Condensed-Phase Photochemical Processes in Titan's Aerosols and Surface: The Role of Longer Wavelength Photochemistry

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Abstract

We will discuss photochemical properties of Titan's organic molecules in the condensed phase as solid aerosols or surface material, from small linear polyyenes (polyacetylenes and polycyanoacetylenes) such as C_2H_2, C_4N_2, HC_5N, etc. In particular we will focus on photochemistry caused by longer wavelength UV-VIS photons (>250 nm) photons that make it through Titan's atmosphere to the haze region (~100 km) and on to the surface of Titan.

1. Introduction

Photochemistry of nitrogen and methane dominated Titan's atmosphere results in the formation of larger organics [1-5] that form the haze region in its lower atmosphere (<100 km) [6, 7] and finally rain down on to Titan's surface [8, 9]. It is assumed that photochemistry is only confined to the upper atmosphere, where high-energy UV photons, electrons, Saturn's magnetospheric particles, and solar wind make their way through. At lower altitudes, due to the lack of high-energy radiation source (other than cosmic rays), it is expected that no further photochemistry could occur. Recent data from Cassini-Huygens [10] indicates that solar light at wavelengths >350 nm makes its way through the haze region on to the surface (modulated by Titan's methane atmosphere). Thus, it is important to understand whether these UV-VIS photons can induce photochemistry in Titan's atmosphere, in particular in condensed-phase organics present in the atmosphere as well as on the surface.

2. Laboratory Experimental Studies

At the *Titan's Organic Aerosol chemiSTry (TOAST)* lab of JPL, we investigate spectroscopic and photochemical properties of Titan's atmospheric molecules such as cyanoacetylenes. As these molecules can't be transported easily, we built dedicated laboratory to synthesize these molecules on the spot and use them for spectroscopic and photochemical studies. We carried out laser irradiation studies using 532 nm, 355 nm, and 266 nm (Nd-YAG laser 2^{nd}, 3^{rd}, and 4^{th} harmonics). IR and UV spectra are monitored simultaneously to follow the reaction kinetics and reaction products.

Our focus is to determine whether at these wavelengths photochemical reactions involving Titan's organic molecules in condensed aerosol haze or on the surface can occur or not. In this talk we will discuss theoretical predictions and experimental findings on the longer wavelength photochemical behavior of Titan's organics.

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