O$_2$(c$^1\Sigma_u^+-b^1\Sigma_g^+$) BAND EMISSION IN THE TERRESTRIAL NIGHTGLOW

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Understanding of the spectroscopy of molecular oxygen has benefited from many investigations of the absorption and emission spectra from planetary atmospheres, a number of which we have described previously at this symposium. In the process of line-by-line assignment of “sky spectra” recorded by astronomers using the Keck I and II telescopes, we have discovered a new O$_2$ band system in the 380-450 nm region of the Earth’s nightglow spectrum.

Sharp isolated lines are assigned to the single Q-branch of O$_2$(c$^1\Sigma_u^-,\nu'=5$-11) radiating to O$_2$(b$^1\Sigma_g^+,\nu''=0$-2), with intensities that follow the $J'(J'+1)(2J'+1)\exp[-B J'(J'+1)/kT]$ formula for rotational coupling with $^3\Pi$ states suggested by Wilkinson and Mulliken [1] for the corresponding a'-X transition in N$_2$. Assignment of lines up to $J'=32$ allows for improvement of centrifugal distortion constants for the O$_2$(c) state [2,3], while the measured positions of the low J lines agree with those calculated from known term energies [2-4].

The individual lines in the 9-1 c-b band are as intense as any lines in the Herzberg I (A-X) or Chamberlain (A'-a) bands at wavelengths longer than 365 nm. Surprisingly, Herzberg II (c-X) band emissions are much weaker than expected from previous studies of the terrestrial [5,6] and venusian nightglows [7,8].