SM21A-0528 0830h POSTER

Solar Wind Asymmetries around magnetic anomalies at the Moon and Mars.

Erika M Harnett[1] (206-543-0212; eharnett@ess.washington.edu)

Robert M Winglee[1] (206-685-8160; winglee@ess.washington.edu)

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

Magnetic anomalies have been found on both the Moon and Mars, but unlike the Moon, the Martian atmosphere is thick enough to hold off the solar wind through thermal pressure, creating a bow shock. 3D fluid simulations show that magnetic anomalies are important in determining how the solar wind interacts with the Moon and Mars. When no substantial atmosphere is present, as in the case of the Moon, the magnetic anomalies can lead to the formation of a localized shock surface that produces asymmetric solar wind flow over the Moon. These asymmetries can be seen well tail of the Moon. In the case of Mars, where there is a thick atmosphere and distinct ionopause, the magnetic anomalies are still able to modify the solar wind flow and the interaction produces an increase in the scale height of the atmosphere opposite the anomalies and creates a magnetopause within the pre-existing bow shock. The importance of the higher order moments of the anomalous field is reduced in the case of Mars, as the interaction region is further from the source. Disturbances in the solar wind flow deep down the tail, and can be modulated by changes in the interplanetary magnetic field.

SM21A-0529 0830h POSTER

3D Boltzmann Simulation of the Io's Plasma Environment with Adaptive Mesh and Particle Refinement

Alexander S Lipatov[1] (734-763-6246; alipatov@engin.umich.edu)

Michael R Combi[1]

[1]Space Physics Research Laboratory, The University of Michigan, 2455 Hayward St., Ann Arbor, MI 48109-2143

The global dynamics of the ionized and neutral components in the environment of Io plays an important role in the interaction of Jupiter's corotating magnetospheric plasma with Io [Combi et al., 2002; 1998; Kabin et al., 2001]. The stationary simulation of this problem was done in the MHD [Combi et al., 1998; Linker et al, 1998; Kabin et al., 2001] and the electrodynamic [Saur et al., 1999] approaches. In this report, we develop a method of kinetic ion-neutral simulation, which is based on a multiscale adaptive mesh, particle and algorithm refinement. This method employs the fluid description for electrons whereas for ions the drift-kinetic and particle approaches are used. This method takes into account charge-exchange and photoionization processes. The first results of such simulation of the dynamics of ions in the Io's environment are discussed in this report.

M R Combi et al., *J. Geophys. Res.*, **103**, 9071, 1998.
M R Combi, T I Gombosi, K Kabin, *Atmospheres in the Solar System: Comparative Aeronomy. Geophys. Monograph Series*, **130**, 151, 2002.
K Kabin et al., *Planetary and Space Sci.*, **49**, 337, 2001.
J A Linker et al., *J. Geophys. Res.*, **103(E9)**, 19867, 1998.
J Saur et al., *J. Geophys. Res.*, **104**, 25105, 1999.

SM21A-0530 0830h POSTER

Characterization of Solar Wind Interaction With Magnetized Bodies

Nojan Omidi[1,2] (nomidi@ece.ucsd.edu)

Xochitl Blanco-Cano[3] (xbc@igeofcu.unam.mx)

Chris Russell[4] (ctrussell@igpp.ucla.edu)

Homa Karimabadi[1] (homa@ece.ucsd.edu)

[1]ECE Dept, UCSD, La Jolla, CA 92093, United States

[2]CalSpace, UCSD, La Jolla, CA 92093, United States

[3]Instituto de Geofisica, UNAM, Mexico City, Co D.F.04510, Mexico

[4]IGPP, UCLA, Los Angeles, CA 90049, United States

Since the dawn of the space age, the magnetosphere has been studied extensively not only to understand the geospace environment but also how solar wind, or stellar winds in general, interact with magnetized bodies. Early theoretical investigations of solar wind interaction with magnetized asteroids suggested that in addition to a magnetospheric type interaction it was possible that, instead, only a whistler wing would be generated. Recently, through 2-D global hybrid (fluid electrons, kinetic ions) simulations, we have demonstrated that depending on the magnetic dipole strength of a body its interaction with the solar wind can be even more diverse and that a variety of solutions exist. For example, in addition to a whistler wing it is possible for a magnetized asteroid to have a set of fast and slow magnetosonic wakes. In another type of solution, a fast magnetosonic wake is the dominant feature of the interaction region. Our studies have also demonstrated that depending on the magnetic field strength of a body, the size of the interaction region may be comparable or smaller than ion gyroradius and, as a result, kinetic motion of the ions has a profound influence on the global structure of the interaction region. We have found that a useful parameter in characterization of the interaction region is Dp, the distance from the body at which solar wind ram pressure is balanced by its magnetic pressure. In this presentation, we illustrate the transition of the interaction region from a single whistler wing to a full magnetospheric type interaction as Dp , normalized to ion inertial length, is increased from values less than 1 to over 100. Implication of these results for various bodies in the solar system is also discussed.

SM21A-0531 0830h POSTER

Global hybrid simulations of the magnetosphere: progress report

Homa Karimabadi[1,2] (homa@ece.ucsd.edu)

Nojan Omidi[1,2] (nomidi@ece.ucsd.edu)

Farzad Kazeminezhad[2]

[1]UCSD, Dept of ECE, La Jolla, CA 92093-0407, United States

[2]SciberNet, Inc., 12837 Caminito del Canto, Del Mar, CA 92014, United States

The ultimate understanding of the magnetosphere requires resolving important small-scale kinetic processes while accounting for the global coupling and dynamics of the magnetosphere. This implies that kinetic global simulations are bound to play a very significant role in our further understanding of the magnetospheric system and that the development of appropriate simulation models is imperative. However, due to their computationally more intensive nature kinetic simulations have been applied sparingly to global modeling efforts. In this regard, the global hybrid simulation model (fluid electrons, kinetic ions) is the next natural step beyond MHD. With more advances in computer technology, it is natural to ask to what extent global hybrid simulations are now possible. We reexamine this issue in detail. As part of this presentation, we will discuss our latest advances in code development and show examples of the application of these new codes to the global magnetospheric problem. In order to quantify the progress in kinetic simulations, we have found it useful to define the parameter kinetic time Tk. Tk is defined as the number of minutes that it takes a global kinetic simulation to run an equivalent of 1 minute in the real magnetospheric time. The goal is to have the kinetic time as close to unity as possible. We will quantify the utility of global kinetic simulations by discussing the values of Tk based on the existing codes, and our new codes.

SM21A-0532 0830h POSTER

From a Weak to a Strong Comet — 3D Global Hybrid Simulation Studies

Uwe Motschmann[1] (495313915186; u.motschmann@tu-bs.de)

Thorsten Bagdonat[1] (495313915187; t.bagdonat@tu-bs.de)

[1]Inst. for Theoretical Physics, TU Braunschweig, Mendelssohnstr. 3, Braunschweig 38106, Germany

Numerical simulation results for the solar wind interaction with a weak comet at different heliocentric distances are presented. The different features of the plasma environment, such as the structured cycloidal tail and non-linear Mach cones typical for weak comets and their relation to structures like shocklets, bow shock, diamagnetic cavity and the "classical" magnetotail formed at stronger comets are discussed. The detailed theoretical investigations of weakly outgassing bodies are of interest for the interpretation of measurements at Borelli and future data from comet Wirtanen, which serves as a typical example.

