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Ground-based monitoring of atmospheric species on Titan and a search for new nitriles with IRTF/TEXES

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The atmosphere of Titan is known to be a laboratory of complex organic chemistry. (Coustenis, 2021) From the Voyager missions, and later the Cassini-Huygens mission, several hydrocarbons and nitriles have been detected and their seasonal variations have been monitored during a period of one Titan season (30 years). Other minor species have been detected from the ground mainly in the millimeter range or using space-borne observatories like ISO. These results have been included in photochemical models that have also predicted the presence of other minor species, among which some have infrared transitions in the 5-25- μm spectral range where propane (C_3H_8) and allene (CH_2CCH_2) have already been detected. We have started an observing program using the TEXES thermal infrared imaging spectrometer at the Infrared Telescope Facility (Mauna Kea Observatory) to monitor the infrared signatures of hydrogen cyanide (HCN) and cyanoacetylene (HC_3N), along with acetylene (C_2H_2 and C_2HD). In addition, we have been searching for cyanopropyne ($\text{C}_4\text{H}_3\text{N}$) and isobutyronitrile ($\text{C}_4\text{H}_7\text{N}$) in the 20-micron region. High-resolution spectra of Titan with TEXES were recorded before where Lombardo et al. (2019) measured HNC (hydrogen isocyanide) in Titan's lower stratosphere (1 ppb around 100 km), which is the first time HNC has been measured at these altitudes. In September 2022 we obtained spectra of Titan in the following spectral ranges: (1) 498-500 cm^{-1} (C_2HD , HC_3N , search for $\text{C}_4\text{H}_3\text{N}$); (2) 537-540 cm^{-1} (C_2HD , search for $\text{C}_4\text{H}_7\text{N}$); (3) 744-749 cm^{-1} (C_2H_2 , HCN); (4) 1244-1250 cm^{-1} (CH_4). Observations are presently being processed. In 2023, laboratory spectra of cyanopropyne and isobutyronitrile have been recorded at Sorbonne Université in the 495-505 cm^{-1} and 510-570 cm^{-1} spectral ranges, respectively, with a spectral resolution of 0.01 cm^{-1} and 0.056 cm^{-1} (Coustenis et al., 2023). Cross sections have been derived for these two molecules and upper limits will be derived for these two molecules in the atmosphere of Titan. TEXES data will also be used for a study of the variations of HCN and HC_3N since the end of the Cassini mission, and for a retrieval of D/H from $\text{C}_2\text{HD}/\text{C}_2\text{H}_2$.

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