resistivity in the LRP region and showed that it has a very small effect on $E_{||}$ (< few %) and that $E_{||}$ is determined primarily by the velocity-space anisotropy and pressure gradient terms in the momentum balance equation. A similar analysis is in process for an upward auroral-current region.

SM42A CC: 518 C Thursday 1030h

Double Layers in Space and Astrophysical Plasmas II *(joint with SA)*

Presiding: **N Singh,** University of Alabama in Huntsville**; C Falthammar,** Royal Institute of Technology

SM42A-01 1030h

Simulation of Current-Driven Double Layers in the Auroral Downward Current Region

David L. Newman[1] (1-303-492-6967; David.Newman@colorado.edu)

Laila Andersson[2] (andersson@fast.colorado.edu)

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

Robert E. Ergun[2] (ree@fast.colorado.edu)

Naresh Sen[1] (Naresh.Sen@colorado.edu)

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

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

Previous 1-D Vlasov simulations have shown that strong laminar double layers can form self-consistently in a current-carrying equipotential plasma at the location of an initially weak charge-neutral density perturbation. The electric fields associated with these simulated double layers correspond well with FAST satellite observations in the downward current region of the auroral ionosphere. Such double layers are considered as special cases of a more general class of structures referred to as *transition layers*, which can be turbulent as well as laminar. New Vlasov simulation studies show that properties of current-driven transition layers, such as their rate of formation and susceptibility to disruption, depend on characteristics of the incoming electron distribution on the high-potential (magnetospheric) side. In particular, an isotropic halo distribution can facilitate formation and stability of laminar double layers. Further extension into a second spatial dimension (using a moment-based algorithm for the ion dynamics perpendicular to **B**) show how the structure of electron phase-space holes generated on the high-potential side of the transition layer differ in the turbulent and laminar regimes. The 2-D simulations also reveal differences in the transverse structure of transition layers for opposite limits of ion magnetization. These simulation results will be discussed in the context of recent satellite observations. Research supported by NSF, NASA, and DOE.

SM42A-02 1045h

Solitary Wave Characteristics as Observed by the Polar Spacecraft

Jim Crumley[1] (320 356-7978; jcrumley@csbsju.edu)

Cynthia Cattell[2] (cattell@belka.space.umn.edu)

Robert Lysak[2] (bob@aurora.space.umn.edu)

John Dombeck[2] (johnd@belka.space.umn.edu)

[1]College of St. Benedict / St. John's University, Peter Engel Science Center, Collegeville, MN 56321

[2]University of Minnesota, School of Physics and Astronomy 116 Church St. SE, Minneapolis, MN 55455

Magnetospheric solitary waves, also known as weak double layers, were first observed in the auroral acceleration region by S3-3, and have since been observed in many regions of the magnetosphere by other spacecraft. We will present results from a statistical study of solitary waves using Polar spacecraft data. Solitary waves in this study are found using high-time resolution burst mode data from Polar's electric field instrument (EFI), though some particle data will be presented as well. The spatial distribution of the solitary waves throughout Polar's orbit will be presented. The solitary wave characteristics shown will focus on ion solitary waves in the low altitude ($\sim 2R_E$ geocentric) portion of Polar's orbit where the orbit crosses auroral field lines. Some electron solitary wave results from both the low and high altitude portions of Polar's orbit will be included as well. Solitary wave results that will be presented include speed, potential amplitude, net potential drop, and scale size. Comparisons will be made with other observational studies, including studies of FAST spacecraft data, and with theoretical and computational studies.

SM42A-03 1100h

Simulations and Analysis of Electron-hole Resistivity in Space Plasmas

Lars Dyrud[1] (ldyrud@bu.edu)

Meers Oppenheim[1] (meerso@bu.edu)

Tengfei Lin[1]

[1]Center for Space Physics Boston University, 725 Commonwealth Ave, Boston, MA 02215, United States

We conducted particle in cell simulations of plasma distributions similar to those resulting from double layers. These cold electron-beam distribution functions rapidly produce electron holes, which are a common occurrence and their structure is fairly well understood. However, it remains unclear whether electron holes are merely interesting plasma phenomena, indicative of a turbulent environment, or they play a critical role in the flow of energy and momentum in the magnetosphere-ionosphere system. We analyzed the possibility that the generation of electron holes induces a parallel resistivity. These simulations show that cold electron beams produce strong anomalous resistivity that should influence the development of current systems anywhere double layers or cold beams form. For example, electron hole resistivity could account for parallel potential drops of the order of hundreds of eV in the auroral downward current region, or provide anomalous diffusion across the magnetopause boundary. To study the parameter dependency of this resistivity, we conducted over 100 2-D PIC simulations and find that the relative beam density plays the largest role in the magnitude of anomalous resistivity.

