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Update on the TEXES Titan Mid-Infrared Spectral Survey

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Abstract

Titan's complicated atmospheric chemistry consumes methane and produces ethane, propane, heavier hydrocarbons, and eventually the thick haze layers. Much of our knowledge of Titan's atmospheric composition comes from relatively low resolution (R=100-1000) mid-infrared spectroscopy from the Voyager and Cassini missions.[1] Higher resolution (R=10,000-100,000) spectroscopy is required to resolve individual emission lines and especially to separate the relative weak lines of trace species from the very strong lines of the more abundant species.[2] High resolution spectroscopy is also useful as a 'ground-truth' for the analysis of lower resolution spectra that measure the shape of a molecular band rather than the numerous individual lines that combine to form the band.

Using the Texas Echelon Cross Echelle Spectrograph (TEXES) at the NASA IRTF we are undertaking a spectral survey of Titan. TEXES provides the capability of acquiring high-resolution (R=100,000) spectra over a wide bandpass, typically 5-10 cm^{-}1. The goal of this survey is to observe Titan's entire spectrum over the wavelength range 7.7-13.8 μm (725-1300 cm^{-1}), the limits of which are set by the atmospheric window in Earth's atmosphere. At the time of this meeting the spectral survey is approximately half completed.

At this meeting we will present the current status of the survey, including results on allene (CH_2CCH_2). We have tentatively identified several of the ν_{10} subbands of allene amongst the strong emission lines of ethane's ν_{12} 822 cm^{-1} band. The observed spectrum of the $\sim$845 cm^{-1} subband are shown in Figure 1.

Although often searched for, allene has not previously been detected in Titan's atmosphere. We discuss the challenges of identifying and measuring the abundance of allene when line lists and strengths are often in significant disagreement. In the case of allene a commonly used line list[3] predicts significantly stronger emission for the same atmospheric abundance than what is predicted using absorption coefficient spectra empirically derived from cold laboratory spectroscopy. The lack of good line lists and/or high-resolution cold laboratory spectra is a significant obstacle to identifying the many as-yet-unidentified emission lines in the survey's spectra.

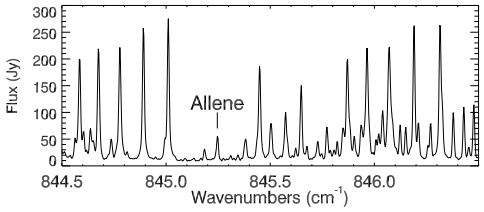

Figure 1: Spectrum surrounding the $\sim$845 cm^{-1} subband of allene, observed with TEXES at the IRTF as part of the TEXES Titan Mid-Infrared Spectral Survey. The spectral resolution is $\sim$90,000.

References

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