“Auld Reekie”
MIST/UKSP 2004
Edinburgh

Abstract Book

and

List of Participants

Monday 29th March 2004
14:00 - 15:35

MIST Session 1

Chair: Alan Thomson

14:00	Welcome	**Alan Thomson**
14:05	A New Artificial Aurora Experiment Using VLF-Induced Particle Precipitation	**M.J. Kosch**
14:20	Radar Experiments With The EISCAT HF Facility	**F. Honary**
14:35	Comparison Of The Characteristic Energy Of Precipitating Electrons Derived From Ground-Based And Dmsp Satellite Data	**M. Ashrafi**
14:50	Drift Of Auroral Absorption	**R. A. Makarevitch**
15:05	Statistical Study Of Night-Time Spike Events	**A. Aminaei**
15:20	Comparisons Of The Plasmaspheric Ions With The CTIP Model And EUV Data From The Image Satellite	**Stuart Thom**

A NEW ARTIFICIAL AURORA EXPERIMENT USING VLF-INDUCED PARTICLE PRECIPITATION

M. J. Kosch and A. Senior
University of Lancaster

The EISCAT Heater is capable of stimulating artificial optical emissions in the ionosphere using high-power high-frequency radio waves. The ionospheric electrons are normally accelerated by mode conversion of the pump wave into upper-hybrid waves. When these electrons collide with the neutral oxygen atoms and nitrogen molecules, they can stimulate optical emissions in the same way as natural auroras. Looking to the future, we describe a new experiment to produce artificial auroras by particle precipitation from the magnetosphere. It is well known that natural lightning produces VLF waves, which can propagate between hemispheres along magnetic field-aligned ducts. Counter streaming magnetospheric electrons can undergo cyclotron resonance with the VLF wave causing pitch angle scattering. If the pitch angle of some of the particles reduces to within the loss cone, the electrons precipitate creating auroras. It is also well known that the Heater can generate VLF waves by modulating the D-region electron temperature, which modulates the Hall conductance. If the electrojet is overhead, it too will be modulated and emit radio waves. By adjusting the VLF modulation, cyclotron resonance can be achieved over a large fraction of the magnetic field line, greatly enhancing the efficiency of pitch angle scattering towards the loss cone. If successful, it will become possible to indirectly sound the magnetospheric particle populations from the ground, as well as image the VLF ducts.

RADAR EXPERIMENTS WITH THE EISCAT HF FACILITY

A. Senior[1], **F. Honary[1]**, M. J. Kosch[1], M. T. Rietveld[2], P. J. Chapman[1], T. S. Kelso[3] and J. P. Martinez[4]
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2. EISCAT Scientific Association, Ramfjordmoen, Norway
3. Center for Space Standards and Innovation, Analytical Graphics Inc., U.S.A.
4. Radio Society of Great Britain

In February and March 2003 the EISCAT HF 'heating' facility was used to provide the transmitting section of a HF radar system. The aim of the experiment was to identify if magnetospheric ducting of HF waves could be detected at high latitudes as has been done at mid and low latitudes. During the experiment, no such ducting was observed, possibly due to the high level of geomagnetic activity resulting in low plasma densities in the observable magnetosphere. However, echoes were observed from targets at ranges of 6000-16000 km, the nature of which are not yet understood. We examine possible causes of the echoes, including reflection from artificial satellites and discuss future ideas for magnetospheric radar using the EISCAT and SPEAR facilities.

COMPARISON OF THE CHARACTERISTIC ENERGY OF PRECIPITATING ELECTRONS DERIVED FROM GROUND-BASED AND DMSP SATELLITE DATA

M. Ashrafi, M.J. Kosch
Lancaster University, Lancaster

Energy maps are important for ionosphere-magnetosphere coupling studies, because quantitative determination of field-aligned currents requires knowledge of the conductances and their spatial gradients.

By combining imaging riometer absorption and all-sky auroral optical data it is possible to produce high temporal and spatial resolution maps of the Maxwellian characteristic energy of precipitating electrons within a 240x240 km^2 common field of view. These data have been calibrated by inverting EISCAT electron density profiles into equivalent energy spectra. In this paper energy maps produced by ground-based instruments (optical and riometer), are compared with DMSP satellite data during geomagnetic conjunctions. For the period 1995-2002 all possible satellite passes over the ground-based instruments' field of view for cloud-free conditions have been considered. During moderate geomagnetic and steady state conditions, without any ion precipitation, there is a good agreement between the satellite and ground-based data.