SM42A-04 1115h

Electromagnetic Radiation From Double Layers in Laboratory and in Space

M. E. Koepke[1] (mkoepke@wvu.edu)

N. Brenning[2] (brenning@plasma.kth.se)

I. Axnas[2] (axnas@plasma.kth.se)

M. Raadu[2] (raadu@plasma.kth.se)

[1]Physics Dept., West Virginia Univ., Morgantown, WV, United States

[2]Alfvén Laboratory, Royal Institute of Technology, Stockholm, Sweden

First results are reported from a project to study by experiments and theory a potentially important mechanism for electromagnetic radiation from space, Double Layer Radiation (DLR). This type of radiation is proposed to come from DL-associated, spatially localized high frequency (hf) spikes [Gunell et al.,1996; McFarland and Wong,1998] which are driven by the electron beam on the high-potential side of the double layer. It is known, but only qualitatively, from laboratory experiments that double layers radiate in the electromagnetic spectrum. These laboratory experiments were made in the 1990's by Volwerk and Lindberg using magnetic pickup coils to measure the electromagnetic radiation from double layers in mercury plasma. The spectrum was found to contain characteristic peaks at the electron gyrofrequency, electron plasma frequency, combinations of the two, and frequencies that might be apparatus-dependent. No clear theoretical model emerged from these investigations, and no absolute calibration of the radiation strength could be obtained. The quantitative evaluation of these measurements is complicated because they were made in the near field of the radiating structure and in the vicinity of conducting laboratory hardware that distorts the field. The situation is further complicated because the localized electrostatic wavelengths (approx. 1 cm) can be relatively small compared to the emitted electromagnetic wavelengths (e.g. 50 cm at 600 MHz, a typical plasma frequency). The alternate explanation, that the radiation might arise directly from the acceleration experienced by single charged particles in the double layer, was outlined by Kuijpers et al. in 1997, but the details of the theory were not provided. In 1986, Borovsky proposed a DLR mechanism for explaining the radiation from current-carrying arms (up to 10E17 amperes) of double radio galaxies. The electromagnetic radiation mechanism was compared to that of a free-electron laser but he described it only schematically. We intend to investigate both the statistical occurrence of hf spikes and the influence of the DL-field-aligned density profile on hf-spike formation in an attempt to interrelate the roles of self-organization of the density profile, ionization and loss, and the ponderomotive force of the hf spike.

SM42A-05 1130h

The Structure of the Parallel Electric Field During Magnetic Reconnection

James F. Drake[1] (301-405-1471; drake@plasma.umd.edu)

Marc Swisdak[1]

Michael Hesse[2]

[1]University of Maryland, IREAP, College Park, MD 20742, United States

[2]NASA/Goddard Space Flight Center, Electrodynamics Branch GSFC, Greenbelt, MD 20771, United States

The parallel electric field ($E_{\|}$) that develops during magnetic reconnection controls the acceleration of particles and is required for the frozen-in condition to be broken. The structure of this parallel field is particularly important in cases with a guide field, where the demagnetization of electrons is not important and the region where $E_{\|} \neq 0$ defines the electron dissipation region. Earlier theoretical models suggested that $E_{\|}$ was non-zero over a scale length ρ_s perpendicular to B, ρ_s being the ion Larmor radius based on the sound speed. We have carried out full particle simulations that demonstrate that the transverse extent of the region where $E_{\|} \neq 0$ is instead the electron scale. Analytic analysis indicates specifically that the scale length is the electron Larmor radius based on an effective electron temperature that is a hybrid of T_e and T_i. The canting of the current layer during guide-field reconnection has now been widely observed [1]. The region where $E_{\|} \neq 0$ can extend significantly away from the x-line proper but only along the separatrix with weak current, which corresponds to an extended density cavity [1,2]. $E_{\|}$ does not simply appear as a uniform field along this separatrix. Even in 2-D simulations $E_{\|}$ breaks into bipolar structures that are reminiscent of the electron-holes seen in earlier 3-D simulations and seen in the satellite observations. The maximum energy of electrons at the x-line appears to correlate with the length of the region where $E_{\|} \neq 0$.

