Titan's Upper Atmosphere: The Great Escape?

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The talk will focus on the escape rates of methane and molecular hydrogen from Titan's upper atmosphere. I will argue that the escape rate of molecular hydrogen is governed by Hunten's limiting flux principle and that it is ~ 1×10^{28} H_2 s^{-1}, derived from diffusion modeling of the data (Cui et al., 2011), the Hunten limiting rate, and numerical solutions to the fluid equations, (Strobel, 2011). This actual escape rate is ~ 1.5 (not 2.5) times the Jeans escape rate (~ 6 ×10^^{27} H_2 s^$^{-1}$) in agreement with the Volkov et al. (2011a) results for larger values of the Jeans lambda parameter and confirms that the Jeans escape rate is not accurate for H_2 in Titan's atmosphere.

The inferences of large escape rates are derived from measured INMS density profiles in the thermosphere and diffusive solutions to the fluid equations where the atmosphere behaves as a continuum fluid. While there are a few flybys where the INMS density profiles can be fit with a gravitational, diffusive equilibrium profile with no upward flux, the majority of the INMS density profiles individually and when averaged require upward fluxes with escape rates in the absence of chemistry. The escape problem is thus seemingly intractable, if its escape rate must be constrained to typical non-thermal rates.

Neither vigorous vertical mixing, which is inconsistent with the mole fraction profile and makes it even more difficult to account for the elevated H2 mole fractions measured by INMS (Strobel 2011), nor the aerosol trapping mechanism which was formulated by Bell et al. (2010) to be most effective below altitudes probed by INMS are solutions. An extremely large chemical loss of due to magnetospheric particle ionization would reduce the escape rate to desired rates, but Cassini magnetospheric measurements rule out the required particle fluxes by at least an order of magnitude. Finally, there has been no reported detection of carbon bearing ions in the outer magnetosphere of Saturn commensurate with the large inferred CH_4 escape rates.