

## SM43C-06 1330h POSTER

### Trapped, Streaming and Counter-Streaming Energetic Electrons in the Geomagnetic Tail: Cluster/RAPID

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During the Cluster orbit 474 on July 26-28, 2003, with apogee in the geomagnetic tail and slightly towards the dawnside, the RAPID energetic particle spectrometer was in its high resolution mode for the entire 58 hours, permitting detailed 3-D electron distributions over an unprecedented length of time. On July 27, from ca. UT 0830 to 2300, very enhanced electron fluxes were observed, exhibiting a wide variety of distributions: trapped, counter-streaming, and field line streaming. The largest fluxes are seen in conjunction with the current sheet crossing, with trapped and counter-streaming distributions observed within very short time intervals. These results are interpreted in terms of the geometry and dynamics of the central plasma sheet.

## SM43C-07 1330h POSTER

### Energetic Electron Distributions at the Dusk and Dawn Magnetotail Flanks: Cluster Rapid Observations

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We use the Cluster Rapid/IES data to characterize the energetic electron fluxes and angular distributions at the dawn and dusk nightside plasmasheet-magnetopause boundary in the magnetotail. During the mid to late June and December 2003 the Cluster satellites were crossing the equatorial plane near the nightside magnetopause at dawn and dusk respectively. We focus on burst mode data, which provides detailed energy and angular distributions for the four spacecraft, during 16 and 24 June 2003. During December, we focus on the new Rapid NM3 data that provides burst-mode-like IES data on C2 only. We examine the electron distributions in light of their possible sources and spatial characteristics.

## SM43D CC: 518 C Thursday 1330h

### The Magnetospheric Interaction With the Jovian Satellites: Theory and Observation I (joint with P)

**Presiding:** C P Paranicas, Applied Physics Laboratory, Johns Hopkins University; C Higgins, Middle Tennessee State University

## SM43D-01 1330h INVITED

### Energetic Particle Interactions in the Vicinity of Io

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Changes in the distribution of energetic particles measured by the Galileo Energetic Particle Detector in the vicinity of Io can be used to model the global distribution of magnetic and electric fields in the vicinity of the moon. Some changes are simply caused by an adiabatic response of the particles as they are carried past Io by the co-rotational flow. There is also evidence for non-adiabatic scattering processes, which allow entry of particles to regions inaccessible by direct flow. The presence of narrow field-aligned electron beams in the wake region behind Io and also across the polar caps of the moon requires a strong acceleration source close to the footprint of the magnetic flux tube in the Jovian upper atmosphere. We suggest that this is a result of current flow between Io and the atmosphere, as a consequence of the differential rotation rates.

## SM43D-02 1350h INVITED

### Thermal Plasmas Near Jupiter's Galilean Moons

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Although the Galileo spacecraft was destroyed during its plunge into Jupiter in September of 2003, scientific efforts related to the Galileo mission are not ended. Among the many gems left to our scientific community as a legacy are the measurements acquired during numerous near encounters with Jupiter's 4 large moons. High-resolution measurements from the plasma instrumentation (PLS) recorded during many of these encounters yield unprecedented evidence of complex phenomena associated with the motions of the moons through the Jovian magnetosphere. The plasma environment of each moon exhibits unique characteristics. Many exciting findings have been reported, but it is unlikely that the full scientific gain from the mission has been realized yet. Additional significant insights can be achieved through theory and modeling efforts guided by these remarkable observations, and through continued analysis of the measurements. With that in mind, we provide an overview of findings based on plasma observations near the moons, and we discuss these findings in the context of other past and recent work directed toward understanding the environments of the moons and their interactions with Jupiter and with Jupiter's magnetosphere.

## SM43D-03 1410h

### Energetic Electron Beams in Ganymede's Magnetosphere

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Data from a series of Galileo close encounters with the Jovian moon Ganymede have provided much information about its magnetic field, its magnetosphere, and its trapped particle populations. Data obtained from the Energetic Particles Detector (EPD) during the final Ganymede encounter on December 28, 2000 yield further insights into the dynamics of Ganymede's magnetosphere. The encounter occurred at mid-latitudes at the beginning of the moon's plasma wake. In the region where trapped-like electron and ion distributions were measured, field-aligned electron beams also were observed. These beams were observed on two of the three occasions when EPD was oriented such that it could sample any extant beams (pitch angles greater than 170 degrees). We will discuss possible sources for these beams and compare them with those measured at Io.