For this purpose a three dimensional hybrid code using curvilinear coordinates was developed. Some numerical techniques are briefly introduced.

SM21B MCC: Hall D Tuesday 0830h

Aurora and Auroral Processes II Posters *(joint with SA)*

Presiding: **E J Lund,** University of New Hampshire**; E Donovan,** University of Calgary

SM21B-0533 0830h POSTER

Dayside High Latitude Auroral Particle Acceleration Observed by the Cluster Satellites

Michiko Morooka[1] (morooka@irfu.se); Mats Andre[1] (Mats.Andre@irfu.se); Jan-Erik Wahlund[1] (jwe@irfu.se); Andrew Fazakerley[2] (anf@mssl.ucl.ac.uk); David Winningham[3] (david@cluster.space.swri.edu); Henri Reme[4] (Henri.Reme@cesr.fr); Iannis Dandouras[4] (Iannis.Dandouras@cesr.fr); Andre Balogh[5] (a.balogh@ic.ac.uk); Elisabeth Lucek[5] (e.lucek@ic.ac.uk); Nicole Cornilleau-Wehrlin[6] (nicole.cornilleau@cetp.ipsl.fr); Stephan Buchert[1] (scb@irfu.se)

[1]Swedish Institute of Space Physics, Uppsala Division, Box 537, SE-751 21, Uppsala Box 537, Sweden

[2]Dept. of Physics, Mullard Space Science Laboratory, Univ. College London, Holmbury St. Mary, Dorking, Surrey RH5 6NT, United Kingdom

[3]Southwest Research Institute, P.O. Drawer 28510, 6220 Culebra road, San Antonio, TX 78238-0510, United States

[4]CESR/CNRS, 9 Avenue du Colonel Roche, B.P. 4346, F-31028 Toulouse Cedex 4, Toulouse B.P. 4346, France

[5]Space and Atmospheric Physics Group, The Blackett Laboratory, Imperial College, Prince Consort Road, London, SW7 2BZ, London SW7 2BZ, United Kingdom

[6]CETP, 10/12 Avenue de L'Europe, F-78140 Velizy, Velizy 10/12, France

We investigate an event observed by the four Cluster satellites in the dayside high latitude auroral region around 80 ILat and 14MLT at an altitude of about about 5Re. The Cluster satellites were located in the auroral region for about 30 minutes, corresponding to several thousand km along the orbit. In this region, the magnetic field showed periodic perturbation of about 2 min., and the upward electron acceleration, usually located just beside the downgoing electron acceleration structures, had the same period. All Cluster satellites observed the periodic acceleration signatures, and hence, we expect that the spacecraft observed filament like auroral arc structures. Similar periodic structures of the electron acceleration and magnetic perturbations have often been observed in the dayside auroral acceleration region by the Cluster satellites. We discuss possible mechanisms to generate the periodic perturbations and their relationship to the auroral particle acceleration phenomena.

SM21B-0534 0830h POSTER

Statistical results on the occurrence frequency of auroral potential structures, upgoing ion beams and plasma density depletions as a function of altitude (5000-30000 km)

Annika Olsson[1] (+46-18-471-5904; ao@irfu.se)

Pekka Janhunen[2] (+358-9-19294635; pekka.janhunen@fmi.fi)

Harri Laakso[3] (+31-71-565-3319; harri.laakso@esa.int)

William K Peterson[4] (303-492-0686; bill.peterson@lasp.colorado.edu)

[1]Swedish Institute of Space Physics/Uppsala Division, Box 537, Uppsala SE-751 21, Sweden

[2]Finnish Meteorological Institute/Geophysical Research, Vuorikatu 15A, Helsinki FIN-00100, Finland

[3]ESA/ESTEC, Code SCI-SB, Postbux 299, Keplerlaan 1, Noordwijk 2200 AG, Netherlands

[4]LASP, University of Colorado, 1234 Innovation Drive, Boulder, CO 80303, United States

In the acceleration region and possibly above, negative potential structures, upgoing ion beams and plasma density cavities are known to be associated with inverted-V electron precipitation and discrete auroral arcs at the conjugate footpoint in the ionosphere. Here

we present results from recent large statistical studies of these three parameters. We especially concentrate on the altitude dependence of each parameter under various Kp index and solar illumination conditions as well as for different magnetic local time (MLT) and invariant latitude (ILAT). We use 3-5 years of Polar data to study the altitude dependence of the occurrence frequency of each parameter. The potential structures are found by locating local minima in the plasma potential which is obtained by integrating the measured spin-plane electric field from the EFI instrument along Polar orbit. Upgoing ion beams are detected from Polar/TIMAS and DE-1/EICS differential energy flux data. Plasma density depletions are studied by thresholding the spacecraft potential data produced by Polar/EFI with various thresholds. All the processing methods are automatic and do not involve manual classification or neural networks. The results show that there is a preferred altitude at about 10000-15000 km altitude for all these auroral-related phenomena. The implications of this to the physics of auroral electron acceleration are discussed.

SM21B-0535 0830h POSTER

Counter-streaming electron beams in the plasma sheet associated with auroral activity

M. Fillingim[1] (1-510-643-8485; matt@ssl.berkeley.edu); G. Parks[1]; R. Lin[1]; M. Wilber[1]; C. Carlson[1]; D. Chua[2]; L. Peticolas[1]

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

[2]Naval Research Laboratory, Code 7623, Washington, DC 20375, United States

Electron observations by the WIND plasma instruments in the near-Earth plasma sheet (at a radial distance of about 10 Earth radii) during a substorm expansion and recovery reveal the presence of counter-streaming electron beams. The beams, which appear shortly after large fluctuations in the magnetic field, are centered at about 1 keV and are confined to pitch angles less than about 10 degrees. These beams appear to be unstable and rapidly decay resulting in bi-directional field-aligned electron distributions. The resulting distributions contain two components: a thermal, relatively isotropic plasma sheet component, and a lower energy, more strongly field-aligned beam remnant. The bi-directional field-aligned distributions are observed for more than one hour. Simultaneous FAST plasma measurements near the magnetic footprint of WIND in the auroral region show a similar two component electron spectrum. The source of the field-aligned beams is unknown, but based on the narrowness of the beams in the plasma sheet, we contend that the source is at low altitude and that the source mechanism is related to the auroral acceleration processes.

