SM42B MC: Hall D Thursday 1330h

Radiation Belt Dynamics and Modeling I

Presiding: **J Rigler,** University of Colorado**; S Kanekal,** University of Maryland

SM42B-0835 1330h POSTER

Relativistic electron response to high speed solar wind streams and coronal mass ejections: A comparison.

S G Kanekal[1] (301-405-6237; kanekal@surya.umd.edu)

D N Baker[1]

J B Blake[2]

[1]LASP, Univ of Colorado, 1234 Innnovation Drive, Boulder, CO 80303, United States

[2]The Aerospace Corpopration, Box 92957, Space Sciences Department, M2/259,, Los Angeles, CA 90009, United States

We use the charged particle detectors onboard SAMPEX satellite to study the relativistic electron response to high speed solar wind streams (HSS) and coronal mass ejections (CME). We will compare and contrast the electron response initiated by these two different interplanetary drivers. It is well known that the high speed streams are more prevalent around the declining part of the solar cycle and coronal mass ejections are more numerous during the ascending part of the solar cycle. However there are also times when both HSS and CMEs are present during the same period. Thus this study will not only explore solar cycle dependence of the relativistic electrons but also the nature of these two interplanetary drivers. We will augment the SAMPEX data with those obtained by sensors onboard Polar as well. Both SAMPEX and Polar cover all L-shells and have accumulated continuous high quality data. Interplanetary data will be provided by ACE and Wind sensors.

SM42B-0836 1330h POSTER

Linear Prediction Filter Analysis of Solar Wind / Magnetosphere Coupling: Studies at non-Geosynchronous Altitudes and High Time Resolution

E. Joshua Rigler[1] (303-492-4831; jrigler@colorado.edu)

Daniel N. Baker[1] (303-492-4509; baker@lasp.colorado.edu)

[1]Laboratory for Atmospheric and Space Physics, University of Colorado Campus Box 590, Boulder, CO 80309, United States

Early comprehensive studies of solar wind / magnetosphere coupling using linear prediction filters (LPFs) were published by Nagai (1988) and Baker et al. (1990). These studies demonstrated the utility of LPF analysis in specifying a global magnetospheric state in terms of energetic electron flux at geosynchronous altitudes. These methods are currently employed in real-time electron radiation belt prediction for satellite operation purposes at NOAA's Space Environment Center (SEC). Both of the previous studies, as well as the algorithms being used at the SEC, are based on daily averaged solar wind, energetic particle measurements, and geomagnetic indices, to remove any diurnal effects. The results presented here utilize these techniques, combined with recently developed statistical mapping algorithms and modern satellite data, to produce linear filters that describe the dynamic relationship between the solar wind and the Earth's energetic electron radiation environment at various local times, L-shells, and at measurement time scales much less than 24 hours.

SM42B-0837 1330h POSTER

Can Cusp-Originated Relativistic Electrons be Identified in the Radiation Belt?

Lun C Tan[1] (ltan@nssdca.gsfc.nasa.gov)

Shing F Fung[2] (shing.fung@gsfc.nasa.gov)

[1]SPDF/Raytheon ITSS, Code 632, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

[2]Space Physics Data Facility, Code 632, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

The discovery of cusp trapping of energetic particles [Chen et al., 1997; Sheldon et al., 1998] has raised an interesting question whether the radiation belt can be filled with cusp-originated relativistic electrons (COREs). After analyzing the propagation of COREs in the magnetosphere we have found that these particles are a potential source of relativistic electrons in the radiation belt. Because of the presence of magnetic field minimum in the outer cusp, a sharp pancake-like pitch-angle distribution should be the salient characteristic to distinguish COREs from other electron sources. From the CRRES-MEA electron data we have collected the impulsive electron flux enhancement events to look for CORE signature. The characteristics of these events are described.

Chen J., et al., A new temporarily confined population in the polar cap during the August 27, 1996 geomagnetic field distortion period, Geophys. Res. Lett., 24, 1447, 1997.

Sheldon, R. B., et al., The discovery of trapped energetic electrons in the outer cusp, Geophys. Rev. Lett., 25, 1825, 1998.

SM42B-0838 1330h POSTER

Modeling the Ionization Yield in Solar Panel Discharges

Shu T Lai (781-377-2932; Shu.Lai@hanscom.af.mil)

Air Force Research Laboratory, Mail Stop: VSBXT 29 Randolph Road, Hanscom AFB., MA 01731-3010, United States

Discharges between differentially charged surfaces and solar cell panels on spacecraft are detrimental to spacecraft operations and survivability. Laboratory experiments reveal that the threshold electrostatic potential for the onset of discharges is lower if the ambient plasma density is higher and that a neutral gas cloud often emerges from the discharge initiation point. We offer a theoretical model for the ionization yield in such a discharge. Electron impact ionization of an expanding cloud of neutral gas emerging from a point on a surface is considered. The electrons are accelerated in the Paschen manner by the electric field between the differentially charged surfaces or panels. The theoretical results show that the ionization yield depends on the initial seed ionization, the time delay of the discharge initiation, the neutral density, the potential between the electrodes, the expansion rate of the cloud, and the electron impact ionization cross-section.

