

Propane on Titan

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Why study propane on Titan?

Titan is the only moon in our solar system to have a substantial atmosphere. Titan's thick atmosphere is simultaneously analogous to and extraordinarily different from that of Earth. Both atmospheres are composed mostly of nitrogen. Both atmospheres have a major component that can exist as a solid, liquid, or gas (water on Earth, methane on Titan). Both have similar vertical temperature-pressure structures, but Titan's atmosphere is ~200 K cooler.

On Titan a complicated network of photochemical reactions leads from methane (CH_4) to the formation of numerous heavier hydrocarbons, including propane (C_3H_8). Eventually these heavier hydrocarbons land on Titan's surface through rain, snow, haze deposition, and/or other condensation processes.

Propane is one of many end-products of the complicated chemistry of Titan's atmosphere. Measuring the abundances of Titan's hydrocarbons provides an important test of models of Titan's atmospheric chemistry and of our fundamental understanding of chemical and physical processes in an unusual atmosphere.

What's new?

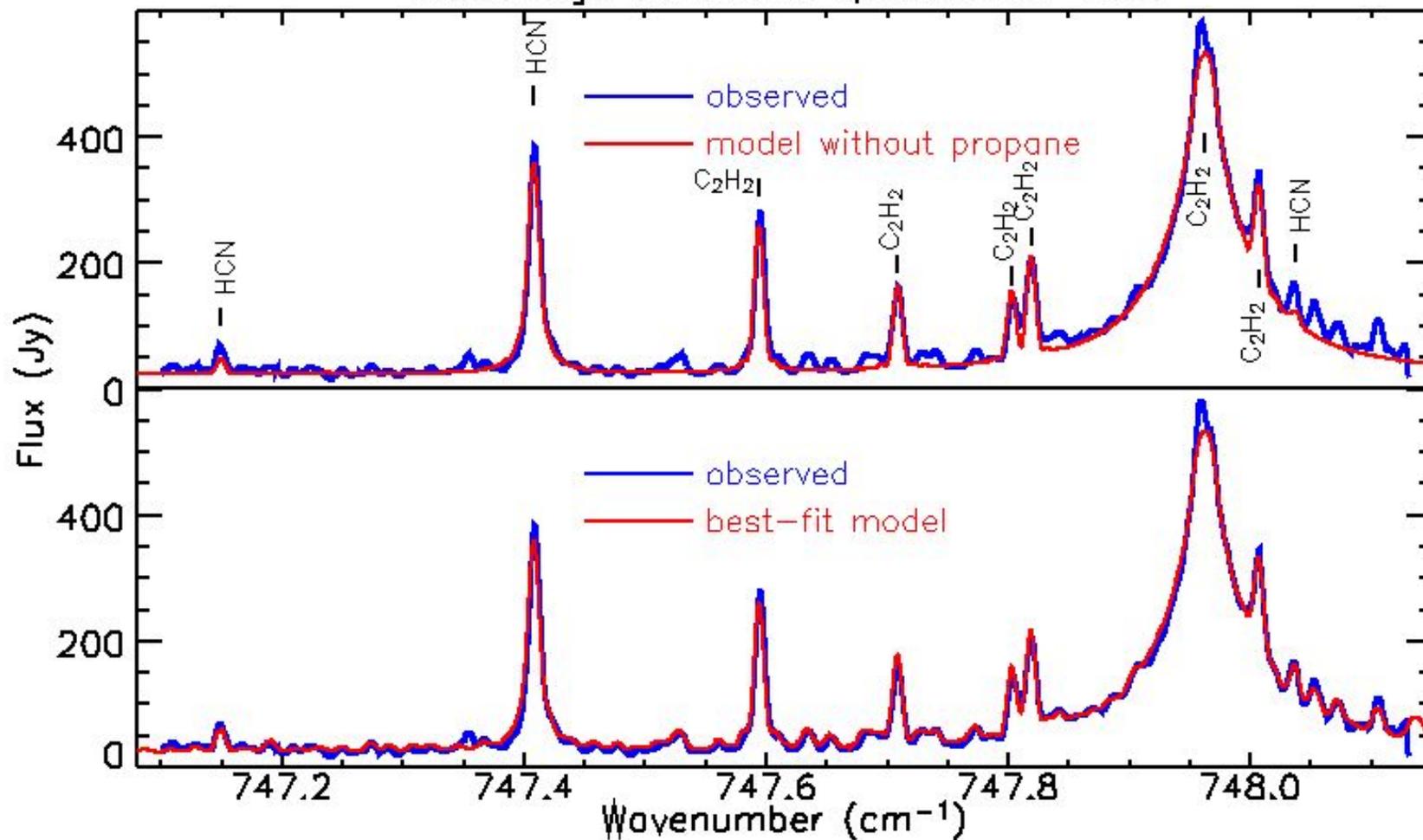
We observed Titan with a spectral resolution of $R \sim 100,000$ using the Univ. of Texas high-resolution 10 micron spectrograph.

