SM21B MCC: Level 1 Tuesday 0830h

Magnetotail and Plasma Sheet I Posters

Presiding: **J M Weygand,** Institute of Geophysics and Planetary Physics, University of California, Los Angeles; **F R Toffoletto,** Rice University

SM21B-0192 0830h POSTER

Hybrid and Hall MHD simulations of the out-of-the-plane magnetic field component: Origin and Generation Mechanism

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Studies of magnetic reconnection predicted the generation of an out-of-the-plane magnetic field component (the so-called core field) due to Hall currents in the vicinity of the x-line. Recent observations of the quadrupole magnetic structures in the magnetotail have led credence to these predictions. However, many details regarding the scales and the magnitude of the core field remain not completely understood. We have used a combination of 2D Hall MHD and hybrid (fluid electron, kinetic ions) simulations of magnetic reconnection to address the generation mechanism and the resulting scales of the core field. We study the evolution of the system with and without a guide field. We have also investigated in detail the properties of reconnection as a function of the extent of the localized resistivity in all three spatial directions. These results along with the relevance of our findings to physics of flux ropes will be discussed.

SM21B-0193 0830h POSTER

Initial value dependence of the tail current sheet tearing - comparing between 2- and 3-D

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We have investigated 1) the two-dimensional Harris type current sheet with an out-of plane magnetic field and investigated 2) the three-dimensional Harris current sheet with no out-of-plane magnetic field, both of which are compared with our previous study. The parameters of all the categories are set to model the magneto-tail. First, we review the previous study, in which how the three key parameters of the initial values, the ion to electron mass ratio (M), the current sheet thickness (D), and the current sheet length (Lx) have the contributions to the magnetic saturation level at the non-linear stage. We have clarified the existence of the critical thickness (Dcr) and described the difference of it corresponding to Lx. The results of investigation 1) showed that i) the magnetic growing time to the saturation level needs more periods the previous, that ii) the structure of the current sheet is modified to be twisted and that iii) a similar relation between D and M is derived. As for the investigation 2), we analysed two key parameter sets; (M,D,Lx)=(400,0.5,12) and (400,0.5,24), which, in the previous study, are not expected to achieve the enough saturation level. The results showed that i) a very rapid magnetic growth occurs (in several ion gyro frequency) in both two cases, that ii) the temporal progression of the structure is different from Lx=12 and 24, that is alike to the previous study. We will present you a detail information on those results and discuss them.

SM21B-0194 0830h POSTER

Instability At The Leading Edge Of A Reconnection Jet

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Magnetic reconnection is one of the most important phenomena in space plasma physics, which is considered to be concerned with large scale energy releasing processes. Especially, a high-speed plasma jet which emerges with magnetic reconnection, so called reconnection jet, is considered to play an important role in energetic processes such as plasma particle acceleration in solar flares. Despite its importance, less attention than it deserves has been paid to understanding its dynamics. In this study, we focus on behavior of reconnection jets by conducting three-dimensional MHD simulations. In our simulations, initial condition of the magnetic field is the one-dimensional Harris current sheet model. Magnetic reconnection is initiated by time-independent spatially fixed anomalous resistivity. We add small perturbations, with their wave number vectors aligned in the initial current direction, to plasma pressure and density, and study how the seeds grow as the reconnection jet develops. Under this condition, numerical results show that the leading portion of the reconnection jet is deformed into wavy configuration and grows into a mushroom-like shape on the central current sheet plane, that is, the perturbations are brought up to an unstable state and start to grow with development of the reconnection jet. In the reconnection process, the leading part of a reconnection jet pushes and compresses the standing plasma ahead of it, and a strong pressure and density gradient develops between the reconnection jet and the plasma in front of the jet. Consequently, in this circumstance, what is developing at the leading edge of the jet is quite likely an interchange unstable configuration. A reconnection jet has more dynamic structure than we have thought. Indeed an extremely complicated flow pattern emerges in the later stage of the instability. The unstable leading part of the reconnection jet may have effects that have not been considered before. We will also discuss how the instability behaves in a more realistic situation, such as in the presence of a non-zero guide field.

