SM44A-02 1550h INVITED

The Martian ionospheric loss rates versus solar EUV flux

Stephen H. Brecht[1] (925-254-3865; sbrecht@pacbell.net)

Stephen A. Ledvina[2] (510-643-1352; ledvina@ssl.berkeley.edu)

Janet G. Luhmann[2] (jgluhman@ssl.berkeley.edu)

[1]Bay Area Research Corp., P.O.Box 366, Orinda, CA 94563, United States

[2]Space Sciences Laboratory, University of California, Berkeley, Berkeley, CA, United States

One of the outstanding questions of Martian aeronomy is the loss rate of atmospheric ions to the solar wind. The outer atmosphere is exposed to the solar wind convection electric field and thus it is expected, and confirmed by observations, that Mars loses its outer ionosphere due to ion pickup. The importance of this loss process relative to other loss processes is however undetermined. For example, oxygen is lost by photochemical escape and pickup ion sputtering in addition to direct ion pickup. The absolute and relative rates are further variable since they are determined bysolar extreme ultraviolet flux as well as solar wind parameters. Using global hybrid simulations of the solar wind interaction with Mars, including an oxygen ionosphere and exosphere, we investigate the dependence of the pickup ion loss rate on solar EUV and solar wind conditions including the interplanetary magnetic field direction. Strategies and sensitivities to Mars ionospheric models will also be discussed within the context of numerical issues to be addressed. This research is ongoing and will report comparisons to theoretical by other researchers. In addition, studies including issues concerning resolution of the simulations will be presented.

SM44A-03 1610h

3D global MHD simulation of the interaction between Saturn's magnetosphere and Titan's atmosphere/ionosphere

YingJuan Ma[1] (734-647-3370; yingjuan@umich.edu)

Andrew F Nagy[1] (anagy@umich.edu)

Thomas Cravens[2] (cravens@ku.edu)

Igor Sokolov[1] (igorsok@umich.edu)

[1]Space Physics Research Laboratory, University of Michigan, Ann Arbor, MI 48109

[2]Dept Physics Astronomy, Univ Kansas, Lawrenc, KS 66045

We present our simulation results of the interaction between Saturn's magnetospheric plasma flow and Titan's atmosphere/ionosphere by using a multi-species global MHD model. A chemical model is used to describe Titan's atmosphere/ionosphere, which is based on 10 neutral and 7 ion spieces. This new model uses spherical coordinates (similar to our Mars model) leading to very good(28km) altitude resolution. The simulation results are compared with the Voyager measurements and we also discuss our plans for the anticipated Cassini observations.

SM44A-04 1630h

The Response of the Magnetotails of Earth and Jupiter to a Rotation of the Interplanetary Magnetic Field

Raymond J Walker[1] (310-825-7685; rwalker@igpp.ucla.edu)

Tatsuki Ogino[2] (ogino@stelab.nagoya-u.ac.jp)

Keiichiro Fukazawa[2] (fukazawa@stelab.nagoya-u.ac.jp)

[1]Institute of Geophysics and Planetary Physics and Department of Earth and Space Science, UCLA, Los Angeles, CA 90095-1567, United States

[2]Solar Terrestrial Environment Laboratory, Nagoya University, Toyokawa, Japan

It has long been recognized that the solar wind and its interplanetary magnetic field (IMF) drive magnetospheric dynamics at the Earth. Jupiter's magnetosphere on the other hand is dominated by a massive rotating equatorial plasma sheet and the solar wind and the IMF are not thought be as important as at Earth. We have carried out global MHD simulations of the response of the magnetospheres of the Earth and Jupiter to northward and southward turnings of the IMF. The most dramatic changes occurred when the IMF at the Earth was southward and that at Jupiter was northward. (Jupiter's intrinsic magnetic field is in the opposite direction to that of the Earth.) In all cases the IMF was turned southward or northward and held constant. For southward IMF at the Earth dayside reconnection was followed by reconnection in the near-Earth magnetotail and a plasmoid was launched tailward. A steadily reconnecting system with a neutral line at x=-16RE then evolved which lasted for the duration of the numerical experiment. In similar fashion dayside reconnection was followed by tail reconnection at Jupiter. However, unlike the case at Earth, the reconnection at Jupiter was episodic both on the dayside and in the tail. Following the onset of dayside reconnection large amplitude waves that modulated the reconnection formed on the Jovian magnetopause. The waves had a wavelength of approximately 30RJ and a period of about 30 hours. During each episode in the tail a near-Jupiter (x<-100RJ) neutral line and plasmoid formed. Then both the neutral line and the plasmoid moved tailward and the process started again about 30 hours later.