URL: http://www.ess.washington.edu/People/Students/matt/AGU2002/

SM21B-0536 0830h POSTER

Electrodynamics of the Duskside Aurora

Jih-Hong Shue[1] (+1-240-228-5014; shuej1@jhuapl.edu); P. T. Newell[1] (newell@oval.jhuapl.edu); K. Liou[1] (Kan.Liou@jhuapl.edu); C.-I. Meng[1] (Ching.Meng@jhuapl.edu); G. A. Germany[2] (germanyg@cspar.uah.edu); M. R. Hairston[3] (hairston@utdallas.edu); F. J. Rich[4] (frederick.rich@hanscom.af.mil)

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, United States

[2]Center for Space Plasma Aeronomic Research, University of Alabama in Huntsville, S131 Technology Hall, Huntsville, AL 35899, United States

[3]Center of Space Science, Unversity of Texas, Dallas, POB 830688, Richardson, TX 75083, United States

[4]Air Force Research Laboratory/VSBXP, 29 Randolph Road, Hanscom AFB, MA 01731, United States

Shue et al. [2002] reported that an auroral feature, which is called the two-cell aurora, was identified from Polar Ultraviolet Imager auroral images. The characteristics of the two-cell aurora are azimuthal elongation over extended local times with gaps at noon and midnight. Its electrodynamic association with the convection, particle precipitation, and field-aligned currents has not been fully understood. In conjunctions with DMSP F12 spacecraft on the duskside branch of the aurora, we are able to investigate the association of auroral emissions with convection reversals, upward field-aligned currents, and energy fluxes and average energy of particles. It is found that the location of the convection reversal is colocated with the upward field-aligned currents. The maximum auroral emissions occur at or poleward of the convection reversals. The energy flux and average energy derived from auroral images are consistent with observations from DMSP in a region mapped to the plasma sheet. However, inconsistency occurs in a region mapped to the plasma sheet boundary layer.

Shue, J.-H., P. T. Newell, K. Liou, C.-I. Meng, Y. Kamide, and R. P. Lepping, Two-component auroras, Geophys. Res. Lett., 29(10), 10.1029/2002GL14657, 2002.

SM21B-0537 0830h POSTER

Multiple-point measurements of auroral ion distributions from the SIERRA sounding rocket

Kristina A Lynch[1] (603-646-9311; kristina.lynch@dartmouth.edu)

Roger Arnoldy[2] (603-862-2751; roger.arnoldy@unh.edu)

Elizabeth MacDonald[2] (eamd2@cisunix.unh.edu)

Paul Kintner[3] (pmk1@cornell.edu)

Eric Klatt[3] (ek59@cornell.edu)

[1]Dept of Physics and Astronomy, Dartmouth College, Wilder Hall, Hanover, NH 03755, United States

[2]Institute for the Study of Earth Oceans and Space, Univ of NH, Morse Hall, Durham, NH 03824, United States

[3]Dept of Electrical Engineering, Cornell Univ, Rhodes Hall, Ithaca, NY 14853, United States

The Sierra auroral sounding rocket provides three-point observations of ion distributions at the poleward edge of a pre-midnight auroral breakup arc system. Comparisons between the bulk flows calculated from the distribution at one point, and the motions of boundaries and structures as seen by relative delays between the three points, allow an examination of flows and motions under auroral arcs. Associated three-point DC electric field data provide another measurement for comparison. Positions and timing for each of the three measurement points are provided by onboard GPS measurements, providing high accuracy for the interpayload comparisons. We present a study of these motions, and relate them to the associated electron precipitation behavior, with examples from both Alfvenic and inverted-V type arcs.

SM21B-0538 0830h POSTER

Sounding Rocket Study of Thermal Electrons in Active Auroral Precipitation

Elizabeth A MacDonald[1] (603.862.1391; eamd2@cisunix.unh.edu); Kristina A Lynch[2] (kristina.lynch@dartmouth.edu); Roger Arnoldy[1] (roger.arnoldy@unh.edu); Paul Kintner[3] (paul@ece.cornell.edu); Eric Klatt[3] (klatt@ece.cornell.edu); James LaBelle[2] (James.W.LaBelle@dartmouth.edu); Marilia Samara[2] (marilia@dartmouth.edu)

[1]Space Science Center, University of New Hampshire, Durham, NH 03820

[2]Dept. of Physics, Dartmouth College, Hanover, NH 03755

[3]Dept. of Electrical and Computer Engineering, Cornell University, Ithaca, NY 14850

The multi-payload sounding rocket SIERRA was successfully launched on 1/14/02 from Poker Flat, Alaska into active post-breakup aurora. The three GPS-equipped payloads carried electric and magnetic field probes, as well as several different particle detectors. The main payload carried a new instrument to measure the thermal core of the electron population. These particles may carry currents between the topside ionosphere and the magnetosphere and its drifts may trigger wave instabilities. Initial analysis results from this new instrument will be presented. Primary emphasis will be placed on interpreting the instrument response, and differentiating between the effects of secondary particles and the thermal core. Also, we will compare the thermal electron behavior with more energetic ions and electrons and will place the measurements in the context of previous theoretical results, including models of auroral energy deposition and Alfvenic acceleration.

URL: http://esp.sr.unh.edu/liz/sierra.htm

SM21B-0539 0830h POSTER

First Results From the Rocket Auroral Correlator Experiment

Craig A. Kletzing[1] (319-335-1904; craig-kletzing@uiowa.edu)

Scott R. Bounds[1] (scott-bounds@uiowa.edu)

James LaBelle[2] (jlabelle@einstein.dartmouth.edu)

Marilia Samara[2] (msamara@stormer.dartmouth.edu)

[1]The University of Iowa, Department of Physics & Astronomy, 203 Van Allen Hall, Iowa City, IA 52242, United States

[2]Dartmouth College, Department of Physics & Astronomy, Hanover, NH 03755-3571, United States

The Rocket Auroral Correlator Experiment (RACE) was launched into active aurora on February 6, 2002 at 9:38:51 UT. At this time the poleward edge of the auroral oval had contracted northward and the rocket traversed the northward region of the active forms. The rocket experiment was designed to investigate the interaction of high frequency waves and electrons. The payload was well-instrumented with two high frequency TM video channels to transmit continuous waveform data as well as high-sensitivity electron detectors to measure field aligned electron fluxes associated with wave activity. During the flight there were several regions of electron precipitation observed simultaneously with strong Langmuir waves. We present examples of the electron spectra and the waveforms associated with them. These results suggest that these Langmuir waves are driven by lower energy electron fluxes below 1-2 keV. We also present preliminary results from a new wave-particle correlator which suggests that the electrons are significantly phase-bunched by the wave electric field.

SM21B-0540 0830h POSTER

Rocket Measurements of Polarization of Auroral HF Waves

Marilia Samara[1] (603-646-1394; samara@dartmouth.edu)

James LaBelle[1] (jlabelle@einsteindartmouth.edu)

Craig A Kletzing[2] (cak@delta.physics.uiowa.edu)

Scott R Bounds[2] (srb@gamma.physics.uiowa.edu)

[1]Dartmouth College, 6127 Wilder Laboratory, Hanover, NH 03755, United States

[2]University of Iowa, 203 Van Allen Hall, Iowa City, IA 52242, United States

On 6 February 2002, at 9:38:51 UT the Rocket Auroral Correlator Experiment (RACE) sounding rocket was launched into active aurora from Poker Flat, Alaska. The payload reached an apogee of 922km at approximately 550 seconds. One objective of this rocket mission is the measurement of approximate polarization (right vs. left) of observed transverse HF waves. Determining this polarization allows us to identify the wave mode and hence use observed wave cutoffs to measure electron density. The signals from perpendicular antennas in the x-y plane are electronically shifted by ±45 degrees using an analog phase shifting circuit which provides a 90 degree phase difference in the frequency range 100kHz-2.4MHz, and the difference and sum of these two signals is taken. The relative amplitudes of these two signals indicate the direction and degree of polarization. The advantage of this technique is that it allows phase information from all frequencies of interest to be transmitted to the ground station using telemetry channels that have amplitude fidelity only, not phase fidelity. In addition to an artificially injected calibration signal the whislter mode, known to be R-mode, will be used as a calibration. Polarization of the other modes will be measured and interpreted. Preliminary analysis of the data reveals Langmuir waves at the plasma frequency, whistler mode emissions and emissions of a to be determined mode (L or X) with a cutoff near the plasma frequency.