SM21B-0195 0830h POSTER

Ion and Electron Dissipation in Collisionless Slow-Mode Shocks

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Ion and electron dissipation in collisionless slow shocks are examined using one-dimensional hybrid (kinetic ions, massless fluid electrons) and full particle (kinetic ions and electrons) simulations. In the hybrid code, two types of electron fluid models are used to determine the electron physics: an adiabatic model, which uses a scalar electron pressure, and a pressure tensor model, in which electron quasi-viscous effects are retained. At moderate oblique angles, the shock dissipation in both the hybrid and the full particle simulations is provided primarily by the ions. For very oblique angles, however, results from hybrid simulations using an adiabatic electron fluid differ from the full particle results, which indicates that the ion dissipation alone is inadequate to set up the shock, and that additional electron dissipation is needed. It is seen in the full particle simulations that at very oblique angles the large mirror effects result in a significant difference in the parallel and perpendicular electron pressures with respect to the local magnetic field. While the electron inertia is negligible, the electron pressure anisotropy gives rise to finite off-diagonal electron pressure tensor terms. Hybrid simulations including the electron quasi-viscous dissipation are presented, and it is concluded that inclusion of electron viscosity is the key element for providing adequate dissipation in setting up very oblique slow shocks such as those observed in the distant magnetotail.

SM21B-0196 0830h POSTER

Coupling of Waves and Reconnection in Thin, Collisionless Current Sheets

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Using a three-dimensional Vlasov code we investigate the coupling of lower hybrid waves and reconnection in thin, collisionless current sheets. It appears that the amplitude of the waves may critically control the moment of initiation of reconnection, it determines the mode of reconnection, whether it is essentially two-dimensional or three-dimensional as well as the reconnection rate. Mainly in the case of non-antiparallel reconnection a transition from regular, well structured, to patchy reconnection and percolation is possible. We derive the parameter-dependence of the behaviour of collisionless reconnection in the presence of waves.

SM21B-0197 0830h POSTER

Interpretation of the Satellite Observations of Current Sheet Bifurcation and Flapping

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By performing three-dimensional kinetic simulations of Harris current sheets, we study the structure of plasma sheet in the Earth's magnetotail. The current sheet is strongly altered by kinking before tearing modes develop. Kinking explains the satellite observations of both flapping of the current sheet and current bifurcation, which have been detected by ISEE1/2, Geotail, and Cluster satellites. The simulation results and the satellite observations show a remarkable agreement. Reconnection is then triggered by the kinking of the current sheet. We study how initially localized reconnection propagates in the current aligned direction, and how kinetic effects result in different dynamics from those reported by Huba and Rudakov's using a Hall-MHD model [Phys. Plasmas 9, 4435 (2002)].

SM21B-0198 0830h POSTER

Bifurcated current sheet : Model, CLUSTER observations and analysis of MHD wave propagation

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CLUSTER observations have recently confirmed previous GEOTAIL observations showing that the magnetotail current sheet can present a bifurcated structure with two off-centre current peaks. Such structures may be described by a kinetic tangential equilibrium which is an exact solution of the Vlasov-Maxwell equations. A tangential equilibrium is characterized by a bulk plasma velocity and magnetic field perpendicular to the density and/or temperature gradient direction. The particle distribution functions are described by an infinite sum of elementary functions parametrized by a vector potential. The model is consistent with CLUSTER observations of a plasma density plateau between the current peaks and the typical size and amplitude of the current distribution. Fitting field and density measurements of the bifurcated current sheets enables us to characterize the required model particle distribution functions, which are then compared with CLUSTER data. Using this semi-analytical model, we analyze the propagation of compressive MHD perturbations in a bifurcated plasmasheet by explicitly solving the linear response of the sheet to an impulsive perturbation, as performed in a companion paper [Fruit et

al.]. Due to the relative homogeneity of the plasma in the centre of the bifurcated sheet, very low frequency mode waves are not as quickly damped as in a Harris-like sheet. We exhibit this behaviour by evaluating the temporal and spatial variations of the wave absorption rate in the sheet. These results are finally compared to CLUSTER data and lead to the suggestion that observations of very low frequency modes may be interpreted as MHD perturbations.

