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$O_2(b^1\Sigma_g^+, v = 0, 1)$ Relative Yield in $O(^1D) + O_2$ Energy Transfer

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Energy transfer from excited $O(^1D)$ atoms to ground-state $O_2(X^3\Sigma_g^-)$ leads to production of O_2 in the first two vibrational levels of the $O_2(b^1\Sigma_g^+)$ state: $O(^1D) + O_2 \rightarrow O(^3P) + O_2(b^1\Sigma_g^+, v = 0, 1)$. Subsequent radiative decay of $O_2(b^1\Sigma_g^+, v = 0, 1)$ to the ground state results in the Atmospheric Band emission, a prominent feature of the terrestrial airglow. The relative yield for production of $O_2(b^1\Sigma_g^+, v = 0, 1)$ in the above process, k_1/k_0, is an important parameter in modeling of the observed O_2 Atmospheric Band emission intensities.

In the laboratory experiments, the output of a pulsed fluorine laser at 157 nm is used to photodissociate molecular oxygen in an O_2/N_2 mixture flowing through a heated gas cell. Photodissociation of O_2 produces a ground-state $O(^3P)$ atom and an excited $O(^1D)$ atom. $O(^1D)$ rapidly transfers energy to the remaining O_2 to produce $O_2(b^1\Sigma_g^+, v = 0, 1)$. The populations of $O_2(b^1\Sigma_g^+, v = 0, 1)$ are monitored by observing emissions in the $O_2(b–X)$ 0–0 and 1–0 bands at 762 and 688 nm, respectively. The value of k_1/k_0 is extracted from the time-dependent $O_2(b^1\Sigma_g^+, v = 0, 1)$ fluorescence signals using computer simulations. We find that production of $v = 1$ is substantially larger than that of $v = 0$.

We will present measurements on k_1/k_0 and its temperature dependence, and discuss the significance of these and other relevant laboratory measurements on the interpretation of the O_2 Atmospheric Band emission.

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