1. M. Tanaka, Phys. Plasmas **3**, 4010, 1996.
2. P. L. Pritchett and F. V. Coroniti, J. Geophys. Res. **109**, A010220, 2004.

SM42A-06 1145h

Response of Dayside Auroras and Ionospheric Plasma Flows to a Solar Wind Pressure Pulse

Alexander Kozlovsky[1] (358-8-5531396; Alexander.Kozlovsky@oulu.fi)

Alexander Koustov[2] (KOUSTOV@DANSAS.USASK.CA)

Vladimir Safargaleev[3] (safargaleev@pgi.kolasc.net.ru)

Nikolai Østgaard[4] (nikost@ssl.berkeley.edu)

[1]Sodankyla Geophysical Observatory, SGO/Oulu unit, University of Oulu, POB 3000, FIN-90014 Oulu, Finland

[2]University of Saskatchewan, Department of Physics and Engineering Physics, Saskatoon, Saskatchewan S7N 5E2, Canada

[3]Polar Geophysical Institute, Apatity, 184200, Russia

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

Global ultraviolet auroral images from the IMAGE satellite are used to investigate the response of the dayside auroral oval to a sudden impulse (SI) in the solar wind pressure. The observations are supplemented by the TV all-sky camera images over Svalbard in the prenon sector. We show that after the SI, new discrete auroral forms appear in the poleward part of the auroral oval so that the middle of the dayside oval moves poleward from about 70 to about 73 deg. AACGM latitude. This poleward shift started in the 15 MLT sector, then similar shift was observed in the MLT sectors located more westerly, and eventually the shift was seen in the 6 MLT sector. Thus, the auroral disturbance "propagates" westward (from 15 MLT to 6 MLT) at an apparent speed of the order of 7 km/s. We show that the above auroral disturbances are associated with the westward propagating convection vortex as inferred from the global convection maps produced by the SuperDARN HF radars. The poleward boundary of the auroral oval did not show any prominent motion associated with the SI. The optical and radar observations

SM

can be interpreted in terms of the pressure disturbance propagation through the magnetosphere at a velocity of the order of 200 km/s that is essentially slower than a magnetosonic (fast Alfvén) wave, and generation of a potential (curl-free) electric field in the wake of the disturbance. We suggest that the interchange instability is a possible reason for the development of discrete dayside auroral forms after the SI. We discuss the reasons for the slow propagation speed of the disturbance and for a vortex-like convection pattern associated with the auroral motions.

SM43A CC: 220 C-E Thursday 1330h

Reconnection? Posters

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

SM43A-01 1330h POSTER

Magnetotail Bubbles and Current Sheet Stability

Joachim Birn[1] (505-667-9232; jbirn@lanl.gov)

Karl Schindler[2] (ks@tp4.ruhr-uni-bochum.de)

Michael Hesse[3] (mhesse@lepvax.gsfc.nasa.gov)

[1]Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, United States

[2]Ruhr University Bochum, Universitaetsstrasse, Bochum D-44780, Germany

[3]NASA Goddard Space Flight Center, Code 696, Greenbelt, MD 20771, United States

Using three-dimensional MHD simulations, we further investigate stability and dynamical properties of the magnetotail current sheet. We compare the effects of localized entropy depletions in 2-D and 3-D models and investigate the role of the entropy distribution in ideal MHD stability. We also investigate the mechanisms that may couple the dynamically evolving flux tubes with near-Earth effects.

SM43A-02 1330h POSTER

Magnetic reconnection in the flow of an MHD-scale Kelvin-Helmholtz vortex triggered by electron inertial effects

Takuma Nakamura[1] (takuma@geo.titech.ac.jp)

Masaki Fujimoto[1] (fujimoto@geo.titech.ac.jp)

[1]Department of Earth and Planetary Sciences Tokyo Institute of Technology , 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8551, Japan, Tokyo, Japan