SM21B-0199 0830h POSTER

Cluster: Bifurcated Current Sheets and Substorm Dynamics

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We report on the evidence for “bifurcated” current sheets in the near-Earth plasma sheet and the possible association of such current sheets with substorm processes. Recent studies using Cluster data have shown evidence for current sheets with two current density peaks rather than a single current density peak as expected for a Harris-type configuration. We will present a statistical search for such bifurcated current density profiles and examine whether such intervals are associated with substorm onsets in the near-Earth plasma sheet. If such bifurcations are associated with onsets, it is possible a double-peaked current density profile is evidence for the structuring of the current expected near a reconnection X-line. As an introduction, a test of the macroscopic consistency of current densities relative to changes in the magnetic field will be presented. We find that the current densities measured with Cluster are often quite reliable.

SM21B-0200 0830h POSTER

A Statistical Study of Plasma Sheet Parameters in Geotail Data and the LFM MHD Model

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We present a comparison of statistical analyses of flow patterns in the near-earth plasma sheet of the geomagnetic tail, and in the near-earth simulation domain of global MHD simulations of the magnetosphere. To ensure a valid data/model comparison, we include in the investigation only subsets of both datasets with similar solar wind input conditions. Statistical earthward flow patterns in the geomagnetic tail have been interpreted as the return flow of reconnected field lines in the Dungey convection model of an open magnetosphere. A similar statistically averaged flow pattern in physics-based global MHD models should provide a necessary but not sufficient condition for model validation. We also investigate trends in other MHD parameters to test for comparison validity, and attempt to measure in both datasets the earthward convecting average mass, momentum, and energy flux through the plasma sheet as functions of solar wind conditions, geomagnetic activity, and convection speed.

SM21B-0201 0830h POSTER

Relationships Between the Flux Tube Volume, Content, Plasma Pressure, and Density in the Plasma Sheet

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Long-term-averaged data-based models of the magnetic field and of many fluid parameters have been created within the plasma sheet using eight years of Geotail data. The models are three-dimensional, making it possible to carry out the integrals that are needed to determine the volume and plasma content of a unit flux tube. Contours of constant flux tube volume and content are compared with contours of the electron and ion pressures, temperatures, and density at the neutral sheet. Those combinations of the fluid parameters which are used to examine the long-term-averaged adiabatic properties of any plasma that remains in a typical moving flux tube also will be shown.

SM21B-0202 0830h POSTER

Comparative modeling of the magnetotail ion population for northward and southward IMF orientations

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We have investigated the mechanisms by which solar wind ions enter the magnetosphere and populate the magnetotail for northward and southward orientations of the interplanetary magnetic field (IMF). We have done so by tracing particle orbits in time-dependent electric and magnetic fields obtained from a three-dimensional global magnetohydrodynamic (MHD) simulation of the magnetosphere which includes both IMF orientations. We found that during northward IMF, solar wind ion entry occurs predominantly through the high-latitude reconnection regions and the dawn side low-latitude boundary layer. Some ions accelerated in the reconnection regions gain access to the plasma sheet at large downtail distances. The population of the plasma sheet for southward IMF is complicated by the dynamic nature of the plasma sheet for this IMF orientation. During this time, the MHD simulation contains an X-line at x $\sim$ -25 R_E downtail. Because of this, the bulk of the plasma mantle finds itself accessing the plasma sheet tailward of the x-line and is lost down the tail. As expected, the plasma mantle is much more robust in particle content and in spatial extent for southward IMF compared to northward IMF. A new feature, however, is the population of the near-Earth (earthward of the x-line) plasma sheet by solar wind ions that are slowed down during their crossing of the magnetopause. Because of their small tailward drift speed, these ions are convected into the near-Earth plasma sheet where they are nonadiabatically accelerated up to tens of keV in energy.