SM21B-0541 0830h POSTER

Detection of Filamentary Structures in the Polar Ionosphere Using the EISCAT Svalbard Radar as an Interferometer

Cesar La Hoz[1] (47-77645161; Cesar.La.Hoz@phys.uit.no); Tom Grydeland[1] (Tom.Grydeland@phys.uit.no); Tor Hagfors[2] (hagfors@linmpi.mpg.de); Mårten Blixt[1] (Marten.Blixt@phys.uit.no); Susumu Saito[3] (susaito@kurasc.kyoto-u.ac.jp); Anja Stromme[1,4] (Anja.Stromme@phys.uit.no); Asgeir Brekke[1] (Asgeir.Brekke@phys.uit.no)

[1] Department of Physics University of Tromso , University of Tromso Department of Physics , Tromso N-9037, Norway

[2] Max-Planck-Institute for Aeronomy , Max Planck Strasse 2, Katlenburg-Lindau D-37176, Germany

[3] Radio Science Center for Space and Atmosphere, Kyoto University , Gokaho, Uji, Kyoto 611-0011 , Kyoto 611-0011, Japan

[4] SRI International, Center for Geospace Research , 333 Ravenswood Ave., Menlo Park, CA 94025, United States

Where currents are carried by a plasma, these currents tend to be bursty and to focus into discrete channels, often with a filamented structure. This situation is very common in nature and in the laboratory. Here we present evidence of bursty and filamentary structures in the terrestrial aurora, observed through the enhancements of radar echoes produced by plasma instability in the filaments. By recording the raw time series from the radar directly, we have resolved the time development of the observed phenomena and we find significant variations on sub-second time scales. Using an interferometric technique to attain sub-beam spatial resolution, we have estimated the horizontal scale size of the structures, and find it to be comparable to the smallest known scale size of optical aurora, which despite extensive theoretical attempts remain little understood (e.g., Borovsky, JGR 98, 6101-6138, 1993). Enhanced radar echoes of this type have been observed previously at several Incoherent Scattering Radar observatories. One of the suggested explanations would enhance only one shoulder. Hence, temporal or spatial averaging of short-lived or spatially small structure was hypothesized to explain simultaneous enhancement of both shoulders. Our time/space resolved observations let us test this hypothesis with the result that time averaging is ruled out, whereas the enhancement of both shoulders appears to occur in the same volume.

SM21B-0542 0830h POSTER

Range Effect in the Spectral Width of E-Region HF Coherent Echoes

Donald W Danskin[1] ((306) 966-6457; danskin@dansas.usask.ca)

Alexandre V Koustov[1] ((306) 966-6426; koustov@dansas.usask.ca)

Roman A Makarevitch[1] ((306) 966-6457; makarevitch@dansas.usask.ca)

Mark Lester[2] (mle@ion.le.ac.uk)

[1] Institute of Space and Atmospheric Studies, University of Saskatchewan 116 Science Place, Saskatoon, SK S7N 5E2, Canada

[2] Department of Physics and Astronomy, University of Leicester, Leicester LEI 7RH, United Kingdom

SuperDARN/CUTLASS Finland HF radar observations of E-region coherent echoes are presented for a two-hour event on 12 February 1999. The Burg spectrum method is applied to study microstructure of the spectra. It is discovered that many spectra with enhanced width are two-peaked with a systematic pattern in their occurrence; namely, the double-peak echoes are typically observed at intermediate or far range, farther than the power maximum of the E-region echo band in the range profile. It is argued that double-peak echoes occur because the radar can access, at certain ranges, both the bottom and the top parts of the electrojet layer where the irregularity velocities are quite different. Ray tracing analysis with measured EISCAT density profiles confirm the possibility of such scattering layers. We also show that the velocity of both peaks was below the EISCAT observed ExB convection velocity which is consistent with the idea that the velocity of E-region decameter irregularities is depressed due to collisions.

SM21B-0543 0830h POSTER

Evening Sector Pulsating Aurora Embedded in Quiet Time Diffuse Aurora

Mark G Ball[1] (ball@phys.ucalgary.ca)

Trond Trondsen[1] (Trondsen@phys.ucalgary.ca)

David Knudsen[1] (Knudsen@phys.ucalgary.ca)

Eric Donovan[1] (eric@phys.ucalgary.ca)

Haikim Diep[1] (diep@phys.ucalgary.ca)

[1] University of Calgary, Department of Physics and Astronomy, 2500 University Dr. NW, Calgary, AB T2N 1N4, Canada

In a recent auroral campaign at Churchill, Canada (69.5° invariant), we operated the University of Calgary's Portable Auroral Imager (PAI - see *Trondsen and Cogger* [*JGR*, pages 363-378, 1997]), and a new high time resolution photometer. The photometer was operated with a filter that blocked out long lived auroral emissions (eg., 557 nm and 630 nm) and took data at a rate of 1 kHz. Between 0300 and 0400 UT, corresponding to the local premidnight sector, the latitude profile of the aurora (determined from CANOPUS All-Sky Imager and Merdidian Scanning Photometer data) was characterized by very dim (several hundreds of Rayleighs), diffuse electron aurora, and correspondingly dim (∼10 Rayleigh) proton aurora. At the same time, the high space and time resolution PAI data show the weak electron aurora to be structured on scales sizes of hundreds of meters. Furthermore, the high time resolution photometer recorded a sequence of 17 second period auroral pulsations spanning tens of minutes. Here, we present the pulsating aurora photometer and PAI data, within the larger scale context provided by the the CANOPUS ground-based instruments. In particular, we explore the location of this pulsating aurora relative to the larger scale proton and electron aurora.

SM21B-0544 0830h POSTER

Assessment of Pulse Counting Magnetometer Technology for Solar-Terrestrial Environment Monitoring

Martin Connors[1] (martinc@athabascau.ca)

Jason Ponto[2] (jibberjason@hotmail.com)

Mike Foote[2] (mfoote@shaw.ca)

[1] Athabasca University, 1 University Drive, Athabasca, AB T9S 3A3, Canada

[2] Athabasca University/U of Alberta, 1 University Drive, Athabasca, AB T9S 3A3, Canada

Commercial pulse-counting fluxgate magnetometer heads offer promise for low-cost magnetic monitoring. Having an entirely digital output consisting of pulses in the tens of kHz, they are well suited to use with microcontrollers. In turn the magnetic data storage and transmission requirements are well handled by personal computers (PCs), to which microcontrollers are easily interfaced. A further relevant technology is that of Global Positioning, which gives a precision time base to be used both for pulse counting and for absolute timing of the measurements. All of these technologies can be integrated to produce a magnetometer with a cost of several hundred dollars. Since the PC required is also not expensive, a magnetometer deployable in large quantities for education or research is possible. Here we assess the quality of magnetic data acquired by sample instruments. We find that resolutions of about 10 nT are attained by thermally insulated devices without active thermal control. This surpasses by a factor of about 10 that of Hall effect sensors and is suitable for applications such as monitoring currents in pipelines. To attain a threshold of 1 nT with 1 second sampling, active thermal control is needed. With the current family of commercial sensors this threshold will be difficult to surpass since an error of one pulse per second corresponds to roughly one nT at current device frequencies. These sensors are thus most suited to studies of morphology of auroral currents, where availability of a large number of stations of limited resolution would enhance the ability to do data inversion.

