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RATE OF THE THREE-BODY ATOMIC OXYGEN REACTION FOR THE EXCITATION OF THE AIRGLOW OI (5577 A) LINE*

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Although the reaction

$$\mathrm{O}+\mathrm{O}+\mathrm{O}\rightarrow \mathrm{O}_2+\mathrm{O}(^1S),$$
$$\mathrm{O}(^1S)\rightarrow \mathrm{O}(^1D)+h\nu, \qquad (1)$$

suggested by Chapman,[1] has generally been accepted as the source of the airglow 5577A emission, no experimental measurement of the rate of this reaction has been published. Recent airglow data pertinent to this discussion have been summarized.[2,3] A flux of 2×10^8 photons/cm^2 column sec (200 Rayleighs) is produced in a layer of the upper atmosphere roughly 10 km thick, centered at approximately 100 km height, where the atomic oxygen concentration is estimated at no more than 2.5×10^{12} atoms/cc. If reaction (1) is the source of 5577 A, its rate must be larger than 10^{-34} cc^2/sec. The measurements to be described place an upper bound of 10^{-36} cc^2/sec on this rate, implying that the Chapman reaction is probably not important in the airglow.

The experiment is simple in concept: The flux of 5577A radiation, I, and the concentration of atomic oxygen, [O], are measured under equilibrium conditions established by reaction (1), i.e., where collisional deactivation[4] and chemical reaction are unimportant relative to the radiative losses of O(^1S) atoms. The ratio $I/[\mathrm{O}]^3$ is then the Chapman reaction rate. These conditions are met in the present experiment, where O is produced by the reaction of NO with the N formed by a microwave discharge in flowing N_2.[5] The NO reaction region is optically isolated from a 72-liter bulb in which the 5577A production is observed. Photometric measurements of this intensity were obtained with a birefringent photoelectric photometer similar to that used for the airglow;[6] the instrument was absolutely calibrated[7] to measure photons/cc directly.

The flow rate of O into the observing bulb is equal to that flow rate of NO which is just sufficient to remove all the N by the reaction[8]

$$\mathrm{NO}+\mathrm{N}\rightarrow \mathrm{N}_2+\mathrm{O}. \qquad (2)$$

This flow rate was measured by timing the pressure decrease in a known storage volume, and the titration point was identified by the minimum response of an auxiliary photomultiplier which was sensitive both to the continuum produced by the reaction of NO with O and to the first positive N_2 bands produced by recombination of N. Because of the long residence time (about 30 sec) of the flowing gas in the large bulb, significant recombination of O occurs. The average concentration of these atoms $\bar{n}$ differs from that in the entering stream n_i in a manner which can be obtained from the equation of continuity,

$$Vkn_0\bar{n}^2=J(n_i-\bar{n})/n_0, \qquad (3)$$

where n_0 is the concentration of N_2, J is the total number flow rate, V is the bulb volume, and the recombination coefficient k is taken[9] to be 1.4 $\times10^{-32}$ cc/sec.

Figure 1 shows four sets of correlated experimental measurements as functions of the total pressure. It is seen that the observed 5577A intensity does not vary as the third power of the

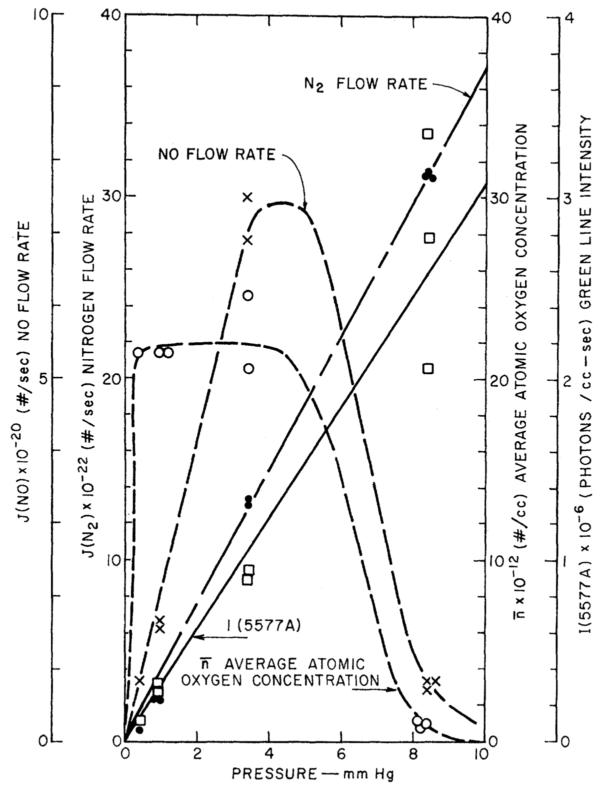

FIG. 1. Experimental results showing that I(5577A) does not vary as $\bar{n}^3$. All ordinates are in absolute units.

atomic oxygen concentration. The Chapman reaction (1), if present, could excite at most only 10% of the observed emission. At a pressure of 0.4 mm Hg we have $\bar{n}=2\times10^{13}$ atoms/cc, while the upper limit of the 5577A flux attributable to the Chapman reaction is 1.5×10^4 photons/cc sec. Therefore the rate coefficient is less than 2×10^{-36} cc^2/sec, which is insufficient by two orders of magnitude for producing the observed airglow intensity.

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COMPARISON OF THE β-α ANGULAR CORRELATIONS IN Li^8 AND B^8 †

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Although the radiations following allowed β decay of unoriented nuclei are uncorrelated in angle with the β rays, forbidden effects may produce correlations of the form $1+B\cos^2\theta$, where the small coefficient B depends on the details of the matrix elements involved. As a possible test of the conserved vector current (C.V.C.) theory,[1] various authors[2,3] have suggested a measurement of the difference, δ, of the B coefficients in the β-α correlations of the two decays: $Li^8(\beta\bar{\nu})Be^{8*}(\alpha)He^4$ and $B^8(\bar{\beta}\nu)Be^{8*}(\alpha)He^4$. Assuming an average strength for the relevant $M1$ matrix element, Bernstein and Lewis[2] predicted $\delta=0.015W_\beta$, where W_β is in Mev and we neglect $m_0{}^2/W_\beta{}^2$. Our preliminary result,[4] $\delta\cong(0.003\pm0.004)W_\beta$, conflicted with this prediction and indicated either the failure of the C.V.C. theory or that the value assumed for the $M1$ matrix element was too large. Since our preliminary measurements, the $M1$ matrix ele-