SM21B-0203 0830h POSTER

The structure of the plasma sheet under northward IMF

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The structure of the plasma sheet under northward IMF is studied by data from the Geotail spacecraft. The plasma sheet is known to become cold and dense (T < 2 keV, n > 1 cm^{-3}) during extended northward IMF periods. We show that such cold-dense ions (CDIs) appear at $|Y_{gsm}| > 10$ R_e, that is, 10 R_e off the tail axis to both flanks. CDIs on the dawnside have higher temperatures and some reach the upper-limit of 2 keV that we use to select CDIs. These CDIs having the highest temperature are distributed at the dawnside plasma sheet inner-edge (R < 15 R_e) and is connected to the hot-dense ions (HDIs: T > 2 keV, n > 1 cm^{-3}) in the further inner region. A survey shows that HDIs under nominal solar wind dynamic pressure appear mostly in the dawnside inner-magnetosphere during extended northward IMF intervals. Both results point to the idea that HDIs are the inner-magnetosphere extension of dawnside CDIs, while such a partner to the duskside CDIs cannot be identified. This structure of the plasma sheet suggests that there is significant dawn-dusk asymmetry in heating and transport in the magnetotail under northward IMF.

SM21B-0204 0830h POSTER

Modeling the Inner Plasma Sheet Equilibrium.

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We present a new numerical algorithm which allows us to solve the system of nonlinear MHD equations. The model was applied to the magnetosphere plasma dynamics in the inner plasma sheet. The objective of this work was a detailed study of the equilibrium of the plasma sheet inner edge where magnetic field lines become stretched out from the dipolar to tail-like topology. This may result in the formation of the locally unstable B-min region observed by spacecraft. Here we present results for two dimensional equilibrium which includes a balance between pressure gradients and magnetic field as it may develop during the growth phase of magnetospheric substorms. At this stage, the inner edge gradually stretches down the tail. Eventually, the equilibrium passes a threshold of its stability. We examine this threshold and compare it with available spacecraft data.

SM21B-0205 0830h POSTER

Global Analysis of Drift Compressional Modes

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The radial localization of drift compressional modes, drift waves dominated by the compressional component ($\delta B_{\parallel}$), is examined using WKB approximations in the radial direction. This method reduces the two-dimensional eigenvalue problem to two nested one-dimensional problems: an integral equation along the field line and a quantization condition in the radial direction as in *Vetoulis and Chen* [1996]. Individual flux-tubes were previously found to be unstable to compressional drift waves in two parameter regimes: (1) when magnetic guiding center drifts are opposite to the diamagnetic drift ($\omega_{*p}/\varpi_D < 0$) and (2) when the temperature gradient is in the opposite direction to the density gradient ($\eta = L_n/L_T < 0$). The radial localization of drift compressional modes is important in assessing the role these modes play in magnetospheric substorms and high-β laboratory devices.

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SM21B-0206 0830h POSTER

Low Frequency Perturbations in the Plasmasheet: Resonant Absorption and Comparison with CLUSTER

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We present an analysis of the propagation of compressive MHD perturbations in a plasmasheet (described as being an Harris-type sheet). We explicitly solve the linear response of the plasmasheet to an initial perturbation by using the Green formalism. Emphasis

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is made on the continuous eigenmodes of the system linked to the resonant absorption process. Through this phenomenon some energy may be tranferred from the waves to the plasma. Using a quasi-analytical model, we (1) precisely quantify the amount of energy that these MHD waves can deposit in the sheet and (2) evaluate the time and space scales of this transfer. These results are then compared with CLUSTER observations. Using a technique of reconstruction of the signal from actually observed fluctuations, we estimate the amplitude of the continuous modes and we precise the role of the resonant absorption mechanism in the energization of the plasmasheet. This can be considered as a first step for an observational quantization of the possible role of this mechanism in natural plasmas.

