

Enceladus Plume Composition

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Abstract

Measurement differences seen in flyby E7 (2 November 2009) as opposed to E5 (9 October 2008) provide some indication of decreased concentration of most organic species and no indication of ^{40}Ar suggesting changes with time or encounter conditions. Exceptions to the decreases in the minor species concentrations include H_2S , HCN , and NH_3 . Tentative measurement of H_2 outflow was observed with mixing ratios $<8\%$.

1. Introduction

The gaseous composition as measured by the Cassini Ion Neutral Mass Spectrometer has been used to infer a plume composition composed mainly of water vapor with percentage amounts of carbon dioxide, ammonia, carbon monoxide and/or molecular nitrogen, and smaller amounts of methane, a combination of acetylene, hydrogen cyanide, and ethylene, propene, argon, and other trace organics (benzene, methanol, formaldehyde, etc) [1]. High signal to noise values on the fifth Cassini flyby of Enceladus allowed the determination of a D/H ratio in water of 2.9×10^{-4} [1] similar to values observed in Oort cloud comets to date and suggesting some similarities in conditions during formation. The high value of inferred ^{40}Ar suggests liquid processes in the interior [1].

2. Comparing Flybys E5 and E7

Figure 1 compares the mass spectra acquired during flyby E7 with the spectra from E5 reported earlier [1]. Several tentative conclusions can be drawn from this comparison. The NH_3 detection is consistent with previous measurements, $\sim 1\%$. However, ^{40}Ar is not detected in E7 and an upper limit of 4×10^{-5} is determined ($\sim 10\%$ of that inferred at E5). E5 had 30x higher signal than E7 at mass 40. The mass group from 24 to 30 Daltons is different in character for E7 as opposed to E5 and HCN is a necessary

component of the deconvolution to provide a proper fit for the E7 mass spectra. We still require N_2 and/or CO at mass 28 in our mass spectral deconvolution, but cannot discriminate between them. The solar occultation results from UVIS on E10 may reduce this ambiguity. D/H cannot be calculated from E7 (The E5 determination of D/H was very fortuitous due to the high flyby velocity), but the $^{18}\text{O}/^{16}\text{O}$ is consistent with previous results. In general, most organic species are depleted with respect to E5 by approximately 1 order of magnitude. The exceptions are H_2S , HCN , NH_3 , and CO or N_2 . H_2 is observed with a mixing ratio of $\sim 8\%$. However, we are still trying to sort out if the H_2 is due to H_2O wall interactions or is it a component of plume gas? CH_3OH is clearly present.

3. Comparison of Mass Spectra

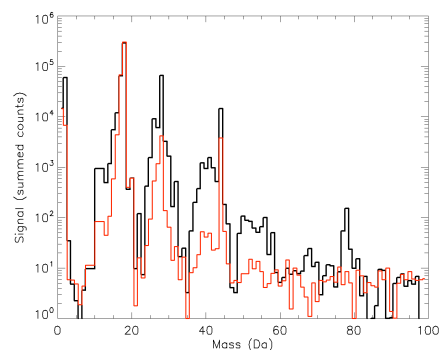


Figure 1: Comparison of E5 and E7 mass spectra.

(2)

4. Summary and Conclusions

We are still trying to sort out if the compositional differences between flybys E5 and E7 are due to sampling of different source regions, temporal

variability, or results from instrument internal effects due to the differences in the flyby speed: E5 – 17.7 km s⁻¹ versus E7 – 7.8 km s⁻¹?

Acknowledgements

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References

[1] J. H. Waite, Jr. et al.: Liquid water on Enceladus from observations of ammonia and ⁴⁰Ar in the plume, *Nature*, Vol. 460, pp. 487-490, 2009.