80, 1, 79)	146.32832 146.67313	83 -3
Qrp Qrp	29, 1, 29	117.12029	2	Ртр Ртр	(62, 1, 61) (61, 1, 60)	91.94161	-9	Rrr	( 10, 1, 9 ) ( 11, 1, 10 )	121.47072	4	Rrr	81, 1, 80	147.01839	12
Qrp	30, 1, 30 }	117.14160	ō	Prp	60, 1, 59	92.36422	-5	Rrr	12, 1, 11 }	121.85548	10	Rrr	82, 1, 81	147.36287	7
Qrp	(31, 1, 31)	117.16363	-1	Prp	(59, 1, 58)		-6	Rrr	( 13, 1, 12 )	122.23953	1	Rrr	(83, 1, 82)	147.70670	-6
Qпр	(32, 1, 32)	117.18641	2	Prp	(58, 1, 57)	93.20797	-6	Rrr	( 14, 1, 13 )	122.62316	7	Rrr	(84, 1, 83)	148.05009	-5
Qrp Qrp	(33, 1, 33) (34, 1, 34)	117,20985 117,23402	0	Prp Prp	( 57, 1, 56 )		-1 -4	Rrr Rrr	(15, 1, 14)	123.00613 123.38851	-4	Rrr Rrr	(85, 1, 84)	148.39291 148.73519	-4 -1
Qпр	35, 1, 35	117.25890	ő	Prp	( 56, 1, 55 ) ( 55, 1, 54 )		-5	Rrr	( 16, 1, 15 ) ( 17, 1, 16 )	123.77046	3	Rrr	( 86, 1, 85 ) ( 87, 1, 86 )		-12
Qnp	36, 1, 36	117.28449	ŏ	Prp	54, 1, 53		-8	Rrr	18, 1, 17 }	124.15181	7	Rrr	91, 1, 90		-38
Qтр	(37, 1, 37)	117.31076	-3	Prp	(53, 1, 52)		15	Rrr	( 19, 1, 18 )	124.53257	8	_		_	
Qnp	(38, 1, 38)	117.33779	0	Prp	(52, 1, 51)		-9	Rrr	( 20, 1, 19 )	124.91271	3	Prn	(81, 1, 81)	87.58591	
Qrp Qrp	(39、1、39) (40、1、40)	117.36549 117.39391	-2 -2	Prp Prp	( 51, 1, 50 ) ( 50, 1, 49 )	96.14641 96.56425	1 -1	Rrr Rrr	( 21, 1, 20 ) ( 22, 1, 21 )	125.29233 125.67138	3 4	Prn Prn	( 80, 1, 80 ) ( 79, 1, 79 )	87.91534 88.24525	3 -17
Qпр	41, 1, 41	117.42303	-3	Prp	49, 1, 48		-2	Rrr	23, 1, 22 }	126.04983	i	Prn	77, 1, 77		-22
Qrp	(42, 1, 42)	117.45288	- 1	Prp	(48, 1, 47)		-5	Rrr	24, 1, 23 }	126.42777	3	Prn	(76, 1, 76)	89.24078	5
Qrp	( 43, 1, 43 )	117.48341	-3	Prp	(47, 1, 46)		-4	Rrr	(25, 1, 24)	126.80569	61	Prn	( 75, 1, 75 )	89.57423	6
$\mathbf{Q}_{\mathbf{TP}}$ $\mathbf{Q}_{\mathbf{TP}}$	( 44, 1, 44 ) ( 45, 1, 45 )	117.51467 117.54660	-2 -5	Prp Prp	( 46, 1, 45 ) { 45, 1, 44 )		-1 -3	Rrr Rrr	( 26, 1, 25 ) ( 27, 1, 26 )	127.18194 127.55808	9	Prn Prn	( 74, 1, 74 ) ( 73, 1, 73 )	89.90826 90.24349	-16 -2
Qrp	(46, 1, 46)	117.57929	-2	Prp	44, 1, 43	99.06130	1	Rrr	28, 1, 27	127.93373	5	Prn	72, 1, 72	90.57948	7
Qrp	47, 1, 47	117.61267	-1	Prp	43, 1, 42	99.47576	î	Rrr	29, 1, 28	128.30877	3	Prn	{ 71, î, 71 }	90.91604	-9
Qrp	(48, 1, 48)	117.64673	-3	Prp	(42, 1, 41)		- 1	Rrr	(30, 1, 29)	128.68324	1	Prn	(70, 1, 70)		-19
Qrp	(49, 1, 49)	117.68153	-2	Prp	(41, 1, 40)	100.30322	2	Rrr	(31, 1, 30)	129.05717	3	Prn	(69, 1, 69)	91.59198	-6
Qrp Qrp	(50, 1, 50) (51, 1, 51)	117.71701 117.75319	-3 -4	Prp Prp	( 40, 1, 39 ) ( 39, 1, 38 )	100.71614 101.12864	-3 -1	Rrr Rrr	( 32, 1, 31 ) ( 33, 1, 32 )	129.43052 129.80320	-5	Prn Prn	(68, 1, 68) (67, 1, 67)	91.93117 92.27112	-4 -8
Qrp	52, 1, 52	117.79014	1	Prp	38, 1, 37		-5	Rrr	$\{34, 1, 32\}$	130.17547	2	Prn	66, 1, 66	92.61191	-9
Qrp	53, 1, 53	117.82777	3	Prp	37, 1, 36		-1	Rrr	(35, 1, 34)	130.54711	4	Prn	65, 1, 65	92.95353	-7
Qrp	(54, 1, 54)	117.86597	-8	Prp ·	(36, 1, 35)	102.36308	0	Rrr	(36, 1, 35)	130.91814	3	Prn	(64, 1, 64)	93.29593	-9
Qrp	( 55, 1, 55 ) ( 56, 1, 56 )	117.90499 117.94478	-8 -1	Prp Prp	(35, 1, 34)	102.77354 103.18349	0 -2	Rrr Rrr	(37, 1, 36)	131.28859 131.65850	0 2	Prn Prn	( 63, 1, 63 ) ( 62, 1, 62 )	93.63917 93.98317	-6 -9
Qrp Qrp	(58, 1, 58)	118.02626	-8	Prp	( 34, 1, 33 ) ( 33, 1, 32 )	103.18349	0	Rrr	( 38, 1, 37 ) ( 39, 1, 38 )	132.02781	ő	Prn	61, 1, 61		-15
Qrp	59, 1, 59	118.06810	-7	Prp	32, 1, 31	104.00191	ĭ	Rrr	40, 1, 39	132.39655	ŏ	Prn	60, 1, 60	94.67367	-3
Qrp	(60, 1, 60)	118.11067	-4	Prp	(31, 1, 30)	104.41038	4	Rrr	(41, 1, 40)	132.76470	-2	Prn	( 59, 1, 59 )	95.02003	-9
Qrp	(61, 1, 61)	118.15391	-3	Prp	(30, 1, 29)	104.81819	-7	Rrr	(42, 1, 41)	133.13230	-2	Pm	(58, 1, 58)	95.36730	-3
Qrp	(62, 1, 62)	118.19781 118.24242	-7 -10	Prp	(29, 1, 28)	105.22569 105.63260	2 4	Rrr Rrr	(43, 1, 42)	133.49934	1 2	Prn Prn	57, 1, 57	95.71532 96.41365	-2 -8
Qrp   Qrp	(63, 1, 63) (64, 1, 64)	118.24242	-10	Prp Prp	( 28, 1, 27 ) ( 27, 1, 26 )	105.63260	3	Rr	(44, 1, 43) (45, 1, 44)	134.23162	-2	Prn	( 55, 1, 55 ) ( 54, 1, 54 )	96.76404	-8 -7
Qnp	65, 1, 65	118.33383	-8	Prp	26, 1, 25	106.44479	Ö	Rrr	(46, 1, 45)	134.59693	ō	Pm	(53, 1, 53)	97.11524	-4
Qrp	(66, 1, 66)	118.38058	-8	Prp	(25, 1, 24)	106.84998 -	14	Rrr	(47, 1, 46)	134.96160	-4	Pm	( 52, 1, 52 )	97.46722	-1
Qrp	(67, 1, 67)		-16	Prp	( 24, 1, 23 )	107.25498	4	Rrr	(48, 1, 47)	135.32577	0	Pm	(51, 1, 51)	97.81996	0
Qrp Qrp	( 68, 1, 68 ) ( 69, 1, 69 )	118.47615 118.52503	-11 -7	Prp   Prp	( 23, 1, 22 ) ( 22, 1, 21 )	107.65916 108.06301	-7 1	Rrr Rrr	( 49, 1, 48 ) ( 50, 1, 49 )	135.68931 136.05229	-2 -1	Prn Prn	( 50, 1, 50 ) ( 49, 1, 49 )	98.17345 98.52775	-3 -2
$\vec{Q}_{1P}$	70, 1, 70	118.57456	-9	Prp	21, 1, 20	108.46629	5	Rrr	$\{51, 1, 50\}$	136.41468	-2	Pm	48, 1, 48	98.88283	-1
Q <sub>TP</sub>	(71, 1, 71)	118.62479	-11	Prp	(20, 1, 19)	108.86900	4	Rrr	(52, 1, 51)	136.77652	-1	Pm	( 47, 1, 47 )	99.23867	- 2
Qrp	(73, 1, 73)	118.72764	15	Prp	(19, 1, 18)	109.27117	3	Rrr	(53, 1, 52)	137.13777	0	Prn	(46, 1, 46)	99.59528	-3

higher in energy. Thus, if these two pairs of levels couple by a J-dependent interaction, the anomalies in the effective B values shown in Fig. 4 can be explained.

As discussed in detail by Urban and Yamada (14) for ketene and diazomethane, the centrifugal distortion resonance between the ground state and the  $v_5 = 1$  state observed for HNCS is induced by an operator

$$\hat{H}_{12}^{(5)} = -\omega_5 q_5 C_5^{ab} [J_a, J_b]_+ = -\frac{1}{2} \omega_5 q_5 C_5^{ab} [\hat{J}_+ + \hat{J}_-, \hat{J}_a]_+, \tag{4}$$