SM21B-0207 0830h POSTER

Observations Of High-Energy Electrons In The Magnetotail Using The Rapid-Ies Instrument On Cluster

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The RAPID instrument on each of the four Cluster spacecraft comprises both an imaging ion mass spectrometer (IIMS) and an imaging electron spectrometer (IES). The latter is capable of detecting electrons within the energy range of some 40 to 500 keV and, when operated in burst mode, provides complete angular coverage every 4-second spacecraft spin period. Such high-energy electrons provide a powerful diagnostic for the acceleration processes associated with magnetospheric boundaries and phenomena. A review of RAPID-IES observations from the majority of the science phase of the Cluster mission thus far reveals populations of energetic electrons associated with the outer radiation belt, the magnetotail current sheet and in the region of the magnetopause. Between July and October 2002, the orbit of Cluster was such that near apogee the spacecraft crossed through the night-side plasma sheet at large separation (5000 km), covering some 8 hours of local time from the dawn to the dusk-side flank. Multi-spacecraft analysis of fluxgate magnetometer (FGM) data during these current sheet crossings can define the orientation, thickness and motion of the boundary and provides a strong context for the analysis of the energetic electron observations. RAPID-IES observations from a number of tail crossings, interpreted with reference to the FGM measurements, reveal populations of energetic electrons associated with incursions by the spacecraft into the tail current sheet. The three-dimensional distribution of these electrons show that the population can be trapped or field-aligned; this we interpret in terms of proximity to reconnection sites, and time elapsed since onset.

SM21B-0208 0830h POSTER

Implications of unusual pitch-angle distributions observed by ISEE-1 and ISEE-2.

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Unusual energetic particle Pitch Angle Distributions (PADs) were found on the night side tail of the earth's magnetosphere using data collected by the ISEE-1 and ISEE-2 satellites. The study was carried out between the hours of 0800-1330 UT on March 3rd, 1979. ISEE-1 was at 3MLT and a radial distance of 15 RE at 1000 UT, when the unusual PADs began to be observed. The period of the observations shows an isotropic increase in the energy ranges 22.5-189 keV for electrons, and 24-142 keV for protons. In the first electron energy channel (22.5-39 keV), the isotropic increase in the intensity of these particles stops for those particles with 90-degree pitch angles before those with parallel/anti-parallel pitch angles (0-30deg.), producing the minimum flux at 90 degrees pitch angles. The resulting PAD is known as a Butterfly PAD. The same is observed for the proton channels P1 through P4. In electron channels E2, E3, E4, we observed something different. Here when the 0-30 pitch angles start to level off, there was a sudden flux drop in the near perpendicular particles producing also the Butterfly PADs. In some channels, the drop in flux is over an order of magnitude. The period for these butterfly distributions is of about 2 hours in the electron channels, and 2 hours for the protons. After that time period, the fluxes changed from butterfly PADs to isotropic PADs. Towards the beginning of the time period studied, we observe the existence of peaked-at-90 degree, isotropic, and butterfly PAD occurring respectively in E1, E2, E3 at the same time and location with the only variable being the respective energy of the electrons being measured. The observations made by ISEE-2 are somewhat different than those made by ISEE-1. ISEE-2 does see a higher flux in the 0-30 degree pitch angles in the protons only, but the ISEE-2 sensors did not resolve the PAD as a function of energy and therefore the energy-integrated PADs are not as clear as those of the ISEE-1 satellite. At 1000 UT, ISEE-2 is at 3.5MLT and a radial distance of 12 RE. The differences and physical implications between ISEE-1 and ISEE-2 will be presented and discussed in detail. During the time period studied, the geomagnetic conditions were rather quiet, and LANL geosynchronous satellites observed no substorms.

