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Vibrational Relaxation of Vibrational Levels Create Population Inversion Continuously on About 21 Transitions

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Abstract: We compute the electron impact excitation rate coefficients of vibrational levels of $C^3 II_u$, $B^3 II_g$ and $A^3 u$ electronic systems of N_2 molecule and show that the population inversion may be obtained on 77 transitions of first and positive system. The laser action has been observed on 7 transitions in second positive system and 14 transitions in first positive system. It has been predicted by proper adjustment of laser parameters amplification may be obtained at remaining wavelengths also. Furthermore it has been shown that the vibrational relaxation de-populates the higher vibrational level and populates the vibrational level with v=0. This shows that the population inversion may be generated continuously on about 10 transitions.

Introduction:

The nitrogen discharge delivers laser action on several UV and IR wavelengths belonging to the second and first positive systems. In the present work it has been shown that the population inversion may be obtained on 22 and 55 transitions for the second positive system and first positive system respectively. Furthermore, it is also shown that the population inversion may be obtained continuously on 10 transitions.

Population Inversion:

The electron impact excitation rate coefficient of the electronic system $^{C3} II_u$, $B^3 II_g$ and A^3 u have been obtained as a function of electron temperature from 0 through 20 eV for the Maxewellian velocity distribution of the discharge electrons. The electron impact excitation of the vibrational levels of the electronics states is assumed to be proportional to the corresponding Frank-Condon factor. The numerical computations show that the population inversions are obtained for the transitions emitting the wavelength underlined in the tables 1 and 2. The laser action has been observed on the transitions corresponding to the wavelengths marked by '*' in the tables.

Results and Discussion :

The computations show that the population inversion is obtained on 22 and 55 transitions of the second and first positive system respectively. But the laser action is observed on 7 and 14 transitions only and that too with the proper adjustment of the discharge parameters. The laser action at the remaining wavelength also may be obtained by suppressing laser action at other wavelengths and favoring the amplification at the desired wavelength.

The computations of electron impact excitation rate co-efficient has already shown that the population inversion can be created on 55 transitions of first positives system and 22 transitions of second positive system. The continuous wave laser may be designed and build using molecular nitrogen at about 10

Table - 1 First Positive System (B^3II_g ------- $A^{3+}u$)

$A^3\Sigma^+_u$ ↓ / B^3II_g → V' / V"	0	1	2	3	4	5	6	7
0	10500*	8912*	7753*	6858	6173	5622	5168	4789
1	12300*	10200	8722*	7626	6772	6114	5582	5142
2	14983*	11933*	9906	8576	7504*	6680	6057	5543
3	18700	14200	11500	9599*	8354	7368	6608	6001
4	25100	17600	13646*	11100	8404	8181	7255	6530
5	37500	22900	16500	13000	12700	9173	8474	7147
6	72900	32500	21000	15000	12500	10400	8954	7874
7	940600	55200	28100	17500	14800	12000	10100	8746
8	-88400	174000	44400	25700	18100	14100	11500	9806
9	-42700	157900	95800	57200	23200	17000	13400	11100

Table - 2 Second Positive System (C^3II_u ------- $B^3\ II_g$)

$C^3\ II_g$ ↓ / B^3II_u → V' / V"	0	1	2	3	4
0	3371*	3159*	2976	2818	2684
1	3577*	3338	3135	2961	2812
2	3804*	3536	3309	3115	2952
3	4058*	3754	3499	3284	3102
4	4343	3997	3709	3468	3266
5	4665	4268	3942	3671	3445
6	5032	4573	4220	3894	3641
7	5452	4917	4489	4140	3856
8	5938	5309	4813	4415	4093
9	6506	5759	5180	4722	4355
10	7180	6281	5599	5067	4647

transitions of first positive system and 11 transitions of second positive system.

References:

1) R. S. Kunabenchi, M. R. Gorbal and M. I. Savadatti, Progress in Q-E, Vol-9, No. 4 (1984).

2) Mau Song Chou and Gerald A Zawadzleas, lEEE J. of QE, Vol.QE-17, No. 1 (1981)

3) L. Y. Nelson, G. J. Mullaney and S. R. Byron, Appl. Phys. Letts. Vol. 22, No. 2 (1973).

4) D. C. Cartwright, S. Trajmar, A Chutjian and W. Willians, Phys. Rev. A, Vol. 16, No. 3, 1041-1051 (1977).