SM44A-05 1645h

Solar Wind Interaction With the Moon

Jasper S Halekas[1] (510-643-4310; jazzman@ssl.berkeley.edu)

Stuart D Bale[1] (bale@ssl.berkeley.edu)

David L Mitchell[1] (mitchell@ssl.berkeley.edu)

[1]Space Sciences Laboratory, University of California, Berkeley, CA 94720, United States

Earth's Moon, lacking both a global magnetic field and any significant atmosphere, presents an ideal location to study plasma flow past a solar system body in one of its simplest incarnations. Despite its relative simplicity, however, the lunar plasma wake interaction displays a rich array of interesting physics, with aspects of both fluid and kinetic behavior that may also prove relevant to smaller obstacles (such as asteroids) or those with more significant magnetic fields. We present a new study of the solar wind interaction with the Moon, using data from the Lunar Prospector (LP) spacecraft to characterize the plasma environment very near the Moon. We utilize magnetometer and electrostatic analyzer measurements from 3813 LP orbits to determine the local magnetic field and electrostatic potential with unprecedented resolution at altitudes of 15-120 km. This exceptionally large data set allows us to examine the low-altitude lunar wake in detail, including its variation with altitude and its symmetry properties. By using WIND to monitor the ambient solar wind (shifting the data appropriately to take into account the separation between WIND and LP), we can also sort LP data by solar wind magnetic field, density, temperature, velocity, etc. to determine how the lunar wake responds to varying plasma conditions and magnetic field orientations. At 80-120 km above the Moon, we observe a "classical" lunar wake signature, with enhanced magnetic fields in the central wake (ensuring pressure balance) and reduced fields near the wake boundary due to diamagnetic currents, together with an ambipolar potential drop across the wake boundary (resulting in central wake potentials 300-400 V negative relative to the solar wind). On some orbits, we also see large magnetic field perturbations ("limb shocks") caused by interactions with crustal magnetic sources near the limb. At lower altitudes, we see a gradual transition from this classical magnetic signature to a more disordered signature, which is influenced more directly by local crustal fields. The observed wake signature at higher altitudes responds clearly to changes in solar wind parameters, while that at lower altitudes is again more disordered and depends more obviously on local crustal fields than solar wind conditions.

SM51A CC: 220 C-E Friday 0830h

The Magnetospheric Interaction With the Jovian Satellites: Theory and Observation II Posters *(joint with P)*

Presiding: **C S Paty,** University of Washington**; C M Cohen,** California Institute of Technology

SM51A-01 0830h POSTER

Characterizing the Energetic Heavy Ion Environment Inside 4 Jovian Radii

C. M. S. Cohen[1] (626 395-6614; cohen@srl.caltech.edu)

E. C. Stone[1]

[1]California Institute of Technology, MC 220-47, Pasadena, CA 91125, United States

On 21 September 2003 Galileo impacted Jupiter to end its 8-year tour of the Jovian magentosphere. During this last phase data was collected in the very inner part of the magnetosphere at distances < 4 Rj. The region from 2 to 4 Rj was previously explored by Galileo during its 34th orbit around Jupiter. We present the combined data from these two passes obtained by the Heavy Ion Counter (HIC) for heavy ions at energies above 2 MeV/nucleon. In particular we discuss the significant ion absorption near the moons Thebe and Amalthea, the anisotropic pitch angle distribution and the dramatic increase in heavy ion intensity with decreasing radius seen in this region

SM51A-02 0830h POSTER

Longitudinal and Temporal Variations in the Io Plasma Torus During the Cassini Jupiter Flyby

Andrew J. Steffl[1] (1-303-492-3617; steffl@colorado.edu)

Fran Bagenal[1] (1-303-492-2598; Fran.Bagenal@lasp.colorado.edu)

Peter A. Delamere[1] (1-303-735-0508; Peter.Delamere@lasp.colorado.edu)

