

the current study are compared with these earlier results. There are a significant number of cases where the observed spectra deviate from a power law, exhibiting a secondary peak around 8 mHz. The regularity and nature of these spectra are examined as well.

SM42B-0843 1330h POSTER

Magnetic Field Line Curvature Induced Pitch Angle Diffusion in the Transient Proton Belts

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When magnetic field line curvature, R_c , is small compared to a particle's "total" gyroradius (the ratio of the particle's speed to its gyrofrequency), its first adiabatic invariant will change. Recent calculations have shown that diffusion caused by particle interactions with magnetic field line curvature (of FLC induced diffusion) can be a significant loss mechanism for the transient proton radiation belts which form outside of $L = 3.5$. In this study, we examine the August 1990 transient belt seen in data from the PROFEL instrument on board the Combined Release and Radiation Effects Satellite (CRRES) for signatures of FLC induced diffusion calculations. We show evidence of FLC induced diffusion, and discuss the limitations of our study as well as possible future improvements.

SM42B-0844 1330h POSTER

Energetic Leptons trapped in the Earth's magnetic field

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Accurate measurements of electron and positron fluxes at energies above 200 MeV have been performed by the AMS instrument at altitudes of 370-390 Km and in the latitude interval $\pm 51.7^\circ$. We present an original analysis of the AMS data, focussed on the study of the magnetically trapped component of these fluxes. As a result, the flux maps as a function of the magnetic variables (L, α_0) are determined in the interval $(0.95 < L < 3, 0 < \alpha_0 < 90)$ for electrons with $E < 10$ GeV and positrons with $E < 3$ GeV. The results are compared with existing data at lower energies and in similar (L, α_0) range. The properties of the trapped particles are also investigated in terms of their residence times and geographical origin by means of a tracing technique. The resulting distributions are discussed and related to the characteristics of the magnetic shells encountered by AMS.

SM42B-0845 1330h POSTER

Protons trapped in the earth's magnetic field observed with the AMS experiment

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Accurate measurements of proton fluxes at rigidities above 400 MeV have been performed by the AMS instrument at altitudes of 370-390 Km and in the latitude interval $\pm 51.7^\circ$. We present an analysis of the AMS data, focussed on the study of the magnetically trapped component of these fluxes. The flux maps as a function of the magnetic variables (L, α_0) are determined in the interval $(0.95 < L < 3, 0 < \alpha_0 < 90)$ for protons with $R < 10$ GV. The results are compared with existing data at lower energies and in similar (L, α_0) range.

SM42B-0846 1330h POSTER

Observations of geomagnetically trapped light isotopes by NINA

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The detector NINA, on board of the satellite Resurs-01-N4, observed hydrogen and helium geomagnetically trapped in the period from November 1998 to April 1999. The ^3He and ^4He power-law spectra reconstructed at L-shell=1.2 have indexes equal to 2.2 ± 0.2 in the energy range 12-50 MeV/n, and 3.6 ± 0.5 in 10-30 MeV/n respectively. The presence of ^2H and ^3H isotopes at L-shell less than 1.2 is unambiguously established.

The measured ratio $^3\text{He}/^4\text{He}$, and the shape of the reconstructed deuterium profile as a function of L-shell, bring to the conclusion that the main source of such radiation belt light isotopes is the interaction of trapped protons with residual atmospheric helium.

URL: <http://wizard.roma2.infn.it/nina>

SM42C MC: 121 Thursday 1330h Plasma Sheet Dynamics II

Presiding: W Horton, Institute for

Fusion Studies; C Z Cheng, Princeton
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SM42C-01 1330h

Wind's Encounter With the Collisionless Magnetic Reconnection Diffusion Region in the Earth's Magnetic Tail

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Magnetic reconnection converts magnetic energy into kinetic energy in the form of bi-directional plasma jets. The process is initiated in a narrow source region, the diffusion region. Previous observations have been restricted to the detection of the consequences of reconnection, such as plasma jets, outside the diffusion region. According to theory, both resistive and collisionless processes can initiate reconnection. One of the key predicted signatures of collisionless reconnection is the separation between ions and electrons in the diffusion region. This separation creates a quadrupole system of Hall currents and an associated set of Hall magnetic fields. Here we report a fortuitous event where the Wind spacecraft encountered an active reconnection diffusion region at the origin of bi-directional jets in the Earth's magnetotail where it detected Hall magnetic field signatures as well as electron beams associated with the Hall current. These observations provide the ultimate evidence for the existence of a magnetotail reconnection regime where collisionless rather than resistive mechanisms dominate; a regime which, according to recent theoretical studies, leads to much faster reconnection than the often assumed resistive regime.

