lative shift (on the order of 1 cps) of the magnetic nuclear sublevels of the ground state of mercury under the influence of 2537 Å resonant radiation.

ROTATIONAL STRUCTURE OF ULTRAVIOLET GENERATION OF MOLECULAR NITROGEN

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A laser generating in the ultraviolet and using molecular nitrogen was first described in [1]. So far, however, no data on the emission spectrum were published. Yet such data are essential both for an explanation of the physical mechanisms that lead to inversion and emission, and for practical applications. In this communication we present results of an investigation of the emission spectrum.

An ordinary laser was used with external mirrors and with windows at the Brewster angle. The discharge was excited with voltage pulses up to 40 kV in a tube of 3 mm i.d. and a discharge length ~ 90 cm. The current pulse duration was ~1.5 μsec. Mirrors with multilayer dielectric coatings were used, having a transmission ~ 40% in the $\lambda \approx 3370$ Å region, as well as sputtered-aluminum mirrors.

Generation was observed at two bands (0-0 and 0-1) of the second positive nitrogen system $C^3\pi_u \rightarrow B^3\pi_g$. The generation power in the 0-0 band (3371 Å edge) is many times larger than in the 0-1 band (3577 Å edge). A considerable super-radiance effect is observed in the 0-0 band [1]. Radiation with a single mirror has practically the same spectrum ad the generation radiation, and differs only slightly in power. In investigation of the radiation from the tube without mirrors, a sharp increase was observed in several lines, compared with the normal spontaneous emission spectrum. This increase is apparently also connected with the super-radiance effect.

The results presented below were obtained at nitrogen pressures close to optimal: ~ 2 torr for the 0-0 band and ~1 torr for the 0-1 band. Spectrally pure nitrogen was used in the experiments, but impurities apparently play a minor role, for in practice similar generation could be observed when the discharge tube was filled with air.

The generation spectrum was investigated with a DFS-13 spectrograph with a 600 lines/mm grating. The spectrum of the 0-0 band was photographed in third order with dispersion ~1.3 Å/mm, and the 0-1 band in second order with dispersion ~ 2.0 Å/mm. In addition to the generation spectrum, to facilitate interpretation of the lines, we photographed the spectrum of the spontaneous emission. The comparison was against the iron and titanium lines. To eliminate random shifts, the generation spectrum was measured with a large number of plates. The estimated wavelength measurement accuracy is $\Delta\lambda \approx 0.02$ Å for the 0-0 band and $\Delta\lambda \approx 0.04$ Å for the 0-1 band.

The measurement results are listed in Tables 1 and 2.

Table 1

Generation spectrum at 0-0 band of second positive nitrogen system $C^3\pi_u \rightarrow B^3\pi_g$

λ_{meas}, Å air	λ_{tab}, Å air	ν_{tab}, cm^{-1} vacuum	Ω		
			0	1	2
3371.437*	3371.437	29652.46			P8, P9
71.408	71.403	652.76			P7
71.379*	71.377	652.98			P10
71.318	71.320	653.48			P6
71.276	71.278	653.85			P11
71.181	71.185	654.67			P5
71.145*	71.151	654.97		P9	P12
71.087	71.088	655.53		P11	
71.038	71.048	655.88		P7	
3370.992	3370.997	656.33		P12	P4
70.928	70.932	656.90		P6	P13
70.841	70.841	657.70	P11	P13	
	{70.824	657.85	P11, P10		
70.817*	{70.807	658.00	P9		
70.760	70.767	658.35		P5	P3
70.717	70.728	658.69	P8		P14
70.666	70.665	659.25		P14	
70.625	70.623	659.58	P7		
70.557	70.567	660.11	P14	P4	
70.527	70.537	660.37	P14		
70.470	70.480	660.87	P6		
70.441*	70.438	661.24		P15	P15
70.376	70.381	661.75	P15		
70.302	70.302	662.44	P5		
70.161	70.174	663.57	P16	P16	
70.134	70.137	663.90	P16		
70.082	70.088	664.33	P4		
3369.905	3369.907	665.92	P17		
69.838	69.844	666.47	P3	P17	
69.760	69.769	667.13	-	-	-
69.256	69.257	671.64	P1	Q1	
3368.432	3368.428	678.94	P21		P20
3366.912	3366.913	692.30		R4	R4
3365.478	3365.478	704.95			R6
65.425	-	-	-	-	-
3364.903	3364.909	709.98	R7	R7	

* Strongest lines

Table 2

Generation spectrum at 0-1 band of second positive nitrogen system $C^3\pi_u \rightarrow B^3\pi_g$

λ_{meas}, Å air	λ_{calc}, Å air	ν_{calc}, cm^{-1} vacuum	Ω 0	Ω 1	Ω 2
3576.950	3576.950	27948.80			P8
	3576.948	948.82			P7
3576.892	3576.898	949.21			P9
	3576.891	949.26			P6
3576.613*	3576.615	951.42		P8, P9	
	3576.612	951.44			P11
	3576.611	951.45		P9	
3576.112*	3576.119	955.29	P7		
	3576.109	955.37		P4	
	3576.107	955.39	P7	P4	
3575.790	3575.798	957.80	P5		
3575.460	-	-	-	-	-

* Strongest lines

In addition to the measured wavelengths, the tables list the corresponding wavelengths and frequencies of the spontaneous spectrum of nitrogen as given in [3]. The classification of the observed line with respect to definite rotational transitions, given in the last columns, is also based on the data of [3]. These columns indicate the branch to which the given line belongs and the rotational quantum number J of the lower state. No agreement could be obtained for two lines. The values λ_{calc} and ν_{calc} in Table 2 were obtained by calculation from the level tables given in [3].

It is seen from the table that the P-branches play the principal role in the generation and that the maximum of generation intensity corresponds approximately to J = 9. It must be noted, however, that unlike the usual situation, generation, albeit less intense, is observed in the 0-0 band for several R-branch lines.

The investigations of the generation and of the inversion mechanisms will be discussed in greater detail elsewhere.

[1] W. Heard, Nature 16, 667 (1963).

[2] A. D. White and J. D. Rigden, Appl. Phys. Lett. 2, 211 (1963); W. R. Bennett, J. W. Knutson, G. N. Mercer, and J. L. Detch, ibid. 4, 180 (1964).

[3] G. H. Dieke and D. F. Heath, Johns Hopkins Spectroscopic Report No. 17, Baltimore, 1959.

1) The super-radiance effect consists in observation of a directed radiation beam, similar to that of a laser, in the absence of a resonator, i.e., without mirrors or with only one mirror [2].