SM42B-0839 1330h POSTER

Space Weather Influences on the Relativistic Electron Population at Geosynchronous Orbits

Ronald K. Elsen (ronald.k.elsen@boeing.com)

The Boeing Company, Boeing Denver Engineering Center, 3800 Lewiston Street, Suite 100, Aurora, CO 80011, United States

Relativistic electrons in the outer radiation belt are often the largest contributors to the total radiation dose deposited in lightly shielded spacecraft electronics for many high altitude orbits. While most of this dose usually comes from electrons with energies around 1 MeV, relatively large electron populations sometimes exist for energies up to about 4 MeV. These electrons can also embed themselves deeply in dielectric and insulating materials in spacecraft, later causing deep dielectric discharges that have been implicated in many spacecraft anomalies. Although electron fluxes measured at geosynchronous altitudes display large dropouts on timescales of a few hours, averaging over 24 hours will generally give a good indication of the strength of the outer edge of the electron belt on most days. Such electron fluences characteristically drop sharply during the first day or so of a geomagnetic storm, then rebound strongly, typically peaking several days later and slowly decaying until again perturbed by geomagnetic activity or a high-speed solar wind stream. In this paper, we study the various space weather factors, such as geomagnetic activity and solar wind parameters, that influence in the daily integrated electron fluences from the GOES spacecraft (energy greater than 0.6 and 2 MeV) and other geosynchronous spacecraft. The >2-MeV electron daily fluence measured by GOES is a sensitive barometer of outer belt fluctuations, having ranged over five orders of magnitude in recent years. In particular, we study the conditions that create the large electron fluences often measured during the week or so after a geomagnetic storm and look for correlations between peak fluences and solar wind parameters. We also study some very large geomagnetic storms that subsequently generated surprisingly small peak electron fluences. Finally, we look at behavior during extremely quiet periods when electron fluxes have remained at very low levels for up to several weeks.

SM42B-0840 1330h POSTER

Simulating Three Dimensional Radiation Belt Dynamics

Kara L Perry[1] (603-646-3969; Kara.Perry@dartmouth.edu)

Alicia A Eccles[1] (aeccles@chaos.dartmouth.edu)

Scot R Elkington[2] (303-735-0810; elkingto@lasp.colorado.edu)

Mary K Hudson[1] (603-646-2976; maryk@gaia.dartmouth.edu)

[1]Dartmouth College, Department of Physics and Astronomy HB 6127, Hanover, NH 03755, United States

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

The model by *Elkington et al.* [1999], which uses a compressed dipole and a time-varying electric field in two dimensions, is extended to three dimensions by specifying a poloidal mode ULF wave with a single vector potential component described by *Li et al.* [1993] resulting in E_ϕ, B_r and $B_{//}$. The toroidal mode can similarly be specified by a single vector potential component yielding E_r and B_ϕ. These vector potentials assume a Gaussian radial amplitude profile, a simple sine or cosine for the parallel mode structure and a time varying exponential depending on the mode number and angle in the azimuthal direction.

Elkington, S. R., M. K. Hudson, and A. A. Chan, Acceleration of relativistic electrons via drift-resonant interaction with toroidal-mode Pc-5 ULF oscillations,*Geophys. Res. Lett.*, 26, 3273, 1999.

Li, X., M. K. Hudson, A. A. Chan, and I. Roth, Loss of ring current O+ ions due to interaction with Pc-5 waves, *J. Geophys. Res.*, 98, 215, 1993.

SM42B-0841 1330h POSTER

Optimal VLF Parameters for Pitch Angle Scattering of Trapped Electrons

Jay M. Albert[1] (781-377-3992; albert@plh.af.mil)

Umran S. Inan[2] (650-723-4994; inan@nova.stanford.edu)

[1]Boston College, St. Clement's Hall 402, 140 Commonwealth Avenue, Chestnut Hill, MA 02467-3862, United States

[2]Stanford University, Space, Telecommunications and Radioscience Laboratory, Stanford, CA 94305-9515, United States

VLF waves are known to determine the lifetimes of energetic radiation belt electrons in the inner radiation belt and slot regions. Artificial injection of such waves from ground- or space-based transmitters may thus be used to affect the trapped electron population. In this paper, we seek to determine the optimal parameters (frequency and wave normal angle) of a quasi-monochromatic VLF wave using bounce-averaged quasi-linear theory. We consider the cumulative effects of all harmonic resonances and determine the diffusion rates of particles with selected energies on particular L-shells. We also compare the effects of the VLF wave to diffusion driven by other whistler-mode waves (plasmaspheric hiss, lightning, and VLF transmitters). With appropriate choice of the wave parameters, it may be possible to substantially reduce the lifetime of selected classes of particles.