DRIFT OF AURORAL ABSORPTION

R. A. Makarevitch and F. Honary
Department of Communication Systems, Lancaster University, Lancaster

Observations by a 7x7-beam imaging riometer in the Northern Scandinavia (~66 deg MLAT) of the drifting cosmic noise absorption (CNA) structures in the morning sector near the drift reversals are presented. An examination of the absorption intensity images revealed several regions with enhanced CNA (absorption patches) slowly drifting through the riometer field of view (FoV). The absorption patches were found to vary in shape, orientation (for elongated arc-like patches), and drift direction. The latter was calculated from the regression lines to positions of the absorption maxima in the FoV images and compared with the direction of electrojet plasma flow from horizontal magnetic perturbations. A reasonable agreement was found between these directions both in point-by-point comparisons and in terms of direction reversal timings. The absorption patches of lower CNA appear to have smaller drift velocities and to be associated with weaker magnetic perturbations. We interpret relatively slow motions of the auroral absorption near the zonal drift reversals as associated with the ExB drift of the entire magnetic flux tube as opposed to the gradient-curvature drift of energetic electrons injected into the ionosphere at the substorm onset.

STATISTICAL STUDY OF NIGHT-TIME SPIKE EVENTS

A.Aminaei, F.Honary
Lancaster University, Lancaster

Imaging riometer data have been used extensively to study substorm phenomena. In particular, short duration, localised, high intensity absorption events, spikes, are of great interest due to their association with substorm onsets. We present statistical study of spike events, their classifications and structures. In addition, the relation of spike events to Pi2 pulsation of magnetometer data for different types of spikes will be presented. We discuss possible magnetospheric sources for precipitation events resulting in absorption spikes and compare our statistical study with previous findings from case studies.

COMPARISONS OF THE PLASMASPHERIC IONS WITH THE CTIP MODEL AND EUV DATA FROM THE IMAGE SATELLITE

Stuart Thom, Richard Balthazor, Graham Bailey, Chris Gurgiolo, Bill Sandel

Helium ions in the Earth's plasmasphere resonantly scatter solar radiation at 30.4nm. The Extreme Ultraviolet Imager (EUV) of the IMAGE (Imager for Magnetopause-to-Aurora Global Exploration) mission studies the global distribution of He^+ by detecting these emissions. We use a coupled thermosphere-ionosphere-plasmasphere model (CTIP) to solve the equations of continuity, momentum and energy balance for O^+ H^+ and more importantly for this investigation, He^+. An inversion tool is used to obtain He^+ from EUV images. These are compared with CTIP model results. Using the CTIP model, we can then find the hydrogen ion density from the EUV images.

Monday 29th March 2004
14:00 - 15:20

UKSP Session 1 - Helioseismology
Chair: Michael Thompson (tbc)

14:00	Welcome	**Lyndsay Fletcher**
14:05	Helioseismology - A BiSON Perspective	**Y. Elsworth**
14:35	Time-Distance Helioseismology of Sunspots	**S. Hughes**
14:50	Resonant Coupling of Non-parallel Global Oscillations	**B. Pinter**
15:05	The Effect of Strong Magnetic Fields on Acoustic Power	**C. J. Nicholas**

HELIOSEISMOLOGY - A BiSON PERSPECTIVE

Y. Elsworth
University of Birmingham

An introduction will be given to the study of the Sun using the technique of helioseismology - resonant sound waves in the solar interior. Some recent highlights will be discussed with an emphasis on those core-penetrating modes that are detected by BiSON - the Birmingham solar oscillation network.

TIME-DISTANCE HELIOSEISMOLOGY OF SUNSPOTS

Stephen J. Hughes, S. Paul Rajaguru, Michael J. Thompson
Imperial College, London

Travel times of acoustic waves inside the Sun are calculated from Dopplergrams of solar oscillations obtained using the GONG ground-based network and the MDI instrument on board SOHO. The travel times are interpreted in the acoustic ray approximation and inverted using an iterative technique to reveal wave propagation-speed anomalies below two active regions. We present results for the two regions, and compare the results of using GONG and MDI data: the regions exhibit similar subsurface structure, and the agreement between the two instruments is good. We also test some alternative analysis techniques, including the use of travel times corresponding to waves that have undergone more than one bounce in the solar interior: these alternative approaches are assessed using synthetic test data and are then applied to solar data.

RESONANT COUPLING OF NON-PARALLEL GLOBAL OSCILLATIONS

Balazs Pinter[1], Robert Erdelyi[1], Marcel Goossens[2]
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Magneto-acoustic and chromospheric gravity waves are studied in a planar, one-dimensional solar model. The model has three distinct layers, representing a polytropic interior beneath the photosphere, a 2Mm thick intermediate layer representing the transitional layer from the solar surface to the corona and an isothermal corona of constant Alfven speed. The magnetic field is assumed to be horizontal, and differs from zero only above the photosphere. The temperature and the magnetic field strength increase from their minima in the intermediate layer so that the plasma-beta remains constant.The horizontal component of the wave propagation is non-parallel to the magnetic field lines. These oscillations can couple resonantly to local MHD slow and Alfven waves arising in the inhomogeneous part of the solar atmosphere. We study the efficiency of this resonant interaction in the presence of atmospheric magnetic field. Frequencies and damping rate of the global modes is determined. We compare the results to observations.