SM21B-0545 0830h POSTER

Propagation of Cyclotron Maser Emissions in the Finite AKR Source Cavity

Philip L Pritchett[1] (1-310-825-3637; pritchet@physics.ucla.edu)

Robert J Strangeway[2] (strange@igpp.ucla.edu)

Robert E Ergun[3] (ree@fast.colorado.edu)

Charles W Carlson[4] (cwc@ssl.berkeley.edu)

[1] Department of Physics and Astronomy, University of California, 405 Hilgard Avenue, Los Angeles, CA 90095-1547, United States

[2] Institute of Geophysics and Planetary Physics, University of California, 405 Hilgard Avenue, Los Angeles, CA 90095-1567, United States

[3] Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80303, United States

[4] Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450

Observations in the AKR source region by the Fast Auroral SnapshoT (FAST) satellite have demonstrated that the primary auroral electron distribution has the form of a "horseshoe" or "shell" structure, that the source region is nerly void of low-energy electrons, and that the radiation exists as a perpendicularly propagating (to within a few degrees) X mode wave. These observations are used to construct a 2-1/2D particle-in-cell simulation model to study the propagation of cyclotron maser emissions within a longitudinal plane in the bounded AKR source region. These simulations indicate that the maser radiation component incident normally on the cavity boundary (with across track E polarization) tends to leak out of the cavity via conversion to the Z mode and absorption by the ambient cold plasma; the reflected flux is very small. These processes destroy the coherence of this component. In contrast, the component propagating in the longitudinal direction (with along track E polarization) is free to grow along an extended path. FAST observations of the perpendicular E polarization in the source region indicate that it varies between being roughly isotropic for weaker AKR intervals to having a substantial (as much as a factor of 100) enhancement of the along track polarization for the most intense AKR emissions. No evidence was found that the across track polarization was ever dominant. The implications of these results will be discussed.

SM21B-0546 0830h POSTER

Dispersion Solver with Relativistic Cyclotron Resonance

Tadas K Nakamura (tadas@fpu.ac.jp)

Fukui Prefectural University, 4-1-1, Matsuoka-Yoshida, Fuk 1195, Japan

A method to calculate linear dispersion relation of electromagnetic waves in a relativistic plasma is proposed. Exact analytic calculation with relativistic cyclotron resonances is extremely difficult because the cyclotron frequency depends on both parallel and perpendicular (to magnetic field) velocities due to the relativistic effect. To avoid this difficulty, the method presented here makes use of algebraic approximation to the velocity distribution function.

Algebraic approximation enables analytical velocity integration with the residue theorem; results are highly accurate when applied to non-relativistic calculation (see references). The same tactics can be applied for relativistic plasmas, however, there comes a problem of branch cut and multiple Riemann surfaces. This problem must be overcome by *ad hoc* technique depending on each specific wave mode. Calculation for a parallel propagating electromagnetic wave in a relativistic plasma will be presented as an example.

References:Lofgren et al., Phys. Plasmas, vol 4, 1124 (1997).Ñakamura, T. K., and M. Hoshino, Phys. Plasmas, vol 5, 3547 (1998).

URL: http://mira.bio.fpu.ac.jp/∼tadas

SM21B-0547 0830h POSTER

Expansion of a dense plasma embedded in an ambient magnetized background plasma

Michael VanZeeland[1] (310-206-1772; mav@physis.ucla.edu)

Walter Gekelman[1]

Stephen Vincena[1]

[1] University of California - Los Angeles, STRB UCLA 1040 Veteran Ave., Los Angeles, CA 90095, United States

The expansion of a dense (initially, $n_{lpp}/n_0 >>1$) laser-produced plasma (lpp) into an ambient magnetized background plasma (He, Ne n=2×10^{12} cm^{-3}, 17 meters long, 80 cm diameter, B_{0z} =.5-1.5 kG) capable of supporting Alfvén waves has been studied in the *LAPD* (*L*Arge *P*lasma *D*evice). In particular, the initial diamagnetic expulsion of the background field for a supersonic expansion has been investigated using a 3-axis inductive probe. The resulting impulse to the background field and induced current profiles are mapped spatially and temporally for each case. It has been found that the presence of a background plasma allows for complex currents to be created which in turn radiate, among others, Alfvén and Lower Hybrid waves. Particle motion across and along the confining background field will be discussed. Comparison will be made to previous experimental work and to relevant astrophysical and laboratory plasmas.

* Work supported by the U.S. Department of Energy and the Office of Naval Research.

SM21B-0548 0830h POSTER

Excitation of VLF hiss by a laser-produced plasma– a laboratory investigation

Stephen T Vincena[1] (310-206-1772; vincena@physics.ucla.edu)

Walter Gekelman[1] (gekelman@physics.ucla.edu)

Mike VanZeeland[1] (mav@physics.ucla.edu)

James Maggs[1] (maggs@physics.ucla.edu)

S
M

[1]UCLA Department of Physics and Astronomy, LAPD Plasma Lab 1040 Veteran Ave, Los Angeles, CA 90095, United States

VLF hiss is an ionospheric radio emission which is closely related to electron precipitation in the earth's auroral zones. In this experiment, a burst of field-aligned electrons is produced by the expansion of a dense, laser-produced plasma (lpp) into a uniform, low-density background plasma.

The experiment is conducted in the upgraded **La**rge **P**lasma **D**evice (**LaPD**) at UCLA. The background plasma is neon, with plasma parameters: $\omega_{ce}/\omega_{pe} = 0.1 - -0.3$, $T_e/T_i \approx 6$, plasma radius=$66r_{ci}$, length=17m. An aluminum target is struck with a NdYAG laser (1J, 7ns pulse) focused to a spot size of less than one millimeter. The ions in the lpp (with energies of several keV) are initially unmagnetized and propagate across the background field. The electrons, however, remain magnetized and a fraction of them jet away from the point source of the laser impact in a field-aligned burst, perhaps forming a beam-like distribution similar to auroral electrons.

The measured electric field spectra ($\omega_{LH} < \omega < \omega_{ce}$) as a function of angle are consistent with a finite line source of lower hybrid waves, with one end fixed at the laser impact site. The spatial morphology of the observed radiation pattern is similar to auroral zone VLF hiss. We present these spectra, correlation measurements, and an estimate of the coupling efficiency of laser power into wave energy.

Work supported by ONR, DOE, and NSF.