In order to understand the structure of an MHD-scale Kelvin-Helmholtz (K-H) vortex universally, magnetic reconnection triggered by the vortex flow must not be neglected. To study the nature of magnetic reconnection within the MHD-scale K-H vortex, we have performed two-dimensional two-fluid simulations considering finite electron inertial effects. In the two-fluid system, magnetic reconnection occurs spontaneously by electron inertial effects. An MHD-scale velocity shear between the two regions is set up and evolution of MHD-scale K-H mode is followed. The K-H vortex can grow up to a highly rolling-up stage when the shaer is strong enough to overcome the stability effect of in-the-plane magnetic field component. In the non-linear state, the magnetic field lines are stretched into an anti-parallel geometry, and then magnetic reconnection occurs within the vortex. First, we have simulated basic cases where the magnetic field has only in-the-plane component with the uniform density. Particularly, we focus on two cases in which in-the-plane component is parallel between two regions and in-the-plane component is anti-parallel. We observe that magnetic reconnection in the flow of the highly rolled-up vortex occurs in both cases. Then, numerous magnetic islands are formed within the vortex by reconnection and the flow pattern of the vortex is destroyed. Only in the anti-parallel case, magnetic reconnection occurs even when the vortex does not highly roll-up. Furthermore, when in-the-plane magnetic intensity is extremely different between two regions, we observe the magnetic islands to be injected into the side with the weaker field. On the basis of these results, we have simulated cases with the LLBL like geometry in a two-dimensional two-fluid system. The density gradient between two sides of the shear layer and the out-of-the-plane magnetic field component are set up. In the LLBL like situation, magnetic reconnection in the flow of the MHD-scale K-H vortex occurs and essential features stay the same as the basic cases.

SM43A-03 1330h POSTER

Formation of Slow Shocks in Anisotropic Plasmas

Chien-Chia Hung[1] (cchung@jupiter.ss.ncu.edu.tw)

L.-N. Hau[1] (lnhau@jupiter.ss.ncu.edu.tw)

[1]Institute of Space Science, National Central University, Chung-Li 320, Taiwan

The Petschek's reconnection model involves two pairs of slow shocks that play the role of accelerating plasma by reducing the magnetic field. There have been some observational evidences for the existence of slow shocks in the Earth's magnetotail where the plasma beta is usually low. For plasmas in strong magnetic field, the thermal pressure is found to display the gyrotropic form with two distinct pressure components parallel and perpendicular to the local magnetic field. In this study, the structure of slow shocks is examined based on the anisotropic MHD model for which the energy closure is of the double-polytropic laws (Hau and Sonnerup, 1993). In particular, slow shocks are formed through the evolution of a tangential discontinuity current sheet initiated by the presence of magnetic normal field. The results are compared with those obtained from the isotropic MHD model.

SM43A-04 1330h POSTER

Time Scales for Energy Release in Hall Magnetic Reconnection

J D Huba[1] (huba@ppd.nrl.navy.mil)

L I Rudakov[2] (rudakov@wam.umd.edu)

[1]Plasma Physics Division, Naval Research Laboratory, Code 6794, Washington, DC 20375, United States

[2]Berkeley Scholars, Inc., 14411 Edmonston Rd, Beltsville, MD 20722, United States

We present a study of the time scales for energy release in 2D Hall magnetic reconnection. We use the NRL Hall MHD code VooDoo for this study. We consider a 2D reversed field current layer with a magnetic perturbation that initiates the reconnection process. We use boundary conditions that allow inflow and outflow (i.e., not periodic) and let the system reach a steady state. We find that the system goes through three stages: a relatively long current layer thinning process, a fast reconnection phase, and a final steady state phase. We define the time scale for energy release as the fast reconnection period: from onset to steady state. Preliminary results indicate that the time for energy release scales as the initial thickness of the current layer. We apply these results to the magnetotail and magnetopause.

Research supported by NASA and ONR.

SM43A-05 1330h POSTER

The scaling of reconnection in magnetospheric relevant systems

Michael A Shay (301-405-1495; shay@glue.umd.edu)

University of Maryland , IREAP, Energy Res Bldg University of Maryland, College Park, MD 20742, United States

Reconnection is a process ubiquitous to plasmas which plays a very important role in the dynamics of the Earth's magnetosphere, allowing solar wind and magnetospheric plasma to mix, and releasing large amounts of magnetic energy in the tail during a substorm. Recently, much progress has been made on understanding how fast reconnection rates consistent with those inferred from observations can occur. However, these previous studies were limited to highly idealized systems lacking many properties ever-present in the magnetosphere: asymmetries acrosss the current sheet, equilibrium normal magnetic fields, equilibrium shear flows, and multiple charged species in the plasma. In this paper, we will present initial results on the scaling of the reconnection rate in these complicated systems and discuss which aspects most strongly affect the reconnection rate.