THE EFFECT OF STRONG MAGNETIC FIELDS ON ACOUSTIC POWER AT THE SURFACE OF THE SUN AS ANALYSED BY MDI

C. J. Nicholas, Prof. M. J. Thompson, Dr S. P. Rajaguru

The Michelson Doppler Imager (MDI) is a high resolution helioseismology instrument on board the SOHO satellite. MDI measures line-of-sight Doppler velocities of either 1024x1024 full disk CCD images, or higher resolution images of smaller regions of the solar disk, at a cadence of one minute. The data used in this work are high resolution (0.42 Mm/pixel).

A pixel by pixel analysis has been made of a time series of MDI Dopplergrams containing a sunspot. Power spectra have been obtained from a Fourier transform of the data. These power spectra are then binned by magnetic field strength and compared to derive the effect of the magnetic field on the oscillations. Results are presented that show the modulation of the acoustic power by the magnetic field in the sunspot and its vicinity. This includes the severe suppression of power at low frequencies (2-5 mHz), corresponding to the main frequency range of p-modes, and the increase in power at high frequencies (5-7 mHz). An unexpected variation of power in ostensibly ‘quiet-sun’ (low magnetic field) regions is particularly notable. Also presented is a comparison of these results with helioseismic ring diagram analysis work. The results generated in this study are used to make predictions of the degree of suppression in the ring results.

Monday 29th March 2004
16:00 - 17:30

MIST Session 2
Chair: Mark Lester

16:00	Substorm Dependence Of Plasmaspheric Hiss	**N.P. Meredith**
16:15	Ground Observations Of Chorus Before, During And After Geomagnetic Storms	**A.J. Smith**
16:30	The Heliospheric Current Sheet At Solar Maximum	**S R Child**
16:45	Modelling Mercury's Magnetosphere	**James Scuffham**
17:00	Magnetosphere-Ionosphere Coupling Currents In Jupiter's Middle Magnetosphere: Effect Of Precipitation-Induced Enhancements Of The Ionospheric Pedersen Conductivity	**J.D. Nichols**
17:15	A New Global Model Of Saturn's Magnetospheric Field	**Christopher Arridge**

SUBSTORM DEPENDENCE OF PLASMASPHERIC HISS

N.P. Meredith[1], R.B. Horne[2], R.M. Thorne[3], D. Summers[4], and R.R. Anderson[5]
1. Mullard Space Science Laboratory
2. British Antarctic Survey
3. University of California, Los Angeles
4. Memorial University of Newfoundland
5. University of Iowa

We analyze wave and particle data from the CRRES satellite to determine the variability of plasmaspheric hiss (0.1 < f < 2 kHz) with respect to substorm activity as measured by AE*, defined as the maximum value of the AE index in the previous 3 hours. The study is relevant to modeling the acceleration and loss of relativistic electrons during storms, and understanding the origin of the waves. The plasmaspheric hiss amplitudes depend on spatial location and susbtorm activity with the largest waves being observed during high levels of substorm activity. Our survey of the global distribution of hiss indicates a strong day-night asymmetry with two distinct latitudinal zones of peak wave activity primarily on the dayside. Equatorial hiss (ABS(MLAT) < 15 deg) is strongest during active conditions (AE* > 500 nT) with an average amplitude of 40 +/- 1 pT observed in the region 2 < L < 4 from 0600 to 2100 MLT. Mid-latitude (15 < ABS(MLAT) < 30 deg) hiss is strongest during active conditions with an average amplitude of 47 +/- 2 pT in the region 2 < L < 4 from 0800 to 1800 MLT, but extending out beyond L = 6 from 1200 to 1500 MLT. Equatorial hiss at 600 Hz has minimum cyclotron resonant energies ranging from ~ 20 keV at L = 6 to ~ 1 MeV at L = 2, whereas mid-latitude hiss at 600 Hz has minimum resonant energies ranging from ~ 50 keV at L = 6 to ~ 2 MeV at L = 2. The enhanced equatorial and mid-latitude hiss emissions are associated with electron flux enhancements in the energy range of tens to hundreds of keV, suggesting that these electrons are the most likely source of plasmaspheric hiss. The enhanced levels of plasmaspheric hiss during substorm activity will lead to increased pitch-angle scattering of energetic electrons and may play an important role in relativistic electron dynamics during storms.

GROUND OBSERVATIONS OF CHORUS BEFORE, DURING AND AFTER GEOMAGNETIC STORMS

A.J. Smith[1], R.B. Horne[1], N.P. Meredith[2] and T.P. O'Brien[3]
1. British Antarctic Survey, Cambridge
2. Mullard Space Science Laboratory, University College London
3. Space Science Department, The Aerospace Corporation, El Segundo, California, USA

