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Molecular Oxygen Absorptions from Red to Radio

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Abstract: The terrestrial atmosphere exhibits strong absorptions in the submillimeter through infrared wavelengths by greenhouse gases such as water and carbon-dioxide. Conversely, the bulk atmospheric gases of nitrogen, oxygen and argon only weakly interact with radiation from radio through optical wavelengths, with only oxygen undergoing resonant absorption under various magnetically induced mechanisms. Since oxygen is well mixed and exhibits a constant mixing ratio, the weak resonant absorptions of oxygen are of high value for quantification of bulk atmospheric properties through remote sensing and oxygen emissions can also be useful for remote characterization of the mesosphere. Since joining the molecular spectroscopy laboratory at the Jet Propulsion Laboratory (JPL), I have studied absorption of many atmospheric gases, and have regularly focused on the exceptional experimental cases for oxygen, which lends itself to special techniques such as multipass Fourier-transform, Zeeman modulated, cavity absorption, and emission spectroscopies. Through combinations of these techniques and literature data, the molecular spectroscopy group at JPL has developed a comprehensive spectroscopic linelist for all oxygen transitions from 1 - 15500 cm-1, including isotopologues. Additional experimental efforts provide pressure-induced lineshape parameters and collision-induced absorption models. In this Hans Liebe Lecture I will present the efforts I have made in my career to build upon the legacy of Hans Liebe and describe the experimental and modeling efforts for molecular oxygen in our laboratory. These efforts include: precision measurements of the oxygen A-band near 0.76 microns; emission of oxygen in the mid- to near-infrared; millimeter and submillimeter measurements of singlet Delta oxygen; water-broadening at 60 - 600 GHz; and refractivity and absorption at L-band.

Biography: Dr. Brian Drouin received the B.S. degrees in mathematics and chemistry from the University of Wisconsin in 1995, and his Ph.D. in chemistry from the University of Arizona in 1999. His background in chemistry and mathematics and interest in molecular structure and symmetry, have nurtured an extensive career in molecular spectroscopy to support remote sensing observations. Beginning with microwave spectroscopy of organometallic compounds, his Ph. D. work involved measurement and analyses of highly precise rotational transition frequencies of molecules in cold molecular beams. At JPL he has recorded and analyzed millimeter and submillimeter spectra of both astrophysical and atmospheric molecules while incorporating state-of-the-art hardware and software into novel spectrometers.

Dr. Drouin is now a JPL principal scientist and is responsible for measurements of molecular data for NASA. His research interests include instrumentation for remote detection of far-infrared radiation, atmospheric chemistry, climate change and pollution, low temperature collisional dynamics, molecular spectra and structure, and instrumentation for laboratory and field studies. He has been principal investigator for several major NASA projects involving atmospheric spectroscopy. Dr. Drouin is the primary caretaker for the JPL spectral line catalog used throughout the spectroscopy and remote sensing communities. He is also the Deputy Principal Investigator and Project Scientist for the Polar Radiant Energy in the Far-InfraRed Experiment (PREFIRE) that will quantify the radiative processes effected by changing temperatures in the Arctic.