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Titan's Stratosphere: Isotopic Ratios in CO and HCN

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Abstract

Simultaneous observations of HCN (4-3), $H^{13}CN$(4-3) and $HC^{15}N$(4-3) rotational transitions from Titan's stratosphere were observed in spring 2011 using the Submillimeter Array (Mauna Kea, Hawaii). The broad bandwidth coverage coupled with high spectral resolution provide a very sensitive measure of the relative abundances of these molecular species. We also report on continued investigations of CO isotopes using archival SMA data to constrain the global $^{12}C/^{13}C$ and $^{18}O/^{16}O$ ratios in carbon monoxide.

1. Introduction

Isotopic ratios from planetary atmospheres represent a path to study atmospheric origin and evolution, as well as fractionation effects. Isotopic ratios of many species in the Titan upper atmosphere have been determined from ground-based ([1], [2], [3]) and spacecraft based ([4], [5], [6], [7], [8]) measurements.

2. New HCN Observations

Here we report on new ground-based observations of the HCN(4-3) rotational transition at 354.505 GHz along with two isotopic variants. The data were obtained in April and May 2011 using the Submillimeter Array (SMA) as part of a program to detect HNC(4-3) at 362.63 GHz. Results on HNC are reported in Moreno et al (this meeting). Data were obtained simultaneously in two receivers to cover the HCN primary line, the HNC line, and the HCN isotopic variants. The data for each day were spectrally shifted and resampled to accurately account for the different LOS velocities at the times of observation, and the resulting spectra are shown in Figures 1 and 2.The HCN+variants will be used to constrain the relative isotopic ratios of $^{12}C/^{13}C$ and $^{14}N/^{15}N$ in HCN and to investigate the vertical profile of each species. For example the HCN line shows unique structure at the line core, which is related to the HCN abundance at high altitudes (~400 km altitude; see Fig. 2 inset).

3. HCN Submillimeter Spectra

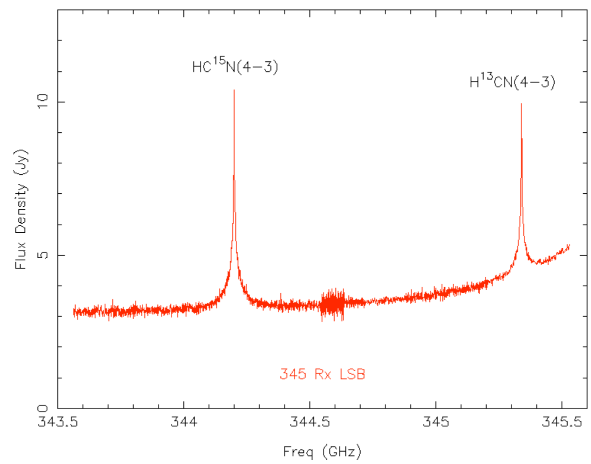

Figure 1: SMA observations of HCN isotopic variant rotational transitions. These lines lie on the broad wing of the CO(3-2) transition centered at 345.8 GHz. The 345 receiver lower sideband (LSB) is shown.

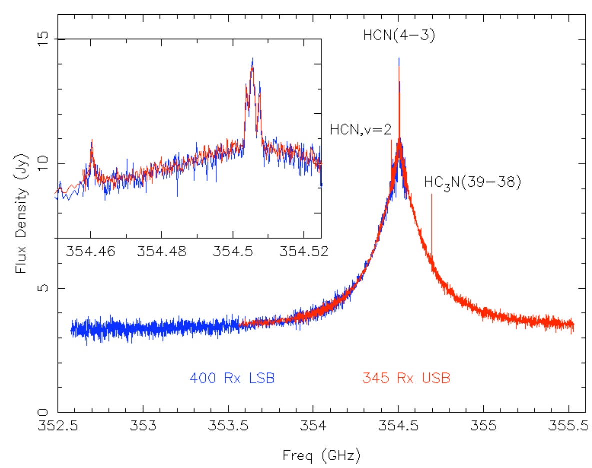

Figure 2: SMA observations of HCN(4-3) along with vibrationally excited HCN and HC_3N(39-38). Data shown represent the USB of the 345 receiver, and the LSB of the 400 receiver; the 400 receiver USB is shown in Moreno et al (this meeting). The inset shows the inner line core HCN hyperfine structure.

4. Reanalysis of $^{12}C/^{13}C$ and $^{16}O/^{18}O$ Isotopic Ratios from CO

In addition to HCN isotopic studies, we will present an improved analysis of our 2008 preliminary findings on the $^{12}C/^{13}C$ and $^{16}O/^{18}O$ ratios in stratospheric carbon monoxide (Gurwell, 2008 DPS meeting), using more recent archival SMA data on $C^{18}O$(3-2) at 329.3 GHz and improved calibration for observations of $C^{18}O$(6-5) at 658.5 GHz.

Acknowledgements

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