SM21B-0209 0830h POSTER

Generation of Field-Aligned Currents Driven by ULF Waves at the Plasmasheet Boundary Layer

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In the plasma sheet boundary layer, the plasma density and the Alfven speed undergo significant variations in order to satisfy the total pressure balance. The inhomogeneity of the plasma pressure and magnetic pressure becomes significant near the plasma sheet boundary layer. We have developed a new three-dimensional MHD wave model that allows for finite plasma pressure. We present the initial results from this numerical model for MHD wave propagation in hot plasmas. Based on this time-dependent model, we study the excitation of ULF modes in the magnetotail. We examine how both shear and fast modes are affected by the plasmasheet and lobe structure. Our results show that localized field-aligned currents are strongly excited at the boundary between the plasma sheet and its surrounding regions. We also discuss and compare our results with observations.

SM21B-0210 0830h POSTER

On Numerical Generation of Structured Adaptive Computational Grids Based on Variable Geomagnetic Field Geometry

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Regional numerical models of magnetosphere-ionosphere coupling processes in realistic geomagnetic field configurations are complicated by the need to specify (artificial) computational boundaries of the region of interest and the development of a nonuniform computational grid for solving the relevant system of equations describing, for example, MHD wave propagation. These numerical issues become especially crucial when the solution of the model equations varies rapidly in time and space within the domain of physical interest and when the boundary surfaces also vary in time due to the large-scale evolution of the geomagnetic field. For some classes of dynamical problems in M-I coupling, it may be beneficial to choose a computational domain defined by a dynamically evolving flux tube. In this paper, various approaches to the generation of dynamically varying computational grids are considered, and examples of such grids are illustrated using magnetic fields generated by a Tsyganenko field model and a global MHD model of the magnetosphere.

SM21B-0211 0830h POSTER

3D Modelling of Wave Propagation in Earth Magnetosphere

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We present results from a three-dimensional global model of Shear-Alfvén waves in the Earth magnetosphere. In this model, the plasma is described in the one-fluid ideal MHD approximation and the governing equations are discretized using finite elements on an unstructured tetrahedral mesh. Because of the strong anisotropy that characterizes magnetized plasmas, the unstructured mesh needs to be aligned along the local magnetic field lines. In practice, this implies that every tetrahedron must have two of its vertices along the same magnetic field line. Results are first presented in the linear approximation; that is, for small amplitude waves with a negligible effect on the background plasma. The evolution of driven, finite amplitude Shear-Alfvén waves is then considered by solving the full set of non linear equations. Simulations are carried for both dipolar, and stretched magnetic field geometries.

SM21B-0212 0830h POSTER

Statistical Properties of Turbulent Electromagnetic Field Inhomogeneities

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We study statistical properties of turbulent electromagnetic field artificially generated with power-law spectra, and discuss the relative importance of adiabatic and non-adiabatic diffusion in such a field. The fields are derived from the vector potential in the Lorentz gauge, with power-law spectrum and random independant phases. The diffusion process as well as the particle heating and acceleration are dependent on the ratio between characteristic scale of the field non-homogeneity and Larmor radius of particle. The regions where the scale of variations is smaller than the Larmor radius are those where the heating is overadiabatic, and the diffusion coefficient can be larger. Thus, the relative volume of these regions and their topological characteristics determine the effectiveness of the heating process and the transport characteristics. We evaluate the scaling properties of these regions for different turbulent spectra as a function of the turbulence spectral index.

SM21B-0213 0830h POSTER

Cluster Wideband Observations of Low Frequency Bursts

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On many occasions the Cluster Wideband (WBD) experiments, when operating in the 77 kHz mode, have detected bursts of emissions with primarily vertical structure extending from the upper frequency limits down to a few tens of kHz. Simultaneous observations from the Geotail Plasma Wave Instrument and the Wind Waves experiment show that those emissions are low frequency bursts. The high-frequency resolution and high-time resolution Cluster WBD measurements

show that for the majority of the observations, the fine structure is quite similar to that observed for the higher frequency Auroral Kilometric Radiation. However, for some observations, the fine structure resembled that for escaping continuum and kilometric continuum radiation. The different implications for the sources and propaagation paths of the emissions will be discussed.