where  $C_5^{ab}$  is a dimensionless parameter,

TABLE VI-Continued

$ \begin{array}{c} Pm & (43, 1, 43) & 100.666979 & -2 & Rm \\ (31, 1, 31) & 129.68347 & -3 & 0 \\ Pm & (41, 1, 41) & 101.38999 & 10 & Rm \\ (31, 13, 32) & 130.08730 & 5 & Qm \\ (72, 12, 12, 12, 12, 12, 12, 12, 12, 12, 1$	Т	ransition	Freq.	Δ	T	ransition	Freq.	Δ	T	ransition	Freq.	Δ	Transition	Freq.	Δ
Pm (44, 1, 44) 100.31084 - 4. Rpg (30, 1, 30) 129.47045 2 Qpp (58, 2, 87) 177.22644 - 22 Pp (18, 2,) 170.10128 Pm (44, 1, 44) 100.310849 - 1 Rpg (31, 13) 129.68347 - 3 Qpp (66, 25) 177.2324.46 Pp (17, 2,) 170.48161 Pm (40, 1, 44) 101.38699 - 1 Rpg (41, 13) 129.68347 - 3 Qpp (67, 2,) 171.72776 - 32 Pp (67, 2,) 171.72776 - 32 Pp (67, 2,) 171.72776 - 32 Pp (77, 2,) 171.727776 - 32 Pp (77, 2,) 171.72776 - 32 Pp (77, 2,) 171.727776 - 32 Pp (77, 2,) 171.72777 -	Prn	(45, 1, 45)	99.95268	-3	Rrp	( 29, 1, 29 )	128.85808	2	Qrp	( 55, 2, 54 )	177.21699	-49	Pr- ( 19, 2, -)	169.71093	-10
Prim (42, 1, 42) 101,02980 1 Rpr (32, 1, 32) 130,09730 5 Qrp (71, 2, 70) 177,27257 -42 Pr. (16, 2, -) 170,88208	Prn	(44, 1, 44)				(30, 1, 30)			Qrp	(58, 2, 57)	177.22644		Pr- (18, 2, -)		
Print (41, 1.41) 101.38999 1 R. R. (33, 1, 33) 130.51171 2 Qrip (72, 2, 71) 177.27736 35 Pr. (15, 2, -) 171.27736 17 Pr. (12, 2, -) 171.36316 18 Print (40, 14) 101.75122 0 Rep 34.5, 34.5 130.51175 2 Qrip (72, 2, 71) 177.27736 35 Pr. (15, 2, -) 171.27736 18 Pr. (12, 2, -) 171.63316 2 Rep 37, 37, 37, 312.17513 2 Pr. (38, 1, 38) 102.47597 0 Rep (36, 1, 36) 131.75913 2 Pr. (36, 1, 36) 132.020377 0 Rep (36, 1, 36) 131.75913 2 Pr. (36, 1, 36) 132.020377 0 Rep (36, 1, 36) 131.75913 2 Pr. (36, 1, 36) 133.59436 1 Rep (39, 1, 39) 133.01800 - 1 Pr. (17, 2, -) 2, 77, 174.646160 19 Pr. (10, 2, -) 172.32516 1 Pr. (35, 1, 36) 133.59416 1 Rep (39, 1, 39) 133.01800 - 1 Pr. (17, 2, -) 2, 7, 174.646160 19 Pr. (10, 2, -) 173.22516 1 Rep (30, 1, 36) 133.59426 2 Pr. (17, 2, -) 2, 77.174.00785 2 Pr. (17, 2, -) 174.00785 2 Pr. (17, 2, -) 174.0		( 43, 1, 43 )													
Pm (30, 1, 40) 101.78122 0 Rtp (34, 1, 34) 130.92685 3 Qtp (76, 2, 75) 177.29457 80 Pr (14, 2, -) 171.603185 1 Pm (37, 137) 102.63081 - Rtp (37, 1, 37) 102.63081 - Rtp (3		( 42, 1, 42 )				32, 1, 32			Qrp	71, 2, 70					
Pm (38, 1, 38)   1024/1397   0. Rp (35, 1, 35)   313.43266   2. Pp (82, 2. 80)   145.27027   19. Pp (13, 2, -)   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   172.05395   1		{ 41, 1, 41 }				33, 1, 33				72, 2, 71					
Pm (38, 1, 38) 102.47597 0 Rp <sup>2</sup> (36, 1, 36) 131.75913 -2 Ppp (82, 2, 80) 145.27028 -11 Pr <sup>2</sup> (12, 2, -) 172.44459 -1 Pm (37, 13, 7) 102.37597 2 Ppp (86, 2, 78) 145.57028 -11 Pr <sup>2</sup> (12, 2, -) 172.44459 -1 Pm (36, 1, 36) 103.20377 0 Rpp (38, 1, 38) 132.58426 2 Ppp (80, 2, 78) 146.04160 19 Pr <sup>2</sup> (10, 2, -) 173.22610 Ppp (70, 2, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14		39 1 39				35 1 35			Qip	(10, 2, 13)	171.29401	80	Pr- \ 13 2		
Pm (37, 1, 37) 102.83981 2 Rp (37, 1, 37) 132.17637 2 Pp (81, 2, 79) 145.68577 .9 Pr (11, 2, -) 172.83565  Pm (38, 1, 35) 103.56881 1 Rp (39, 1, 39) 133.01280 1 Pp (79, 2, 77) 146.42708 0 Pr (10, 2, -) 173.22610  Pm (38, 1, 35) 103.56881 1 Rp (39, 1, 39) 133.01280 1 Pp (79, 2, 77) 146.42708 0 Pr (8, 2, -) 173.31699  Pm (31, 1, 31) 104.50348 1 Rp (41, 1, 43) 134.89405 7 Pp (77, 2, 75) 447.8984 1  Pm (32, 1, 32) 104.66841 -1 Rp (41, 1, 43) 134.89405 7 Pp (76, 2, 74) 147.58457 12 Pr (7, 2, -) 174.78999 1  Pm (31, 1, 31) 105.03648 2 Rp (41, 1, 43) 134.89405 7 Pp (75, 2, 74) 147.58457 12 Pr (5, 2, -) 174.78999 1  Pm (32, 1, 32) 104.66841 -1 Rp (41, 1, 43) 134.89405 7 Pp (75, 2, 74) 147.58457 12 Pr (61, 2, -) 175.57231  Pm (32, 1, 32) 104.66842 2 Rp (45, 1, 46) 135.53866 2 Pp (77, 2, 75) 148.75466 0 Pr (4, 2, -) 175.57231  Pm (28, 1, 22) 105.77479 1 Rp (46, 1, 46) 135.53866 2 Pp (77, 2, 75) 148.74285  Pm (28, 1, 22) 105.77479 1 Rp (46, 1, 46) 135.53866 2 Pp (77, 2, 76) 148.72866 0 Pr (4, 2, -) 175.57231  Pm (28, 1, 22) 105.78479 1 Rp (46, 1, 46) 135.53866 2 Pp (77, 2, 76) 148.72866 5 Rr (2, 2, -) 177.87831  Pm (28, 1, 22) 105.78479 1 Rp (47, 1, 48) 135.23852 0 Pp (70, 2, 68) 148.72856 5 Rr (2, 2, -) 179.08506  Pm (28, 1, 22) 105.82879 1 Rp (46, 1, 64) 135.38689 2 Rp (47, 1, 48) 136.3868									Pro	(82, 2, 80)	145,27028	-11			
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Pri (31, 1, 31) 105.03649 2 Rrp (44, 1, 44) 135.11596 -3 Prp (74, 2, 72) 145.35646 0 Pr. (4, 2, -) 175.51311 -1 Pri (23, 1, 23) 105.03632 2 Rrp (44, 1, 44) 135.53866 -2 Pri (74, 2, 72) 148.35646 3 Pr. (4, 2, -) 175.57321 -1 Pri (23, 1, 23) 105.07479 -1 Rrp (46, 1, 46) 135.96207 1 Prp (72, 2, 70) 145.74255 -3 Rr. (2, 2, -) 175.31194 -1 Pri (26, 1, 26) 106.88791 -2 Rrp (49, 1, 46) 135.83686 0 Prp (72, 2, 70) 145.7265 -3 Rr. (2, 2, -) 175.03636 -1 Pri (26, 1, 26) 106.88791 -2 Rrp (49, 1, 46) 135.83686 0 Prp (72, 2, 70) 145.12684 -3 Rr. (4, 2, -) 179.03506 -1 Pri (25, 1, 26) 107.63370 -3 Rrp (51, 1, 51) 138.08922 -3 Prp (82, 2, 76) 155.28794 -3 Rr. (5, 2, -) 179.08507 -1 Pri (25, 1, 25) 107.26077 0 Rrp (52, 1, 52) 135.851672 -2 Pri (72, 2, 55) 151.06107 -7 Rr (7, 2, -) 180.27021 -1 Pri (22, 1, 22) 108.38243 -3 Rrp (51, 1, 51) 138.08922 -3 Prp (68, 2, 64) 151.44774 -3 Rr. (7, 2, -) 180.27021 -1 Pri (21, 1, 21) 108.75864 17 Rrp (54, 1, 54) 138.037377 0 Pri (25, 1, 21) 109.13408 0 Rrp (55, 1, 55) 139.80325 -7 Prp (65, 2, 63) 151.83493 -1 Rr (9, 2, -) 180.056204 -1 Pri (21, 1, 21) 109.5106 4 Rrp (56, 1, 56) 140.23351 -4 Prp (63, 2, 67) 152.68866 -1 Rr (1, 2, -) 181.43686 -1 Pri (13, 1, 1) 109.5106 4 Rrp (56, 1, 56) 140.66443 -3 Prp (63, 2, 67) 152.68866 -3 Rr (14, 2, -) 181.43686 -1 Pri (17, 1, 1) 10.26713 3 Rrp (56, 1, 56) 140.66443 -3 Prp (63, 2, 67) 153.38243 -7 Rr (10, 2, -) 181.43686 -1 Pri (17, 1, 1) 10.26713 3 Rrp (56, 1, 56) 140.5938 -8 Pri (25, 2, 5) 153.39243 -7 Rrp (69, 2, 68) 153.76864 -3 Rr (14, 2, -) 183.13607 -1 Pri (15, 1, 1, 1) 11.26760 -6 Rrp (11, 61) 143.28037 -7 Pri (52, 2, 5) 153.39243 -7 Rrp (69, 2, 54) 153.39243 -7 Rrp (69, 2,								1	Prp	77, 2, 75			Pr- (7, 2, -)		
Prin (20, 1, 30)   105.40528   2. Rrp (45, 1, 45)   135.53866   2. Prp (74, 2, 72)   148.53666   0. Pr. (4, 2, -)   175.57231   176.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231   177.57231	Prn		105.00641			43, 1, 43			Prp	75 2 73			Pr. (6, 2, -		
Prin (29, 1, 29) 105.77479 - 1 Rrp (46, 1, 46) 135.96207 1 Prip (73, 2, 70) 148.74255 - 3 Prin (23, 1, 25) 106.14593 84 Rrp (47, 1, 47) 136.36617 4 Prin (27, 1, 27) 106.51614 2 Rrp (48, 1, 48) 136.81088 0 Prip (71, 2, 69) 149.51506 - 2 Rr- (3, 2, -) 178.31194 - 179.709305 Prin (23, 1, 25) 106.88791 2 Rrp (49, 1, 49) 137.26522 0 Prip (71, 2, 69) 149.51506 - 2 Rr- (3, 2, -) 178.03305 Prin (23, 1, 25) 107.26023 18 Rrp (30, 1, 35) 137.66243 - 1 Prip (69, 2, 67) 150.26794 3 Rr- (4, 2, -) 179.03505 Prin (23, 1, 25) 107.26023 18 Rrp (30, 1, 35) 137.66243 - 1 Prip (69, 2, 67) 150.26794 3 Rr- (5, 2, -) 179.48671 - 1 Rr- (5, 2, -) 179.48671 - 1 Rr- (5, 2, -) 179.48671 - 1 Rr- (23, 1, 22) 108.36640 1 Rrp (34, 1, 54) 139.37377 0 Prip (67, 2, 64) 151.44774 - 3 Rr- (8, 2, -) 180.66204 - 1 Rr- (19, 1, 2) 109.13408 0 Rrp (55, 1, 55) 139.80325 - 7 Prip (64, 2, 62) 152.22137 - 4 Rr- (10, 2, -) 181.05385 Prin (20, 1, 1, 1) 109.51506 4 Rrp (56, 1, 56) 140.66443 - 3 Prip (63, 2, 64) 152.46936 1 Rr (9, 2, -) 181.05385 Prin (20, 1, 1, 1) 109.5150 6 4 Rrp (56, 1, 56) 140.66434 - 3 Prip (63, 2, 64) 152.46936 1 Rr (10, 2, -) 181.4668 Prin (17, 1) 110.26713 3 Rrp (58, 1, 58) 141.52831 - 3 Prip (63, 2, 64) 152.46936 1 Rr (11, 2, -) 182.2595 Prin (15, 1, 15) 111.02676 6 Rrp (61, 1, 64) 142.39496 - 3 Prip (61, 2, 59) 153.38243 7 Rr (14, 2, -) 182.2595 Prin (15, 1, 1, 1, 11) 110.2673 3 Rrp (59, 1, 59) 141.52831 - 3 Prip (62, 2, 60) 152.99537 - 1 Rr- (12, 2, -) 182.25255 Prin (15, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,		30. 1. 30			Ren	45 1 45			Prp	74 2 72			Pr. \ 4 2		
Pro (28, 1, 28) 106.14593 & Rpp (47, 1, 47) 136.34617 4 Prp (77, 2, 70) 149.12884 5 Rr. (2, 2, ) 178.31194 - Pro (25, 1, 25) 107.26023 - 18 Rrp (59, 1, 56) 136.81088 0 Prp (71, 2, 59) 149.51506 - 2 Rr. (3, 2, ) 178.30194 - Pro (25, 1, 25) 107.26023 - 18 Rrp (50, 1, 56) 137.36243 - 1 Prp (69, 2, 67) 150.28794 3 Rr. (5, 2, ) 179.3695 - Pro (21, 1, 24) 107.63373 8 Rrp (51, 1, 51) 138.08922 - 3 Prp (68, 2, 66) 150.67444 - 1 Rr. (6, 2, ) 179.38794 - Pro (22, 1, 24) 108.06767 0 Rrp (53, 1, 52) 138.08922 - 3 Prp (68, 2, 66) 151.06674 - 1 Rr. (6, 2, ) 179.38794 - Pro (22, 1, 24) 108.07670 0 Rrp (53, 1, 52) 138.08922 - 3 Prp (68, 2, 66) 151.06674 - 1 Rr. (6, 2, ) 179.38794 - Pro (22, 1, 24) 109.5106 4 Rrp (54, 1, 54) 139.37377 0 Prp (64, 2, 64) 151.06744 - 1 Rr. (6, 2, ) 180.05385 - Pro (20, 1, 24) 109.51106 4 Rrp (56, 1, 56) 140.23351 - 4 Prp (63, 2, 61) 152.60836 1 Rrp (11, 2, ) 181.83762 - Pro (18, 1, 18) 109.88873 3 Rrp (57, 1, 57) 140.66443 - 3 Prp (62, 2, 62) 152.95377 - 1 Rr. (12, 2, ) 181.83762 - Pro (16, 1, 16) 110.46673 3 Rrp (58, 1, 58) 141.09598 - Rrp (61, 2, 69) 152.95377 - 1 Rr. (12, 2, ) 182.62158 - Pro (15, 1, 16) 110.26713 3 Rrp (58, 1, 58) 141.09598 - Rrp (61, 2, 69) 152.95377 - 1 Rr. (12, 2, ) 182.62158 - Pro (14, 1, 14) 111.40676 6 Rrp (61, 1, 61) 141.52831 - 3 Prp (62, 2, 63) 151.56846 - 3 Rr. (14, 2, ) 183.03560 - Pro (15, 1, 14) 111.107676 6 Rrp (61, 1, 61) 142.39933 - 3 Prp (62, 2, 63) 151.36844 - 3 Rr. (13, 2, ) 183.40567 - Pro (14, 1, 14) 111.40676 6 Rrp (61, 1, 61) 142.39933 - 3 Prp (62, 2, 63) 151.36844 - 3 Rr. (13, 2, ) 183.40567 - Pro (14, 1, 14) 111.40676 6 Rrp (61, 1, 61) 142.3993 - Rr (16, 2, 4) 142.3993 - Rr (16, 2, 4) 143.1076 - Rr (13, 14, 14) 114.0676 6 Rrp (61, 1, 61) 142.3993 - Rr (16, 2, 4) 143.0906 - Rr (16, 2					Rrp	46, 1, 46			Pro	73, 2, 71			( ., -,	1.0.0.201	