It has been suggested that whistler mode chorus waves play a significant role in the acceleration and loss of relativistic electrons in the outer radiation belt during geomagnetic storms. Previous experimental work on this topic has used space-based observations of chorus, but ground ELF/VLF observations commonly exhibit chorus and provide an alternative viewpoint. In a previous MIST talk we discussed the chorus observed by the VLF/ELF Logger Experiment (VELOX) instrument at Halley station, Antarctica (76°S, 27°W, L = 4.3), during the large Bastille Day storm in July 2000. Such events are not typical and the response varies greatly from storm to storm so a statistical approach is advantageous. In this paper we present data from a complete solar cycle (1992–2002) of nearly continuous (>95%) VLF/ELF observations at Halley station, to show that there is statistical evidence for enhanced whistler mode chorus waves during geomagnetic storms. The data comprise 1 s resolution measurements of ELF/VLF wave power in eight frequency bands from 500 Hz to 10 kHz. The average behaviour has been found from a superposed epoch analysis using 372 storms with minimum Dst less than -50 nT, including 82 large storms with minimum Dst less than -100 nT. Compared with average prestorm levels, the chorus intensity decreases in the storm main phase but is enhanced in the recovery phase, typically maximising a day after the storm onset. The decrease is in contrast to the space observations, in which the chorus appears at the start of the storm, and is

due to propagation effects between the source and the ground receiver. At 1 kHz the enhancement is independent of storm severity, suggesting a saturation effect, whereas larger storms produce larger wave intensities at higher frequencies in the chorus band (e.g., 3 kHz), which is interpreted as the effect of a chorus source region located on lower L shells than for weaker storms. A long-enduring depression in wave intensities, of 10 days or more, is found above the top of the normal chorus band (~4 kHz). We suggest that this is due to precipitation from enhanced relativistic particle fluxes affecting the subionospheric propagation of spherics from nearby thunderstorm regions across the L = 2–4 zone. A similar superposed epoch analysis using a second set of 244 events during the same solar cycle, for which relativistic electron data were available from the GOES and LANL satellites, gave broadly similar results overall. When we further classified these storms into subsets according to the post-storm relativistic electron fluxes observed at geosynchronous orbit 48-72 hours after the storm minimum Dst, we found that there was no correlation between storm size and whether relativistic electron flux enhancements were seen. However, the events with flux enhancements did have elevated levels of magnetic activity (Kp) lasting for days after the storm, and significantly, more intense chorus was observed in storms with larger post-storm relativistic fluxes, at least at the lower chorus frequencies (~1 kHz) more than 1 day after the Dst minimum. This is consistent with theories which propose that chorus is at least partly responsible for accelerating the electrons. At higher chorus frequencies (~2 kHz) and less than ~1day after the Dst minimum, the reverse effect was observed. This may be a propagation effect on lower L-shells, when the chorus source decays more quickly because of the recovering (expanding) plasmapause and is more than offset by attenuation caused by disruption of the ducted propagation paths from the source to the receiver. In storms with enhanced electron fluxes we expect an increase in precipitation and this is assumed to be the reason for the long-enduring post-storm VLF wave intensity depression observed at frequencies above the chorus band following these events.

THE HELIOSPHERIC CURRENT SHEET AT SOLAR MAXIMUM

S R Child, R J Forsyth
Imperial College London

Since 1990, the Ulysses mission has explored the third dimension of the heliosphere from an elliptical orbit inclined at approximately 80° to the solar equatorial plane. Data from this spacecraft has enabled us to expand our knowledge of the heliosphere over a full range of latitudes at both solar minimum and maximum. Here we present an ongoing attempt to understand the evolution of the heliospheric magnetic field through solar maximum by studying Ulysses observations of the heliospheric current sheet (HCS). The location and orientation of HCS crossings observed both by Ulysses and by ACE at 1AU have been obtained for the majority of the solar maximum Ulysses orbit, in particular during the high latitude phases. Interpretation of this information has been guided by the predictions of potential field models of the solar corona in an attempt to understand the large-scale topology and evolution of the HCS during this period. The results to date suggest a single highly tilted current sheet at solar maximum, with Ulysses being in close proximity to the HCS for large sections of the high latitude orbital segments.

MODELLING MERCURY'S MAGNETOSPHERE

James Scuffham, Andre Balogh
Imperial College London

There have been several attempts to model the magnetosphere of Mercury based on simply scaling models of the Earth's magnetosphere. While this approach has had many successes, it remains physically unsatisfactory, as it ignores the fundamentally different boundary conditions that apply at the two planets. The higher solar wind dynamic pressure and smaller dipole moment at Mercury make its magnetosphere very small and highly dynamic; solar wind driven convection is the dominant plasma transport process. The stronger interplanetary magnetic field means that reconnection may proceed more efficiently, making the magnetosphere adopt a very open configuration. There are no trapped particles, and therefore no ring current can form at Mercury. In addition, field aligned currents may be insignificant due to the lack of an ionosphere.

In this work, we analyse existing magnetospheric modelling techniques, particularly those of Tsyganenko, and attempt to apply them directly to Mercury with these different boundary conditions in mind. The lack of data has made the parameterisation of the model very difficult. However, we present fits to Mariner 10 data demonstrating the flexibility of the model. As new data becomes available from Messenger and BepiColombo it will be easily incorporated into the model.