SM21B-0214 0830h POSTER

Amplitude and Time Duration Statistics of Electrostatic Solitary Waves Observed by the Cluster Fleet in the Magnetic Field Regime 5-550 nT

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The high resolution Wideband plasma wave receiver onboard each of the four Cluster spacecraft observes electrostatic solitary waves throughout much of the 4 x 19 Re Cluster orbit. These solitary waves, when clearly distinguished from other wave emissions, are generally in the form of bipolar (one positive peak and one negative peak) and tripolar (two positive peaks, one negative peak, or vice versa) pulses. The amplitudes and time durations of these pulses vary throughout the orbit. Using a statistical meaningful set of measurements from many Cluster orbits, we show that there appears to be a dependence of the amplitude and time duration of the solitary waves upon the strength of the local magnetic field. We discuss explanations for this dependence by interpreting these electrostatic solitary waves as Bernstein-Greene-Kruskal (BGK) mode phase space holes and double layers.

SM21B-0215 0830h POSTER

Plasma Weak Turbulence Theory: From Bi-fluid To Hall-MHD, Hamiltonian Canonical Formulations

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The different levels of description of fluid media (e.g. MHD, Hall-MHD, bi-fluid,...) are commonly known under the form of Newtonian systems of equations. Nevertheless, this form proves to be in general inconvenient for applying some general mathematical treatments such as deriving the so-called "weak (or wave) turbulence theories" of these media. We show that the Hamiltonian formalism is the most powerful mathematical frame for such studies. We therefore look for Hamiltonian formulations for the different levels of the fluid description of a plasma, using the variational principle with the appropriate Lagrangian invariants. Starting from the bi-fluid system, we show that such a formulation can be obtained by combining the Lagrangians already used for describing: i) the motion of a charged particle in an electromagnetic field; ii) the evolution of an electromagnetic field in presence of sources; iii) the motion of a neutral fluid (Clebsch variables). The result is obtained in terms of generalized-Clebsch variables. Reducing this bi-fluid Hamiltonian formulation to lower orders of the fluid approximations is then shown to be mandatory to obtain analytical results for linear waves and non linear wave-wave couplings. We show how this goal can be reached in two steps, leading to: i) a "Reduced Bi-Fluid" system, with the displacement current neglected and ii) the Hall-MHD system, with the electron mass neglected. We show that the only generalized Clebsch variables of each species are sufficient to describe the full Hall-MHD dynamics. Some future applications of such a powerful formalism are outlined.

SM21B-0216 0830h POSTER

Magnetic Fluctuations in the Magnetosheath: Cluster Data and the K-Filtering Method

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Magnetic turbulence in the magnetosheath certainly plays an important role in the transfers between the solar wind and the magnetosphere. A few theoretical models exist for interpreting the role of the magnetic fluctuations in these transfers, but experimental constraints are now available which can help to decide between them and allow for new advances. The k-filtering technique has been designed for analysing the spatial structure of the electromagnetic field from multi-point measurements: for each temporal frequency it can provide a 3-D spectrum in the wave-vector space. Taking advantage of short CLUSTER separations (100 km), we have applied this method to the magnetic Cluster-STAFF data and present the results obtained in the frequency range about 0.3 - 3 Hz, in the magnetosheath close to the magnetopause. This frequency range allows to focus on wavelengths that are most generally larger than the spacecraft separation, avoiding the so-called spatial aliasing effect. We can exhibit the first direct determination of the field energy distribution in the (omega, k) space for this frequency range. Moreover, we show that the energy maxima distribution in (omega, k) domain is in a good agreement with the prediction of the linear theoretical wave dispersions. Besides this identification of the nature of turbulence from the point of view of the wave dispersion, a study of the polarization is also initiated for each energy peak. As the existing theories for magnetosheath turbulence rely on assumptions as bi-dimensionality or weak/or strong wave-wave interactions, we show how the k-filtering method allows yielding valuable constraints to all these theoretical issues.