Prin (27, 1, 27) 106.51614 2 Rpp (48, 1, 48) 136.81088 0 Prin (71, 2, 69) 149.51506 -2 Rr. (3, 2, -) 178.70349 Prin (25, 1, 26) 106.88791 2 Rpp (49, 1, 49) 137.23632 0 Prin (25, 1, 26) 107.26023 -18 Rpp (50, 1, 50) 137.66243 -1 Prin (69, 2, 67) 150.28794 3 Rr. (4, 2, -) 179.95906 -1 Rpp (24, 1, 24) 107.63370 3 Rpp (51, 1, 51) 138.08922 -3 Rpp (68, 2, 66) 150.67444 -1 Rr. (6, 2, -) 179.887843 -1 Rpp (22, 1, 22) 108.382473 3 Rpp (52, 1, 52) 138.51672 -2 Prin (67, 2, 66) 150.67444 -1 Rr. (6, 2, -) 179.87843 -1 Rpp (22, 1, 22) 108.38243 3 Rpp (53, 1, 53) 138.51672 -2 Prip (67, 2, 65) 151.06107 0 Rr. (7, 2, -) 180.27021 -1 Rpp (22, 1, 2) 108.75804 17 Rpp (54, 1, 54) 139.37377 0 Prip (65, 2, 64) 151.44747 -3 Rr. (8, 2, -) 180.67021 -1 Rpp (17, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	Prn	(28, 1, 28)	106.14593	84	Rrp	(47, 1, 47)			Prp		149.12884		Rr- (2, 2, -)	178.31194	-10
Pri (26, 1, 26) 106.88791 2, Rrp (49, 1, 49) 137.23632 0 Prp (70, 2, 88) 149.9049 3 Rr. (5, 2, ) 179.08506 Pri (24, 1, 24) 107.63370 3 Rrp (51, 1, 51) 138.08922 -3 Prp (68, 2, 66) 150.67444 -1 Rr. (6, 2, ) 179.08506 Pri (24, 1, 24) 107.63370 3 Rrp (51, 1, 51) 138.08922 -3 Prp (68, 2, 66) 150.67444 -1 Rr. (6, 2, ) 179.87843 Pri (24, 1, 24) 107.63370 3 Rrp (53, 1, 53) 138.94494 3 Prp (66, 2, 64) 151.44774 -3 Rr. (8, 2, ) 180.06204 Pri (21, 1, 21) 108.75804 17 Rrp (54, 1, 54) 138.037377 0 Prp (65, 2, 64) 151.44774 -3 Rr. (8, 2, ) 180.06204 Pri (21, 1, 21) 108.75804 17 Rrp (54, 1, 54) 139.37377 0 Prp (65, 2, 64) 151.44774 -3 Rr. (10, 2, ) 181.05385 - Pri (20, 1, 1, 20) 109.13408 0 Rrp (55, 1, 55) 140.6343 -3 Prp (64, 2, 62) 152.22137 -4 Rr. (10, 2, ) 181.43585 - Pri (15, 1, 13) 109.5106 4 Rrp (55, 1, 55) 140.6343 -3 Prp (62, 2, 60) 152.29937 -1 Rr. (10, 2, ) 181.43585 - Pri (15, 1, 13) 109.5106 4 Rrp (55, 1, 55) 140.6343 -3 Prp (62, 2, 60) 152.29937 -1 Rr. (12, 2, ) 183.23584 - Pri (15, 1, 15) 110.63627 3 Rrp (55, 1, 55) 140.6343 -3 Prp (62, 2, 60) 152.99337 -1 Rr. (12, 2, ) 183.23585 - Pri (15, 1, 15) 110.63627 3 Rrp (55, 1, 55) 141.05885 -3 Prp (61, 2, 59) 153.33843 -5 Rr. (13, 2, ) 182.22959 - Pri (15, 1, 1, 11) 110.2577 3 Rrp (55, 1, 55) 141.05885 -3 Prp (60, 2, 88) 153.7666 -3 Rr. (12, 2, ) 183.03807 - Pri (14, 1, 1, 11) 112.55285 2 Rrp (62, 1, 62) 142.39493 -7 Prp (50, 2, 86) 154.54499 0 Rr. (16, 2, ) 183.0359 Pri (10, 1, 11) 112.55285 2 Rrp (64, 1, 64) 143.69907 -5 Prp (57, 2, 55) 154.54499 0 Rr. (16, 2, ) 183.7977 - Pri (13, 1, 15) 111.78802 0 Rrp (62, 1, 66) 144.57388 0 Prp (55, 2, 53) 155.70676 -5 Rr. (19, 2, ) 183.7977 - Pri (13, 1, 15) 111.78802 0 Rrp (62, 1, 66) 144.57388 0 Prp (55, 2, 55) 154.64499 0 Rr. (16, 2, ) 183.7977 - Pri (15, 1, 15) 113.30255 1 Rrp (66, 1, 66) 144.57388 0 Prp (57, 2, 55) 155.64891 - Rrp (13, 1, 15) 111.78805 1 Rrp (77, 1, 77) 144.13634 6 Prp (77, 1, 77) 144.13634 6 P		(27, 1, 27)			Rrp	(48, 1, 48)			Prp	(71, 2, 69)			Rr- (3, 2, -)		
$ \begin{array}{c} Pm \ (24, 1, 24) \ 107,63370 \ 3 \ Rrp \ (51, 1, 51) \ 138,08922 \ -3 \ Prp \ (68, 2, 66) \ 150,67444 \ -1 \ Rr \ (6, 2, -) \ 179,87843 \ -1 \ Prp \ (67, 2, 65) \ 151,067444 \ -1 \ Rr \ (6, 2, -) \ 179,87843 \ -1 \ Prp \ (67, 2, 65) \ 151,06744 \ -1 \ Rr \ (6, 2, -) \ 180,06204 \ -1 \ Prp \ (67, 2, 65) \ 151,06744 \ -1 \ Rr \ (6, 2, -) \ 180,06204 \ -1 \ Prp \ (61, 2, 64) \ 151,06744 \ -1 \ Rr \ (9, 2, -) \ 180,06204 \ -1 \ Rr \ (9, 1, 20) \ 139,37377 \ 0 \ Prp \ (66, 2, 64) \ 151,3439 \ -1 6 \ Rr \ (9, 2, -) \ 181,05385 \ -1 \ Prp \ (17, 1, 19) \ 109,51106 \ 4 \ Rrp \ (55, 1, 55) \ 139,80325 \ -7 \ Prp \ (64, 2, 62) \ 152,22137 \ -4 \ Rr \ (10, 2, -) \ 181,44568 \ -7 \ Rr \ (11, 2, -) \ 181,33762 \ -7 \ Rr \ (11, 17) \ 110,26731 \ 3 \ Rrp \ (55, 1, 55) \ 140,66443 \ -3 \ Prp \ (62, 2, 64) \ 152,295537 \ -1 \ Rr \ (12, 2, -) \ 183,3762 \ -7 \ Prp \ (61, 16, 110,64627 \ 3) \ Rr \ (98, 1, 88) \ 141,09589 \ 8 \ Prp \ (61, 2, 59) \ 153,35343 \ 5 \ Rr \ (13, 2, -) \ 182,62188 \ -7 \ (16, 1, 16) \ 110,64627 \ 3 \ Rrp \ (59, 1, 59) \ 141,52831 \ -3 \ Prp \ (60, 2, 58) \ 153,376964 \ -3 \ Rr \ (14, 2, -) \ 183,00380 \ -7 \ (17, 15) \ 111,02613 \ 3 \ Rrp \ (60, 1, 60) \ 141,96127 \ -4 \ Prp \ (59, 2, 57) \ 154,16489 \ -5 \ Rr \ (15, 2, -) \ 183,00380 \ -7 \ -7 \ (13, 1, 13) \ 111,78060 \ -6 \ Rrp \ (61, 16) \ 142,89493 \ -3 \ Prp \ (52, 2, 56) \ 154,54429 \ 0 \ Rr \ (16, 2, -) \ 183,00380 \ -7 \ Prp \ (13, 1, 13) \ 111,78060 \ -6 \ Rrp \ (61, 16) \ 142,89493 \ -3 \ Prp \ (52, 2, 51) \ 154,54429 \ 0 \ Rr \ (15, 2, -) \ 183,40587 \ -7 \ Prp \ (52, 2, 51) \ 154,54429 \ 0 \ Rr \ (15, 2, -) \ 183,40587 \ -7 \ Prp \ (52, 2, 51) \ 154,54429 \ 0 \ Rr \ (15, 2, -) \ 184,54587 \ -7 \ Prp \ (52, 2, 51) \ 154,54429 \ 0 \ -7 \ (13, 13) \ 111,78060 \ -7 \ Rr \ (13, 2, -) \ 182,62188 \ -7 \ (13, 13) \ 111,78060 \ -7 \ Rr \ (13, 2, -) \ 184,54529 \ -7 \ Prp \ (52, 2, 51) \ 154,54429 \ -7 \ Rr \ (13, 2, -) \ 184,54529 \ -7 \ Rr \ (14, 1, 2, -) \ 184,54529 \ -7 \ Rr \ (14, 1, 2, -) \ 184,54529 \ -7 \ Rr \ (14, 1, 2, -) \ 184,5452$									Prp				Rr- (4, 2, -)		
$\begin{array}{c} Pm \ (23, 1, 23) \ 108,00767 \ 0 \ Rrp \ (52, 1, 52) \ 138,51672 \ -2 \ Prp \ (67, 2, 68) \ 151,06107 \ 0 \ Rrp \ (7, 2, -) \ 180,027021 \ -2 \ Prp \ (21, 1, 21) \ 108,75804 \ 17 \ Rrp \ (54, 1, 54) \ 139,37377 \ 0 \ Prp \ (65, 2, 63) \ 151,83439 \ -16 \ Rr \ (9, 2, -) \ 181,05385 \ -2 \ Prp \ (18, 1, 18) \ 109,88043 \ 0 \ Rrp \ (55, 1, 55) \ 139,80325 \ -7 \ Prp \ (64, 2, 62) \ 152,60337 \ -4 \ Rr \ (10, 2, -) \ 181,44568 \ -2 \ Prp \ (11, 1, 19) \ 109,51106 \ 4 \ Rrp \ (55, 1, 55) \ 140,23351 \ -4 \ Prp \ (63, 2, 61) \ 152,60836 \ 1 \ Rr \ (11, 2, -) \ 181,83762 \ -7 \ Prp \ (11, 1, 17) \ 110,26713 \ 3 \ Rrp \ (57, 1, 57) \ 140,66443 \ 3 \ Prp \ (62, 2, 60) \ 152,99537 \ -1 \ Rr \ (11, 2, -) \ 181,83762 \ -7 \ Prp \ (64, 2, 59) \ 153,338243 \ -5 \ Rr \ (13, 2, -) \ 182,62155 \ -7 \ Rr \ (15, 1, 15) \ 111,026713 \ 3 \ Rrp \ (59, 1, 59) \ 141,52831 \ 3 \ Prp \ (62, 2, 58) \ 153,7964 \ -3 \ Rr \ (13, 2, -) \ 182,62155 \ -7 \ Rr \ (14, 1, 4) \ 111,40676 \ 6 \ Rrp \ (61, 1, 61) \ 141,239493 \ -7 \ Prp \ (52, 2, 56) \ 154,54492 \ 0 \ Rr \ (15, 2, -) \ 183,40567 \ -7 \ Prp \ (13, 1, 13) \ 111,78802 \ 0 \ Rrp \ (63, 1, 63) \ 142,23946 \ -4 \ Prp \ (57, 2, 55) \ 154,45689 \ -5 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (12, 1, 12) \ 112,7009 \ 3 \ Rrp \ (63, 1, 63) \ 143,26427 \ 4 \ Prp \ (56, 2, 54) \ 155,70676 \ -5 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ (15, 2, -) \ 184,19006 \ -7 \ Rr \ ($		25, 1, 25			Rrp				Prp				Rr- { 5, 2, -		
$\begin{array}{c} \Pr (22,1,22) \   108.38243 \   3 \   Rrp \   54,1,54 \   139.37377 \   0 \   Prp \   66,2,64 \   151.44774 \   -3 \   Rr \   9,2,- \   181.053865 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   -3 \   $		24, 1, 24			Krp				Prp				Rr- (6, 2, -		
$\begin{array}{c} \Pr (21,1,21) \ 108.75804 \ 17 \ Rrp \ (54,1,54) \ 139.37377 \ 0 \ Prp \ (65,2,63) \ 151.83439 - 16 \ Rr \ (10,2,-1) \ 181.03885 - Prn \ (19,1,19) \ 109.51106 \ 4 \ Rrp \ (56,1,56) \ 149.23351 \ -4 \ Prp \ (63,2,61) \ 152.60836 \ 1 \ Rr \ (11,2,-1) \ 181.43568 - Prn \ (11,1,17) \ 110.26713 \ 3 \ Rrp \ (57,1,57) \ 140.66443 \ 3 \ Prp \ (62,2,60) \ 152.60836 \ 1 \ Rr \ (11,2,-1) \ 181.83762 - Prn \ (17,1,17) \ 110.26713 \ 3 \ Rrp \ (58,1,58) \ 141.09598 \ -8 \ Prp \ (61,2,59) \ 153.38243 \ -5 \ Rr \ (13,2,-1) \ 182.22959 - Prn \ (15,1,15) \ 111.02613 \ 3 \ Rrp \ (60,1,60) \ 141.96127 \ -4 \ Prp \ (59,2,57) \ 154.15899 \ -5 \ Rr \ (15,2,-1) \ 183.01360 - Prn \ (13,1,14) \ 111.46076 \ 6 \ Rrp \ (61,1,6) \ 141.96127 \ -4 \ Prp \ (59,2,57) \ 154.15899 \ -5 \ Rr \ (15,2,-1) \ 183.0967 \ -7 \ Prn \ (13,1,13) \ 111.78802 \ 0 \ Rrp \ (63,1,63) \ 143.26427 \ -4 \ Prp \ (55,2,56) \ 155.353914 \ -8 \ Rr \ (15,2,-1) \ 184.19006 \ -7 \ Rr \ (11,1,11) \ 111.255285 \ 2 \ Rrp \ (64,1,64) \ 143.69997 \ -5 \ Prp \ (55,2,54) \ 155.39914 \ -5 \ Rr \ (19,2,-1) \ 184.58206 \ -7 \ Rr \ (11,1,11) \ 111.255285 \ 2 \ Rrp \ (64,1,64) \ 143.69997 \ -5 \ Prp \ (55,2,54) \ 155.39914 \ -5 \ Rr \ (19,2,-1) \ 184.58206 \ -7 \ Rr \ (13,1,13) \ 111.78902 \ 0 \ Rrp \ (51,165) \ 144.13544 \ -6 \ Prp \ (57,2,55) \ 155.2531 \ 155.09445 \ -5 \ Rr \ (19,2,-1) \ 184.58206 \ -7 \ Rr \ (13,1,13) \ 111.78902 \ 0 \ Rrp \ (65,1,65) \ 144.13544 \ -6 \ Prp \ (57,2,55) \ 155.2531 \ 155.09445 \ -5 \ Rr \ (19,2,-1) \ 184.58206 \ -7 \ Rr \ (11,1,11) \ 112.55285 \ 2 \ Rrp \ (65,1,65) \ 144.35348 \ 0 \ Prp \ (53,2,55) \ 155.48217 \ -6 \ Rr \ (12,2,-1) \ 185.36817 \ -7 \ Rr \ (13,1,13) \ 113.39145 \ -7 \ Rr \ (13,13) \ 113.3914 \ -8 \ Rr \ (13,2,2,-1) \ 185.36817 \ -7 \ Rr \ (13,13) \ 114.68459 \ 0 \ Rrp \ (13,13) \ 114.685965 \ -7 \ Rr \ (13,13) \ 114.685965 \ -7 \ Rr \ (13,13) \ 114.685965 \ -7 \ Rr \ (1$		23, 1, 23			Pro	52, 1, 52			Prp				R.r. { /, 2, ·		
$ \begin{array}{c} \Pr (20, 1, 20) \ 109.13408 \ 0 \ Rrp \ (55, 1, 55) \ 139.80325 \ -7 \ Prp \ (64, 2, 62) \ 152.22137 \ -4 \ Rr \ (10, 2, -) \ 181.43668 \ -2 \ Prn \ (18, 1, 18) \ 109.88873 \ 3 \ Rrp \ (57, 1, 57) \ 140.66443 \ -3 \ Prp \ (62, 2, 60) \ 152.99337 \ -1 \ Rr \ (12, 2, -) \ 182.22959 \ -2 \ Prn \ (16, 1, 16) \ 110.64627 \ 3 \ Rrp \ (58, 1, 58) \ 141.09598 \ -8 \ Prp \ (61, 2, 59) \ 153.289337 \ -1 \ Rr \ (12, 2, -) \ 182.22959 \ -2 \ Prn \ (16, 1, 16) \ 110.64627 \ 3 \ Rrp \ (50, 1, 60) \ 141.98127 \ -4 \ Prp \ (59, 2, 57) \ 154.15689 \ -5 \ Rr \ (15, 2, -) \ 183.01360 \ -2 \ Prn \ (15, 1, 15) \ 111.02613 \ 3 \ Rrp \ (60, 1, 60) \ 141.98127 \ -4 \ Prp \ (59, 2, 57) \ 154.15689 \ -5 \ Rr \ (15, 2, -) \ 183.01360 \ -2 \ Prn \ (11, 1, 14) \ 111.40676 \ 6 \ Rrp \ (61, 1, 61) \ 142.39493 \ -3 \ Prp \ (58, 2, 56) \ 154.54429 \ 0 \ Rr \ (16, 2, -) \ 183.79772 \ -2 \ Prn \ (13, 1, 13) \ 111.78802 \ 0 \ Rrp \ (62, 1, 62) \ 142.82964 \ -4 \ Prp \ (57, 2, 55) \ 155.53914 \ -8 \ Rr \ (17, 2, -) \ 184.97977 \ -2 \ Prn \ (11, 1, 11) \ 112.52525 \ 2 \ Rrp \ (64, 1, 64) \ 143.69997 \ -5 \ Prp \ (55, 2, 53) \ 155.50676 \ -5 \ Rr \ (19, 2, -) \ 184.97397 \ -2 \ Prn \ (10, 1, 10) \ 112.93634 \ 2 \ Rrp \ (65, 1, 65) \ 144.13634 \ -6 \ Prp \ (57, 2, 55) \ 156.94457 \ -6 \ Rr \ (19, 2, -) \ 185.36651 \ -2 \ Rrp \ (10, 1, 10) \ 112.93634 \ 2 \ Rrp \ (61, 1, 66) \ 144.57348 \ 0 \ Prp \ (53, 2, 54) \ 155.09445 \ -3 \ Rr \ (20, 2, -) \ 185.36651 \ -2 \ Rrp \ (57, 1, 67) \ 145.0112 \ -2 \ Prp \ (52, 2, 50) \ 156.86998 \ -8 \ Rr \ (22, 2, -) \ 186.515104 \ -2 \ Rrp \ (61, 16, 1) \ 145.0121 \ -2 \ Prp \ (52, 2, 50) \ 156.86998 \ -8 \ Rr \ (22, 2, -) \ 186.515104 \ -2 \ Rrp \ (61, 16, 1) \ 146.528875 \ -4 \ Prp \ (50, 2, 48) \ 157.62499 \ -6 \ Rr \ (23, 2, -) \ 186.543568 \ -2 \ Rrp \ (51, 1, 5) \ 114.864849 \ 0 \ Rrp \ (51, 16, 16, 16, 16, 16, 16, 16, 16, 16, 1$					Brn	53, 1, 33			Prp						