SM43A-06 1330h POSTER

Plasma Transport Across the Magnetopause

C Z Cheng[1] (609-243-2648; fcheng@pppl.gov)

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

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

Particles enter the magnetosphere through transport processes which occur near the magnetopause. It has been estimated that the transport coefficient must be $D \sim 10^9 \mathrm{m}^2/\mathrm{s}$ in order to maintain a quasi-steady plasma density gradient at the magnetopause. There are two main candidate mechanisms for producing this transport: direct entry along reconnected field lines and particle transport via wave-particle interactions. Most of the observed wave energy is at frequencies below the ion cyclotron frequency and the low frequency transverse wave are almost always observed during magnetopause crossings. When there is large magnetic shear (southward IMF) across the magnetopause, the magnetic reconnection rate is expected to be faster and the transverse wave amplitude is observed to be larger. A larger reconnection rate would imply a faster particle entry into the magnetosphere from the magnetosheath. It has also been shown that larger amplitude kinetic Alfveń waves with wavelength the order of ion gyroradii can cause stochastic particle transport leading to magnetosheath ion entry across the magnetopause with $D \sim 10^9 \mathrm{m}^2/\mathrm{s}$. We will discuss the relative importance of these two mechanisms for producing plasma transport arcoss the magnetopause.

SM43A-07 1330h POSTER

Motion of the Flank LLBL During Changes of Upstream Parameters

Jana Safrankova[1] (+420 2 2191 2301; jana.safrankova@mff.cuni.cz)

Zdenek Nemecek[1] (+420 2 2191 2301; zdenek.nemecek@mff.cuni.cz)

Lubomir Prech[1] (+420 2 2191 2304; lubomir.prech@mff.cuni.cz)

Jean-Andre Sauvaud[2] (sauvaud@mailhost.cesr.fr)

Jiri Simunek[3] (sim@ufa.cas.cz)

[1]Charles University, V Holesovickach 2, Prague 180 00, Czech Republic

[2]CESR/CNRS, 9, Ave Colonel Roche, Toulouse 314 00, France

[3]Institute of Atmospheric Physics, Bocni II, 1401, Prague 141 31, Czech Republic

The magnetopause is a principal boundary dividing the magnetospheric and solar wind plasmas and magnetic fields. At low latitudes, one can identify the low-latitude boundary layer (LLBL) on the magnetospheric side and rather often a depletion layer on the magnetosheath side of the magnetopause. A thickness of these layers varies from 0.2 to 1 Earth's radius but several examples of a very thick LLBL have been reported in flank parts of the magnetopause. Plasma parameters inside the LLBL are variable, the spacecraft usually observes a mixture of magnetosheath and plasma sheet plasmas. Several mechanisms including intermittent reconnection, impulsive penetration, and Kelvin-Helmholtz instability have been proposed to explain this phenomenon. We are using the INTERBALL-1/MAGION-4 satellite pair separated by several thousands of kilometers in order to distinguish between spatial and temporal changes. The observation of LLBL crossings invoked by sudden changes of upstream conditions during strongly northward IMF, shows that (1) even very complicated temporal profile measured by one satellite can be explained in terms of surface waves, (2) the LLBL thickness is a rising function of the solar wind dynamic pressure, and (3) the most probable source of a magnetosheath-like plasma in the flank LLBL is reconnection in the cusp region.

SM43B CC: 220 C-E Thursday 1330h

Bow Shock, Foreshock, and Magnetosheath Posters *(joint with SH)*

Presiding: **H Kucharek,** University of New Hampshire**; L L Kepko,** Center for Space Physics, Boston University

SM43B-01 1330h POSTER

Statistical analysis of periodic solar wind number density variations

Larry L. Kepko[1] (lkepko@bu.edu)

Harlan Spence[1] (spence@bu.edu)

[1]CSP Boston University, 725 Commonwealth Ave., Boston, MA 02215, United States

Several recent studies have suggested that the solar wind sometimes contains number density variations at periodic, repeatable intervals. As these number density variations interact with the Earth, they alternately compress and expand the magnetosphere, leading to