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 $\mu A/m^2$ in field-aligned current density for the formation of large spirals as for example

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often seen in the westward traveling surge. Black aurora is found to be associated with spatially restricted regions within a region of generally isotropic pitch angle distributions in which the strong pitch angle diffusion is suppressed at energies greater than 2 keV. If downgoing electric fields existed in these regions, they were too small for any particle or field measurements on FAST to confirm their existence. In a few cases of flickering aurora the data indicate that the modulating process extends below the altitude of the satellite. The FAST data, with its very high temporal resolution, combined with the auroral video provide a unique data set for the study of small scale temporal and spatial structures in the aurora that has yet to be fully explored.

SM21C-03 1100h

Optical Signatures and Models of Dispersive Nonlinear Field Line Resonances

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The nightside auroral zone is threaded by geomagnetic field lines that support localized ultra-low frequency (ULF) shear Alfven field line resonances (FLRs). Small-scale dispersive FLRs are excited through resonant mode conversion of global scale compressional waves that propagate isotropically through the magnetosphere. In the more distant magnetotail, warm plasma dispersive effects exclude the excitation of latitudinally narrow FLR wave fields. Closer to Earth, flux tubes are loaded with colder plasma that favors inertial scale dispersive effects and nonlinear wave processes. We identify preferential locations in the magnetosphere where small-scale discrete arcs preferentially form, and analyze their spatiotemporal characteristics. We demonstrate that the smallest scales form on field lines where two competing wave dispersion mechanisms cancel. Over realistic timescales, this situation naturally occurs as a result of shear Alfven wave ponderomotive forces that are associated with up-flowing ions and Earthward motion of the resonance position in the magnetosphere. The amplitudes, perpendicular widths, and latitudinal dependence of dispersive scale ULF waves are analyzed and compared with CANOPUS magnetometer and meridian scanning photometer data. Optical signatures of FLR-related arcs are also presented, and differences between dawn and midnight region arcs are discussed in the context of anomalously low FLR frequencies (1-4 mHz between L 7-11).

SM21C-04 1115h

Relationship Between Alfvénic Aurora and Large-Scale Convection and Currents

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While Alfvén-wave-induced electron precipitation and fluctuations are prevalent near the polar cap boundary and in the cusp, where the field-aligned currents tend to be irregular, isolated Alfvénic arcs also form within slowly varying, large-scale regions of convection and field-aligned current. Is the occurrence of these isolated Alfvénic arcs regulated by magnetotail processes or M-I coupling? Observations and theory show that the ionospheric conductivity becomes severely depleted in regions of downward field-aligned current while the associated Pedersen electric field is simultaneously enhanced. This situation creates conditions favorable to feedback instability, which develops on a time scale of a few minutes or less and releases energy into ionospheric Alfvén resonator oscillations that would otherwise flow into ionospheric Joule dissipation. Using numerical simulations based on a two-fluid MHD model of magnetospheric Alfvén wave dynamics and E-region ionospheric activity, we have investigated the development of such oscillations in large-scale (of order 100-km), field-aligned current channels. The energetics of these processes are described along with diagnostics that illustrate measurements of the effect by a low-altitude, polar-orbiting satellite. Modulation of electron precipitation by IAR oscillations is also discussed.