SM42C-02 1345h

Field-Aligned-Current Signatures of Externally Driven Reconnection and Reconnection Induced by Anomalous Resistivity

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The classical model of substorm onset involves a partial diversion of the cross-tail current in the magnetotail along field lines into the ionosphere on the dawn side, through the westward electrojet, and then back up along field lines to the tail on the dusk side—the substorm current wedge [McPherron *et al.*, 1973]. On the other hand, collisionless reconnection along an extended neutral line leads to a pattern of in-plane Hall currents that produce a coaxial field-aligned-current (FAC) system in a meridian plane. These contrasting FAC patterns are compared to the results of 3-D particle-in-cell simulations of two processes that are frequently proposed as models for substorm onset: reconnection due to anomalous resistivity generated by local current-driven wave turbulence and localized reconnection driven by an externally imposed convection electric field. In the former case the cross-tail current is forced to flow around the reconnection region—either to the ionosphere or tailward—by a periodic blocking procedure. In the latter case tailward propagation of magnetic flux away from a y dependent magnetic field structure leads to the local reconnection. The nature of the FAC systems for the two cases will be discussed.

SM42C-03 1400h

Rapid magnetic field dissipation via coupling between KH and LHD instabilities in the magnetotail current sheet (1)

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Nonlinear dynamics of cross-tail current instabilities (modes with wavenumber vectors parallel to the current sheet) are studied by 2D PIC code simulations. For an ion-scale current sheet initially carried dominantly by ions, we found that the Kelvin-Helmholtz instability destabilized by the velocity shear between the lobe and the current-carrying ions comes to dominate after a few tens of the ion-gyration periods. The non-linear evolution of the Kelvin-Helmholtz instability warps the plasma sheet significantly and excites lower hybrid drift waves at its edge. Rapid magnetic field dissipation is observed associated with the non-linear coupling between these two instabilities. We show that the non-linear coupling between these two instabilities is responsible for the observed rapid dissipation. The simulation result presents a new route for magnetic field dissipation in an ion-scale current sheet.

SM42C-04 1415h

The Structure of the Dissipation Region for Component Reconnection: Particle Simulations

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Results from a kinetic simulation of component reconnection are presented. Reconnection proceeds in a current sheet with 100 degrees magnetic field rotation. As a result, magnetic reconnection forms distinctively different signatures from what was found from kinetic models of anti-parallel reconnection. In particular, ion and electron flow patterns are substantially distorted, the shear magnetic field component does not exhibit a quadrupole structure, and electron orbits in the diffusion region are substantially modified. The emphasis of the investigation is on the modifications to the diffusion region, with particular emphasis on the electron diffusion zone. Here the formation and role of electron pressure anisotropies in the presence of a strong guide field is studied in detail.

SM42C-05 1430h

Nonlocal Kinetic Analysis of Plasma Instabilities Relevant to the Onset of Reconnection in the Geomagnetaotail Current Sheet

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We present the results of a nonlocal kinetic analysis of instabilities responsible for two basic types of magnetic reconnection in the Earth's magnetotail, associated with the formation of X- and Y-lines. We consider in particular the stability of isotropic modified Harris equilibria with nonzero normal component of the magnetic field with respect to tearing mode, which forms the X-line pattern. The problem is solved using the finite element technique and the drift-kinetic description of electrons with additional bounce averaging for the trapped population. It is found that the mode is unstable for typical ion-to-electron temperature ratios if the current sheet is long enough to allow a population of transient electrons. This however is not the case in the near-Earth region. As a result the perturbation of the near-Earth current sheet violates continuity rather than topology and the thin current sheet (TCS) is formed as the central part of the Y-line pattern. We consider the stability of two basic self-consistent TCS models, isotropic and forced current sheets with respect to perturbations propagating in the dawn-dusk direction using similar finite element technique and nonlocal kinetic description of electron and ion species.

SM42C-06 1445h

Generation of Near-Earth Reconnection by Divergent Flows in the Plasma Sheet

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A global two-dimensional hybrid simulation is carried out to study the evolution of the near-Earth plasma sheet. The simulation domain contains the near-earth magnetotail from GSM x=0 to -40Re in the midnight meridian plane. The Earth's ionosphere is taken to be a perfect conductor. The simulation shows that reconnection X lines and plasmoids can be generated by diverging flows in the plasma sheet. These diverging flows can be caused by variations in the of the Maxwell stress due to variations of Bx and Bz components of the magnetic field outside the current sheet. In addition, the flow acceleration/deceleration in the plasma sheet can also be caused by variations in the local plasma mass density.

Comparison runs have been made with a Harris model current sheet with zero Bz. We saw no evidence of reconnection. This indicates that divergent plasma flow is a sufficient condition for reconnection, even in a dissipationless plasma.

SM42C-07 1530h

Simulation of Plasma Instabilities for Current Disruption in the Magnetotail

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The cross-field current instability (CCI) has been proposed as a potential candidate for current disruption and substorm expansion onset. In this paper, we

use the particle simulation to investigate the excitation and nonlinear evolution of CCI. We have performed runs in both one-dimensional and two-dimensional situations. In the one-dimensional runs, we design the setup to simulate the Ion Weibel instability and the Modified-Two-Stream instability. The results are found to be consistent with theoretical predictions of growth rate and nonlinear evolution. In the two-dimensional run, the expected wave mode is found. Current filamentation and current sheet flapping are observed at the nonlinear stage.