Pm (19, 1, 19) 109.51106 4 Rrp (56, 1, 56) 140.23351 -4 Prp (63, 2, 6) 152.60865 1 Rr (12, 2, -) 181.83762 - Pm (17, 1, 17) 110.26713 3 Rrp (58, 1, 58) 141.09598 -8 Prp (61, 2, 59) 153.38243 -5 Rr (13, 2, -) 182.62158 - Pm (15, 1, 16) 110.64627 3 Rrp (59, 1, 59) 141.52831 -3 Prp (60, 2, 58) 153.38243 -5 Rr (13, 2, -) 182.62158 - Pm (15, 1, 15) 111.02613 3 Rrp (60, 1, 60) 141.96127 -4 Prp (59, 2, 57) 154.15689 -5 Rr (15, 2, -) 183.40567 - Pm (14, 1, 14) 111.04676 6 Rrp (61, 1, 61) 142.39493 -3 Prp (58, 2, 56) 154.34429 0 Rr (16, 2, -) 183.40567 - Pm (14, 1, 14) 111.04676 6 Rrp (61, 1, 61) 142.39493 -3 Prp (58, 2, 56) 154.34166 -6 Rr - (17, 2, -) 183.40567 - Pm (13, 1, 13) 111.78802 0 Rrp (62, 1, 62) 142.82926 -4 Prp (57, 2, 55) 154.93166 -6 Rr - (17, 2, -) 184.19006 - Pm (12, 1, 12) 112.17009 3 Rrp (63, 1, 63) 143.26427 -4 Prp (56, 2, 54) 154.39166 -6 Rr - (17, 2, -) 184.19006 - Pm (11, 1, 11) 112.55285 2 Rrp (64, 1, 64) 143.65997 -5 Prp (55, 2, 53) 155.70676 -5 Rr - (19, 2, -) 184.97397 - Pm (10, 1, 10) 112.93334 2 Rrp (65, 1, 65) 144.136894 -6 Prp (54, 2, 52) 156.08445 -3 Rr - (20, 2, -) 185.76875 - Pm (9, 1, 9) 113.32055 1 Rrp (66, 1, 66) 144.57348 0 Prp (53, 2, 51) 156.48217 -6 Rr - (21, 2, -) 185.75875 - Pm (8, 1, 8) 131.70549 2 Rrp (67, 1, 67) 145.0121 2 Prp (52, 2, 50) 156.8998 -8 Rr - (22, 2, -) 185.75875 - Pm (5, 1, 6, 14) 147.752 2 Rrp (68, 1, 68) 145.44962 -5 Prp (51, 2, 49) 157.25791 -6 Rr - (23, 2, -) 186.54335 - Pm (5, 1, 6, 14, 14, 14, 14, 14, 14, 14, 14, 14, 14		20, 1, 20			Rrp	55. 1. 55			Pro						
Prm (17, 1, 17) 110,26713 3 Rrp (58, 1, 58) 141,09598 -8 Prp (61, 2, 58) 153,38243 -5 Rr (13, 2, -) 182,62158 - Prm (15, 1, 16) 110,64627 3 Rrp (59, 1, 59) 141,52831 -3 Prp (60, 2, 58) 153,38243 -5 Rr (15, 2, -) 183,01360 - Prm (15, 1, 15) 111,02613 3 Rrp (60, 1, 60) 141,96127 -4 Prp (59, 2, 57) 154,15689 -5 Rr (15, 2, -) 183,01360 - Prm (11, 1, 14) 111,04676 6 Rrp (61, 1, 61) 142,39493 -3 Prp (58, 2, 56) 154,45429 0 Rr (16, 2, -) 183,05677 - Prm (13, 1, 13) 111,78802 0 Rrp (62, 1, 62) 142,82926 -4 Prp (57, 2, 55) 154,93166 -6 Rr (17, 2, -) 184,19006 - Prm (12, 1, 12) 112,17009 3 Rrp (63, 1, 63) 143,26427 -4 Prp (56, 2, 54) 154,93166 -6 Rr (17, 2, -) 184,19006 - Prm (11, 1, 11) 112,55285 2 Rrp (64, 1, 64) 143,65997 -5 Prp (55, 2, 53) 155,70676 -5 Rr (19, 2, -) 184,97397 - Prm (10, 1, 10) 112,93634 2 Rrp (65, 1, 65) 144,13644 -6 Prp (54, 2, 52) 160,9445 -3 Rr (20, 2, -) 185,76875 - Prm (9, 1, 9) 113,32055 1 Rrp (66, 1, 66) 144,57348 0 Prp (53, 2, 51) 156,48217 -6 Rr (21, 2, -) 185,75875 - Prm (8, 1, 8) 113,70549 2 Rrp (67, 1, 67) 145,0112 -2 Prp (52, 2, 50) 156,48217 -6 Rr (21, 2, -) 185,75875 - Prm (7, 1, 7) 144,0715 2 Rrp (68, 1, 68) 145,44962 -5 Prp (51, 2, 49) 157,25791 -6 Rr (23, 2, -) 186,54335 - Prm (5, 1, 6) 144,7752 2 Rrp (69, 1, 69) 145,88875 -4 Prp (50, 2, 48) 157,64589 -6 Rr (24, 2, -) 186,54335 - Prm (5, 1, 5) 144,86459 0 Rrp (70, 1, 70) 146,32832 28 Prp (49, 2, 47) 158,03394 -8 Rr (25, 2, -) 187,32805 - Prm (5, 1, 5) 144,86459 0 Rrp (70, 1, 70) 146,32832 28 Prp (49, 2, 47) 158,03394 -8 Rr (25, 2, -) 187,32805 - Prm (5, 1, 5) 144,86459 0 Rrp (70, 1, 70) 146,32832 28 Prp (49, 2, 47) 158,03394 -8 Rr (25, 2, -) 187,32805 - Prm (5, 1, 5) 144,66459 0 Rrp (71, 1, 71) 146,76900 -9 Prp (48, 2, 4) 159,9860 -9 Rr (26, 2, -) 187,32805 - Prm (5, 1, 5) 144,66459 1 Rrp (71, 1, 71, 71) 146,76900 -9 Prp (49, 2, 4) 159,9860 -9 Rr (28, 2, -) 188,50235 - Prm (5, 1, 5) 144,66459 1 Rrp (71, 1, 71, 71, 74, 146,7690 -9 Prp (49, 2, 4) 159,9860 -9 Rr (28, 2, -) 188,50235 - Prm (5, 1, 5) 144,54645 - Prm (5, 1, 5) 144,54645 -													Rr- (11, 2, -		
Prm (16, 1, 16) 110.64627 3 Rrp (59, 1, 59) 141.52831 3 Prp (60, 2, 58) 153.76664 -3 Rr (14, 2, -) 183.01360 - Prm (14, 1, 14) 111.40676 6 Rrp (61, 1, 61) 141.96167 4 Prp (59, 2, 57) 5 Rr (15, 2, -) 183.01360 - Prm (14, 1, 14) 111.40676 6 Rrp (61, 1, 61) 142.39493 3 Prp (58, 2, 56) 154.54429 0 Rr (16, 2, -) 183.79772 - Prm (13, 1, 13) 111.78802 0 Rrp (62, 1, 62) 142.39493 3 Prp (58, 2, 56) 154.54429 0 Rr (16, 2, -) 183.79772 - Prm (12, 1, 12) 112.17009 3 Rrp (63, 1, 63) 143.26427 4 Prp (56, 2, 54) 155.31914 -8 Rr (18, 2, -) 184.58206 - Prm (11, 1, 11) 112.53634 2 Rrp (64, 1, 64) 143.69997 -5 Prp (5, 2, 54) 155.70676 -5 Rr (19, 2, -) 184.58206 - Prm (10, 1, 10) 112.39534 2 Rrp (64, 1, 66) 144.57348 0 Prp (54, 2, 52) 156.09445 -3 Rr (20, 2, -) 185.36651 Prm (8, 1, 8) 113.70549 2 Rrp (66, 1, 66) 144.57348 0 Prp (52, 2, 50) 156.86998 -8 Rr (22, 2, -) 185.36651 Prm (8, 1, 8) 113.70549 2 Rrp (68, 1, 68) 145.44962 -5 Prp (52, 2, 50) 156.86998 -8 Rr (22, 2, -) 186.54335 Prm (6, 6) 114.56459 0 Rrp (70, 1, 70) 146.32832 -28 Prp (50, 2, 48) 157.64589 -6 Rr (24, 2, -) 186.93568 Prm (5, 1, 5) 114.86459 0 Rrp (70, 1, 70) 146.32832 -28 Prp (49, 2, 47) 188.03394 -8 Rr (25, 2, -) 187.32805 Prm (3, 1, 3) 115.64091 -2 Rrp (74, 1, 74) 146.5090 -9 Prp (48, 2, 46) 188.42208 -8 Rr (25, 2, -) 187.32805 Prm (3, 1, 3) 115.64091 -2 Rrp (74, 1, 74) 146.5090 -9 Prp (48, 2, 46) 188.42208 -8 Rr (25, 2, -) 188.50525 Rrp (2, 1, 2) 117.98695 -10 Rrp (74, 1, 74) 146.5090 -9 Prp (46, 2, 44) 195.19860 -9 Rr (28, 2, -) 188.50525 Rrp (3, 1, 3) 115.64091 -2 Rrp (74, 1, 74) 146.5090 -9 Prp (46, 2, 44) 195.19860 -9 Rr (28, 2, -) 188.50525 Rrp (4, 1, 4) 115.75653 1 Rrp (74, 1, 75) 148.53782 -9 Prp (40, 2, 44) 159.19860 -9 Rr (28, 2, -) 188.50525 Rrp (4, 1, 4) 115.76691 2 Rrp (76, 1, 76) 148.98180 -2 Prp (40, 2, 44) 159.19860 -9 Rr (28, 2, -) 188.0002 Rrp (4, 1, 4) 118.77477 0 Rrp (76, 1, 76) 148.98180 -2 Prp (40, 2, 44) 159.97547 -5 Rr (30, 2, -) 190.46773 Rrp (71, 77, 71) 146.76600 -9 Prp (40, 2, 44) 159.97547 -5 Rr (30, 2, -) 189.68268 Rrp (5, 1, 5) 1	Prn	(18, 1, 18)		3				-3		(62, 2, 60)	152.99537	-1	Rr- (12, 2, -	182.22959	-14
Prm (15, 1, 15) 111.02613 3 Rrp (60, 1, 60) 141.96127 -4 Prp (59, 2, 57) 154.15589 -5 Rr- (15, 2, -) 183.40587 - Prm (11, 1, 14) 111.140676 6 Rrp (61, 1, 61) 142.39493 3 Prp (58, 2, 55) 154.93166 -6 Rr- (17, 2, -) 184.19006 Prm (12, 1, 12) 112.17009 3 Rrp (62, 1, 62) 142.82926 -4 Prp (57, 2, 55) 154.93166 -6 Rr- (17, 2, -) 184.19006 Prm (12, 1, 12) 112.17009 3 Rrp (62, 1, 63) 143.26427 -4 Prp (57, 2, 55) 154.93166 -6 Rr- (17, 2, -) 184.19006 Prm (11, 1, 11) 112.55285 2 Rrp (64, 1, 64) 143.69997 -5 Prp (56, 2, 54) 155.30194 -8 Rr- (18, 2, -) 184.58206 - Prm (11, 1, 11) 112.55285 2 Rrp (65, 1, 65) 144.13634 0 Prp (53, 2, 51) 156.09445 -3 Rr- (20, 2, -) 185.36651 Prm (9, 1, 9) 113.32055 1 Rrp (65, 1, 65) 144.57348 0 Prp (53, 2, 51) 156.48217 -6 Rr- (21, 2, -) 185.78875 Prm (8, 1, 8) 113.70549 2 Rrp (67, 1, 67) 145.01121 -2 Prp (52, 2, 50) 156.86998 -8 Rr- (22, 2, -) 186.54335 Prm (6, 1, 6) 114.47752 2 Rrp (68, 1, 66) 144.57348 0 Prp (50, 2, 48) 157.62598 -8 Rr- (22, 2, -) 186.54335 Prm (6, 1, 6) 114.47752 2 Rrp (69, 1, 69) 145.88875 -4 Prp (50, 2, 48) 157.62598 -8 Rr- (24, 2, -) 186.93568 Prm (5, 1, 5) 114.86459 0 Rrp (70, 1, 70) 146.52822 -28 Prp (50, 2, 48) 157.64589 -6 Rr- (24, 2, -) 186.93568 Prm (3, 1, 3) 115.64091 -2 Rrp (77, 1, 71) 146.76900 -9 Prp (48, 2, 46) 158.40208 -8 Rr- (26, 2, -) 187.72045 Prm (3, 1, 3) 115.64091 -2 Rrp (77, 1, 77) 146.782812 -2 Prp (40, 2, 44) 159.18960 -9 Rr- (28, 2, -) 188.50525 Rrp (3, 1, 4) 118.86531 -1 Rrp (73, 1, 73) 147.65211 -2 Prp (40, 2, 44) 159.18960 -9 Rr- (28, 2, -) 188.9391 Rrp (73, 1, 73) 147.65211 -2 Prp (40, 2, 44) 159.18960 -9 Rr- (28, 2, -) 188.9391 Rrp (73, 1, 73) 146.78281 -2 Prp (40, 2, 44) 159.18960 -9 Rr- (32, 2, -) 188.50525 Rrp (5, 1, 5) 119.16971 -2 Rrp (77, 1, 76) 148.937166 -4 Prp (41, 2, 39) 161.14127 -9 Rr- (33, 2, -) 190.86028 Rrp (5, 1, 5) 119.16971 -2 Rrp (77, 1, 77) 149.42637 -5 Prp (42, 2, 44) 159.18960 -9 Rr- (32, 2, -) 189.29021 Rrp (7, 1, 77) 119.96170 -4 Rrp (73, 1, 78) 149.87166 -4 Prp (41, 2, 39) 161.14127 -9 Rr- (33, 2, -) 190.86028 Rrp (5		( 17, 1, 17 )											Rr- (13, 2, -		
$\begin{array}{c} \Pr \left( \begin{array}{c} 14, 1, 14 \end{array} \right) \ 111.40676 \ 6 \ Rrp \ (61, 1, 61) \ 142.39493 \ .3 \ Prp \ (58, 2, 55) \ 154.93166 \ .6 \ Rrc \ (17, 2, -) \ 183.79772 \ .7 \\ Prn \ (13, 1, 13) \ 111.78802 \ 0 \ Rrp \ (62, 1, 62) \ 142.82926 \ .4 \ Prp \ (57, 2, 5) \ 154.93166 \ .6 \ Rrc \ (17, 2, -) \ 184.19006 \ .7 \\ Prn \ (12, 1, 12) \ 112.17009 \ .3 \ Rrp \ (63, 1, 63) \ 143.26427 \ .4 \ Prp \ (56, 2, 54) \ 155.31914 \ .8 \ Rrc \ (18, 2, -) \ 184.18206 \ .7 \\ Prn \ (10, 1, 10) \ 112.93634 \ .2 \ Rrp \ (64, 1, 64) \ 143.69997 \ .5 \ .7 \\ Prn \ (9, 1, 9) \ 113.32055 \ .1 \ Rrp \ (66, 1, 66) \ 144.13634 \ .6 \ .7 \\ Prp \ (54, 2, 52) \ 156.09445 \ .3 \ Rrc \ (20, 2, -) \ 185.36651 \ .7 \\ Prn \ (8, 1, 8) \ 113.70549 \ .2 \ Rrp \ (67, 1, 67) \ 145.01121 \ .2 \ .7 \\ Prn \ (7, 1, 7, 114.09115) \ .2 \ Rrp \ (68, 1, 68) \ 145.43962 \ .5 \ .7 \\ Prn \ (5, 1, 6) \ 144.87752 \ .2 \ Rrp \ (69, 1, 69) \ 145.88875 \ .4 \ .7 \\ Prp \ (52, 2, 48) \ 157.64589 \ .6 \ Rrc \ (23, 2, -) \ 186.53358 \ .7 \\ Prn \ (5, 1, 5) \ 114.86459 \ .0 \ Rrp \ (70, 1, 70) \ 146.32832 \ .28 \ .7 \\ Prn \ (5, 1, 5) \ 114.86459 \ .0 \ Rrp \ (70, 1, 70) \ 146.32832 \ .28 \ .7 \\ Prn \ (3, 1, 3) \ 115.64091 \ .2 \ Rrp \ (72, 1, 72) \ 147.21021 \ .6 \ .7 \\ Prp \ (34, 2, 45) \ 158.81027 \ .1 \\ Rrp \ (3, 1, 3) \ 115.64091 \ .2 \ Rrp \ (74, 1, 74) \ 148.09461 \ .7 \ .7 \\ Prp \ (45, 2, 45) \ 158.81027 \ .1 \\ Rrp \ (3, 1, 3) \ 118.39058 \ .2 \ Rrp \ (74, 1, 74) \ 148.09461 \ .7 \ .7 \\ Prp \ (45, 2, 45) \ 158.81027 \ .7 \ .2 \ .1 \ .88.50525 \ .7 \\ Rrp \ (4, 1, 4) \ 115.798695 \ .10 \ Rrp \ (75, 1, 75) \ 148.53782 \ .9 \ .7 \\ Prp \ (45, 2, 45) \ 158.81027 \ .7 \ .2 \ .1 \ .88.50525 \ .7 \\ Rrp \ (5, 1, 5) \ 119.16971 \ .2 \ Rrp \ (75, 1, 75) \ 148.53782 \ .9 \ .7 \\ Prp \ (45, 2, 45) \ 158.81027 \ .7 \ .2 \ .1 \ .88.50525 \ .7 \ .7 \ .1 \ .7 \ .7 \ .7 \ .7 \ .7$		(16, 1, 16)											Rr- (14, 2, -)		
