HIGH VIBRATIONAL LEVELS OF $O_2(b^1\Sigma_g^+)$ AND $O_2(a^1\Delta_g)$

K. S. KALOGERAKIS, D. L. HUESTIS, P. C. COSBY, T. G. SLANGER, R. A. COPELAND , *Molecular Physics Laboratory, SRI International, Menlo Park, CA 94025*; A. TOTTH, *Bowdoin College, Brunswick, Me.*

Relaxation of laser-excited $O_2(A^3\Sigma_u^+, v = 6-10)$ in collisions with O_2 populates high vibrational levels of $O_2(b^1\Sigma_g^+)$ and $O_2(a^1\Delta_g)$. Previous work on the spectroscopy of O_2 emissions from the Earth's night atmosphere has enabled us to assign the Q-branches of thirteen (v',v") bands in the (2+1) REMPI spectra of $O_2(b^1\Sigma_g^+, v" = 10-15)$ and $O_2(a^1\Delta_g, v" = 16-19)$, through the intermediate Rydberg levels $3d\pi\ ^1\Sigma_g^+(v' = 2-5)$ and $^1\Delta_g(v' = 4,5)$, repectively.

The derived spectroscopic constants for $O_2(b^1\Sigma_g^+, v" = 10-13)$ agree with our previous work. Improved values are obtained for $v" = 14, 15$. Our constants for $3d\pi\ ^1\Sigma_g^+(v' = 5)$ are the first available. Our spectra are better calibrated and our constants for the $v' = 2-4$ levels significantly more precise than the 1988-1992 work in the groups of Chupka and Houston.

The energies of $O_2(a^1\Delta_g, v" = 16-19)$ were known previously only to within about 80 cm^{-1} from the 1995 electron scattering work of Allan. The highest level known accurately from nightglow spectra is $v" = 11$. Our spectral analysis gives precise rotational constants and ΔG values for these vibrational levels and for $3d\pi\ ^1\Delta_g(v' = 4,5)$. The absolute term energies are uncertain by about 5 cm^{-1} based on earlier work in the groups of Chupka and Houston.

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