MAGNETOSPHERE-IONOSPHERE COUPLING CURRENTS IN JUPITER'S MIDDLE MAGNETOSPHERE: EFFECT OF PRECIPITATION-INDUCED ENHANCEMENTS OF THE IONOSPHERIC PEDERSEN CONDUCTIVITY

J.D. Nichols and S.W.H. Cowley
Radio & Space Plasma Physics Group, University of Leicester

The dynamics of Jupiter's plasma environment is dominated by the outflow of material originating from the moon Io, which orbits deep within the magnetospheric cavity. Breakdown of corotation associated with this radial transport results in the formation of a magnetosphere-ionosphere coupling current system which transfers angular momentum to the magnetospheric plasma and has been linked to the formation of the main jovian auroral oval. In this talk we consider the effect of precipitation-induced enhancements of the Pedersen conductivity on the current system parameters and compare the results with those obtained by assuming constant conductivity. We find that this helps resolve some outstanding discrepancies between theory and observation. Specifically, we find that the effect on the ionospheric field-aligned current is to concentrate it in a narrow peak which maps to the inner edge of the middle magnetosphere (~20 RJ), which is to where the 'main oval' aurorae have traditionally been mapped. Correspondingly, the total equatorial radial current shows a large increase in magnitude over this region and plateaus off thereafter, in accordance with Galileo magnetometer data. In addition, we find that the plasma angular velocity is maintained near to rigid corotation over a much larger region than for the constant conductivity models, again consistent with observations.

A NEW GLOBAL MODEL OF SATURN'S MAGNETOSPHERIC FIELD

Christopher S. Arridge, Michele K. Dougherty
Imperial College London

We introduce a new 3-D Kronian magnetospheric global field model (GFM), built in preparation for the arrival of Cassini-Huygens at Saturn in July 2004. The rationale for such studies is that magnetospheric magnetic field models act as 'magnetosphere maps' to aid the understanding of fields and particle data. We outline previous modelling work undertaken, and in the context of magnetic field 'modules', discuss the individual models of various sources (current systems) of magnetic field external to Saturn's planetary field. The methods used in constructing the model, and the model outputs are outlined. We present results comparing and contrasting the previous in-situ spacecraft observations (Pioneer 11, Voyagers 1 & 2) with modelled predictions thus highlighting deficiencies in the model. The expected results for Cassini Saturn Orbit Insertion (SOI) are presented.

Monday 29th March 2004
16:00 - 17:00

UKSP Session 2 - Flows and Dynamos
Chair: Yvonne Elsworth

16:00	A Review of the Solar Dynamo	**D. Hughes**
16:30	Ultra-efficient Tracking of Photospheric Flows	**H. E. Potts**
16:45	The Role of Transport in Solar and Stellar Dynamos	**S. Tobias**

A REVIEW OF THE SOLAR DYNAMO

David Hughes
Department of Applied Mathematics, University of Leeds

I shall review the current state of play regarding the solar dynamo, taking account of recent helioseismology observations, numerical simulations and theoretical considerations from mean field electrodynamics.

ULTRA-EFFICIENT TRACKING OF PHOTOSPHERIC FLOWS

H. E. Potts
University of Glasgow

We present a method for tracking solar photospheric flows that is highly efficient, and demonstrate it using high resolution MDI continuum images. The method involves making a surface from the photospheric granulation data, and allowing many small floating tracers or balls to be moved around by the evolving granulation pattern. The results are tested against synthesised granulation with known flow fields and compared to the results produced by Local Correlation tracking (LCT). We also investigate the maximum spatial and temporal resolution of the velocity field that it is possible to extract, based on the statistical properties of the granulation data. We conclude that both methods produce results that are close to the maximum resolution possible from granulation data. The code runs approximately 200 times faster than similarly optimised LCT code, making real time applications possible.

This new tracking method has allowed us to look at the horizontal velocity fields in the photosphere over large areas and timescales in unprecedented detail, allowing detailed examination of supergranule dynamics.

THE ROLE OF TRANSPORT IN SOLAR AND STELLAR DYNAMOS

Joanne Mason, David Hughes and **Steve Tobias**
University of Leeds

The generation of magnetic fields in moderately rotating stars with deep convective envelopes (such as the Sun) is believed to result from dynamo action at or near the base of the convective layer. The convection is responsible for generating and transporting magnetic flux. Here we describe how transport processes, in particular magnetic pumping, may play a role in determining observables such as cycle period and amplitude of magnetic field in such stars.