SM21B-0549 0830h POSTER

Alfvén Waves Generated by Expanding Plasmas in the Laboratory and in Space

Walter Gekelman[1] (310-206-1772; gekelman@physics.ucla.edu)

Mike VanZeeland[1] (310-206-1772; mav@physics.ucla.edu)

Steve Vincena[1] (310-206-1772; vincena@physics.ucla.edu)

Patrick Pribyl[1] (310-206-1772; pribyl@physics.ucla.edu)

[1]University of California, Los Angeles, 1000 Veteran Avenue, Los Angeles, CA 90095, United States

There are many situations, which occur in space (coronal mass ejections, supernovas), or are man-made (upper atmospheric detonations) in which a dense plasma expands into a background magnetized plasma, that can support Alfvén waves. The *LA*rge *P*lasma *D*evice (*LAPD*) is a machine, at UCLA, in which Alfvén waves propagation in homogeneous and inhomogeneous plasmas has been studied. These will be briefly reviewed. Then a new class of experiments which involve the expansion of a dense (initially, $n/n_o >>1$) laser-produced plasma into an ambient highly magnetized background plasma capable of supporting Alfvén waves will be presented. The 150 MW laser is pulsed at the same 1 Hz repetition rate as the plasma in a highly reproducible experiment. The laser beam impacts a solid target such that the initial plasma burst is directed either along or across the magnetic field. The interaction results in the production of intense shear and compressional Alfvén waves, as well as large density perturbations. The waves propagate away from the target and are observed to become plasma column resonances. The magnetic fields of the waves are obtained with a 3-axis inductive probe. Spatial patterns of the magnetic fields associated with the waves and density perturbations are measured at over 10^4 locations and will be shown in dramatic movies. These are used to estimate the coupling efficiency of the laser energy and kinetic energy of the dense plasma into wave energy. The wave generation mechanism is due to field aligned return currents, which replace fast electrons escaping the initial blast.

Work supported by ONR, DOE, and NSF

SM21B-0550 0830h POSTER

Structures Formed by Supersonic Density Filaments

Frank S Tsung[1] ((310) 825-xxxx; tsung@physics.ucla.edu)

George J Morales[1] ((310) 825-xxxx; morales@physics.ucla.edu)

Jean-Noel Leboeuf[1] ((310) 825-xxxx; leboeuf@physics.ucla.edu)

[1]UCLA, 405 Hilgard Ave., Los Angeles, CA 90095, United States

This computer-simulation study is motivated by recent spacecraft observations in the auroral ionosphere of field-aligned density depletions (FREJA) having short transverse scale and of kinetic structures moving at the electron thermal speed (FAST). An electromagnetic PIC code that follows the relativistic, magnetized dynamics of electron and ions is used to examine the nonlinear plasma structures that are formed when a density filament is driven at supersonic speed along the geomagnetic field. It is found that the ambient plasma allows the ballistic outflow of fast electrons and results into a moving, dipolar-current system that generates a 3-D magnetic topology. The field-aligned currents develop small-scale, large potential structures that generate ion distribution functions with large velocity spread. The moving filament carves out a trailing, deep density channel in the ambient plasma.

This work is sponsored by ONR and NSF.

SM21B-0551 0830h POSTER

Kinetic Simulation of Alfvén Waves with Small Transverse Scale

J Tonge[1] (310-267-5230; tonge@physics.ucla.edu)

F S Tsung[1] (tsung@physics.ucla.edu)

G J Morales[1] (morales@physics.ucla.edu)

J-N Leboeuf[1] (leboef@physics.ucla.edu)

[1]University of California, Los Angeles, Dept. of Physics and Astronomy 1-130 Knudsen Hall, Los Angeles, CA 90095

Recent observations (FREJA, FAST, POLAR) show that Alfvén waves of small transverse scale are present in regions of the auroral ionosphere where strong acceleration of energetic ions and electrons results. In this study computer simulation is used to explore the self-consistent, kinetic behavior of these Alfvén waves through selected cases. An electromagnetic PIC code is used to study Alfvén waves which are excited at a boundary and propagate along the geomagnetic field. A comparison is made between cases with a single perpendicular wave number and cases with finite structures that give rise to field-aligned current filaments. The transition between the inertial and kinetic regimes is explored as well as the modifications produced by hot ions. Some nonlinear cases are also explored by systematically increasing the excitation amplitude of the antenna.

This work is sponsored by NSF.

SM21B-0552 0830h POSTER

The role of lower hybrid wave collapse in the auroral ionosphere

Peter W Schuck[1,3] (schuck@ppdmail.nrl.navy.mil)

Gurudas I Ganguli[1] (guru@ppdmail.nrl.navy.mil)

Paul M Kintner[2] (paul@ee.cornell.edu)

[1]Naval Research Laboratory, 4555 Overlook Ave, SW, Washington, DC 20375

[2]School of Electrical Engineering, Cornell University, Ithaca, NY 14853

[3]National Research Council Postdoctoral Fellow, 500 5th Street, NW, Washington, DC 20001

In regions where lower hybrid solitary structures (LHSS) are observed, the character of auroral lower hybrid turbulence (LHT) (0-20 kHz) is investigated using the amplitude probability distribution of the electric field. The observed probability distributions are accurately described by a Rayleigh distribution with two degrees of freedom. The statistics of the LHT exhibit no evidence of the global modulational instability or self-similar wave collapse. We conclude that nucleation and resonant scattering in pre-existing density depletions are the processes responsible for LHSS in auroral LHT.

SM21B-0553 0830h POSTER

Properties and Theory of Lower-Hybrid Density Cavities

David J Knudsen[1] (403-220-8651; knudsen@phys.ucalgary.ca); Benjamin Bock[1] (bock@phys.ucalgary.ca); Johnathan K. Burchill[1] (burchill@phys.ucalgary.ca); Joshua Curtis[1] (curtis@phys.ucalgary.ca); Robert F. Pfaff[2] (rob.pfaff@gsfc.nasa.gov); Scott R. Bounds[3] (srb@delta.physics.uiowa.edu); James H. Clemmons[4] (James.H. Clemmons@aero.org); Don D. Wallis[5] (dwallis@eisa.com)

[1]University of Calgary, Department of Physics, 2500 University Drive N.W., Calgary, AB T2N 1N4, Canada

[2]NASA GSFC, Code 696, Bldg. 2, Room 213, Greenbelt, MD 20771, United States

[3]University of Iowa, Department of Physics and Astronomy, 203 Van Allen Hall, Iowa City, IA 52242, United States

[4]The Aerospace Corporation, MS M2/254, 270 Coral Circle, El Segundo, CA 90245, United States

[5]Magnametrics, 2340 Briar Hill Drive, Ottawa, ON K1H 7A9, Canada

Lower-hybrid cavities are wave-filled, cylindrical density cavities aligned with the geomagnetic field. They have relative density depletions of several to tens of percent, diameters of order 20-50 m, and are associated with ion heating transverse to the geomagnetic field. Several aspects of these structures remain unexplained, including the cause of the density depletion and the reason for their relatively narrow distribution of diameters. We present statistical properties of several hundred cavities observed on the OEDIPUS-C and GEODESIC sounding rockets, flown into the nightside auroral ionosphere through plasma densities varying over two orders of magnitude. The average cavity chord lengths are observed not to depend on density, demonstrating that cavity sizes are not determined by electron inertial length, for example. A subset of cavities also exhibit slight density increases or "shoulders at the their perimeters. Density cavities with these features can be explained by tracing ion trajectories in the presence of ion heating localized on the scale of an ion gyroradius. The dependence of cavity depth and shape on heating intensity and scale size is predicted using Monte Carlo and semi-analytical descriptions of heated ion motion near cavities.