[1]Univ. of Colorado/LASP, Campus Box 392, Boulder, CO 80309-0392, United States

The Cassini Ultraviolet Imaging Spectrograph (UVIS) obtained several thousand 2-D spectrally dispersed images of the Io torus during the Jupiter flyby. We use a "cubic centimeter" spectral emissions model to derive electron temperatures and densities and ion mixing ratios from the UVIS spectra. We find relatively minor variations (~5% amplitude) of the torus brightness and electron temperature with System III longitude when averaged over a 44-day period during the inbound leg of the flyby (1Oct2000-14Nov2000). The peak in brightness of the torus ansa occurred near λ_{III}=110°, while the peak in torus electron temperature occurred near λ_{III}=40°. The magnitude of the temperature variation is consistent with that found by the analysis of Voyager UVS spectra by Herbert and Sandel (2000), but the phase is offset by ~160°. In contrast to the long-term longitudinal variations, we find variations of almost a factor of two in the composition and electron temperature of the torus plasma over one Jovian rotation. Both the magnitude and the phase of these strong longitudinal variations are observed to change with time. The change in phase is not consistent with plasma that is simply lagging behind the corotation velocity by ~3% i.e. System IV.

SM51A-03 0830h POSTER

Time variability of plasma production in the Io torus

Fran Bagenal[1] (bagenal@colorado.edu)

Peter Delamere[1] (delamere@lasp.colorado.edu)

Andrew Steffl[1] (steffl@colorado.edu)

Mihaly Horanyi[1]

[1]Laboratory of Atmospheric and Space Physics University of Colorado, UCB 392, Boulder, CO, United States

Observations of ultraviolet emissions from the major ion species (S^+, S^{++}, S^{+++}, O^+, O^{++}) of the Io plasma torus made during the Cassini (October 2000 - March 2001) flyby have revealed significant time variability in density, composition and temperature. Our homogeneous torus model for mass and energy flow suggests that the observed variability is best characterized by a sudden change in the neutral source rate, abruptly decreasing from 1.8 tons/s to 0.7 tons/s near the beginning of the Cassini observing window. Simultaneous observations of Jovian dust streams by the Galileo space craft during the Cassini flyby show a significant (ie. ~ 2-3 orders of magnitude) and short-lived (i.e. time scale ~ few weeks prior to and concurrent with the opening of the Cassini observing window) enhancement in the dust emission rate. Assuming that the dust streams are related to Io's volcanic activity [Kruger et al., 2003] and that the volcanic activity is coupled to plasma production in the torus, we have modeled the time variability of torus plasma conditions using the time scales of dust emission variability to constrain Io's neutral source rate. Preliminary results suggest that the increased neutral source rate is a small fraction of the observed dust emission rate enhancement.

SM51A-04 0830h POSTER

Simulation/Data Comparisons of Ganymede's Magnetosphere

Carol S Paty[1] (carol@ess.washington.edu)

Robert Winglee[1] (winglee@ess.washington.edu)

Erika Harnett[1] (eharnett@ess.washington.edu)

[1]University of Washington, Earth and Space Sciences Box 351310, Seattle, WA 98195-1310, United States

Multi-fluid simulations in 3D were performed of Ganymede to gain further understanding of its near space environment and the dynamics resulting from interactions between Ganymede's magnetosphere and ionosphere and Jupiter's corotational plasmasphere. This study incorporates the effects of different local orientations of Jupiter's magnetosphere as well as different incident plasma densities on the location and amount of flux into Ganymede's ionosphere. It is shown that the location of penetration of Jupiter's magnetospheric plasma is effected by the dynamic pressure of the incident flow; at higher pressures the location is nearer to the equator, while at lower pressure the penetration latitude is closer to the poles. Simulation results are compared to and explained in terms of observations made of Ganymede's UV aurora. Ion dependent mass loading and mass loss in the coupled Ganymede-Jupiter system were also tracked so as to provide a more complete interpretation of the dynamic role played by Ganymede's magnetosphere and ionosphere imbedded in the Jovian system.

SM51A-05 0830h POSTER

Charged Particle Losses near the Inner Galilean Satellites

Chris Paranicas[1] ((240)228-8652; chris.paranicas@jhuapl.edu)

Andreas Lagg[2] (lagg@linmpi.mpg.de)

Norbert Krupp[2] (krupp@linmpi.mpg.de)

Joachim Woch[2] (woch@linmpi.mpg.de)

Barry H Mauk[1] ((240)228-6023; barry.mauk@jhuapl.edu)

[1]Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD 20723, United States

[2]Max Planck Institut fuer Aeronomie, Max-Planck-Strasse 2, Katlenburg-Lindau 37191, Germany

To study the losses of energetic charged particles in the inner magnetosphere of Jupiter, we have calculated proton phase space densities from the Galileo Energetic Particles Detector (EPD) data. The phase space density as a function of L shell is believed to obey a diffusion equation. In previous calculations, the phase space density in the inner magnetosphere has been shown to decrease inward toward the planet, suggesting sources at large distances, and losses due to satellite sweeping and other effects. The Galileo data reveal features indicating a loss process near the satellites Io and Europa. We also verify a region of strong loss just outside the orbital radius of Io. We will present loss rate estimates for the relevant physical processes within a diffusion context. These loss rate calculations, for instance, allow us to place an upper bound on the neutral gas distribution in radius (or L shell).