Tuesday 30th March 2004
09:00 - 10:30

MIST Session 3

Chair: Richard Horne

09:00	Waves Observed In A Perturbed Magnetosheath	**I. Bates**
09:15	Simultaneous In-Situ Observations Of The Signatures Of Dayside Reconnection At The High And Low Latitude Magnetopause	**J.A. Wild**
09:30	Multi-Instrument Observations Of Bursty Bulk Flows In The Near-Earth Plasma Sheet	**A. Grocott**
09:45	Cluster Peace Observations Of Electron Distributions In And Around Magnetotail Flux Ropes	**C.J. Owen**
10:00	A Structured Magnetospheric Cusp Observed By Cluster During A Geomagnetic Storm	**N. Balan**
10:15	Simultaneous Interhemispheric Observations Of The Cusp	**Atousa Goudarzi**

WAVES OBSERVED IN A PERTURBED MAGNETOSHEATH

I. Bates[1], H. St. C. K. Alleyne[1], M. Andre[2]
1. Space Systems Group, Automatic Control and Systems Engineering Department, University of Sheffield
2. Swedish Institute of Space Physics, Uppsala Division, Uppsala, SWEDEN

The Magnetosheath is a region containing a dynamic turbulent plasma. The behaviour of waves inside this plasma is important as they provide a mechanism by which energy is transported through the Magnetosheath. It is from in-situ measurements that data can be obtained, with the CLUSTER satellite providing a suitable dataset, and analysed to study the waves.

Data from an in-bound satellite crossing of the Earth's Bow Shock and Magnetosheath, observed by the CLUSTER satellites with the Electric Field and Waves (EFW) instrument, are used in this study. This particular crossing, actually double crossing, is interesting as it allows a comparison between Magnetosheaths observed under very similar conditions with the significant difference being the second Magnetosheath, relative to the first, is recovering from a relatively minor compression.

The satellites pass from the Solar Wind through the Bow Shock and spend one hour inside the Magnetosheath before an upstream pressure pulse arrives at the Bow Shock which pushes it inwards, towards the Earth, across the satellites. The satellites remain in the Solar Wind for another hour until the effects of the pressure pulse pass and the Bow Shock moves outward and again crosses the satellites after which they remain inside the Magnetosheath to complete their crossing.

Two intervals, one inside the first Magnetosheath encounter, one inside the second, are studied. Waveforms from the EFW instruments are analysed with the Phase Differencing technique to determine propagation characteristics of the waves in both intervals. This information is then used to offer an interpretation of what is happening in the Magnetosheath in terms of wave modes.

SIMULTANEOUS IN-SITU OBSERVATIONS OF THE SIGNATURES OF DAYSIDE RECONNECTION AT THE HIGH AND LOW LATITUDE MAGNETOPAUSE

J.A. Wild[1], S.E. Milan[1], S.W.H. Cowley[1], J.M. Bosqued[2], H. Rème[2], S. Kokubun[3], Y. Saito[4], T. Mukai[4], B.M.A. Cooling[5] and A. Balogh[6]
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2. CESR/CNRS, Toulouse
3. Tokyo Institute of Technology
4. Institute of Space & Astronautical Science, Japan
5. Formerly at Queen Mary, University of London
6. Imperial College

At around 07 UT on 17 February 2003, the quartet of Cluster spacecraft made an outbound crossing of the high latitude post-noon sector magnetopause. Simultaneously, the Geotail satellite was skimming the noon-sector magnetopause just southward of the subsolar point. Whilst both spacecraft were located in the magnetosheath, in close proximity to the magnetopause, they observed the characteristic magnetic field signatures of flux transfer events (FTEs). The synchronicity of the FTEs was remarkable given the large separation of the Geotail and Cluster spacecraft. A detailed examination of the magnetic field signatures reveals bipolar perturbations consistent with previous statistical surveys of FTEs based upon single-spacecraft data. However, the provision of simultaneous observations at both high and low latitudes constrains the source

region of the FTEs and suggests that the interpretation of the magnetic field signatures of FTEs may not be as straightforward as previously thought.

MULTI-INSTRUMENT OBSERVATIONS OF BURSTY BULK FLOWS IN THE NEAR-EARTH PLASMA SHEET

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During the first three years of its mission the Cluster constellation has passed through the near-Earth inner central plasma sheet ~300 times. During these passes Cluster has been able to identify a large number of 'bursty bulk flow' events at a range of local times. The present study concerns a subset of such events, for which good coincident and conjugate ground-based observations exist and attempts to order their various ionospheric signatures within a simple physical framework. SuperDARN radar observations of ionospheric plasma velocities have been used to investigate the associated ionospheric flows and concurrent global convection patterns. The upstream interplanetary magnetic field has been monitored during these events by the ACE spacecraft, with ground magnetometers from a number of northern hemisphere arrays providing measurements of the terrestrial field. These data have been used to classify the BBFs in terms of the prevailing IMF clock angle and substorm phase. Preliminary results are discussed.

CLUSTER PEACE OBSERVATIONS OF ELECTRON DISTRIBUTIONS IN AND AROUND MAGNETOTAIL FLUX ROPES

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3. Los Alamos National Laboratory, Los Alamos, NM, USA.