As a result we are able to spectrally resolve propane features from acetylene features and for the first time unambiguously detect propane and measure its abundance in Titan's atmosphere.

The next figure shows one section of the spectrum we obtained.

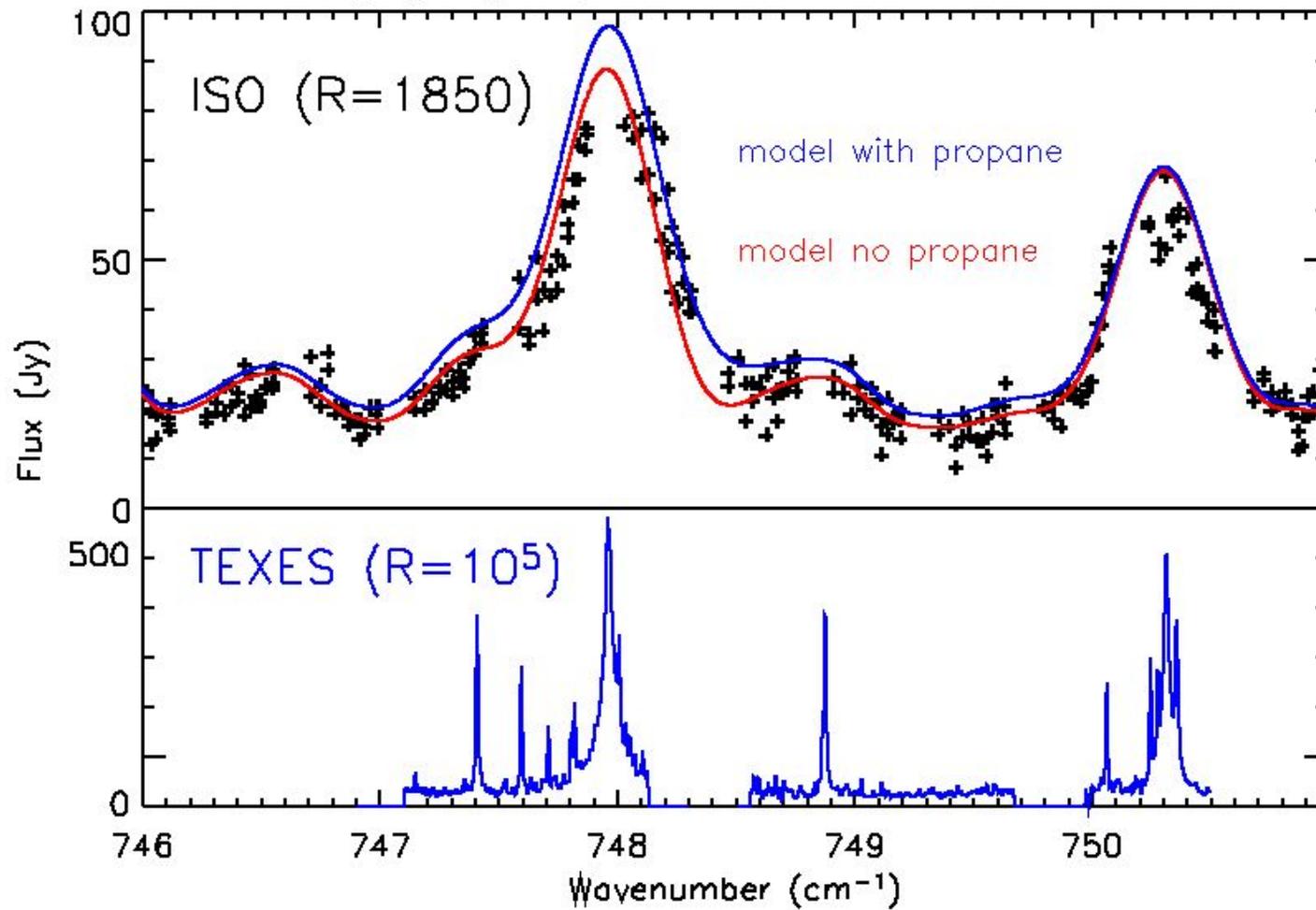
We measured a propane fractional number abundance of $(6.2 \pm 1.2) \times 10^{-7}$.

TEXES high-resolution spectrum of Titan



In the upper panel we fit a model using only C₂H₂ and HCN, leaving many obvious residual features. In the lower panel we include propane in the model and find that nearly every feature is now fitted well.

Why high spectral resolution matters



The upper panel shows the Infrared Space Observatory spectrum of Titan. Overplotted on the ISO spectrum are the model spectra (with and without propane) from our work. The lower panel shows our new high resolution spectrum of Titan. Note the different vertical scales. The high resolution of TEXES is clearly required for a definitive detection of propane.