Abstract

Cassini at Titan and Enceladus

W.T. Kasprzak1, H.B. Niemann1, S. Atreya8, J. Demick-Montelara1, T. Owen9, E. Raen1, J. Haherelman1, E. Patrick1, J. H. Waite2, R. Yelle3, T.E. Cravens4, J. Luhmann5, R. McNutt6, W. Ip7, I.P. Robertson4, S. Ledvina5, H.B. Niemann1, G. Fletcher2, R. Thorpe7, D. Gell2, B. Magee2, M. Benna1, A. Simon-Miller1, NASA/GSFC, Code 699, Greenbelt, MD 20771. wayne.t.kasprzak@nasa.gov, 2SwRI, 6220 Culebra Road, San Antonio, TX, 78238. hwaite@swri.edu, 3University of Arizona, Tucson, AZ 85721. yelle@lpl.arizona.edu, 4University of Kansas, 1082 Malott Hall, Lawrence, KS 66045-2151. cravens@ku.edu, 5SSL, University of California, Berkeley, CA 94720-7450. jgluhman@ssl.berkeley.edu, 6APL JHU, 11100 Johns Hopkins Rd., Laurel, MD 20723-4638. ralph.mcnutt@jhuapl.edu, 7National Central University, Chung Li 32054, Taiwan. wingip@astro.ncu.edu.tw, 8University of Mich., Ann Arbor, MI48109-2143. 9University of Hawaii, Honolulu, HW 96822.

Introduction: The Huygens Gas Chromatograph Mass Spectrometer (GCMS) [2] and Cassini Orbiter Ion and Neutral Gas Mass Spectrometer (INMS) [1] were built at GSFC. The INMS probes the upper atmosphere/ionsphere of Titan above 950 km on repeated flybys. The GCMS instrument was opened to the lower atmosphere of Titan at 147 km altitude and obtained gas composition data during the 2 hour and 27 minute descent of the probe to the surface on Jan. 14, 2004 with another 70 minutes of data obtained on the surface before loss of communications with the orbiter.

Titan: The primary goal of the INMS during flybys of Titan is a determination of the neutral gas and thermal ion abundance. The INMS verified that the upper atmosphere consists of mainly CH4 and N2 with traces of other hydrocarbons and nitriles. Isotopic 40Ar has been detected along with H2 [6]. The ionsphere composition has a complex carbon-nitrile chemistry that includes hydrocarbons up to at least C7 that have been detected [3,14]. A “hot” component of the neutral atmosphere has been detected [12] due to plasma-ion induced heating.

The GCMS instrument also confirmed that the main constituents of Titan’s lower atmosphere are N2 and CH4 [7] with the near surface ratio of CH4 (~5%) higher than that observed in the stratosphere (1.4%) [9]. Heavier mass molecules are not present in the lower atmosphere and the organic chemistry seems concentrated in aerosols. Isotopic ratios for 12C/13C, 14N/15N , 36Ar/40Ar and the absence of the heavier noble gases Kr and Xe suggest a history for Titan’s atmosphere.

Water Ions in Saturn’s Ring System: The INMS detected ions H+, O+ and O2+ just prior to the ring plane crossing [13]. O2 suggests a tenuous atmosphere of neutral O2 created by dissociation of water with the atomic O forming O2 by ion chemistry or icy surface reactions and loss of H2 into Saturn’s environment.
Enceladus Plume Vapor: On a close fly-by (E3; July 14, 2005; 168 km altitude) of this icy satellite, INMS [4] found the plume atmosphere to be primarily H$_2$O with traces of N$_2$ and/or CO, CH$_4$ and CO$_2$ plus C$_2$H$_2$ and C$_3$H$_8$. VIMS stellar occultation results imply that CO is not present. Enceladus is like Titan with N$_2$ derived from NH$_3$ delivered to the bodies although NH$_3$ was not detected. The source of the gas are jets issuing from the higher temperature fractures in the south polar region crust plus a sputtered gas source. The origin and lifetime of the jets is still being debated.

The gas/ice-particle plume is the main contributor to the E-ring. The Cassini magnetic field results [5], along with the high bolometric albedo [10] were the first indications of an active water gas source on Enceladus that was finally observed in the flyby E3.