Recent Cluster observations have revealed the occurrence of magnetic flux ropes in the magnetotail at ~15-20 R_E near substorm onset [e.g. Slavin et al., 2003]. The 4-point Cluster measurements reveal that such flux ropes can have either an Earthward or tailward direction of motion at these distances, with average speeds ~500 km s^{-1}. In addition, the motion of such flux tubes may cause a displacement of the surrounding plasma sheet and a compression of the exterior lobe magnetic field, and can thus be associated with a 'travelling compression region (TCR)' signature. In this paper we examine the electron distributions in and around such flux rope/TCR signatures as they pass over the Cluster tetrahedron. In the exterior region, electron distributions provide a remote diagnostic for processes, such as magnetic reconnection occurring at multiple sites within the plasma sheet, which lead to the formation of flux ropes and drive their motion. Within the flux ropes, we are able to assess the electron contribution to the overall current structure, which can be estimated by use of the 4-point curlometer technique. The implications for force balance within the flux ropes are discussed.

A STRUCTURED MAGNETOSPHERIC CUSP OBSERVED BY CLUSTER DURING A GEOMAGNETIC STORM

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7. CETP/CNRS and VSQP University, Uelizy, France
8. University of Iowa, Iowa, USA

Results are presented from a study of the northern magnetospheric cusp crossed by the 4 Cluster satellites during 16:25-17:55 UT on 18 April 2002 when a moderate geomagnetic storm was in progress, solar wind dynamic pressure was rather low, and IMF Bz was suitable (southward) for reconnection at subsolar magnetopause. The satellite orbit and data from the FGM, CIS, PEACE, STAFF and WHISPER instruments indicate that the satellites have crossed through a structured exterior cusp. The entry in the cusp region is identified by drop in total magnetic field, increase in high energy ion and electron fluxes, appearance of magnetosheath like (100 eV) electron flux, drop in low energy (< 10 eV) electron flux, and starting of high frequency (> 20 kHz) magnetic and electric waves. The ion density and temperature in the cusp region are anti-correlated for energy conservation, and ion temperature exhibits strong anisotropy. Three distinct anti-sunward ion flow events are detected in the cusp region. The sharp inward/outward walls of the anti-sunward flow events are detected with expected/reversed time sequence by the 4 satellites, with time delays of up to 10 sec./4 sec. That suggests reversed accelerated plasma flows inside the events, with faster acceleration closer to the walls, compared to the flows outside the events. The fluctuations in the magnetic field component By (≈ 50 nT) associated with the anti-sunward ion flow events are found to be nearly twice as strong as those in Bx and Bz, suggesting strong field-aligned currents.

SIMULTANEOUS INTERHEMISPHERIC OBSERVATIONS OF THE CUSP

Atousa Goudarzi, Mark Lester, Steve Milan
University of Leicester

We investigate two intervals of flow in the dayside cusp region during a variety of Interplanetary Magnetic Field (IMF) directions, measured by the Advance Composition Explorer (ACE) spacecraft. The SuperDARN radars in both hemispheres are used to obtain the ionospheric flows, while Defence Meteorological Satellite Program (DMSP) satellites provide clear identification of the ionospheric cusp and the low latitude boundary layer (LLBL). We compare the flows stimulated in both hemispheres and initial analysis suggests that the flows respond differently in the two hemispheres to changes in the IMF orientation. We compare our observations to existing theoretical predictions.

Tuesday 30th March 2004
09:00 - 10:30

UKSP Session 3 - The Lower Solar Atmosphere

Chair: Eric Priest

09:00	Oscillations and Dynamics of the Lower Atmosphere	**R. Erdelyi**
09:30	Dynamic Properties of Solar Spicules Observed by SUMER/SOHO	**L. D. Xia**
09:45	Wave Damping in Solar Prominences	**I. Ballai**
10:00	Low Atmospheric Signature of the Fast Solar Wind in Coronal Holes	**M. D. Popescu**
10:15	Coronal Bright Points and the Chromospheric Network: Oscillations Link?	**I. Ugarte-Urra**

OSCILLATIONS AND DYNAMICS OF THE LOWER ATMOSPHERE

R. Erdelyi
University of Sheffield

The transition from the dense solar surface (photosphere) to the hot and tenuous corona occurs only in a narrow approx 2.5 Mm thick layer in the solar atmosphere. Recent high-resolution observations by e.g. SOHO and TRACE supplemented with superb data from ground-based instruments have revealed many great details about the ongoing physical processes in the lower part of the solar atmosphere.

In this talk we review some aspects of the very rich physics in this transitional layer, covering e.g. the coupling of solar global oscillations to the low atmosphere; the importance of the magnetic carpet; the dynamic consequencies of such coupling (i.e. small-scale energy releases like blinkers, explosive events, etc.).