SM21B-0554 0830h POSTER

Nonlinear Energization of Ionospheric Ions by Electrostatic Fields

Abhay K Ram[1] (1-617-253-2595; abhay@mit.edu)

David J Strozzi[1] (1-617-253-2539; dstrozzi@mit.edu)

Abraham Bers[1] (1-617-253-4195; bers@mit.edu)

[1]Plasma Science and Fusion Center, M.I.T., 77 Massachusetts Avenue, Cambridge, MA 02139, United States

We extend our previous analysis of transverse energization of ionospheric ions by electrostatic lower hybrid waves, propagating perpendicular to the geomagnetic field [1], to waves propagating obliquely to the field. The analysis in [1] showed that low energy ions can undergo nonlinear coherent energization from their initial ambient low energies to gravitational escape energies if the bandwidth of the frequency spectrum of the waves extends beyond twice the ion cyclotron frequency. While the rocket observations of the upper auroral ionosphere indicate that electrostatic waves are propagating essentially across the geomagnetic field, a small parallel component of the wave vector cannot be ruled out. We determine the effect of oblique propagation of the waves on the nonlinear coherent energization of ions and obtain conditions for which this energization can persist.

In the auroral ionospheric plasmas, intense electrostatic fields in density depleted regions and associated transverse energization of ions are also observed. We have been studying, theoretically and computationally, the generation of fields in density cavities. Intense localized electric fields can be generated in regions where plasma resonances (e.g., the lower hybrid or the upper hybrid resonances) exist. An appropriate description of the fields is obtained from Maxwell's equations for a cold plasma with a spatial profile. The characteristic features of the fields obtained from this description will be presented. In contrast to a spectrum of plane waves, the fields in density gradients are localized to spatial scales that are small compared to the ion Larmor radius. Also, the interaction of ions with these localized fields is significantly different from that with obliquely propagating electrostatic waves. We find that the phase space of the energized ions can be chaotic, and, for long-time interactions, the ions can undergo large energy gains akin to Levy flights. Detailed analytical and numerical results of the comparison between the interaction of ions with localized field structures and with plane waves will be presented.

This work is supported by NSF Grant No. ATM-98-06328 and by NSF-DOE Grant No. DE-FG02-99ER-54555.

[1] A.K. Ram, A. Bers, and D. Benisti, *J. Geophys. Res.* **103**, 9431 (1998).

SM21B-0555 0830h POSTER

Electrostatic Ion Cyclotron Waves in the Auroral Ionosphere

Martin V. Goldman[1] (goldman@spot.colorado.edu)

David L. Newman[1]

Laila Andersson[2]

Robert E. Ergun[2]

[1]Center for Integrated Plasma Studies, University of Colorado, UCB 390, Boulder, CO 80309-0390, United States

[2]Laboratory for Atmospheric and Space Physics, University of Colorado, UCB 392, Boulder, CO 80309-0392, United States

Electrostatic waves near harmonics of the ion cyclotron frequency are often seen in the auroral ionosphere.[1] These waves propagate almost perpendicular to the geomagnetic field but are sometimes observed in conjunction with parallel bipolar field structures. This presentation is based on some unpublished FAST satellite data in a downward current region showing electron and ion distribution functions measured over intervals during which waves are observed (over shorter times) near ion cyclotron harmonics. Model particle distributions closely related to the measured ones are used in a linear stability analysis to study instabilities that are capable of saturating into the observed wave spectra and particle distributions. Typically, the measured distributions are highly anisotropic and have drifts. Two kinds of instabilities are found: *current-driven* instabilities, which represent a generalization of Kindel-Kennel[2] instabilities, and *loss-cone-driven* instabilities. (It is also known that *shear* in the velocity distribution can drive cyclotron harmonic waves in the *upward* current region.[3]) An interesting new method for studying stability of quasilongitudinal wave in a magnetoplasma is also presented.

Research supported by NSF, NASA, and DOE.

[1] R. E. Ergun, et al., *Geophys. Res. Lett.*, **25**, 2025 (1998); F. J. Crary, et al., *Geophys. Res. Lett.*, **28**, 3059 (2001).

[2] J. M. Kindel and C. F. Kennel, *J. Geophys. Res.*, **76**, 3055 (1971).

[3] V. V. Gavrishchaka et al., *Phys. Rev. Lett.*, **85**, 4285 (2000).

SM21B-0556 0830h POSTER

Ion Cyclotron Waves and Ion Heating in the Auroral Ionosphere

Jay R Johnson[1] (609 243-2603; jrj@pppl.gov)

C Z Cheng[1] (fcheng@pppl.gov)

[1]Princeton University, Plasma Physics Laboratory PO Box 451, Princeton, NJ 08543, United States

Upwelling ions are commonly observed along auroral field lines in association with electromagnetic ion cyclotron waves. The waves may be caused by any of a number of mechanisms: electron current or beams, ion beams, velocity shear, temperature anisotropy, and/or loss cone. Usually these waves are observed with a downward Poynting flux, and it is expected that they propagate into the ionosphere where they can heat ionospheric oxygen and helium. We have solved the electromagnetic wave equations for ion cyclotron waves as they propagate along the magnetic field lines into the ionosphere. Based on the wave solutions, it is possible to understand how much wave energy is deposited in the heavy ions through ion cyclotron and Joule dissipation as well as the location where the energy is deposited. The dissipation has a sensitive dependence on the density of the minority species and on the spectrum of the ion cyclotron waves. We provide ion heating rates as a function of altitude below the satellite for commonly observed wave spectra and discuss the resulting ion distributions.

SM21C MCC: 131 Tuesday 0830h

Magnetic Reconnection: Magnetopause *(joint with NG, SH)*

Presiding: **J Raeder,** University of California, Los Angeles**; J D Scudder,** University of Iowa Department of Physics and Astronomy

SM21C-01 0830h

Magnetopause reconnection tailward of the cusp during northward interplanetary magnetic field and its relation to magnetosheath properties

Steven M Petrinec[1] (650-354-5562; petrinec@spasci.com)

Karlheinz J Trattner[1] (650-424-2445; trattner@spasci.com)

Stephen A Fuselier[1] (650-424-3334; fuselier@spasci.com)

[1]Lockheeed Martin ATC, B/255, O/L9-42 3251 Hanover St., Palo Alto, CA 94304-1181, United States

This study examines the location of the reconnection site on the magnetopause for conditions of northward IMF. Ion distribution functions are obtained from the Toroidal Imaging Mass, Angle Spectrometer (TIMAS) instrument during passes through the dayside cusp region by the NASA/GGS Polar spacecraft when the interplanetary magnetic field (IMF) was steady and northward. Ion cutoff velocities are used in conjunction with the Onsager et al. (GRL, 1990) formula to estimate the distance from the Polar spacecraft to the site of reconnection. The Tsyganenko 1996 magnetospheric magnetic field model is used to map these determined distances along the magnetospheric magnetic field to the magnetopause. It is found that nearly all of these reconnection sites lie tailward of the cusp, in places for which the magnetosheath flow is considered to be super-Alfvenic (using hydrodynamic theory and a magnetosheath magnetic field model). Different scenarios are discussed, including the possibility of the existence of a non-stationary reconnection site, and the existence of a plasma depletion layer which acts to significantly reduce the magnetosheath Alfven speed close to the magnetopause. From the observations and mapped reconnection locations, we also estimate by how much the ion density must decrease (and the magnetic field increases) in the plasma depletion layer in order that the reconnection locations lie in sub-Alfvenic magnetosheath flow.