SM51A-06 0830h POSTER

A Voyager Statistical Analysis of Satellite Phase with Jupiter's Radio Emission

Chuck Higgins[1] (615-898-5946; higgins@physics.mtsu.edu)

Kelley Klecker[1] (615-898-2130; blackhole1200@hotmail.com)

Doug Menietti[2] (319-335-1919; jdm@space.physics.uiowa.edu)

[1]Middle Tennessee State University, Dept. of Physics Astronomy Box 71 1301 E. Main St., Murfreesboro, TN 37132, United States

[2]University of Iowa, Dept. of Physics and Astronomy, Iowa City, IA 52242, United States

Recent observations from the Galileo spacecraft show the influence of the satellite phase of Callisto and Ganymede on the radio emission generated in the Jovian magnetosphere. Our current analysis shows that Voyager 1 and 2 data also show correlations. In an attempt to quantify the significance of these correlations, we have completed a statistical analysis of Jupiter's emission intensity and occurrence probability with all four Galilean satellites. We analyzed the peak correlations on an occurrence probability graph of satellite phase versus Jovian longitude, and present the significance as standard deviations (sigma) above background. Our analysis shows peaks of significance of at least 2 sigma for Io, Ganymede, and Callisto. Results of all four Galilean satellites are displayed and discussed.

SM51B CC: 220 C-E Friday 0830h

Comparative Magnetospheres II Posters *(joint with P)*

Presiding: **K Kabin,** University of Alberta**; S Ledvina,** University of California, Berkeley

SM51B-01 0830h POSTER

The Ionosphere of Titan

John D Clark[1] ((785)864-4042; jdclark@ku.edu)

Tom Cravens[1]

Ned Keller[2]

Loren Acton[3]

[1]University of Kansas, Dept. of Physics and Astronomy 1251 Wescoe Hall Dr., Rm. 1082, Lawrence, KS 66045, United States

[2]The King's College, Dept. of Physics 350 Fifth Ave., New York, NY 10118, United States

[3]Montanta State University, Dept. of Physics, 264 EPS Bldg. POB 173840, Bozeman, MT 59717, United States

Titan has an atmosphere consisting mainly of molecular nitrogen and methane. Solar extreme ultraviolet and x-ray radiation and energetic electrons from Saturn's magnetosphere interact with the upper atmosphere producing an ionosphere. We will review our current understanding of Titan's ionosphere and will emphasize the energy deposition in the atmosphere from solar ionizing radiation and from magnetospheric electrons. We will present results from a two-dimensional suprathermal electron model that includes Auger electrons produced by K-shell ionization processes. We will compare our results for a Titan ionosphere at solar maximum conditions that correspond to Voyager encounter with results for solar minimum conditions that correspond to the expected arrival of Cassini orbiter.

SM51B-02 0830h POSTER

A comparison of the plasma interaction at Io, Pluto and comet Borrelly

Peter Delamere[1] (delamere@lasp.colorado.edu)

Fran Bagenal[1] (bagenal@colorado.edu)

[1]Laboratory for Atmospheric and Space Physics University of Colorado, CB 392 Duane Physics D133, Boulder, CO, United States

Coupling between spatially separate, but magnetically linked plasmas is a general problem in space plasma physics. Familiar examples include the Io-Jupiter interaction and the solar wind interaction with Pluto's escaping atmosphere and cometary environments. Standard magnetohydrodynamic (ideal MHD) treatments provide a basis for understanding the coupling processes; however, in many cases kinetic and other "non-ideal" processes modify the nature of the interaction. Io represents an example where local ion kinetics are relatively unimportant and an MHD approach may be adopted to study the Alfvenic coupling between Io and Jupiter. Interestingly though, Io's plamsa coupling is modified by high latitude parallel electric fields. Pluto, on the other hand, is dominated by local ion kinetic effects and the coupling is spatially varied. At Pluto the ion gyroradius of both solar wind protons and pickup ions is much larger than the obstacle scale size, but the solar wind ion inertial length is comparable to Pluto's diameter. Finally, comets represent an interesting intermediate case where at large distances from the sun the interaction is kinetic dominated and closer to the sun the interaction can be understood with a fluid description. In situ observations of comet Borrelly at 1.4 AU suggest that ion kinetic effects may be responsible for asymmetries in its plasma environment.