SM21C-05 1130h INVITED

Alfven wave produced auroras during substorms

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IMAGE FUV observations when the FAST satellite transits the aurora have provided evidence that Alfven wave-dominated aurora play a significant part in substorm aurora. In the FAST satellite data, Alfven wave dominated aurora can be distinguished from "inverted V" produced auroras that are accelerated by field aligned electric fields by the dominance of high fluxes of low energy electrons with beam like field aligned pitch angle distribution and accompanying strong wave activity. Each FAST transit provides a snapshot of the spatial morphology of the precipitating particles, field aligned current profiles and the fluctuating E and BM fields. We have examples of FAST transits with simultaneous IMAGE FUV observations during various stages of magnetospheric substorms and in temporary auroral intensifications so called pseudo-break ups. Most often such Alfvenic aurora is located at the poleward edge of the substorm surge arc, however there are examples of Alfven wave produced auroras in the center of the auroral region while surrounded by other types of aurora. One case when a FAST pass occurred approximately one minute after substorm onset showed that the most intense onset aurora was produced by Alfven wave accelerated super-thermal electrons and that this aurora was located well equatorward of the open closed field line boundary. Within the auroral feature the low energy ion fluxes showed periodic fine structure in the ExB direction and the magnetometer measurements also confirmed the presence of waves in this feature. In contrast to several substorm models the intense surge was not produced by a field aligned quasi-static electric field. The onset arc was also the poleward boundary of the intense energetic protons. Equatorward of the surge, there was a broader region of electron precipitation with embedded quasi-static "inverted V" electric fields. The FAST particle and magnetometer measurements are consistent with a field-aligned current structure in which the bulk of the upward current was carried by the "inverted V" precipitation region. The wave accelerated electron auroras are produced by converting the high intensity wave energy (Poynting) fluxes into electron energy and therefore the Alfven wave accelerated auroras are footprints of regions of the magnetosphere where magnetic reconfigurations take place.

SM21C-06 1150h

Alfvén wave modulation of Substorms and outflowing O+ ions Observed by Cluster: Bulk Parameter View

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The Cluster spacecraft often encounters the current sheet in the geomagnetic tail. This talk will discuss the behavior of a substorm that occurred on October 1, 2001. Cluster observed the substorm from onset through the recovery phase. This talk will highlight the behavior of bulk parameters (density, mean velocity annd temperature) and the subsequent talk by E. Lee et al. will expand the discussion to kinetic features.The substorm onset occurred ≈0927 UT (AE index) and at synchronous altitude it was signified by large pulse-like variations in the magnetic field at ≈0930 UT. Cluster detected the onset signature at ≈0927 UT at geocentric coordinates (-16.1, 6.2, 4.9)R_E. Cluster first crossed the current sheet at ≈0938 UT and subsequently Alfvén waves modulated the tail allowing Cluster to move back and forth across the current sheet several times. Outflowing ionospheric O+ show periodic bursts of ≈1-2 minutes associated with the Alfvén wave oscillation indicating strong MI coupling. Longer period modulations (≈6-10 minutes) were observed in energetic particles injected at synchronous altitudes. Prior to the first current sheet crossing, mean velocities $\langle \mathbf{v} \rangle$ of ion distributions were ≈500 km/s in the tailward direction. As Cluster crossed into the southern hemisphere, mean ion velocities $\langle \mathbf{v} \rangle$ reached values of ≈1000 km/s but in the earthward direction, and remained in that direction through the end of the recovery. However, these velocity moments do not mean the plasma was flowing because kinetic features show Cluster was close to the high latitude boundary of the plasma sheet. The time delay between the synchronous altitude and Cluster indicates that the substorm onset was located between the synchronous altitude and the Cluster orbit.

SM21C-07 1205h

Alfvén Wave Modulation of Substorms and Outflowing O+ ions Observed by Cluster: Kinetic Features

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The bulk parameter picture will now be expanded to provide a more comprehensive view of substorm dynamics in the geomagnetic tail. Phase space distributions of ions show presence of multiple component plasmas, H+ and O+. Both field-aligned unidirectional and bidirectional beams are observed at energies varying from a few hundred eV to ≈3 keV. The 2D cuts of the 3D distributions show very complex and highly time varying features. Extremely large gradients in the phase space occur with ions existing in one $\mathbf{v}_\perp$ quadrant and none in other quadrants. This yields large $\langle \mathbf{v} \rangle_\perp$ which can be falsely interpreted as flowing plasmas. What is actually happening is that the Cluster was remote sensing a nearby boundary. This is another example that shows using moments alone to characterize the plasma sheet can lead to misleading results. Using the 4 Cluster data, the current sheet thickness is estimated to be around ≈1000-2000 km. This thickness is comparable to the few keV ion Larmor radius. Both ionospheric and plasma sheet ions are observed in the current sheet indicating a strong MI coupling existed. These observations require kinetic interpretation and new kinetic models of substorms must be developed to explain them.