## SM43D-04 1425h INVITED

### Satellite-magnetosphere interactions at Jupiter as revealed with energetic charged particle measurements

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Aspects of the interactions between Jupiter's magnetosphere and the Galilean satellites are reviewed as revealed by measurements of energetic charged particles. Addressed specifically are: 1) Energetic charged particle diagnostics of the connection between the satellites and Jupiter; 2) Diagnostics on the topology,

geometry, and evolution of the magnetosphere-satellite interactions; 3) Interactions between energetic particles and the satellite surfaces and atmospheres; and 4) the dispersal of satellite generated materials within Jupiter's space environment. Outstanding questions are highlighted as they may relate to such future missions as the Jupiter Icy Moon Orbiter (JIMO) and the Jupiter Polar Orbiter.

## SM43D-05 1445h INVITED

### Moon-Ionosphere Coupling

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Data acquired by Galileo in its glorious tour of the Jovian magnetosphere, supplemented by the auroral images acquired by the Hubble Space Telescope, provide the foundation for increasingly detailed and sophisticated descriptions of the perturbations of the magnetospheric plasma as a result of its interaction with a good-sized moon. Many aspects of the interaction had been anticipated before the close flybys occurred, but perhaps not all of the early work on the subject had been fully digested. We now know much more about the disturbances launched from the moon into the Jovian ionosphere but we are still wringing our hands over the evidence that strong coupling to the ionosphere extends along the orbits of the moons far into the downstream region. The development of field-aligned electric fields coupling the moons to the planet has been upgraded from speculative to probable following multiple observations of narrowly beamed relativistic electrons on passes by Io. Questions remain as to how energy from equatorial regions reaches the auroral ionosphere of Jupiter despite the strong reflection of Alfvén waves from field-aligned density gradients. Although this matter is not fully understood, some interesting ideas have been proposed and will be discussed.

### SM44A CC: 518 C Thursday 1530h Comparative Magnetospheres I (joint with P)

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

## SM44A-01 1530h INVITED

### Mars Global Surveyor Observations of High Altitude Ionospheric Clouds

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As Mars Global Surveyor orbits Mars, it crosses into different plasma regimes, as is evident by the electron spectra obtained by the Electron Reflectometer (ER). Below about 380 km, the electron spectra are dominated by locally produced photoelectrons indicating the solar wind electrons do not have access to that region. We investigate the appearance of this electron signature at altitudes above the observed photoelectron boundary height. These may be detached high altitude ionospheric clouds, analogous to those observed at Venus by the Pioneer Venus Orbiter. Like at Venus, we are unable to distinguish the morphology of the clouds with a single cut through at any given time. However, we analyze their occurrence rates as a function of position and upstream parameters to understand the conditions under which they occur.

## SM44A-02 1550h INVITED

## The Martian ionospheric loss rates versus solar EUV flux

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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 by solar 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

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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 species. 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

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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 to 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

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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

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On 21 September 2003 Galileo impacted Jupiter to end its 8-year tour of the Jovian magnetosphere. During this last phase data was collected in the very inner part of the magnetosphere at distances  $< 4 R_J$ . The region from 2 to 4  $R_J$  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

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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 ( $\sim 5\%$  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  $\lambda_{III} = 110^\circ$ , while the peak in torus electron temperature occurred near  $\lambda_{III} = 40^\circ$ . 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  $\sim 160^\circ$ . 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  $\sim 3\%$  i.e. System IV.

## SM51A-03 0830h POSTER

## Time variability of plasma production in the Io torus

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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 spacecraft during the Cassini flyby show a significant (i.e.  $\sim 2-3$  orders of magnitude) and short-lived (i.e. time scale  $\sim$  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.