SM21B-0217 0830h POSTER

Linear Property and Nonlinear Evolution of Buneman Instability

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The Buneman instability is one of the most fundamental instabilities that arise along the magnetic field line, when thermal electrons are accelerated by an external electric field along the ambient magnetic field. Such electric fields are induced, when the magnetosphere undergoes dynamic changes of its structure such as magnetic reconnection or reconfiguration. We first assume a stable plasma with thermal electrons and ions at rest, where the thermal electrons and ions can have different temperatures as specified by the thermal velocities Ve and Vi, respectively. Under the electric field imposed along the magnetic field, the thermal electrons are accelerated to a finite drift velocity Vd relative to the thermal ions. When the Vd exceeds a critical value, the Buneman instability sets in to convert the drift kinetic energy to electrostatic field energy and thermal energies of electrons and ions. As the electrostatic field grows the electrons are rapidly diffused through nonlinear trapping motion. We first present a series of linear dispersion analyses of the Buneman instability for various combination of Ve/Vd and Vi/Vd. We then performed particle simulations starting with a finite drift velocity Vd and with various initial thermal velocities Ve/Vd and Vi/Vd. The nonlinear evolutions of the instability result in a variety of electrostatic potential structures along the magnetic field line such as electron holes, ion holes, ion acoustic waves and double layers. The final state of the nonlinear evolution also depends on whether the system is uniform with periodic boundaries or nonuniform with open boundaries.

SM21C MCC: 2008 Tuesday 1020h

Dynamic Aurora: The Role of Alfvén Waves in I-M Coupling II *(joint with SA, AE)*

Presiding: **J Spann,** NASA Marshall Space Flight Center**; C Pollock,** Southwest Research Institute

SM21C-01 1020h INVITED

Accelerated electrons associated with Alfven waves

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Electron acceleration by inertial Alfven waves has been theoretical suggested for many years. Observations show that this acceleration process can produce some of the most intense auroral forms, particularly at the polar-cap boundary of the night side auroral oval. This acceleration processes, however are not routinely distinguished by optical observations. This talk reviews in-situ electron observations and will describe the difference in the optical signature from quasi-static acceleration in the upward current region (inverted-V), pitch angle scattered (diffuse) and dynamic accelerated (Alfven wave) electrons. From optical perspective it is hard but not impossible to distinguish the optical signatures. One of the problems is the life times of the emissions lines. To routinely analyze the optical trace of the processes presented above becomes difficult since most of the time more than one process is active at the same time. The presentation will focus on the possibilities to optically observe the dynamics and fine structure of the electron precipitation caused by Alfven waves and provides two-dimensional information about the dynamic processes.

SM21C-02 1040h INVITED

Optical Auroral Imaging Conjugate to the FAST Satellite

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Most satellite data are essentially point observations made along the satellite orbital track. Although reasonable assumptions can be made in many cases, fundamentally, one cannot differentiate between spatial and temporal structures. To overcome this shortcoming we recorded video images of the aurora conjugate to the FAST satellite from an instrumented jet aircraft. A total of 29 flights were made during Moon-down periods in January and February of 1997 and 1998. In each flight the aircraft was flown along the FAST satellite path such that the aurora of interest would be in the magnetic zenith at the time of the pass. A variety of aurorae were encountered between 20 and 23 MLT. We present the main findings from our analysis of these conjunctions. The auroral luminosity measured by the cameras corresponds well with the precipitating energy flux measured by FAST. In the discrete aurora the luminosity is accounted for by energetic electrons, but in the diffuse (evening) aurora equatorward of the discrete arcs proton precipitation can contribute significantly. In relatively quiet multiple arcs, the observed orientation of the arcs agree well with the orientation of the field-aligned current sheets derived from the FAST magnetometer data implying that the currents represent the arc morphology. In dynamic aurora the geometry of the current sheets are more complicated and the relationship does not hold. Complicated electron distribution functions and field measurements are also observed as arcs change morphology and propagate westward. There is a current threshold (at 100 km altitude) of approximately 2.2 μA/m^2 in field-aligned current density for the formation of large spirals as for example

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