$O_2(^5\Pi_g)$, ION-PAIR STATES, AND OXYGEN ATOM RECOMBINATION

D. L. HUESTIS, C. G. BRESSLER, AND R. A. COPELAND, *Molecular Physics Laboratory, SRI International, Menlo Park, CA 94025*.

Collisions of oxygen or nitrogen molecules with laser-excitated high vibrational levels of $O_2(A^3\Sigma_u^+)$ produce a longer lived excited state, whose resonant multiphoton ionization (REMPI) spectrum cannot be assigned to any known singlet or triplet system [1]. We attribute the lower state of this new transition to the predicted [2,3] but previously unobserved $^5\Pi_g$ valence state of O_2. The regular sequence of vibrational bands observed suggests that the upper state is an ion-pair state of O_2, dissociating to $O^+ + O^-$. Two vibrational levels have been observed in the lower state and ten in the upper state, the latter in the range 97,000 to 100,000 cm^{-1}.

Ab initio calculations [2,3] indicate that, although quite weakly bound, at large internuclear distances the $^5\Pi_g$ valence state should be the lowest of the states dissociating to ground state atoms. Because of its high degeneracy it could be a key intermediate state in O + O recombination [4,5]. We are developing a more detailed and quantitative theoretical model of O + O + M collisions. In addition to the experimental spectroscopy and kinetics results, we will also present preliminary work on spin-orbit resolved long-range potential curves for O_2 and implications for oxygen atom recombination and the role of $O_2(^5\Pi_g)$ in predicting atmospheric nightglow emissions [6].

References:

[1] C. G. Bressler and R. A. Copeland, "Collisional Production and Removal of O_2 in the $^5\Pi_g$ State," in preparation.
[2] R. P. Saxon and B. Liu, J. Chem. Phys. **67**, 5432 (1977).
[3] H. Partridge, C. W. Bauschlicher, S. R. Langhoff, and P. R. Taylor, J. Chem. Phys. **95**, 8292 (1991).
[4] P. C. Wraight, Planet. Space Sci. **30**, 251 (1982).
[5] D. R. Bates, Planet. Space Sci. **36**, 875 (1988).
[6] T. G. Slanger and D. L. Huestis, J. Geophys. Res. **86**, 3551 (1981).

Acknowledgments:
This work is supported by the NASA Sun-Earth Connection and Planetary Atmospheres Programs.