TERAHERTZ AND INFRARED LABORATORY SPECTROSCOPY IN SUPPORT OF NASA MISSIONS

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The JPL molecular spectroscopy group supports NASA programs encompassing Astrophysics, Atmospheric Science, and Planetary Science. Ongoing activities include measurement and analysis of molecular spectra in the terahertz and infrared regions under conditions akin to the remote environments under study in NASA missions. This presentation will show the implementation of state-of-the-art spectroscopic techniques to fulfill spectroscopic demands of the Herschel Space Observatory[a] and the Orbiting Carbon Observatory re-flight (OCO-2)[b].

A demonstrative example of the significantly improved frequency predictions for the H_3O^+ ground state high-J transitions will be given. This work was critical to Herschel's successful identification of highly excited metastable H_3O^+ Terahertz lines with $J = K$ up to 11, one of the Herschel mission's many surprising observational results. The observation and subsequent laboratory work revealed that (1) these highly excited H_3O^+ lines had already been observed by European Southern Observatory's Atacama Pathfinder Experiment telescope a few years before but had been classified as U-lines; (2) the H_3O^+ number density was previously underestimated by an order of magnitude, due to ignorance of the population in the metastable states.

A second example focuses on O_2, an important absorber from the microwave through the deep UV. This work is motivated by the challenge of developing an accurate and complete spectroscopic characterization of molecular oxygen across a wide frequency range for current and planned Earth atmospheric observations. Especially, OCO-2 utilizes the O_2 A-band for air mass calibration; extremely accurate O_2 molecular data, i.e., line positions with uncertainty on the order of MHz for the A-band around 13000 cm^{-1}, are required to fulfill the demand of the proposed 0.25% precision for the carbon dioxide concentration retrievals.

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[a] G. Pilbratt, J. Riedinger, T. Passvogel, G. Crone, D. Doyle, U. Gageur et al. A&A, 518, L1 (2010).

[b] D. Crisp, B.M Fisher, C. O'Dell, C. Frankenberg, R. Basilio, H. Boesch et al., Atmos. Meas. Tech. 5, 687-707 (2012).