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The expanded bow shock on and around "the day the solar wind almost disappeared" allowed Geotail to make a magnetosheath pass near dusk (16-20 magnetic local time) lasting 54 hours. During this time, interplanetary parameters varied adiabatically in such a way that they included two extremes of magnetosheath structures, one dominated by magnetohydrodynamic effects and the other by gas dynamic effects. Magnetic fluctuations in the high- β_p magnetosheath were dominated by compressional mirror mode waves, and left and right-handed transverse waves. In contrast, the low- β_p magnetosheath, lasting for over 1 day, was devoid of mirror oscillations and permeated instead by transverse waves of weak intensity. We relate the weak intensity of these transverse waves to the low dynamic pressure. Left-handed ion cyclotron waves were replaced by bursts of right-handed waves when the solar wind proton temperature anisotropy became negative ($T_{\parallel} > T_{\perp}$). Unlike the normal case, these right-hand waves were not daughter waves but derived their energy source from the magnetosheath anisotropy. The weak transverse activity is examined and modeled. The study extends our knowledge of magnetosheath properties made possible by the extreme range of external parameters during the period studied.

SM43C CC: 220 C-E Thursday 1330h

Cluster Posters (joint with SH)

Presiding: J E Borovsky, Los Alamos National Laboratory; P W Daly, Max-Planck-Institut für Aeronomie

SM43C-01 1330h POSTER

A Survey of Energetic Plasma Observations by the RAPID Experiment on Cluster

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In the near Earth environment, plasma with particle energies of tens to hundreds of keV provides a powerful diagnostic of the acceleration processes associated with magnetospheric boundaries and phenomena. Such energetic plasma can be detected by the RAPID (Research with Adaptive Particle Imaging Detectors) experiment on Cluster, which comprises an imaging ion mass spectrometer (IIMS) and an imaging electron spectrometer (IES). A survey of the RAPID electron and ion observations taken since June 2002, the start of near-continuous coverage, is presented and interpreted in the context of corresponding magnetic field observations from both Cluster and ACE. The Bryant plot representation, used to provide an overview of the data, reveals populations of energetic ions and electrons within the magnetosphere associated with the radiation belt, when Cluster is at perigee, and the plasma sheet. The latter population is observed from the dawn to dusk flank on both the dayside, on the inner edge of the magnetopause, and in the magnetotail. Asymmetries in the fluxes of ions and electrons observed on the flanks are related to the oppositely directed effect of gradient and curvature drift on electrons and ions from the tail. Energetic ions are also observed outside the magnetopause, in the bowshock and solar wind, where their observation appears to be governed to some degree by the solar wind conditions.

SM43C-02 1330h POSTER

A multifractal analysis of magnetic field fluctuations inferred from Cluster measurements: Evidence for intermittent turbulence in the plasma sheet.

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Cluster fluxgate magnetometer data and ion spectroscopic data are employed to construct and interpret scaling exponential functions and intermittency coefficients for magnetic field fluctuations. This technique, often used in analysis of space and laboratory plasmas, is used to look for intermittent plasma turbulence. Our results show non-self similar scaling in the plasma sheet MHD inertial range, which suggests that intermittent turbulence is common in the plasma sheet. The degree of non-self similar scaling varies with both the distance from the plasma sheet and the geomagnetic activity. The strength of the intermittent turbulence is quantified with the intermittency coefficient, which varies from about 0 to 0.27 for regions in the lobe and plasma sheet.

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SM43C-03 1330h POSTER

Cluster measurements in the context of global modeling and observations

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The magnetospheric research community has long sought the capability to view the Sun-Earth system in a global way and concurrently to probe the microphysical details of key physical regions. This objective has now been substantially realized with the combination of the CLUSTER constellation and global imaging missions. With the addition of SOHO, ACE, FAST, SAMPEX, POLAR, and various geostationary orbit spacecraft, there is an ability to apply both telescopic and microscopic principles. Many recent examples serve to illustrate the observational power of these new tools. Using events from 2001 and 2003, we have observed strong geomagnetic storms and have studied powerful compression of the magnetosphere and concomitant particle injection events. Using tail crossing events in 2001-2002, CLUSTER observed clear substorm sequences of events in the mid-magnetotail region ($X \sim -19R_E$). In these cases, CLUSTER data reveal microphysical details while other spacecraft show the global, macroscopic context. We have used the Lyon-Fedder-Mobarry MHD simulation code to numerically model several of these specific events. The new observations and model comparisons are leading to new understandings of magnetospheric processes. Several of the cases to be presented show global features consistent with present-day models of substorm and storm dynamics, but the specific details reveal heretofore unappreciated aspects of processes such as magnetic reconnection and particle acceleration.

SM43C-04 1330h POSTER

High latitude boundary observed by Cluster

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We present statistical results based on the data set obtained by Cluster when these spacecraft were in the vicinity of the dayside magnetopause. Sometimes a clear boundary signature was observed, sometimes the magnetic field, plasma density, and flow changed smoothly and no clear boundary signature was observed, and at other times the boundary is partly clear (not all of the three parameters have clear boundary). Twenty-eight clear boundary crossings, 39 unclear boundary crossings and 19 partly clear boundary crossings have been selected from about 300 boundary crossings (we have data for 86 crossings) that occurred during the period from Jan. 1 to Apr.30, 2001 and Mar. 1 to Apr.30, 2002. We have studied the conditions related to the formation of these three kinds of different boundaries. Clear boundary signatures were observed during northward IMF or these boundaries were located between the magnetosheath and the high latitude trapping region. Unclear boundary signatures were observed during southward or variable IMF. We will report on the dependence of these three boundary types on the dipole tilt angle, solar wind pressure and the Interplanetary Magnetic Field (IMF) as well as determining the relationship of energetic particles to this region. Whether the boundaries are rotational or tangential discontinuity has also been studied.

SM43C-05 1330h POSTER

Intercalibration of the Magnetometers Onboard the CLUSTER Spacecraft from Natural Constraints

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The calculation of spatial magnetic field gradients requires the determination of orientations, zero levels and scale factors (calibration parameters) of all four CLUSTER magnetometers with very high accuracy (48 parameters, overall). This daunting task is made easier by natural constraints imposed on geophysical signals by nature. For example by observing that on a spinning spacecraft, the spin tone and its second harmonic are introduced in the magnetic field data by eight (per spacecraft) of the calibration parameters, one can determine their value by using techniques that reduce spin induced tones in the observations. Another constraint is provided by the fact that $\nabla \times \mathbf{B}$ is zero everywhere and $\nabla \cdot \mathbf{B}$ is zero in certain regions of the magnetosphere. Corrections to 12 additional calibration parameters can be obtained by ensuring that $\nabla \times \mathbf{B}$ and $\nabla \cdot \mathbf{B}$ are zero in those regions. The above techniques are however incapable of providing absolute values of the offsets of the spin axis sensors. We recover these by using the fact that rotational discontinuities in the solar wind do not change the magnitude of the magnetic field. Finally, a complete calibration can be cross-checked by comparing the data from the four magnetometers when they are relatively close together in the solar wind and should see no systematic differences in the magnetic field over a sufficient long period of time. Additionally, we describe how we handle small discontinuities that occur when a magnetometer switches from one range to another.

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.