SM42C-08 1545h

Nonlocal Electromagnetic Drift Instabilities in Current Sheet Equilibrium

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The identification of the onset mechanism for magnetic reconnection in collisionless plasmas in general, and substorm expansion in specific, is one of the outstanding problems in (space) plasma physics. Traditional approach has been based upon collisionless tearing instability. However, some recent developments provide evidence suggesting that the reconnection onset might be highly relevant to the generation of anomalous resistivity by drift instabilities. In this paper, drift instabilities in one-dimensional current sheet configuration are investigated. Nonlocal two-fluid stability analysis is formulated, and a class of unstable modes with multiple eigenstates, similar to that of the familiar quantum mechanical potential-well problem, are identified by numerical means. Finite-beta and electromagnetic effects on these modes are also discussed.

SM42C-09 1600h

Thin current sheets in the magnetotail and the loss of equilibrium

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Using two-dimensional magnetohydrostatic equilibrium theory, together with flux, entropy, and topology conservation, we demonstrate that a finite boundary deformation of magnetotail equilibria can lead to locally infinite current density enhancement, that is, the formation of a singular current sheet. Equilibrium configurations that satisfy the constraints cease to exist when the boundary deformation exceeds the critical value. This provides a strong argument for onset of instability or the loss of equilibrium, regardless of the dissipation mechanism. The major feature causing the current density increase appears to be the localized increase of the boundary flaring angle, rather than the absolute magnitude of the boundary deformation. Such boundary perturbations might be caused by a solar wind pressure variation or suitable changes of the boundary electric field. Catastrophe points can be reached even for relatively small perturbations of the boundary. In those cases, the excess energy associated with the thin current sheet is small. Nevertheless a major disruption may be triggered when the underlying configuration becomes unstable upon the local breakdown of ideal MHD.

SM42C-10 1615h

Models of Two-Dimensional Embedded Thin Current Sheets From Vlasov Theory

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Using steady-state Vlasov-theory, we obtain an explicit description of the properties of thin current sheets in two space dimensions. The treatment is self-consistent and based on exact particle orbits including chaotic motion, the plasma is treated as quasi-neutral. The method is not restricted to local Maxwellian distributions functions, which opens the possibility to model thin current sheets embedded in wider sheets. In the limit of vanishing particle gyro-scales the present description overlaps with magnetohydrostatics. Two cases of kinetic current sheet equilibria are presented. One of them adds particle orbit effects to an MHD-equilibrium that we obtained as a member of an adiabatic sequence, which reaches a singularity for a finite boundary perturbation (presented separately). The results illustrate how finite ion gyro-scales affect the current sheet structure for increasing ion gyro-scale. Further aspects that are analyzed include the contributions of electrons and ions to the total current density, Hall-currents, the occurrence of significant electric fields, the role of the ion/electron temperature ratio and the consequences of a Galilean transformation.

SM42C-11 1630h

A Unified Model for Explosive Thinning and Onset of Substorm

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It is shown in this study that explosive thinning of near-Earth plasma sheet and onset of substorm can be modeled based on a similar physical process. Kinetic effects of ions and electrons are included in this study. Electric field is allowed to deviate from potential field in the ionosphere prior to onset of substorm. Based on our model, a vortex distribution of electric field followed by convergent electric field distribution should appear in the pre-midnight region of ionosphere at poleward edge of diffuse aurora near the end of growth phase. A downward field-aligned current resulted from these E-field distributions can trigger explosive thinning of near-Earth plasma sheet. Similar changes of electric field distribution can take place in the near-Earth plasma sheet as a result of localized explosive thinning and non-uniform distribution of energetic ions. An upward field-aligned current can be formed as a result of these types of E-field distributions. The upward field-aligned current can trigger dipolarization of the thin current sheet. A positive feedback mechanism for cross-tail current disruption is identified after the initial dipolarization processes. Based on our model, onset of substorm expansion phase can proceed after the initial dipolarization if enough energetic ions have been accumulated in the near-Earth plasma sheet. Likewise, the substorm expansion phase will end when there are not enough energetic ions in the distant tail.

SM42C-12 1645h

Statistical and Superposed Epoch Studies of Dipolarization Events Using Data from Wind Perigee Passes

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We will present results from a study of magnetic field data from perigee passes of the Wind spacecraft through the magnetotail from 1995 to 2000. Wind spent over 500 hours in the magnetotail during this time period. Based upon a > 15 degree change in magnetic field inclination, a database was compiled of 65 potential dipolarization events in the near magnetotail at distances of -18 RE < XGSM < -6 RE. Most of the dipolarization events were found to occur within a few RE of the neutral sheet. By studying the locations at which magnetic field dipolarizations were observed in the Wind perigee pass data set, we hope to develop a statistical representation of the azimuthal and radial extent of the substorm current wedge. Substorm onset times based upon AKR observations by the Wind WAVES experiment, geosynchronous observations, Polar images, and ground magnetometer data will be used to perform a superposed epoch study of the radial and azimuthal expansion of the substorm current wedge. Results will be compared to other studies of dipolarizations and the magnetotail current systems.