EPSC Abstracts
Vol. 11, EPSC2017-230, 2017
European Planetary Science Congress 2017

Saturn's Magnetospheric Plasma Flow Encountered by Titan

I. Sillanpää

Finnish Meteorological Institute, Helsinki, Finland
(ilkka.sillanpaa@fmi.fi, twitter: @samooja)

Abstract

Titan has been a major target of the ending Cassini mission to Saturn. 126 flybys have sampled, measured and observed a variety of Titan's features and processes from the surface features to atmospheric composition and upper atmospheric processes. Titan's interaction with the magneto-spheric plasma flow it is mostly embedded in is highly dependent on the characteristics of the ambient plasma. The density, velocity and even the composition of the plasma flow can have great variance from flyby to flyby. The plasma properties have not yet been analyzed for all Titan flybys. Our purpose is the present the plasma flow conditions for all over 70 flybys of which we have Cassini Plasma Spectrometer (CAPS) measurements.

1. Introduction

The plasma flow in the outer parts of Saturn's magnetosphere is very variable in density (up to two orders of magnitude), velocity (in both speed and direction), and composition (the oxygen or water ion content can very from none existent to dominating the plasma pressure and possibly even the number density). This has been demonstrated in previous studies, e.g. [1].

Westlake et al. and Bell et al. [2, 3] have simulated the drastic effects of changing plasma flow conditions to the temperature of Titan's upper atmosphere and the density variations there.

There have been previous studies of the magnetic environment [4] and the ambient electron fluxes [5] but the main plasma parameters such as ion density, total pressure, plasma velocity and composition have not been collected to statistically analyze the environment Titan is embedded in.

FINNISH METEOROLOGICAL INSTITUTE

Sillanpää et al. [6] showed the importance of even a small oxygen ion contribution to the overall interaction between Titan's atmosphere and the ambient plasma. Our plan is collect and analyze the statistics of the plasma conditions encounter by Titan.

2. Analyzing plasma flow conditions

Cassini has been orbiting Saturn since 2004 and has had a total of 126 flybys of Titan. The Cassini mission will end in September 2017 when it will be directed to Saturn atmosphere. Cassini Plasma Spectrometer and its IMS instrument have provided important ion measurement from the flybys. There developed a short circuit in CAPS in the summer of 2011, after which no further Titan flyby measurements were obtained by CAPS. However, there are the results of over 70 flybys that will be analyzed in the planned study.

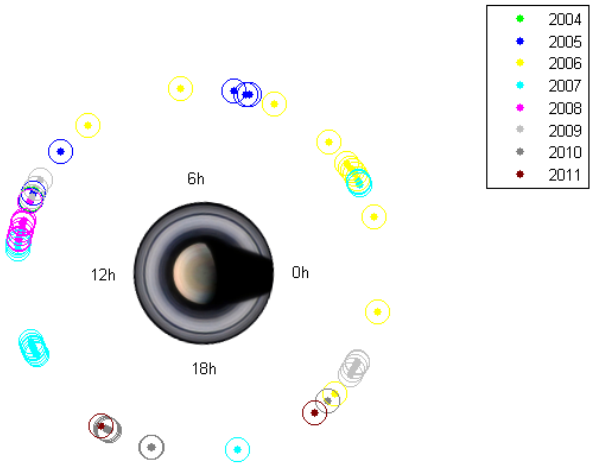

Figure 1: The relative locations of Cassini's Titan flybys, which have CAPS measurements available. Titan's orbit is about 20 Saturn radii from Saturn.

The importance of providing the plasma conditions for each flyby has been demonstrated by the numerous case studies that have been made with limited number plasma conditions around Titan analyzed. Such a data set combined with the numerical simulations of Titan's interaction (such as [7,8]) we believe that an accurate estimate of the total plasma outflow from Titan over Cassini's mission can be obtained.

References

[1] Thomsen, M.F., Reisenfeld, D.B., Delapp, D.M., Tokar, R.L., Young, D.T., Crary, F.J., Sittler, E.C., McGraw, M.A., and Williams, J.D., Survey of ion plasma parameters in Saturn's magnetosphere, J. Geophys. Res., 115, A10220, doi:10.1029/2010JA015267, 2010

[2] Westlake, J., Bell, J.M., Waite, J.H., Johnson, R.E., Luhmann, J.G., Mandt, K.E., Magee B.A., and Rymer, A.M.: Titan's thermospheric response to various plasma environments, J. Geophys. Res., 116(A3), doi:10.1029/ 2010JA016251, 2011.

[3] Bell, J., Westlake, J., and Waite, J.H.: Simulating the time-dependent response of Titan's upper atmosphere to periods of magnetospheric forcing, Geophysical Res. Lett., 38(6), doi:10.1029/2010GL046420, 2011.

[4] Simon, S., Wennmacher, A., Neubauer, F.M., Bertucci, C.L., Kriegel, H., Saur, J., Russell, C.T., and Dougherty, M.K.: Titan's highly dynamic magnetic environment: A systematic survey of Cassini magnetometer observations from flybys TA – T62, Plan. Space Sci., 58(10), doi:10.1016/j.pss.2010.04.021, 2010.

[5] Rymer, A.M., Smith, H.T., Wellbrock, A., Coates, A.J., and Young, D.T., Discrete classification and electron energy spectra of Titan's varied magnetospheric environment, Geophys. Res. Lett., 36, L15109, doi:10.1029/2009GL039427, 2009.

[6] Sillanpää, I., Young, D.T., Crary, F., Thomsen, M., Reisenfeld, D., Wahlund, J-E., Bertucci, C., Kallio, E., Jarvinen, R., and Janhunen, P., Cassini Plasma Spectrometer and Hybrid Model Study on Titan's Interaction: Effect of Oxygen Ions, J. Geophys. Res., 116, doi:10.1029/2011JA016443, 2011.

[7] Sillanpää, I., and Johnson, R.E., The Role of Ion-Neutral Collisions in Titan's Magnetospheric Interaction, Planetary and Space Science 108, doi:10.1016/ j.pss.2015.01.007, 2015.

[8] Sillanpää, I., Kallio, E., Janhunen, P., Schmidt, W., Harri, A.-M., Mäkinen, T., Mursula, K., Vilppola, J., and Tanskanen, P., Hybrid Simulation Study of Ion Escape at Titan for Different Orbital Positions, Advances in Space Research 38, p. 799 – 805, 2006.