

TABLE I. Pure rotational transitions conspicuously affected by the tunneling-rotation interaction.

Rotational transition						0 ⁺			0 ⁻		
						Obs (MHz)	O-C (MHz)	$\Delta\nu^a$ (MHz)	Obs (MHz)	O-C (MHz)	$\Delta\nu^a$ (MHz)
<i>J</i>	<i>K_a</i>	<i>K_c</i>	<i>J</i>	<i>K_a</i>	<i>K_c</i>						
22	6	17	21	6	16	570 10.563	0.051	-2.656	570 17.749	-0.130	8.163 ^b
22	5	17	21	5	16	570 17.759	0.050	-2.957	570 22.300	-0.062	5.181 ^b
23	6	18	22	6	17	590 63.041	-0.010	-2.474 ^b	590 67.000	0.098	4.939 ^b
23	5	18	22	5	17	590 65.746	0.046	-2.609 ^b	590 68.700	0.104	3.861 ^b
24	6	19	23	6	18	611 17.843	-0.012	-2.318 ^b	611 19.636	-0.050	3.183
24	5	19	23	5	18	611 18.831	0.026	-2.375 ^b	611 20.344	0.045	2.794
24	7	18	23	7	17	632 81.430	-0.101	-3.439 ^b	632 92.721	0.002	11.629
24	6	18	23	6	17	632 95.590	0.027	-4.099	633 01.675	0.037	5.921
25	7	19	24	7	18	653 26.863	0.040	-3.238 ^b	653 33.080	0.003	7.004
25	6	19	24	6	18	653 32.169	-0.020	-3.543 ^b	653 36.732	0.190	4.824 ^b
26	7	20	25	7	19	673 75.028	0.036	-3.041	673 78.487	0.006	4.540
26	6	20	25	6	19	673 76.902	-0.084	-3.175 ^b	673 79.838	0.066	3.713 ^c
27	7	21	26	7	20	694 26.209	0.020	-2.862	694 27.954	0.022	3.077
27	6	21	26	6	20	694 26.894	-0.017	-2.920	694 28.412	0.015	2.767
25	8	18	24	8	17	675 31.896	-0.075	-4.242 ^b	675 62.798	-0.021	30.796
25	7	18	24	7	17	675 94.357	-0.058	-6.912	676 01.985	-0.013	5.134
26	8	19	25	8	18	695 68.735	0.166	-4.214 ^b	695 85.021	0.017	16.542
26	7	19	25	7	18	695 94.106	-0.111	-5.557 ^b	696 01.517	-0.014	6.200
27	8	20	26	8	19	716 05.531	-0.063	-4.055 ^b	716 15.063	0.003	9.839
27	7	20	26	7	19	716 15.173	-0.582	-4.695 ^b	716 22.000	0.341	5.690 ^b
28	8	21	27	8	20	736 45.866	0.003	-3.842	736 51.507	-0.013	6.343
28	7	21	27	7	20	736 49.743	-0.023	-4.134	736 54.054	0.004	4.700
29	8	22	28	8	21	756 89.998	-0.004	-3.624	756 93.322	-0.006	4.328
29	7	22	28	7	21	756 91.407	-0.054	-3.753	756 94.298	0.032	3.687
30	8	23	29	8	22	777 37.698	-0.059	-3.426	777 39.679	0.174	3.051 ^b
30	7	23	29	7	22	777 38.307	0.017	-3.478	777 39.679	-0.164	2.805 ^b
28	9	20	27	9	19	758 71.620	-0.185	-4.884 ^b			
28	8	20	27	8	19	759 16.322	0.006	-7.452 ^b			
29	9	21	28	9	20	778 99.884	-0.037	-4.870			
29	8	21	28	8	20	779 18.131	-0.013	-6.134			
30	9	22	29	9	21	799 31.220	0.045	-4.698	799 39.661	0.009	8.758
30	8	22	29	8	21	799 38.408	0.011	-5.291	799 44.300	-0.031	5.664
31	9	23	30	9	22	819 66.995	-0.033	-4.464 ^b	819 72.500	0.128	5.951 ^b
31	8	23	30	8	22	819 69.831	0.020	-4.731 ^b	819 74.300	0.146	4.700 ^b
32	9	24	31	9	23	840 07.552	0.079	-4.224 ^c	840 11.000	0.237	4.231 ^b
32	8	24	31	8	23	840 08.543	0.024	-4.340	840 11.500	0.078	3.735 ^b
29	10	20	28	10	19	801 66.888	-0.039	-4.369 ^c			
29	9	20	28	9	19	803 35.207	0.188	-13.012 ^b			
30	10	21	29	10	20	821 91.038	-0.015	-5.296			
30	9	21	29	9	20	822 65.129	0.081	-9.952 ^d			
31	10	22	30	10	21	842 10.101	-0.014	-5.604			
31	9	22	30	9	21	842 41.403	0.030	-7.967			

^aShift of the transition frequency caused by the tunneling-rotation interaction.^bOverlapped. Not weighted.^cBroad line. Weighted by 0.3.^dPartially overlapped. Weighted by 0.2.

by the $\langle 0^+ | \mu_b | 0^- \rangle$ and $\langle 0^- | \mu_b | 0^+ \rangle$ elements, yielding *b*-type dipole selection rules ($\Delta J = 0$ or ± 1 , $\Delta K_a = \text{odd}$, and $\Delta K_c = \text{odd}$).

Spectral searches in the frequency region 27.9–84.2 GHz gave a large number of strong absorption lines, among which about 150 each were assigned to *R*-branch ($\Delta J = 1$) rotational transitions in the 0⁺ and 0⁻ states. A table listing the observed transition frequencies and their assignment has been deposited as an AIP document.²⁰ Listed here, in Table I, are those selected lines which are conspicuously perturbed by the tunneling-rotation interaction.

The assigned transitions have *J''* values ranging from 12 through 39; the maximum *K''_a* and *K''_c* are 10 and 39, respec-

tively. The observed lines obey the selection rules $\Delta J = 1$, $\Delta K_a = 0$, and $\Delta K_c = 1$, consistent with *a*-type transitions, meaning that the transitions occurred within the tunneling substrates, 0⁺ or 0⁻. Characteristic groups of lines with band headlike structures appeared every 2070 MHz, which corresponds to twice the *C*₀ rotational constant. Each group consists of rotational lines corresponding to the same $2J - K_c$ value.

The spectrum observed at around 69.3 GHz (Fig. 3), corresponding to the group of lines with $2J - K_c = 33 - 32$, shows a splitting into the 0⁺ and 0⁻ components separated by about 4 MHz. In Fig. 3, the lines are simply designated by *J_K* using the oblate symmetric top limit notation, because