Prn (13, 1, 13) 111.78802 0 R;p (62, 1, 62) 142.82926 -4 Prp (57, 2, 55) 154.93166 -6 R;- (17, 2, -) 184.19006 Prn (12, 1, 12) 112.7009 3 R;p (63, 1, 63) 143.62427 -4 Prp (56, 2, 53) 155.70676 -5 R;- (19, 2, -) 184.58206 - Prn (11, 1, 11) 112.52285 2 R;p (64, 1, 64) 143.69997 -5 Prp (55, 2, 53) 155.70676 -5 R;- (19, 2, -) 184.58206 - Prn (11, 1, 10) 112.93634 2 R;p (65, 1, 65) 144.13634 -6 Prp (54, 2, 5) 156.09445 -3 R;- (20, 2, -) 185.36651 Prn (9, 1, 9) 113.32055 1 R;p (66, 1, 66) 144.57348 0 Prp (53, 2, 51) 156.48217 -6 R;- (21, 2, -) 185.3651 Prn (8, 1, 8) 113.70549 2 R;p (67, 1, 67) 145.01121 -2 Prp (52, 2, 50) 156.88998 -8 R; (22, 2, -) 185.75875 Prn (8, 1, 6) 114.47752 2 R;p (69, 1, 69) 145.88875 -4 Prp (50, 2, 48) 157.25791 -6 R;- (23, 2, -) 186.54335 Prn (6, 1, 6) 114.47752 2 R;p (69, 1, 69) 145.88875 -4 Prp (50, 2, 48) 157.25791 -6 R;- (23, 2, -) 186.533568 Prn (5, 1, 5) 114.86459 0 R;p (70, 1, 70) 146.52832 -28 Prp (49, 2, 48) 157.25891 -4 R;- (25, 2, -) 187.32805 Prn (4, 1, 4) 115.25258 18 R;p (71, 1, 71) 146.76900 -9 Prp (48, 2, 46) 158.42208 -8 R;- (26, 2, -) 187.32805 Prn (3, 1, 3) 115.64091 -2 R;p (72, 17, 2) 147.65211 -2 Prp (46, 2, 44) 159.19860 -9 R;- (28, 2, -) 188.11285 R;p (7, 1, 7) 149.9617 -7 Prp (45, 2, 44) 159.19860 -9 R;- (28, 2, -) 188.50255 R;p (3, 1, 3) 118.38058 2 R;p (75, 1, 75) 148.53782 -9 Prp (44, 2, 42) 159.97547 -5 R;- (30, 2, -) 189.69201 R;- (25, 2, -) 189.692		{ 15, 1, 15 }			Кгр				Ргр	(59, 2, 57)					
$\begin{array}{c} \Pr \left( \begin{array}{c} 12, \ 1, \ 12 \end{array} \right) \ 112.17099 \ \ 3 \ \ Rrp \ \ (63, 1, 63) \ \ 143.26427 \ \ \ ^4 \ \ Prp \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$		14, 1, 14			Rrp				Ргр				Rr- (16, 2, -		
$\begin{array}{llllllllllllllllllllllllllllllllllll$		13, 1, 13			Rrp D-n	62, 1, 62			Prp	\ 57, 2, 55 \			Rr-   17, 2, -		
$\begin{array}{llllllllllllllllllllllllllllllllllll$					Brn	64 1 64			Pro	55, 2, 54	155.70676		Rr. 119 2		
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$ \begin{array}{c} Rrp & (3, \ 1, \ 3) & 118.38058 & 2 & Rrp & (75, \ 1, \ 75) & 148.53782 & -9 & Prp & (43, \ 2, \ 42) & 159.97547 & -5 & Rr & (30, \ 2, \ -) & 189.29021 \\ Rrp & (4, \ 1, \ 4) & 118.77477 & 0 & Rrp & (76, \ 1, \ 76) & 148.98180 & -2 & Prp & (42, \ 2, \ 40) & 160.75257 & -10 & Rr & (32, \ 2, \ -) & 190.07521 \\ Rrp & (5, \ 1, \ 5) & 119.16971 & 2 & Rrp & (77, \ 1, \ 77) & 149.42637 & -5 & Prp & (42, \ 2, \ 40) & 160.75257 & -10 & Rr & (32, \ 2, \ -) & 190.07521 \\ Rrp & (6, \ 1, \ 6) & 119.56531 & -1 & Rrp & (78, \ 1, \ 78) & 149.87166 & -4 & Prp & (41, \ 2, \ 39) & 161.14127 & -9 & Rr & (33, \ 2, \ -) & 190.07521 \\ Rrp & (7, \ 1, \ 7) & 119.96170 & 4 & Rrp & (79, \ 1, \ 78) & 149.87166 & -4 & Prp & (41, \ 2, \ 39) & 161.14127 & -9 & Rr & (33, \ 2, \ -) & 190.046773 \\ Rrp & (8, \ 1, \ 8) & 120.35863 & -7 & Rrp & (80, \ 1, \ 80) & 150.376445 & 12 & Prp & (39, \ 2, \ 3) & 161.91885 & -11 & Rr & (35, \ 2, \ -) & 191.25278 \\ Rrp & (9, \ 1, \ 9) & 120.75649 & 5 & Rrp & (81, \ 1, \ 81) & 151.21161 & 6 & Prp & (38, \ 2, \ 6) & 162.30790 & 3 & Rr & (36, \ 2, \ -) & 191.6532 \\ Rrp & (10, \ 1, \ 10) & 121.15491 & 2 & Rrp & (82, \ 1, \ 82) & 151.65973 & 4 & Pr & (37, \ 2, \ -) & 162.69717 & 31 & Rr & (37, \ 2, \ -) & 192.03772 \\ Rrp & (11, \ 1, \ 1) & 121.55405 & 2 & Rrp & (84, \ 1, \ 84) & 152.55785 & 5 & Pr & (35, \ 2, \ -) & 163.86435 & 50 & Rr & (38, \ 2, \ -) & 192.42231 \\ Rrp & (13, \ 1, \ 13) & 122.35445 & 1 & Rrp & (87, \ 1, \ 87) & 153.91010 & -1 & Pr & (34, \ 2, \ -) & 163.86495 & 67 & Rr & (40, \ 2, \ -) & 193.21516 \\ Rrp & (14, \ 1, \ 4) & 122.356031 & 2 & Qrp & (50, \ 2, \ 48) & 177.13878 & 11 & Pr & (31, \ 2, \ -) & 163.86495 & 67 & Rr & (40, \ 2, \ -) & 193.21516 \\ Rrp & (14, \ 1, \ 14) & 122.356031 & 2 & Qrp & (50, \ 2, \ 48) & 177.13878 & 11 & Pr & (31, \ 2, \ -) & 163.86495 & 67 & Rr & (40, \ 2, \ -) & 193.21516 \\ Rrp & (15, \ 1, \ 15) & 123.15765 & 1 & Qrp & (50, \ 2, \ 48) & 177.13878 & 11 & Pr & (31, \ 2, \ -) & 163.86495 & 67 & Rr & (40, \ 2, \ -) & 193.21516 \\ Rrp & (17, \ 1, \ 17) & 123.96366 & $	Rrp	(2, 1, 2)	117.98695	-10		74, 1, 74				45. 2. 43					
Rrp (4, 1, 4) 118.77477 O Rrp (76, 1, 76) 148.98180 -2 Prp (43, 2, 41) 160.36399 -7 Rr (31, 2, -) 189.68268   Rrp (5, 1, 5) 119.16971 2 Rrp (77, 1, 77) 149.42637 -5 Prp (42, 2, 40) 160.75257 -10 Rr (32, 2, -) 190.07521   Rrp (6, 1, 6) 119.56531 -1 Rrp (78, 1, 78) 149.87166 -4 Prp (41, 2, 39) 161.14127 -9 Rr (33, 2, -) 190.46773   Rrp (7, 1, 7) 119.96170 4 Rrp (79, 1, 79) 150.31768 1 Prp (40, 2, 38) 161.53003 -9 Rr (34, 2, -) 190.86025   Rrp (8, 1, 8) 120.335863 -7 Rrp (80, 1, 80) 150.76445 12 Prp (39, 2, 37) 161.91885 -11 Rr (35, 2, -) 191.25278   Rrp (9, 1, 9) 120.75649 5 Rrp (81, 1, 81) 151.21161 -6 Prp (38, 2, 36) 162.30790 3 Rr (36, 2, -) 191.64532   Rrp (10, 1, 10) 121.15491 2 Rrp (82, 1, 82) 151.65973 4 Pr (37, 2, -) 162.69717 31 Rr (37, 2, -) 192.03772   Rrp (11, 1, 11) 121.55405 2 Rrp (83, 1, 83) 152.10844 3 Pr (36, 2, -) 163.08643 50 Rr (38, 2, -) 192.24297   Rrp (12, 1, 12) 121.95386 -2 Rrp (84, 1, 84) 152.55785 5 Pr (35, 2, -) 163.47558 51 Rr (39, 2, -) 192.24297   Rrp (14, 1, 14) 122.35445 1 Rrp (87, 1, 87) 153.91010 -1 Pr (33, 2, -) 163.46456 57 Rr (40, 2, -) 193.21516   Rrp (14, 1, 14) 122.35545 1 Qrp (6, 2, 4) 177.13878 11 Pr (32, 2, -) 164.54328 35 Rrr (41, 2, 39) 193.60718   Rrp (15, 1, 15) 123.15765 1 Qrp (6, 2, 4) 177.13878 11 Pr (32, 2, -) 164.54328 35 Rrr (42, 2, 40) 193.99968   Rrp (16, 1, 16) 123.56031 2 Qrp (50, 2, 48) 177.10805 51 Pr (31, 2, -) 165.03266 30 Rrr (43, 2, 41) 194.39197   Rrp (17, 1, 17) 123.96366 2 Qrp (50, 2, 48) 177.12089 0 Pr (28, 2, -) 165.03266 30 Rrr (43, 2, 41) 194.39197   Rrp (19, 1, 19) 124.77246 3 Qrp (55, 2, 53) 177.20898 0 Pr (28, 2, -) 166.50129 20 Rrr (46, 2, 44) 195.56956   Rrp (20, 1, 20) 125.17790 3 Qrp (55, 2, 53) 177.20898 0 Pr (28, 2, -) 166.50129 20 Rrr (47, 2, 45) 195.86254   Rrp (22, 1, 22) 125.599086 3 Qrp (55, 2, 55) 177.21427 51 Pr (27, 2, -) 166.59037 12 Rrr (47, 2, 45) 195.86254   Rrp (22, 1, 22) 125.599086 3 Qrp (55, 2, 55) 177.21427 51 Pr (27, 2, -) 166.59037 0 Rrr (49, 2, 47) 196.74691   Rrp (21, 1, 21) 125.58385 -15 Qrp (55, 2, 63) 177.20899			118.38058			(75, 1, 75				(44, 2, 42)			Rr (30, 2, -		
$ \begin{array}{c} Rrp & \{6, \ 1, \ 6\} & 119,56531 & -1 \\ Rrp & \{7, \ 1, \ 7\} & 119,56170 & 4 \\ Rrp & \{7, \ 1, \ 7\} & 119,96170 & 4 \\ Rrp & \{7, \ 1, \ 7\} & 119,96170 & 4 \\ Rrp & \{7, \ 1, \ 7\} & 119,96170 & 4 \\ Rrp & \{7, \ 1, \ 7\} & 119,96170 & 4 \\ Rrp & \{7, \ 1, \ 7\} & 119,96170 & 4 \\ Rrp & \{8, \ 1, \ 8\} & 120,35863 & -7 \\ Rrp & \{8, \ 1, \ 8\} & 120,35863 & -7 \\ Rrp & \{8, \ 1, \ 8\} & 120,35863 & -7 \\ Rrp & \{8, \ 1, \ 8\} & 120,35863 & -7 \\ Rrp & \{8, \ 1, \ 8\} & 150,31768 & 12 \\ Rrp & \{9, \ 1, \ 9\} & 120,75649 & 5 \\ Rrp & \{8, \ 1, \ 8\} & 151,62116 & -6 \\ Rrp & \{1, \ 1, \ 10\} & 121,5491 & 2 \\ Rrp & \{8, \ 1, \ 8\} & 151,62116 & -6 \\ Rrp & \{1, \ 1, \ 1\} & 121,55496 & 2 \\ Rrp & \{8, \ 1, \ 8\} & 152,10844 & 3 \\ Rrp & \{1, \ 1, \ 1\} & 121,55386 & -2 \\ Rrp & \{8, \ 1, \ 8\} & 152,55785 & 5 \\ Rrp & \{1, \ 1, \ 1\} & 121,55386 & 2 \\ Rrp & \{1, \ 1, \ 2\} & 122,554785 & 5 \\ Rrp & \{1, \ 1, \ 1\} & 122,35445 & 1 \\ Rrp & \{8, \ 1, \ 8\} & 152,55785 & 5 \\ Rrp & \{1, \ 1, \ 1\} & 122,35445 & 1 \\ Rrp & \{8, \ 1, \ 8\} & 153,91010 & -1 \\ Rrp & \{1, \ 1, \ 1\} & 123,53666 & 67 \\ Rr & \{4, \ 2, \ 4\} & 177,13878 & 11 \\ Rrp & \{1, \ 1, \ 1\} & 123,53666 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ 1, \ 1\} & 123,56366 & 2 \\ Rrp & \{1, \ $						(76, 1, 76			Prp	43, 2, 41					
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$ \begin{array}{llllllllllllllllllllllllllllllllllll$										1 40, 2, 38			Rr.   34, 2, -		
$ \begin{array}{c} Rrp & (10,\ 1,\ 10) & 121.15491 & 2 & Rrp & (82,\ 1,\ 82) & 151.65973 & 4 & Pr. & (37,\ 2,\ -) & 162.69717 & 31 & Rr. & (37,\ 2,\ -) & 192.03772 & Rrp & (11,\ 1,\ 11) & 121.55405 & 2 & Rrp & (81,\ 1,\ 84) & 152.55785 & 5 & Pr. & (35,\ 2,\ -) & 163.86435 & 51 & Rr. & (39,\ 2,\ -) & 192.82231 & Rrp & (12,\ 1,\ 12) & 121.95386 & -2 & Rrp & (84,\ 1,\ 84) & 152.55785 & 5 & Pr. & (35,\ 2,\ -) & 163.86495 & 67 & Rr. & (39,\ 2,\ -) & 192.82231 & Rrp & (11,\ 14) & 122.575571 & 2 & Pr. & (33,\ 2,\ -) & 164.64328 & 35 & Rr. & (40,\ 2,\ -) & 193.21516 & Pr. & (33,\ 2,\ -) & 164.64328 & 35 & Rr. & (42,\ 2,\ 40) & 193.99968 & Rrp & (16,\ 1,\ 16) & 123.56031 & 2 & Qrp & (50,\ 2,\ 48) & 177.13878 & 11 & Pr. & (32,\ 2,\ -) & 164.64328 & 35 & Rr. & (42,\ 2,\ 40) & 193.99968 & Rrp & (16,\ 1,\ 16) & 123.56031 & 2 & Qrp & (50,\ 2,\ 48) & 177.20358 & 74 & Pr. & (30,\ 2,\ -) & 165.32261 & 25 & Rr. & (44,\ 2,\ 42) & 194.78465 & Rrp & (18,\ 1,\ 18) & 124.36770 & 2 & Qrp & (53,\ 2,\ 52) & 177.20358 & 74 & Pr. & (30,\ 2,\ -) & 165.42211 & 25 & Rr. & (44,\ 2,\ 42) & 194.78465 & Rrp & (19,\ 1,\ 19) & 124.77246 & 3 & Qrp & (55,\ 2,\ 53) & 177.20389 & Pr. & (28,\ 2,\ -) & 166.59093 & 12 & Rr. & (45,\ 2,\ 43) & 195.7713 & Rrp & (19,\ 1,\ 12) & 125.58385 & 15 & Qrp & (55,\ 2,\ 63) & 177.23351 & 34 & Pr. & (26,\ 2,\ -) & 166.59093 & 12 & Rr. & (47,\ 2,\ 45) & 195.96202 & Rrp & (21,\ 1,\ 21) & 125.58385 & 55 & Qrp & (55,\ 2,\ 63) & 177.23351 & 34 & Pr. & (25,\ 2,\ -) & 167.37049 & 4 & Rr. & (49,\ 2,\ 47) & 196.74691 & Rrp & (23,\ 1,\ 23) & 126.39838 & 2 & Qrp & (75,\ 2,\ 73) & 177.26111 & 44 & Pr. & (24,\ 2,\ 2,\ -) & 168.54042 & -2 & Rr. & (51,\ 2,\ 49) & 197.53312 & Rrp & (26,\ 1,\ 26) & 127.21549 & 0 & Qrp & (45,\ 2,\ 45) & 177.19997 & 15 & Pr. & (27,\ 2,\ 2,\ -) & 168.54042 & -2 & Rr. & (52,\ 2,\ 50) & 197.82409 & Rrp & (26,\ 1,\ 26) & 127.21549 & 0 & Qrp & (47,\ 2,\ 45) & 177.19997 & 15 & Pr. & (22,\ 2,\ -) & 168.54042 & -2 & Rr. & (52,\ 2,\ 50) & 197.82409 & Rrp & (26,\ 1,\ 26) & 127.21549 & 0 & Qrp & (47,\ 2,\ 45) & 177.19997 & 15$													Rr. 136 2		
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$ \begin{array}{c} Rrp & \{15, \ 1, \ 15\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	Rrp	(13, 1, 13)	122.35445						Pr-	(34, 2, -)	163.86495	67	Rr- (40, 2, -	193.21516	45
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	rup	( 40, 1, 20	, 120.44040	2	Qip	( 03, 2, 52	, 111.21101	-3	L I-	(20, 2, -)	109.32000	-10	Tur ( 34, 2, 32	1 130.1000	