SM21C-02 0845h

Observation of lower hybrid drift instability in the diffusion region at a reconnecting magnetopause

Stuart D Bale[1] (+1 510 643 3324; bale@ssl.berkeley.edu)

Forrest S Mozer[1] (fmozer@ssl.berkeley.edu)

Tai Phan[1] (phan@ssl.berkeley.edu)

[1]Space Sciences Laboratory, University of California, Berkeley, CA 94720-7450, United States

Intense lower hybrid waves are observed in the Hall current region of a reconnecting current sheet at the earth's magnetopause. Large measured cross-field drifts and density gradients are the likely sources of free energy through a lower hybrid drift instability (LHDI), which is stabilized near the neutral point where the plasma β is large. Harris neutral sheet and linear models are fitted to the data and inferred current density profiles are compared to the observed current density from particle measurements. We estimate the contribution of LHDI anomalous resistivity to the parallel electric field and show that it is more than 100 times smaller than the measured parallel field at the separator boundaries and essentially zero near the neutral point, leaving gradient electron pressure tensor and inertial terms or anomalous resistivity from higher frequency instabilities to support any parallel fields there and, hence, control the reconnection process.

SM21C-03 0900h

Cluster Observations of the Magnetopause at Ion and Electron Scales

Mats Andre[1] (mats.andre@irfu.se); Andris Vailvads[1] (andris.vaivads@irfu.se); Stephan Buchert[1] (stephan.buchert@irfu.se); Laurence Rezeau[2] (laurence.rezeau@cetp.ipsl.fr); Andrew Fazakerley[3] (anf@mssl.ucl.ac.uk); Jean-Andre Sauvaud[4] (Jean-Andre.Sauvaud@cesr.fr)

[1]Swedish Inst Space Physics, Box 537, Uppsala SE 751 21, Sweden

[2]CETP, 10/12 Avenue de L'Europe, Velizy F-78140, France

[3]Mullard Space Science Laboratory, Univ. College London, Holmbury St. Mary, Dorking, Surrey, London RH5 6NT, United Kingdom

[4]CESR/CNRS, 9 Avenue du Colonel Roche, B.P. 4346, Toulouse Cedex 4 F-31028, France

Observations of the magnetopause by the four Cluster satellites are presented. We investigate electric and magnetic field, and wave, data together with particle observations obtained at satellite separations from around hundred to thousands of kilometres. Observations include examples of strong (10 mV/m) varying electric fields in narrow (much less than an ion gyroradius) boundaries, extending along the magnetopause for at least several ion gyroradii. The emissions in these "turbulent boundaries are broadband in frequency. The potential drop across this narrow region can be a few hundred Volts, which may be important for energization of particles close to the magnetopause. We investigate the nature of this decoupling of ion and electron motion, and its relation to various transport processes across the magnetopause. We also compare waves and particle energization at the magnetopause with similar phenomena in the auroral region.

SM21C-04 0915h

Ambipolar Electric Fields Parallel and Perpendicular to the Local Magnetic Field: Magnetopause and Depletion Layers

Jack D Scudder[1] (319-335-0804; jack-scudder@uiowa.edu)

Nelson Maynard[2]

Dan Ober[2]

Forrest Mozer[3]

[1]University of Iowa Department of Physics and Astronomy , Dubuque at Jefferson, Iowa City, IA 52240, United States

[2]Mission Research Corporation, One Tara Blvd, Nashua, NH 030602, United States

[3]UC Berkeley SSL, Centennial Road and Grizzly Peak Road, Berkeley, CA 94720, United States

The electric fields that occur in a plasma in the presence of pressure gradients have long been inventoried in laboratory plasmas, but only recently have these same effects been taken seriously in the experimental space science community. When these effects are present, the electric field can no longer be inferred from fluid velocities and the magnetic field, but there are substantial (and detectable mV/m class) corrections to the unipolar electric field associated with the pressure gradients of the electron part of the plasma. A pressure ridge is theoretically anticipated astride the separator which implies that there are pressure gradients there and, in general, parallel electric fields of this type. Pressure gradient electric fields, whether parallel or not to B, occur in other places as well; accordingly the detection of pressure gradients and parallel E are not, by themselves, sufficient to indicate reconnection.

In this paper we illustrate the power of cross strapping the plasma, electric and magnetic field measurements to elucidate a new picture of the electrodynamics of the magnetopause and its associated boundary layers. Even depletion layers, long held to be the hallmark of a magnetopause that is locally "closed", will be illustrated with well developed pressure gradient and parallel electric fields. A particularly well resolved layer yields the following picture of the scale lengths involved in this layer. As pressure variations are perceived in the time domain, the comparisons of the electron flow and the electromagnetic field suggest waxing and waning gradients that may be inverted to determine the time sequence of spatial scales encountered. As the depletion layer is traversed, the spatial scales do on average decrease, but they do not collapse to the electron inertial scale before the magnetopause is traversed. This type of crossing will be contrasted with a magnetopause layer where the observer penetrates the separator and all the classically expected signatures of reconnection are observed, and the spatial scales of such a reconnecting layer has collapsed to and asymptoted to the limiting electron inertial length, thereby demagnetizing the electrons. Such comparisons give the impression that the sights of reconnection depend on the precised collapse of scales that the local boundary conditions require: if they are not short enough to demagnetize the thermal electrons reconnection does not occur; if it does it has been observed to occur.

SM21C-05 0930h

What is Behind the Plasma Depletion Layer?

Y. L. Wang[1] (310-825-8070; ylwang@igpp.ucla.edu)

J. Raeder[1] (jraeder@igpp.ucla.edu)

C. T. Russell[1] (ctrussel@igpp.ucla.edu)

[1]Institute of Geophysics and Planetary Physics, University of California, Los Angeles, 405 Hilgard Avenue, IGPP/UCLA, Los Angeles, CA 90095-1567, United States

The plasma depletion layer (PDL) is a layer on the sunward side of the magnetopause with lower plasma density and higher magnetic field compared to the corresponding upstream magnetosheath values. It predominantly occurs during northward IMF conditions. In this presentation, we investigate the basic physics of the formation of the PDL, which is fundamental for the understanding of the magnetosheath and magnetopause boundary layer. In a previous study, we have validated our global model by comparing model results with PDL observations. We now extend this work by studying the more detailed physics of the PDL with global MHD simulations. Detailed force analysis shows that different forces are playing different roles at different locations. A new technique is presented to test the location of the possible slow mode front in the magnetosheath. The results show that, when we assume a magnetopause wave source, slow mode fronts do not exist for typical IMF and solar conditions that otherwise lead to PDL formation. A more detailed flux tube depletion process in the magnetosheath is described. The results are compared with the former results by Zwan and Wolf [1976]

S M