SM51B-03 0830h POSTER

Multispecies Hybrid Simulations of Titan's Plasma Interaction

S. A. Ledvina[1] ((510)643-1352; ledvina@ssl.berkeley.edu)

S. H. Brecht[2] (sbrecht@pacbell.net)

J. G. Luhmann[1] (jgluhman@ssl.berkeley.edu)

T. E. Cravens[3] (cravens@ku.edu)

K. C. Hansen[4] (kenhan@umich.edu)

[1]Space Sciences Lab, University of California, Berkeley, CA 94720, United States

[2]Bay Area Research Corp, 93 Moraga Way 200, Orinda, CA 94563, United States

[3]Department of Physics Astronomy, University of Kansas, Lawrence, KS 66045, United States

[4]Space Physics Research Lab, University of Michigan, Ann Arbor, MI 48109, United States

The interaction of Titan's ionosphere with Saturn's magnetospheric plasma is complicated by the significant size of the ion gyroradii relative to the size of Titan. Voyager 1 found a two species plasma consisting of H^+ and N^+ with number densities of 0.1 and 0.2 cm^{-3} respectively, near Titan. The gyroradii of the incident N^+ was found to be 2.25 R_T (1 R_T = 2575 km), while the gyroradii of the H^+ was smaller at 0.16 R_T. In addition Voyager detected the presence of several pickup ion species. The heavy pickup ion species (N_2^+, H_2CN^+, $C_2H_5^+$) are expected to have gyroradii 4-5 R_T. The scale of the interaction region is dominated by the size of the ambient and pickup ion gyroradii rather than the size of Titan. We investigate Titan's interaction with its surrounding plasma environment using multispecies hybrid simulations. We use a H^+ and N^+ upstream plasma and represent Titan's ionosphere by three generic ion species, a light, medium and heavy using the same formalism as Cravens et al.(1998). The magnetospheric plasma parameters (density, temperature, magnetic field and velocity) near Titan are based on 3-D MHD simulations of Saturn's magnetosphere (Hansen, 2001). We apply our results to the conditions expected at Titan during the first flyby of Cassini in October later this year.

SM51B-04 0830h POSTER

Effects of the Crustal Fields on the Solar Wind-Martian Ionosphere Interaction: A Global Hybrid Model

Naoki Terada[1] (+81-533-89-5517; teradan@stelab.nagoya-u.ac.jp)

Hiroyuki Shinagawa[1] (sinagawa@stelab.nagoya-u.ac.jp)

[1]Solar-Terrestrial Environment Laboratory, Nagoya University, Honohara 3-13, Toyokawa, Aichi 442-8507, Japan

Effects of the crustal magnetic fields on the Martian plasma environment are investigated using a comprehensive 2-D global hybrid (particle ions/fluid electrons) simulation model. The model includes the entire solar wind-planetary ionosphere interaction region self-consistently, i.e., the region above 100 km altitude with a finest resolution of 5 km in radial direction, with a kinetic ion treatment. We conduct simulations with a variety of crustal field strength; for example, a crustal field that is not able to withstand incoming solar wind by itself, and a strong one that is enough to balance the external pressure around the ionopause altitude. The result indicates that even a weak crustal field can affect the interaction significantly, because of the field compression occurring just above the ionopause. We will also discuss the modification of ion escape rate, mass and momentum transport efficiency across the ionopause, and relationship with the ejection of ionospheric plasma clouds.

SM51B-05 0830h POSTER

The Local Time Variations of Jupiter's Current Sheet Location and Thickness

Krishan K Khurana[1] (3108258240; kkhurana@igpp.ucla.edu)

Hannes K Schwarzl[1] (3108251995)

[1]Institute of Geophysics and Planetary Physics, Slichter Hall, UCLA, Los Angeles, CA 90095, United States

The six spacecraft that have traveled through the magnetosphere of Jupiter have encountered Jupiter's current sheet over all local times and varying solar wind ram directions. We use magnetic field data from these