$$C_5^{ab} = [4\pi^2 h/(\omega_5 c)]^{3/2} a_5^{ab}/(2I_a I_b), \tag{5}$$

and  $\omega_5$  is the wavenumber of the harmonic oscillation of the  $\nu_5$  mode. The standard second order perturbation treatment of the  $\hat{H}_{12}$  of Eq. (4), where the rotational and vibrational motions are separately handled, results in the quadratic centrifugal distortion term in the effective rotational Hamiltonian. However, such a separation is not adequate for the present system, because the energy separation between the interacting levels coupled by  $\hat{H}_{12}$  is strongly dependent on the  $K_a$  value.

TABLE VI-Continued

T	ransition	Freq.	Δ	1	ransition	Freq.	Δ	Tı	ansition	Freq.	Δ	Tı	ansition	Freq.	Δ
Rrr (		199.10113	1	Prn	( 42, 2, 41 )	160.75553	-7	Qr-	( 66, 3, - )	228.33640	1	Pr-	( 37, 3, -	) 213.93517	
Rer (	56, 2, 54	199.49344	3	Prn	(41, 2, 40)	161.14397	-5	Qr-	(65, 3, -)	228.33937	1	Pr-	(36, 3, -	214.32783	
Ŗт (	57, 2, 55	199.88567	0	Pm	(40, 2, 39)	161.53259	6	Qr-	64, 3, -	228.34231	1	Pr-	( 35, 3, -	214.72044	-3
Rrr (	58, 2, 56	200.27793	4	Pm	39, 2, 38		-11	Qr-	63, 3, -	228.34523	2	Pr-	( 34, 3, -	215.11300	-6 -3
Rrr (	59, 2, 57 60, 2, 58	200.67012	3	Prn	(38, 2, 37)	162.30957	-26	Qr- Qr-	( 62, 3, - ) ( 61, 3, -	) 228.34814 ) 228.35099	5 6	Pr- Pr-	( 33, 3, - ( 32, 3, -	) 215.50561 ) 215.89820	-3
Rrr	61, 2, 59	201.45448	ģ	Rrp	(41, 2, 40)	193.60984	-2	٥r-	60, 3,	228.35383	8	Pr-	31, 3, -	216.29072	-
Rrr	62, 2, 60	201.84660	11	Rrp	42, 2, 41	194.00263	î	Qr-	59, 3,	228.35663	10	Pr-	30, 3, -	216.68323	
Rer	63, 2, 61	202.23863	8	Rrp	43, 2, 42	194.39529		Õr-	58. 3.	228.35941	14	Pr-	29, 3, -	217.07573	
Rrr	64, 2, 62		-11	Rrp	44, 2, 43	194.78810	-8	Qr-	57, 3,	228.36213	14	Pr-	28, 3, -	217.46822	-5
Rrr (	65, 2, 63	203.02257	2	Rrp	(45, 2, 44)		-10	Qr-	( 56, 3,	228.36484	18	Pr-	( 27, 3, -	217.86068	-6
Rrr (	66, 2, 64)	203.41458	10	Rrp	(46, 2, 45)	195.57377	-3	Qr-	(55, 3, -)	228.36753	23	Pr-	( 26, 3, -	218.25315	-3
Rrr (	67, 2, 65	203.80643	6	Rrp	(47, 2, 46)	195.96663	1	Qr-	(54, 3, -)	228.37018	26	Pr-	( 25, 3, -	218.64553	-7
Rr (	68, 2, 66	204.19830	9	Rrp	(48, 2, 47)	196.35949	3	Qr-	53, 3, -	228.37277	29	Pr-	(24, 3, -)	219.03794	-5 -5
Rrr (	69, 2, 67 ) 70, 2, 68 )	204.59006 204.98182	5 7	Rrp	( 49, 2, 48 ) ( 50, 2, 49 )	196.75232 197.14522	1 5	Qr-	[ 52, 3, - ] 51, 3, - ]	228.37530 228.37781	29 30	Pr- Pr-	( 23, 3, - ) ( 22, 3, -	) 219.43030 ) 219.82261	-8
Rit (	71, 2, 69	204.36162	ģ	Rrp	(51, 2, 50)	197.53807	3	Qr-	50, 3,	228.38029	33	Pr-	21, 3, -	220.21494	-6
Rrr (	72, 2, 70	205.76517	š	Rrp	52, 2, 51	197.93097	5	Qr-	49, 3,	228.38274	36	Pr-	20, 3,	220.60722	-5
Rrr (	73, 2, 71	206.15670	4	Rrp	33, 2, 52	198.32387	6	Qr-	48, 3,	228.38521	45	Pr-	19, 3, -	220.99948	-3
Rrr (	74, 2, 72	206.54828	9	Rrp	54, 2, 53	198.71677	6	Qr-	47, 3,	228.38757	47	Pr-	18, 3, -	221.39167	-6
Rrr (	75, 2, 73	206.93970	5	Rrp	( 55, 2, 54 )	199.10965	4	Qr-	46, 3,	228.38992	52	Pr-	( 17, 3, -	221.78416	
Purr (	76, 2, 74	207.33114	9	Rrp	(56, 2, 55)	199.50261	9	Qr-	(45,3,-)	228.39209	44	Pr-	( 16, 3, - )	222.17598	-6
Pur (	77, 2, 75	207.72245	6	Rrp	( 57, 2, 56 )	199.89554	10	Qr-	( 43, 3, - )	228.39676	72	Pr-	(15, 3, -	222.56812	-3
Rrr (	78, 2, 76	208.11371	4	Rrp	( 58, 2, 57 )	200.28846	. 9	n	/ n= n )	105 10445		Pr-	(14, 3, -	222.96017	-4
Rrr (	79, 2, 77	208.50489	2	Rrp	(59, 2, 58)	200.68142	12	Pr-	85, 3, -	195.10445 195.88694	1	Pr- Pr-	( 13, 3, -	223.35219 223.74416	-5 -7
Rrr ( Rrr (	80, 2, 78 ) 81, 2, 79	208.89607	-5	Rrp	(60, 2, 59) (61, 2, 60)	201.07439 201.46729	16 12	Pr- Pr-	( 83, 3, - ) 82, 3, - )	196.27878		Pr-	( 12, 3, - ) ( 11, 3, - )	224.13611	-7
Rer	82, 2, 80	209.67843	36	Rrp Rrp	62, 2, 61		12	Pr-	81. 3.	196.67049	-6	Pr-	10, 3, -	224.52804	-4
Rrr	83, 2, 81	210.06890	-9	Rrp	63, 2, 62	202.25348	43	Pr-	80. 3.	197.06292	70	Pr-	(9, 3, -	224.91991	-4
	84, 2, 82	210.45988	5	Rrp	64, 2, 63	202.64630	30	Pr-	78, 3, -	197.84533		Pr-	8, 3, -	225.31173	-3
(	,, ,			Rrp	(65, 2, 64)	203.03910	15	Pr-	77, 3, -	198.23743		Pr-	7, 3, -		-17
Pm (		145.31139	12	Rrp	(66, 2, 65)	203.43216	25	Pr-	( 76, 3, - )	198.62928		Pr-	(6, 3, -	226.09521	-5
Pm (	81, 2, 80)	145.69511	29	Rrp	(67, 2, 66)		12	Pr-	( 75, 3, - )	199.02120		Pr-	(5, 3, -	226.48711	17
Prn (	80, 2, 79)	146.07882	30	Rrp	(68, 2, 67)	204.21801	20	Pr-	74, 3, -	199.41318		-			
Prn (	79, 2, 78 ) 78, 2, 77 )	146.46246 146.84666	9 29	Rrp	(69, 2, 68) (70, 2, 69)	204.61104 205.00391	28 20	Pr-	73, 3, - 72, 3, -	199.80526		Rr- Rr-	$\begin{cases} 3, & 3, - \\ 4, & 3, - \end{cases}$	230.00971	-5 -8
Prn ( Prn (	77, 2, 76	147.23055	4	Rrp Rrp	70, 2, 69 }	205.39688	21	Pr-	71, 3, -	200.19728		Rr-	5, 3, -	230.79196	-5
Pm (	75, 2, 74	147.99933	11	Rrp	72 2, 71	205.78987	25	Pr-	70, 3,	200.98159	-11	Rr-	6, 3, -	231.18300	-4
Pm (	74, 2, 73	148.38394	16	Rrp	73, 2, 72 }		25	Pr-	69, 3, -	201.37376		Rr-	7, 3, -	231.57397	-5
Pm (	73, 2, 72)	148.76864	15	Rrp	( 74, 2, 73 )	206.57581	30	Pr-	68, 3, -	201.76601	-10	Rr-	8, 3, -	231.96488	-5
Pm (	72, 2, 71)	149.15345	12	Rrp	(75, 2, 74)		26	Pr-	67, 3, - )	202.15825		Rr-	(9, 3, -	232.35574	-5
Pm (	71, 2, 70	149.53852	21	Rrp	(76, 2, 75)		36	Pr-	66, 3, - )	202.55064	-3	Rr-	(10, 3, -	232.74655	-3
Pm (	70, 2, 69	149.92357	15	Rrp	77, 2, 76	207.75471	37	Pr-	65, 3, -	202.94275		Rr-	11, 3, -	233.13727	-4
Prn.( Prn.(	69, 2, 68 ) 68, 2, 67	150.30884 150.69411	17 7	Rrp Rrp	( 78, 2, 77 ) ( 79, 2, 78 )	208.14761 208.54055	34 35	Pr-	64, 3, - 63, 3, -	203.33524	-12	Rr- Rr-	( 12, 3, - ( 13, 3, -	233.52793	-5 -6
Prn (	68, 2, 67) 67, 2, 66)	151.07961	6	Rrp	( 79, 2, 78 ) ( 80, 2, 79 )	208.93364	51	Pr-	62, 3, -	204.12010	-6	Rr-	14, 3,	234.30906	-6
Pm }	66, 2, 65	151.46528	9	Rrp	81, 2, 80	209.32642	38	Pr-	61, 3, -	204.51248		Rr-	15, 3,	234.69954	-5
Pm }	65, 2, 64	151.85102	7	Rrp	82, 2, 81	209.71939	43	Pr-	60, 3, -	204.90497		Rr-	16, 3, -	235.08997	-2
Prn (	64, 2, 63 )	152.23691	7	Rrp	(83, 2, 82 )	210.11226	39	Pr-	59, 3, - )	205.29750	-7	Rr-	( 17, 3, - )	235.48029	-4
Prn (	63, 2, 62 )	152.62270		Rrp	(84, 2, 83)	210.50520	43	Pr-	58, 3, - )	205.69008	0	Rr-	( 18, 3, - )	235.87053	-7
Pm (	62, 2, 61 )	153.00895	- 5	_				Pr- (	57, 3, - )	206.08256	-6	Rr-	19, 3, -	236.26076	-3
Pm (	61, 2, 60)	153.39530	4	Qr-	(87, 3, -)	228.26823	0	Pr-	56, 3, - )	206.47510	-7	Rr-	20, 3, -	236.65088	-4
բու (	60, 2, 59	153.78170	6	Qr-	86, 3, -	228.27168	0	Pr-	55, 3, - }	206.86766	-8	Rr-	21, 3, -	237.04094	-4
Pm ( Pm (	59, 2, 58 ) 58, 2, 57 )	154.16816 154.55473	-3	Qr-	( 85, 3, - ) ( 84, 3, - )	228.27508 228.27837 -	-4	Pr- (	54, 3, - ) 53, 3, - )	207.26027	-5 -5	Rr-	22, 3, - 23, 3, -	237.43094	-3 -3
Prn (	57, 2, 56	154.94148	-1	Qr- Qr-	83, 3, -	228.28182 -		Pr-	52, 3, -	208.04549	-5	Rr-	23, 3, -	238.21072	-1
Pm (	56, 2, 55	155.32834	ò	Ğr-	82, 3, -	228.28519 -		Pr-	51, 3,	208.43840	24	Rr-	25, 3,	238.60049	-1
Prn (	55, 2, 54	155.71532	ž	٥r-	79, 3, -	228.29528	-7	Pr-	50, 3,	208.83073	-6	Rr-	26, 3,	238.99020	Ó
Prn (	54, 2, 53	156.10236	-2	۷r-	78, 3, - 1	228.29843 -	22	Pr-	49, 3, -	209.22338	- 5	Rr-	( 27, 3, - )	239.37981	- 1
Prn (	53, 2, 52 )	156.48954	-3	٧r-	(77, 3, -)	228.30179 -		Pr-	48, 3, -)	209.61603	-5	Rr-	28, 3, -	239.76935	· 2
Prn (	52, 2, 51 )	156.87688	1	Qr-	( 76, 3, - )	228.30511	-8	Pr-	47, 3, -)	210.00870	-4	Rr-	29, 3, -	240.15883	-1
Prn (	51, 2, 50 )	157.26423	-4	Qr-	(75, 3, -)	228.30833	-9	Pr-	46, 3, - )	210.40137	-2	Rr-	( 30, 3, - )	240.54825	1
Prn (	50, 2, 49		-10	Qr-	(74, 3, -)	228.31156	-7	Pr-	45, 3, - )	210.79402	-3	Rr-	$\{31, 3, -\}$	240.93755	-1
Prn (	49, 2, 48	158.03931	-9	Qr-	(73, 3, -)	228.31474	-8	Pr-	44, 3, -	211.18667	-4	Rr-	$\{\begin{array}{cccc} 32, \ 3, \ -\end{array}\}$	241.32680	0 5
Prn. (	48, 2, 47	158.42715	2	Qr-	72, 3, -	228.31790	-8	Pr-	43, 3, -)	211.57934	-3 7	Rr-	( 33, 3, - ) 34, 3, -	241.71601	0
	47, 2, 46 )	158.81493 159.20282	-2 -6	Qr- Qr-	$\{\begin{array}{ccc} 71, \ 3, \ - \\ 70, \ 3, \ - \end{array}\}$	228.32107 228.32421	-5 -2	Pr-	42, 3, - ) 41, 3, - )	211.97210 212.36465	-4	Rr- Rr-	34, 3, - 3 35, 3, -	242.10505 242.49407	2
Prn (							- 4	4 1-	-11, 3, - /	£12.30103		au-			_
Prn (	46, 2, 45)						-2	Pr-	40.3.	212.75729	- 5		36. 3.		4
	46, 2, 45 ) 45, 2, 44 ) 44, 2, 43 )	159.59081 159.97890	-10	Qr- Qr-	69, 3, - ) 68, 3, - )	228.32729 228.33036	-2 -1	Pr-	40, 3, - ) 39, 3, - )	212.75729 213.14995	-5 -3	Rr- Rr-	36, 3, - 37, 3, -	242.88302 243.27185	4 2

In the symmetric-top approximation, the centrifugal distortion energy,  $\Delta E_{\rm cd}(J,K)$ , due to the  $H_{12}^{(5)}$  term in Eq. (4) for the rotational levels of the ground state is thus calculated on the basis of harmonic-oscillator-symmetric-rotor wavefunctions (14),

$$\begin{split} \Delta E_{\rm cd}(J,K) &= \left\langle v = 0; J, K \middle| \hat{H}_{12}^{(5)} \middle| v = 0; J, K \right\rangle \\ &= \frac{\left\langle v = 0; J, K \middle| \hat{H}_{12}^{(5)} \middle| v_5 = 1; J, K + 1 \right\rangle}{\times \left\langle v_5 = 1; J, K + 1 \middle| \hat{H}_{12}^{(5)} \middle| v = 0; J, K \right\rangle} \\ &= \frac{\left\langle v_5 = 1; J, K + 1 \middle| \hat{H}_{12}^{(5)} \middle| v = 0; J, K \right\rangle}{\left\langle v = 0; J, K \middle| \hat{H}_{02} + \hat{H}_{20} \middle| v = 0; J, K \right\rangle} \\ &- \left\langle v_5 = 1; J, K + 1 \middle| \hat{H}_{02} + \hat{H}_{20} \middle| v_5 = 1; J, K + 1 \right\rangle \end{split}$$