SM42B-0842 1330h POSTER

CRRES Electric Field Power Spectral Distributions

Donald H Brautigam[1] ((781)377-3890; Donald.Brautigam@hanscom.af.mil)

Jim Bass[2] (bass@ziggy.radex.plh.af.mil)

John Wygant[3] (wygant@ham.space.physics.umn.edu)

[1]Air Force Research Laboratory, Space Vehicles Directorate, 29 Randolph Rd, Hanscom AFB, MA 01731-5000, United States

[2]Radex,Inc., 3 Preston Ct., Bedford, MA 01730, United States

[3]School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, United States

The ULF wave power during the CRRES mission is investigated using the CRRES electric field instrument. The wave power spectral characteristics are examined as a function of L in terms of long-term averages, and in terms of magnetic activity (Kp). Previous work has fit the power spectral density to activity-dependent power law spectra [Holzworth and Mozer, 1979]. Results from

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 Transien Proton Belts

Shawn L. Young[1,2] ((781) 377-9666; Shawn.Young@Hanscom.AF.MIL)

Richard E. Denton[2] (Richard.Denton@Dartmouth.EDU)

Brian J. Anderson[3] (brian.anderson@jhuapl.edu)

Mary K. Hudson[2] (mary.k.hudson@dartmouth.edu)

[1]Space Weather Center of Excellence, Space Vehicles Directorate, Air Force Research Laboratory, AFRL/VSBXR, 29 Randolph Road, Hanscom AFB, MA 01731-3010, United States

[2]Dartmouth College, Department of Physics and Astronomy , HB 6127, Wilder Laboratory, Dartmouth College, Hanover, NH 03755, United States

[3]Johns Hopkins University, Applied Physics Laboratory, 1110 Johns Hopkins Rd. JHU/APL, Laurel, MD 20723-6099, United States

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 PROTEL 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

Gennaro Esposito[1] (gennaro.esposito@pg.infn.it)

Emanuele Fiandrini[1] (emanuele.fiandrini@pg.infn.it)

[1]University and INFN, Via Pascoli 2, Perugia, pg 06100, Italy

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 +/-51.7deg. 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,alpha0) are determined in the interval (0.95<L<3, 0<alpha0<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,alpha0) 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

Emanuele Fiandrini[1] (emanuele.fiandrini@pg.infn.it)

Gennaro Esposito[1] (gennaro.esposito@pg.infn.it)

[1]University and INFN, Via Pascoli 2, 06100, pg Perugia, Italy

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 +/-51.7 deg. 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,alpha0) are determined in the interval (0.95<L<3), (0<alpha0<90) for protons with R<10 GV. The results are compared with existing data at lower energies and in similar (L,alpha0) range.

SM42B-0846 1330h POSTER

Observations of geomagnetically trapped light isotopes by NINA

Piergiorgio Picozza (+39-06-72594576; piergiorgio.picozza@roma2.infn.it)

University of Rome Tor Vergata and INFN, via della Ricerca Scientifica 1, Rome 00133, Italy

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 ^{3}He and ^{4}He 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 ^{2}H and ^{3}H isotopes at L-shell less than 1.2 is unambiguously established.

The measured ratio ^{3}He/^{4}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 Plasma Physics Laboratory

SM42C-01 1330h

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

Marit Øieroset[1] (510-642-2290; oieroset@ssl.berkeley.edu)

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

Masaki Fujimoto[2] (fujimoto@geo.titech.ac.jp)

Robert Lin[1] (rlin@ssl.berkeley.edu)

Ronald Lepping[3] (rpl@leprpl1.gsfc.nasa.gov)

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

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

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

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 quadrupolar 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

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

Ferdinand V Coroniti[1] (coroniti@astro.ucla.edu)

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

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 freqently 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)

Iku Shinohara[1] (+81-42-759-8404; iku@stp.isas.ac.jp)

Daisuke Hayashi[2] (+81-3-5734-3535; dhayashi@geo.titech.ac.jp)

Hiroshi Suzuki[2] (+81-3-5734-3535; hsuzuki@geo.titech.ac.jp)

Masaki Fujimoto[2] (+81-3-5734-3535; fujimoto@geo.titech.ac.jp)

[1]Institute of Space and Astronautical Science, 3-1-1 Yoshinodai, Sagamihara 229-8510, Japan

[2]Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8551, Japan

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

Masha Kuznetsova[1] (masha@elbrus.gsfc.nasa.gov)

Michael Hesse[1] (301-286-8224; hesse@gsfc.nasa.gov)

Masahiro Hoshino[2] (hoshino@eps.s.u-tokyo.ac.jp)

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

[2]University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan

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 quadrupolar 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.