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Methane Group Ions Produced by Titan's Exosphere and Ionosphere

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We will be presenting results of methane ions that can be injected into Saturn's magnetosphere as pick up ions from Titan's exosphere and outflowing methonium ions CH_5^+, the $HCNH^+$ ion and the ethenium ions $C_2H_5^+$ from Titan's ionosphere. Ionospheric outflows have been seen during the T9 flyby (Sittler et al., 2010), and the T63 and T75 flybys (Coates et al., 2012) where source rates to magnetosphere can be significant $\sim$ 4.0x10^{24} ions/s. When methane pickup ions are born within Titan's exosphere and convective electric field points outward these ions will populate Saturn's magnetosphere, while inward convective electric field (Saturn side for dipolar magnetospheric fields) will heat the upper atmosphere and exosphere. Using 1D exosphere Westlake et al. (2011) found that the exosphere was hotter and more extended when Titan was within Saturn's sheet, while in lobe like regions of magnetosphere the exosphere is cooler. Using a 3D exosphere model, which can include winds and asymmetric heating at exobase to model methane pickup ion densities; we estimate that when within Saturn's sheet the exobase T $\sim$ 190° K and the estimated density is $\sim$ 2x10^{-3} ions/cm^3 which are observable, while in lobe like regions exosphere T $\sim$ 110° K and densities $\sim$ 10^{-6} ions/cm^3 not observable. The heating from methane pickup ions can be complex depending upon magnetic field geometry, dipolar (heating on Saturn side) and disc geometry (below sheet north polar heating and above sheet south polar heating). This CH_4^+ pickup ion density difference we estimate can be used by the CAPS ion instruments to determine if the magnetosphere is in the sheet (also plasma sheet usually dominated by water group ions with O^+ ions) or lobe state (light ions H^+/H_2^+ dominating the composition). We find CH_4^+ pickup ions for T36 and T39 flybs when Titan is within Saturn's magntospheric sheet, while during T41 when within lobe regions of Saturn's magnetosphere CH_4^+ pickup ions were not observed. But for T41 the magnetic field was equatorially confined so during approach from within Titan's wake Cassini was magnetically connected and ionospheric outflows like T9 were observed. We will discuss the compositional signatures in the CAPS IMS data and the likely chemistry of Titan's ionosphere.

References:

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