TABLE VI-Continued

	ransition	Freq.	Δ	Tr	ansition	Freq.	Δ	Tr	ansition	Freq.	Δ	Tr	ansition	Freq.	Δ
Rr-	( 39. 3 )	244.04930	2	Qr-	( 29, 4, - )	273.75568	-17	Pr-	( 58, 4, - )	251.87180	-10	Rr-	( 20, 4, - )	281.84014	1
Rr-	40, 3, -	244.43791	3	Qr-	30, 4, - 1	273.77542	3	Pr-	57, 4, -			Rr-	21, 4, -	282.24581	14
Rr-	(41, 3, -)	244.82643	3	Qr-	31, 4, - }	273.79557	0	Pr-	56, 4, -	252.57901		Rr-	( 22, 4, - )	282.65186	3
Rr-	(42, 3, -)	245.21488	4	Qr-	(32,4,-)	273.81639	0	Pr-	(55, 4, -)	252.93413		Rr-	( 23, 4, - )	283.05867	5
Rr-	(43, 3, -)	245.60323	4	Qr-	33, 4, - )	273.83783	-2	Pr-	(54, 4, -)	253.28955		Rr-	24, 4, -	283.46603	-1
Rr- Rr-	(44, 3, -) (45, 3, -)	245.99147 246.37955	1 -10	Qr-	( 34, 4, - ) ( 35, 4, - )	273.85997 273.88280	3 12	Pr- Pr-	( 53, 4, - ) ( 52, 4, - )	253.64564 254.00231	-4	Rr-   Rr-	25, 4, -	283.87409 284.28279	2 6
Rr-	(46, 3, -	246.76778	-10	Qr-	36, 4, - )	273.90605	1	Pr-	51, 4, -	254.35977	-4	Rr-	( 26, 4, - ) ( 27, 4, - )	284.69201	1
Rr-	47, 3, -	247.15582	5	Qr-	37, 4, - }	273.93002	-2	Pr-	50, 4, -			Rr-	28, 4, -	285.10195	6
Rr-	(48, 3, -)	247.54376	6	Qr-	( 38, 4, - )	273.95471	3	Pr-	( 49, 4, - )	255.07658	-1	Rr-	( 29, 4, - )	285.51247	7
Rr-	(49, 3, -)	247.93147	-8	Qr-	( 39, 4, - )	273.98001	7	Рт-	( 48, 4, - )	255.43592	-5	Rr-	( 30, 4, -	285.92359	7
Rr-	(50, 3, -)	248.31935	4	Qr-	( 40, 4, - )	274.00592	8	Pr-	(47, 4, -)	255.79598	-3	Rr-	(31, 4, -	286.33534	9
Rr- Rr-	(51, 3, -) (52, 3, -	248.70704 249.09462	6 5	Qr- Qr-	( 41, 4, - ) ( 42, 4, - )	274.03236 274.05938	0 -14	Pr- Pr-	( 46, 4, - ) ( 45, 4, -	256.15668 256.51807	-5 -3	Rr-	( 32, 4, - ) ( 34, 4, -	286.74764 287.57416	6 9
Rr-	54, 3,	249.86956	8	Qr-	43, 4, - }	274.08730	0	Pr-	44, 4, -	256.88012	-2	Rr-	35. 4	287.98830	7
Rr-	55, 3, -	250.25683	3	Qr-	44, 4, - )	274.11574	4	Pr-	43, 4, -	257.24288	3	Rr-	36, 4, -	288.40309	11
Rr-	( 56, 3, - )	250.64408	5	Qr-	(45, 4, -)	274.14475	2	Pr-	( 42, 4, - )	257.60623	0	Rr-	( 37, 4, -	288.81842	10
Rr-	57, 3, -	251.03122	4	Qr-	( 46, 4, - )	274.17437	0	Pr-	(41, 4, -)	257.97026	-1	Rr-	( 38, 4, -	289.23435	8
Rr- Rr-	( 58, 3, - ) ( 59, 3, -	251.41830 251.80524	7	Qr- Qr-	( 47, 4, - ) ( 48, 4, - )	274.20465 274.23555	1 2	Pr- Pr-	( 40, 4, - ) ( 39, 4, -	258.33496 258.70038	-2 3	Rr-	( 39, 4, - ) ( 40, 4, - )	289.65086 290.06803	5 9
Rr-	60, 3, -	252.19211	4	Qr-	{ 49, 4, - }	274.26708	5	Pr-	(38, 4, -	259.06635	-5	Rr-	(41, 4, -	290.48576	10
Rr-	61, 3, -	252.57901	15	Q̈́r-	50, 4, - }	274.29916	ĭ	Pr-	37, 4, -	259.43309	-2	Rr-	42, 4, -	290.90408	12
Rr-	62, 3, -	252.96559	4	Qτ-	51, 4, - )	274.33190	1	Pr-	36, 4, -	259,80049	ō	Rr-	43, 4, -	291.32291	6
Rr-	(63, 3, -	253.35218	2	Qr-	(52, 4, -)	274.36523	- 1	Pr-	( 35, 4, - )	260.16853	-1	Rr-	( 44, 4, -	291.74234	2
Rr-	64, 3, -	253.73871	4	Qr-	( 53, 4, - )	274.39920	1	Pr-	34, 4, -	260.53724	-2	Rr-	(45, 4, -	292.16246	9
Rr- Rr-	(65, 3, -) (66, 3, -)	) 254.12508 ) 254.51135	-1 -7	Qr- Qr-	( 54, 4, - ) ( 55, 4, - )	274.43376 274.46892	-1	Pr- Pr-	(33, 4, -) (32, 4, -)	260.90666 261.27667	1 -4	Rr-	( 46, 4, - ) ( 47, 4, -	292.58309 293.00429	9
Rr-	67, 3, -	254.89768	3	Qr-	56, 4, -	274.50468	-3	Pr-	31, 4, -	261.64737	-7	Rr-	48, 4, -	293.42607	9
Rr-	68, 3, -	255.28383	4	Qr-	{ 57, 4, - }	274.54103	-6	Pr-	30, 4,	262.01882	- 2	Rr-	49, 4, -	293.84841	9
Rr-	(69, 3, -	255.66990	6	Qr-	(58,4,-)	274.57808	0	Pr-	[ 29, 4, - ]	262.39089		Rr-	( 50, 4, -	294.27139	16
Rr-	(70, 3, -)	256.05577	-3	Qr-	(59, 4, -)	274.61568	2	Pr-	(28, 4, - )	262.76363		Rr-	(51, 4, -)	294.69482	11
Rr-	(71, 3, -)	256.44167	1	Qr-	( 60, 4, - )	274.65379	-6	Pr-	27, 4, -	263.13704	-1	Rr-	52, 4, -	295.11883	8
Rr- Rr-	( 72, 3, - ) ( 73, 3, -	) 256.82738 ) 257.21309	-5 -1	Qr- Qr-	( 61, 4, - ) ( 62, 4, - )	274.69270 274.73198	-8 -2	Pr- Pr-	(26, 4, -) 25, 4, -	263.51112 263.88587	-1 -1	Rr- Rr-	(53, 4, -) (54, 4, -)	295.54340 295.96863	5 12
Rr-	74, 3, -	257.59878	10	Qr-	63, 4, -	274.77197	1	Pr-	24, 4, -	264.26129		Rr-	55, 4, -	296.39426	5
Rr-	(75, 3, -	257.98419	2	Qr-	(64, 4, -)	274.81247	-5	Pr-	( 23, 4, -	264.63739	1	Rr-	(56, 4, -	296.82051	5
Rr-	(76, 3, -	258.36957	1	Qr-	(65,4,-)		-14	Pr-	(22, 4, -)	265.01413		Rr-	( 57, 4, - )	297.24738	11
Rr-	(77, 3, -	258.75489	4	Qr-	66, 4, - )	274.89532	-7	Pr-	21, 4, -	265.39156	0	Rr Rr	58, 4, -	297.67470	8
Rr- Rr-	( 78, 3, - ) ( 79, 3, -	259.14012 259.52510	-5	Qr- Qr-	( 67, 4, - ) ( 68, 4, - )	274.93773 274.98070	3 10	Pr- Pr-	( 20, 4, - ( 19, 4, -	265.76967 266.14839	-3	Rr-	( 59, 4, - ) ( 60, 4, - )	298.10244 298.53101	-8 6
Rr-	80. 3.	259.91020	-5	Qr-	69, 4, -	275.02388	-19	Pr-	18, 4, -	266.52785	-3	Rr-	61, 4, -	298.96002	10
Rr-	81, 3, -	260.29528	22	Qr-	70, 4, - }	275.06810	-3	Pr-	17, 4, -	266.90794	-1	Rr-	62, 4, -	299.38954	11
Rr-	(82, 3, -	260.67957	-30	Qr-	(71, 4, -)	275.11269	-7	Pr-	[ 16, 4, - ]	267.28873	1	Rr-	(63, 4, -	299.81958	12
Rr-	(83, 3, -	261.06458	-1	Qr-	( 73, 4, - )	275.20370	-3	Pr∙	15, 4, -	267.67015	-1	Rr-	64, 4, -	300.25006	4
Rr- Rr-	( 84, 3, - ) ( 85, 3, -	) 261.44916 ) 261.83388	-5 16	Qr- Qr-	( 74, 4, - ) ( 75, 4, - )	275.25010 275.29688	-10	Pr- Pr-	( 14, 4, - ) ( 13, 4, -	268.05226 268.43504	0	Rr- Rr-	(65, 4, - ) (66, 4, -	300.68116 301.11284	5 12
Iu-	( 60, 3, -	201.03300	10	۷۲-	76, 4, -	275.34408	-38	Pr-	( 13, 4, - ) ( 12, 4, -	268.81852	6	Rr-	(66, 4, - ) (67, 4, -	301.54489	4
Qr-	(6, 4, -	273.48510	-7	ζ̈́r-	{ 77, 4, - }	275.39268	19	Pr-	11, 4, -	269.20253		Rr-	68, 4, -	301.97738	-12
Qr-	(7, 4, -	273.48990	14	Qr-	(78,4,-)	275.44129	20	Pr-	(10, 4, -	269.58734	2	Rr-	(69, 4, -	302.41085	19
Qr-	(8, 4, -	273.49504	3	Qr-	( 79, 4, - )	275.49040	16	Pr-	(9, 4, -	269.97276	1	Rr-	(71, 4, -	303.27844	-6
Qr-	(9, 4, -)	273.50091	0	Qr-	(80, 4, -)		-11	Pr-	8, 4, -	270.35889	4	Rr-	72, 4, -	303.71314	-4
Qr- Qr-	{ 10, 4, - } { 11, 4, -	) 273.50743 ) 273.51477	-4 9	Qr- Qr-	( 81, 4, - ) ( 83, 4, - )	275.59028 275.69208	- 29	Pr- Pr-	(7, 4, -) 6, 4, -	) 270.74567 ) 271.1 <b>32</b> 57	7	Rr- Rr-	( 73, 4, - ) ( 74, 4, - )	304.14850 304.58416	14 12
Qτ-	12, 4, -	273.52257	2	A1-	( 00, 4, - )	a10.03208	- 23	1 1-	(0, 4, -	, 211.13231	-40	Rr-	75, 4, -	305.02049	29
Qr-	13, 4, -	273.53110	3	Pr-	( 75, 4, - )	245.96259		Rr-	(4, 4, -	275.43810	2	Rr-	76, 4, -	305.45712	25
Qr-	(14, 4, -	273.54014	-11	Pr-	(74, 4, -)	246.30530		Rr-	(5, 4, -)	275.83338	0	Rr-	77, 4, -	305.89409	8
Qr-	( 15, 4, -	273.55004	-3	Pr-	( 73, 4, - )	246.64839		Rr-	(6, 4, -	276.22931	-2	Rr-	( 78, 4, -	306.33189	25
Qr- Qr-	{ 16, 4, - } { 17, 4, -	) 273.56064 ) 273.57145	9 -23	Pr- Pr-	( 72, 4, - ) ( 71, 4, - )	246.99216 247.33647	-5 -9	Rr- Rr-	(7, 4, -) (8, 4, -)	276.62592	-1 -2	0-	( 76 T	313 01704	-71
Qr-	18, 4,	273.58343	-23	Pr-	{ 70, 4, - }	247.68145	-9	Rr-	(8, 4, -) (9, 4, -)	277.02315 277.42109	3	Qr- Qr-	(76、5、-) (75、5、-)	312.81724 312.84718	-/1 -/t
Õr-	19, 4, -	273.59586	-4	Pr-	69, 4, -	248.02650		Rr-	(10, 4, -	277.81961	2	۷r-	74, 5, -	312.87617	3
Qr- Qr-	( 20, 4, -	273.60906	8	Pr-	(67, 4, -)	248.72018	-19	Rr-	( 11, 4, -	278.21863	-14	Qr-	( 73, 5, - )	312.90469	-2
Qr-	21, 4,	273.62271	0	Pr-	(66, 4, -)	249.06789	-5	Rr-	(12, 4, -	278.61860	0	Qr-	(72, 5, -	312.93272	-21
Qr-	( 22, 4, -	273.63693	-16	Pr-	(65, 4, -)		-11	Rr-	( 13, 4, -	279.01901	-5	Qr-	( 71, 5, -	312.96068	-12
Qr- Qr-	23, 4, - 24, 4, -	) 273.65210 ) 273.66776	-2 -4	Pr- Pr-	( 64, 4, - ) ( 63, 4, -	249.76511 250.11441	9	Rr- Rr-	14, 4, -	279.42018	2 2	Qr-	( 70, 5, - ) ( 69, 5, -	312.98839	6 67
Qr-	25, 4, -	273.68407	-4 -5	Pr-	( 63, 4, - ) ( 62, 4, - )	250.11441		Rr-	( 15, 4, - ) ( 16, 4, -	) 279.82192 ) 280.22413		Qr- Qr-	(69, 5, - ) (68, 5, -	313.01616 313.04222	-8
Qr.	26, 4, -	273.70108	ŏ	Pr-	61, 4,	250.40432	23	Rr-	17, 4,	280.62736	7	Qr-	67, 5, -	313.06909	33
Qr-	(27, 4, -	273.71881	11	Pr-	(60, 4, -)	251.16694	-5	Rr-	(18, 4, -	281.03094	0	Qr₋	66, 5, -	313.09482	-3
Qr-	(28, 4, -	) 273.73703	8	Pr-	( 59, 4, - )	251.51908	-4	Rr-	( 19, 4, -	281.43524	2	Çr-		313.12060	1

$$+ \frac{\left\langle v = 0; J, K \middle| \hat{H}_{12}^{(5)} \middle| v_{5} = 1; J, K - 1 \right\rangle}{\times \left\langle v_{5} = 1; J, K - 1 \middle| \hat{H}_{12}^{(5)} \middle| v = 0; J, K \right\rangle}{\left\langle v = 0; J, K \middle| \hat{H}_{02} + \hat{H}_{20} \middle| v = 0; J, K \right\rangle} \\ - \left\langle v_{5} = 1; J, K - 1 \middle| \hat{H}_{02} + \hat{H}_{20} \middle| v_{5} = 1; J, K - 1 \right\rangle}$$

$$= \frac{1}{8} (\omega_{5} C_{5}^{ab})^{2} \left\{ \frac{(2K+1)^{2} [J(J+1) - K(K+1)]}{E_{0}(J, K) - E_{5}(J, K+1)} \right\}$$

TABLE VI-Continued

Tr	ansition	Freq.	Δ	Transition	Freq.	Δ	T	ransition	Freq.	Δ	Transition	Freq.	Δ
Qr- (	( 64, 5, - )		11	Pr- ( 55, 5,	) 291.84489	4	Rr-	( 27, 5, - )	324.78275	4	Qr- (49, 6, -	350.88759	15
Qr- (	(63, 5, -)	313.17081	-17	Pr- (54, 5,	· ) 292.25660		Rr-	(28, 5, -)	325.16274	5	Qr- (50, 6, -)	350.88146	
Qr- (	(62, 5, -)	313.19569	6	Pr- (53, 5,			Rr-	(29, 5, -)	325.54227	2	Qr- (51, 6, -	350.87522	
Qr- ( Qr- (	( 61, 5, - ) ( 60, 5, - )	313.21982 313.24393	-9 10		· ) 293.07990 · ) 293.49043		Rr- Rr-	( 30, 5, - ) ( 31, 5, - )	325.92136 326.30011	-2 3	Qr- (52, 6, -) Qr- (53, 6, -)	350.86870 350.86251	-23
Qτ- (	59, 5, -	313.26745	7	Pr- (50, 5,	293.90099		Rr-	32, 5, - }	326.67837	Ö	Qr- (54, 6, -	350.85552	
Qr- (	58, 5, - {	313.29051	-5	Pr- (49, 5,	294.31125		Řr-	33, 5, - }	327.05625	3	Qr- (55, 6, -	350.84932	6
Qr- (	( 57, 5, - )	313.31327	-11	Pr- (48, 5,	· ) 294.72128	-7	Rr-	(34, 5, -)	327.43370	5	Qr- ( 56, 6, -	350.84274	29
Qr-	(56, 5, -)	313.33579	-3	Pr- (47, 5,	295.13079		Rr-	( 35, 5, - )	327.81069	3	Qr- (57, 6, -	350.83508	
Qr- (	( 55, 5, - )	313.35786	-3	Pr- (45, 5,	295.94905		Rr-	(36, 5, -)	328.18730	6	Qr- (58, 6, -	350.82838	
Qr- ( Qr- (	( 54, 5, - ) ( 53, 5, - )	313.37961 313.40089	-2 -2	Pr- (44, 5, Pr- (43, 5,	296.35768 296.76591	-7 -8	Rr- Rr-	( 37, 5, - ) ( 38, 5, - )	328.56350 328.93914	11 3	Qr- (59, 6, -) Qr- (60, 6, -)	) 350.82165 ) 350.81403	
Qr-	52, 5, - }	313.42180	-5	Pr- (42, 5,	297.17382	-7	Rr-	39, 5, - (	329.31444	3	Qr- (61, 6, -	350.80636	
Qr- (	( 51, 5, - <u>(</u>	313.44244	2	Pr- (41, 5,		-8	Rr-	40, 5, - }	329.68932	4	• • • •	,	
Qr- (	( 50, 5, - )	313.46261	-1	Pr- (40, 5,		1	Rr-	(41, 5, -)	330.06373	0	Pr- (51, 6, -)	330.92974	
Qr- (	( 49, 5, - )	313.48237	-6	Pr- (39, 5,			Rr-	( 42, 5, - )	330.43782	7	Pr- ( 50, 6, -	331.32567	
Qr- (	(48, 5, -)	313.50179	-7 -2	Pr- (38, 5, Pr- (37, 5,		17	Rr-	(43, 5, -)	330.81141	7	Pr- \ 48, 6, -	332.11870	
Q1- ( Q1- (	( 47, 5, - ) ( 46, 5, - )	313.52090 313.53958	-1	Pr- (37, 5, Pr- (36, 5,		-8 -8	Rr- Rr-	( 44, 5, - ) ( 45, 5, - )	331.18461 331.55734	11 10	Pr- (47, 6, -) Pr- (46, 6, -)	332.51463 332.91099	-23
Qr. (	45, 5, - }	313.55787	-i		300.01941	ő	Rr-	46, 5, - }	331.92966	12	Pr- (45, 6, -	333.30699	
Qr-(	(44, 5, -)	313.57569	-9	Pr- (34, 5,	300.42453	4	Rr-	(47, 5, -)	332.30152	9	Pr- (44, 6, -	333.70309	7
Qr- (	( 43, 5, - )	313.59327	-3		300.82921	0	Rr-	( 48, 5, - )	332.67277		Pr- (43, 6, -	334.09905	
Qr- (	(42, 5, -)	313.61033 313.62719	-11 0		301.23349	-8	Rr-	(49, 5, - )	333.04399 333.41455	9 5	Pr- ( 42, 6, - ) Pr- ( 40, 6, -	334.49489 335.28591	
Qr-( Qr-(	( 41, 5, - ) ( 40, 5, - )	313.64349	-6	Pr- (31, 5, Pr- (30, 5,	301.63757 302.04119	-1	Rr- Rr-	( 50, 5, - ) ( 51, 5, - )	333.78475	7	Pr- ( 40, 6, - ) Pr- ( 39, 6, - )	335.68144	
Õr i	39, 5, - }	313.65953	1	Pr- 29, 5,	302.44439	-7	Rr-	52, 5, - }	334.15445	3	Pr- 38, 6, -	336.07698	
Qr- ( Qr- (	(38, 5, -)	313.67513	2	Pr- (28, 5,	302.84736	1	Rr-	( 53, 5, - )	334.52406	32	Pr 37, 6,	336.47226	
Qr- ( Qr- (	( 37, 5, - )	313.69022	-8	Pr- (27, 5,	303.24975		Rr-	(54, 5, -)	334.89263	0	Pr. (36, 6, -	336.86782	6
Qr- (	( 36, 5, - )	313.70534	23 -3	Pr- 26, 5,	303.65197	-6	Rr-	( 55, 5, - )	335.26114	. 5	Pr- (35, 6, -)	337.26292	-4
Qr- ( Qr- (	( 35, 5, - ) ( 34, 5, - )	313.71949 313.73355	-3	Pr- 25, 5, Pr- 24, 5,	304.05383 304.45520	-2	Rr- Rr-	( 56, 5, - ) ( 57, 5, - )	335.62930 335.99700	17 25	Pr- (34, 6, -) Pr- (33, 6, -)	337.65821 338.05314	12
Žr- (	33, 5, - \	313.74723	6	Pr- 23, 5,	304.85621	-4	Rr-	58, 5, - )	336.36391	-1	Pr- 32, 6, -	338.44792	-11
Qr- (	32, 5, - )	313.76031		Pr- ( 22, 5,		0	Rr-	59, 5, - )	336.73076	8	Pr- 31, 6, -	338.84290	2
Qr- (	(31, 5, -)	313.77312	-12	Pr- (21, 5,	305.65714	-4	Rr-	(60, 5, -)	337.09697	- 5	Pr- (30, 6, -)	339.23753	
Qr- (	( 30, 5, - )	313.78568	- 1	Pr- 20, 5,		-8	Rr-	(61, 5, -)	337.46273		Pr- (29, 6, -)	339.63244	
Qr- ( Qr- (	( 29, 5, - ) ( 28, 5, - )	313.79766 313.80940	-9 0	Pr- 19, 5, Pr- 18, 5,	306.45646	-12 2	Rr- Rr-	( 62, 5, - ) ( 63, 5, - )	337.82898 338.19365	57 19	Pr- ( 28, 6, - ) Pr- ( 27, 6, - )	340.02709 340.42083	
Ğr- (	27, 5, -	313.82067	1	Pr- 17, 5,	307.25467	20	Rr-	64, 5, -	338.55804	-6	Pr- (26, 6, -	340.81489	
Qr- (	(26, 5, -)	313.83151	-1	Pr- (16, 5,	307.65280	-3	Rr-	(65, 5, - )	338.92241	10	Pr- (25, 6, -)	341.20953	
Qr-(	( 25, 5, - )	313.84200	1	Pr- (15, 5,	308.05076	-5	Rr-	(66, 5, - )	339.28637	28	Pr- (24, 6, -)	341.60341	
Qr- (	( 24, 5, - )	313.85211	5	Pr (14, 5	308.44833	-6	Rr-	(67, 5, -)	339.64945	-1	Pr- (23, 6, -)	341.99812	
Qr- ( Qr- (	( 23, 5, - ) ( 22, 5, - )	313.86178 313.87093	-6	Pr- { 13, 5, Pr- { 12, 5,	308.84537	-22 10	Rr-	(68, 5, -)	340.01295	56	Pr- (22, 6, -) Pr- (21, 6, -)	342.39223 342.78609	-1 -4
Ğr- (	21, 5, - }	313.87980	-6	Pr (11, 5		1	Qr-	( 20, 6, - )	351.00915	34	Pr- (20, 6, -)	343.17988	-5
Q̃r- (	( 20, 5, - )		-20	Pr- 10, 5,	310.03479	-4	٥r-	(21,6,-)	351.00673	40	Pr- (19, 6, -	343.57360	- 2
Qr- (	(19, 5, -)	313.89647	7	Pr- (9, 5,	310.43059	12	Qr-	(22,6,-)	351.00402	30	Pr- (18, 6, -)	343.96695	
Qr- ( Qr- (	18, 5, - )	313.90414	7	Pr- (8, 5,	310.82562	-7	Qr-	(23, 6, -)	351.00141	41	Pr- (17, 6, -)	344.36060	
Qr- (	( 17, 5, - ) 16, 5, - )	313.91140 313.91820	ó	Rr- (5, 5,	) 316.31678	-6	Qr- Qr-	( 24, 6, - ) ( 25, 6, - )	350.99855 350.99543	40 24	Pr- (16, 6, -)	344.75397 345.14755	18
Žr- (	15, 5, -		-28	Ru 6. 5.	316.70603	ĭ	Õr-	26, 6, - }	350.99241	31		345.93311	
Žr- (	14, 5, - )	313.93073	1	Rr (7, 5,		3	Qr-	( 27, 6, - )	350.98938	48	(, -,		
Qr-(	( 13, 5, - )	313.93657	19	Rr- (8, 5,	317.48319	5	Qт-	(28, 6, - )	350.98581	24	Rr- (6, 6, -)	353.77168	4
Qr- ( Qr- (	(12, 5, -)	313.94173	10	Rr- (9, 5,		7	Qr-	( 29, 6, - )	350.98251	38	Rr (7, 6, -)	354.16229	0
Qr- ( Qr- (	( 11, 5, - ) ( 10, 5, - )	313.94652 313.95101	3 8	Rr- (10, 5, Rr- (11, 5,		-8	Qr-	( 30, 6, - ) ( 31, 6, - )	350.97863 350.97495	7 8	Rr- (8, 6, -) Rr- (9, 6, -)	354.55281 354.94321	-1 -2
Qr−( Qr-	(9, 5, -)		-31	Rr- (11, 5, Rr- (12, 5,	319.03239	-3	Qr- Qr-	( 31, 6, - ) ( 32, 6, - )	350.97109	3	Rr- (9, 6, -)	355.33367	17
Žr-	8, 5, - }	313.95901	39	Rr- (13, 5,	319.41873	2	٥r.	33, 6, - 1	350.96723	10	Rr- (11, 6, -)	355.72361	-4
Qr-	(7, 5, -)	313.96212	25	Rr- (14, 5,	319.80455	-3	Qr-	( 34, 6, - )	350.96321	14	Rr- (12, 6, -)	356.11364	-3
Qr-	(6, 5, -)	313.96500	31	Rr- (15, 5,	) 320.19002	-1	Qr-	(35, 6, -)	350.95874		Rr- (13, 6, -)	356.50363	.8
Pr- (	(65, 5, -)	287.70813	.33	Rr- (16, 5, Rr- (17, 5,		0	Qr- Qr-	( 36, 6, - ) ( 37, 6, - )	350.95417 350.95002		Rr- (14, 6, -) Rr- (15, 6, -)	356.89350 357.28277	
Pr-	64, 5, -	288.12325		Rr- (18, 5,		1	Qr-	38, 6, -	350.94579	16	Rr- (16, 6, -	357.67239	-10
Pr- (	63, 5, - }	288.53795		Rr- (19, 5,	321.72771	6	Qr-	( 39, 6, - )	350.94099	3	Rr- (17, 6, -)	358.06146	
Pr- (	62, 5, - }	288.95266	4	Rr- (20, 5,	322.11094	-7	Qr-	(40, 6, - )	350.93613	-4	Rr- (18, 6, -)	358.45134	35
Pr- (	61, 5, - )	289.36673	0	Rr- (21, 5,		3	Qr-	41, 6, - }	350.93124	-2	Rr- (19, 6, -)		-11
Pr- ( Pr- (	60, 5, - ) 59, 5, - )	289.78029 290.19367		Rr- (22, 5, Rr- (23, 5,		-1 0	Qr-	(42, 6, -)	350.92630 350.92114	8	Rr- (20, 6, -)	359.22909	8
Pr- {	58, 5, - )		-35 -14	Rr- (23, 5, Rr- (24, 5,		-6	Qr-	( 43, 6, - ) ( 44, 6, - )	350.92114	4			
Pr- }	57, 5, -	291.01990		Rr- (25, 5,		-1	Qr-	45, 6, -	350.91045	10			
		291.43257				ō		48, 6, - }	350.89345				

