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Titan's Propane from Cassini Infrared Spectroscopy

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Propane gas (C_3H_8) was first detected in the atmosphere of Titan by the Voyager 1 IRIS spectrometer, during the 1980 encounter (Maguire et al., 1981), and remains the heaviest saturated hydrocarbon (alkane) found there to date. Although the identification was based on the detection of several bands (including 748, 922, 1054, 1158 cm^{-1}), only the ν_{26} band at 748 cm^{-1} has been subsequently modeled to retrieve the abundance, due to the unique availability of its line parameters in the GEISA database (Husson et al. 1992). Subsequent measurements from the ground (Roe et al., 2003) and Earth-orbit (ISO - Coustenis et al. 2003) have also focused on this one band, deriving an abundance of $\sim$0.5 ppm, although it remains compromised by coincidence with the R-branch of the much stronger acetylene (C_2H_2) gas.

The Composite Infrared Spectrometer (CIRS) instrument carried on-board the Cassini spacecraft in Saturn orbit has now been observing Titan during more than 50 flybys over 5 years, and offers a fresh perspective on the prevalence of propane. With much improved spectral and spatial resolution and sensitivity over IRIS, CIRS is also able to perform repeated limb sounding (viewing through the atmosphere above the surface) to increase signal-to-noise still further. Modeling and removal of the emissions of other gases now shows clearly for the first time a multitude of propane bands: including the four seen by IRIS and at least four others (869, 1338, 1376, 1472 cm^{-1}).

In addition, a new line atlas for three bands of propane at shorter wavelengths (1300-1500 cm^{-1}) has now been compiled, based on the work of Flaud et al. (2001). With this, we now have the potential to model these weaker bands, and to check the measurements made by CIRS using the 748 cm^{-1} band alone. Preliminary analysis has shown that the retrievals are very sensitive to the spectral baseline (haze model) assumed, and that existing lab tholin spectral properties (Khare et al. 1984) do not well match the opacity in this spectral region.

In this paper, we present the CIRS spectra showing all the visible propane bands, with a view to stimulating laboratory spectroscopic study of the remaining mid-IR bands (especially at 869, 922, 1054 and 1158 cm^{-1}). We also report on our progress in the modeling of the 6-8 and 13 micron bands, and give an update on the propane abundance at low latitudes.

References:

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