$$+\frac{(2K-1)^2[J(J+1)-K(K-1)]}{E_0(J,K)-E_5(J,K-1)}\right\}, \quad (6)$$

where  $E_0(J,K)-E_5(J,K\pm 1)$  in the denominators are the energy differences between the interacting rovibrational levels. K again represents  $K_a$ . With the second-order perturbation expression given above, we were able to explain the observed anomalies in the effective B values; the interaction matrix elements are sufficiently small compared to the denominator in Eq. (6) and thus can be handled by the perturbation treatment. The resonance effect, as well as the avoided level-crossing effect, is interpreted by the strong K dependence of the denominators.

TABLE VII

Newly Observed Submillimeter-Wave Lines of HNCS in MHz<sup>a</sup>

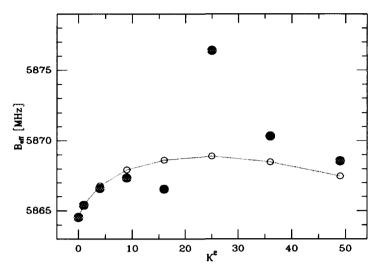
Transition	Freq.	Δ	Transition	Freq.	Δ
Rgr (75, 0, 75)	889248.997	3	Rgr (75, 2, 74)	889624.696	-9
Rqr (76, 0, 76)		-3	Rqr (76, 2, 75)		11
Rgr (80, 0, 80)	947439.425	-1	Rqr (80, 2, 79)	947848.610	2
Rqr (81, 0, 81)	959070.465	2	Rqr (90, 2, 89)	1064118.466	-2
Rqr (85, 0, 85)			- , ,		
Rgr (87, 0, 87)	1028804.865	-10	Rgr (75, 3, -)	889753.492	52
Rqr (88, 0, 88)	1040418.362	-6	Rqr (76, 3, -)	901404.827	39
, , , ,			Rqr (80, 3, -)	947987.880	-73
Rqr (75, 1, 75)	888013.733	79	Rqr (81, 3, -)	959627.929	-126
Rgr (76, 1, 76)	899642.087	74	- • • • •		
Rgr (80, 1, 80)	946133.235	43	Rqr (75, 4, -)	889656.457	-1
Rqr (81, 1, 81)	957750.320	41	Rqr (76, 4, -)	901307.117	1
Rqr (85, 1, 85)	1004194.916	-28	Rqr (80, 4, -)	947887.728	1
Rqr (87, 1, 87)	1027402.623	-42	Rqr (81, 4, -)	959527.230	-1
Rqr (75, 1, 74)	890842.021	33	Prp (30, 0, 30)	944663.104	11
Rqr (76, 1, 75)	902506.288	24	Prp (25, 0, 25)	1005559.487	-6
Rqr (80, 1, 79)	949140.601	4	Prp (24, 0, 24)	1017690.465	-14
Rqr (81, 1, 80)	960793.336	-5	Prp (23, 0, 23)	1029805.234	-5
Rqr (85, 1, 84)	1007380.045	-38	Prp (22, 0, 22)	1041903.741	20
Rqr (87, 1, 86)	1030658.421	-84	Prp (21, 0, 21)	1053985.868	-6
Rqr (75, 2, 73)	889670.824	-2			
Rqr (76, 2, 74)	901321.885	3			
Rqr (80, 2, 78)	947904.165	0			
Rqr (81, 2, 79)	959544.102	-8			
Rqr (87, 2, 85)	1029334.343	12			
Rqr (90, 2, 88)	1064196.370	-6			

a) For notation see Table VI. The observed-calculated values are in the columns of  $\Delta$  in kHz.

Ignoring the J dependence in the denominator of Eq. (6), which is much smaller than the K dependence, the shift in the effective B value for each K state due to the  $\hat{H}_{12}$  interaction has been calculated. The denominators were evaluated from the observed K-rotational term values of the ground and the excited states given in Fig. 5. The energy of the  $K_a = 7$  and 8 levels of the  $v_5 = 1$  state were roughly estimated by extrapolation to be 1633 and 1984 cm<sup>-1</sup>, respectively. By an iterative procedure, with the assumption that  $\omega_5 = 469.2$  cm<sup>-1</sup>, the dimensionless interaction coefficient  $C_5^{ab}$  has been determined to be  $5.41(5) \times 10^{-5}$ , by requiring the deperturbed B values to be dependent on K, but as smooth as possible. The estimated deperturbed B values are also indicated in Fig. 4 by open circles.

## VI. DISCUSSION

Figure 6 illustrates the  $K_a$  dependence of the effective B values of DNCS, where no crossing of the energy levels is expected between the ground and the lowest excited bending state in the observed range of the quantum number  $K_a$ . More rigorously, it



Ftg. 4. The anomalous  $K_a$  dependence of the effective rotational constant B for each  $K_a$  is shown. The solid circles indicate the experimental values. For these substates, where the K doubling has been observed, the average of the two components is used for the plot. By removing the contributions from the centrifugal distortion resonance, the open circles represent the deperturbed B values.

should be mentioned that the exact locations of the rotational levels of the lowest excited state of DNCS are still unknown. However, an estimation from the vibrational energy obtained by the low-resolution infrared spectra reported by Draper and Werner (15) suggests that the energy separations of the interacting levels should be much larger in DNCS than in HNCS, because of the smaller rotational constant A. Thus, as expected, the effective B values of DNCS depend on  $K_a$  very smoothly, and no resonance effect can be detected. The standard theory predicts a closely linear behavior of B in dependence on  $K_a^2$ , with a slope represented by the centrifugal correction constant  $D_{JK}$ . However, the plotted B values (Fig. 6) deviate markedly from linearity. This nonlinear  $K_a^2$  dependence is caused mainly by the quasilinearity effect, but also in part by the centrifugal distortion resonance.

A similar, but more pronounced, nonlinear  $K_a^2$  dependence has been observed also in HNCS for the deperturbed B values, as shown in Fig. 4, where the nonlinearity is more dramatic. Since the reduced mass for the quasilinear bending vibration is much smaller in HNCS than in DNCS, one expects that the ground state level of HNCS is higher and closer to the top of the potential hump than that of DNCS, as shown in Fig. 3 of Ref. (8). This behavior is due to the zero-point vibrational effect. Consequently, the anomaly due to the quasilinearity is expected to be larger in HNCS.

In the rotational structure of HNCS, the combined effects of the centrifugal distortion resonance and quasilinearity find their clearest visible expression in the different degradings of the individual Q branches (see Fig. 1). Commencing with the  $'Q_2$  branch through  $'Q_6$ , the direction of the degrading changes from blue to red, back to blue for  $'Q_4$ , and again to red for  $'Q_5$ . Finally, the  $'Q_6$  and presumably all higher- $K_a Q$  branches are degraded to the red, as one normally would have expected to hold for all Q branches, in which case HNCS would be a well behaved close prolate rotor.

The influence of quasilinearity on the centrifugal distortion resonance can be estimated from a comparison of the magnitude of the centrifugal distortion resonance parameter  $C_3^{ab}$ . For HNCS,  $C_3^{ab} = 5.41(5) \times 10^{-5}$  compares with  $C_3^{ab} = 15.8 \times 10^{-5}$ 

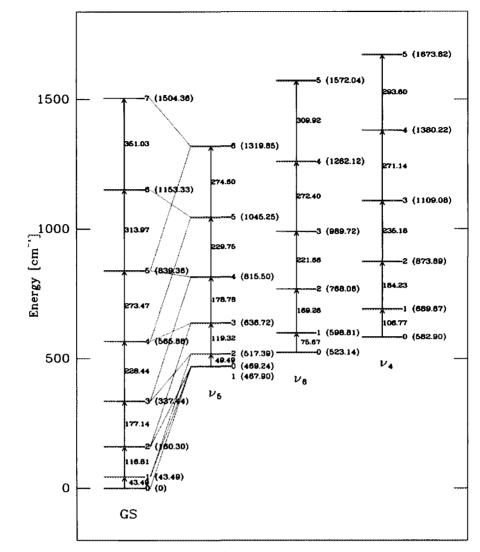


FIG. 5. The  $K_a$  rotational levels are plotted for the ground state and the three lowest bending states of HNCS. The near-resonance condition can be seen for the ground state ( $K_a = 5$  level) and the  $v_5 = 1$  state ( $K_a = 4$  level). Details of the excited states will be presented in a forthcoming paper.

of diazomethane (14),  $C_5^{ab} = 15.1 \times 10^{-5}$  of ketene (14),  $C_5^{ab} = 7.9309(13) \times 10^{-5}$  of HNNN (16), and  $C_5^{ab} = 8.09 \times 10^{-5}$  of HNCO (17). They are of same order of magnitude; even this parameter is smaller for HNCS or HNCO, typical quasilinear molecules, than for ketene or diazomethane. This fact indicates that the centrifugal distortion resonance is independent of the property of molecular quasilinearity. Centrifugal distortion resonance is a general interaction for a large variety of molecules, as was stated in Ref. (7); it becomes relevant in the ground state spectra if the rotational constant A is relatively large compared to the lowest vibrational energy. Its effect can even be observed if the energy difference between the two vibrational states coupled by this interaction is small enough.

Hegelund and Bendtsen (16) have analyzed the ground state rotational levels of HNNN simultaneously with the two lowest bending excited states, where they have

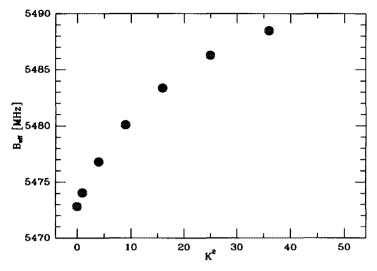


Fig. 6. The  $K_a$  dependence of the effective B values of DNCS is shown on the same scale as that used in Fig. 4. Although present in DNCS, the resonance effect is not as obvious as in HNCS. The observed  $K_a$  dependence, however, is caused by the combined effects of centrifugal distortion resonance and quasilinearity. The latter effect is more important for the observed  $K_a$  states in DNCS.

used Watson-type effective rotational Hamiltonians for each vibrational state, and have taken into account the Coriolis interactions between the two excited states and the centrifugal distortion resonance between the ground state and the lowest excited state. Such an analysis, which would be desirable for the present treatment, has not been done in this study because of the following difficulties. First, since the quasilinear effect is much larger for HNCS than for HNNN, a Watson-type effective rotational Hamiltonian for asymmetric tops is not appropriate to represent the rotational levels, even for the deperturbed ground state. Second, in HNCS there are three excited bending states ( $\nu_4$ ,  $\nu_5$ ,  $\nu_6$ ), instead of two, coupled together by strong Coriolis interactions (Fig. 5). One of the three states ( $\nu_4$ ) is the first excited state of the quasilinear bending mode, and the vibrational energy level of this state is close to the top of the potential barrier. Thus, compared to the ground state, much stronger anomalies are expected in the rotational energies of  $\nu_4$  due to the quasilinearity.

In this study, we presented the effective molecular parameters for each  $K_a$  rotational state, which can reproduce the observed line positions. In other words, for the first time, we can reproduce the observed energy levels up to  $K_a = 7$  for HNCS, up to  $K_a = 6$  for DNCS, and up to  $K_a = 5$  for HNC<sup>34</sup>S. Reliable rotational constants A, B, and C for these three isotopomers could be determined by applying a Watson-type Hamiltonian for the low- $K_a$  lines, which confirm the previously reported values (5). The revision of the rotational constants in the present work does not seem to require a revision of the  $r_s$  structure (5).

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