DYNAMIC PROPERTIES OF SOLAR SPICULES OBSERVED BY SUMER/SOHO

L. D. Xia[1], J. G. Doyle[1] and M. D. Popescu[1,2]
1. Armagh Observatory, College Hill, Armagh
2. Astronomical Institute of the Romanian Academy, RO-75212 Bucharest 28, Romania

Spicules are the most prominent small-scale structures seen on the solar limb in the H&alpha line. They are jet-like structures with sharp boundaries that extend from the chromosphere upward into the corona. When seen in EUV lines emitted in the transition region, similar structures with broader widths can also be observed, but they disappear at a temperature above 500 000 K. The connection between the H&alpha and the EUV spicules has not yet been established. It is suggested that the EUV spicules are very likely a hot sheath of the cooler H&alpha spicules. The mass and energy flow carried by spicules may play a very important role on the overall mass and energy balance of the chromosphere and corona. For example, it is thought that spicules may be responsible for the systematic redshifts measured in transition region lines, and transport the initial solar wind from the lower chromosphere into the corona. In this contribution we study the dynamic properties of the EUV spicules. The data selected for this study were obtained as time series in polar coronal holes by SUMER/SOHO. The short exposure time and the almost fixed position allow the analysis of their occurrence, lifetime, LOS velocity, etc. In addition, we discuss the possible relationship between EUV spicules and other phenomena observed in EUV lines on the solar disk.

WAVE DAMPING IN SOLAR PROMINENCES

Istvan Ballai
SPARC, Department of Applied Mathematics, University of Sheffield

The present contribution aims to discuss the damping of linear compressional MHD waves in solar prominences due to non-ideal effects. The obtained results show that the dominant mechanism is thermal radiation provided the supposition of optically thin prominence is valid. Damping due to thermal conduction is a viable attenuation mechanism provided the wavelength of the waves is small.

LOW-ATMOSPHERIC SIGNATURE OF THE FAST SOLAR WIND IN CORONAL HOLES

M. D. Popescu[1, 2] L. D. Xia[1] and J. G. Doyle[1]
1. *Armagh Observatory, College Hill, Armagh*
2. *Astronomical Institute of the Romanian Academy, RO-75212 Bucharest 28, Romania*

We have searched for the fast solar wind signature in coronal hole (CH) regions, being particularly interested to find its origins as low as possible in the solar atmosphere. We first analysed a raster taken in the northern Pole CH, in which we saw the plasma characteristics from the low transition region (TR), in the O III 703.87 Å line (originating at 80 000 K), as well as the corona, in the Mg IX 706.02 Å line (1 000 000 K).

For Mg IX, we find that low CH intensities correspond to line of sight up-flows of 5 km/s. In the case of the low TR line, downward motion is predominant, with an average velocity of 5 km/s in the CH, and 6 km/s in the quiet Sun (QS). Its red-shifted appearance is sprinkled with blue-shifts forming a small-scale network pattern with average negative values of 4 km/s in the CH and 3 km/s in the QS. The up-flows seen in the O III line are mostly found at the magnetic network intersection with the inter-network cells (network boundaries). Sometimes they are caused by high velocity transient events, such as bi-directional jets, which dislocate plasma up to 100-150 km/s. However, most of the up-flows occur on a much reduced scale and our next task is to find whether they constitute a steady flow or are produced as a result of transient features. For this, we further analyse time series data acquired in another polar CH region in lines originating from TR and coronal temperatures, in which we will check the flows (dis)continuity. Our data were acquired with the SUMER spectrograph on SoHO.

CORONAL BRIGHT POINTS AND THE CHROMOSPHERIC NETWORK: OSCILLATIONS LINK?

I. Ugarte-Urra[1], J.G. Doyle[1], V.M. Nakariakov[2] and C.R. Foley[3]
1. Armagh Observatory
2. University of Warwick
3. MSSL, University College London

We present a wavelet analysis of the temporal variations experienced by four Coronal Bright points seen in He I 584 Å, O V 629 Å and Mg VII/IX 368 Å CDS/SOHO wide slit movies. We find periods of oscillation ranging between 400 and 900 seconds, with signatures as well at 1000 and 250 seconds. These periods are in the range of periods found for the chromospheric network. We propose that a fraction of the Network Bright Points seen on this chromospheric network are the footpoints of the loops that coronal bright points are made of.

Tuesday 30th March 2004
11:00 - 12:15

MIST Session 4
Chair: Elizabeth Lucek

11:00	Magnetosheath Neutral Atom Observations And The Relationship With Radar Backscatter In The Cusp – Combined Observations From Image Lena And Superdarn	**H. Khan**
11:15	Superdarn Spectral Width Boundaries With Dmsp Particle Precipitation Proxies For The Open-Closed Field Line Boundary	**G. Chisham**
11:45	A Large Scale ULF Wave Observed In The Dawn Sector Magnetosphere Using The Superdarn HF Radars	**L J Baddeley**
11:30	A Statistical Investigation Of Magnetospheric Particle Populations Overlying Spear	**M.E. Wilson**
12:00	Mapping Fractal Structures To The Ionosphere	**Iain Coleman**

MAGNETOSHEATH NEUTRAL ATOM OBSERVATIONS AND THE RELATIONSHIP WITH RADAR BACKSCATTER IN THE CUSP – COMBINED OBSERVATIONS FROM IMAGE LENA AND SUPERDARN

H. Khan[1], M. R. Collier[2], M. Lester[1], T. E. Moore[2]
1. University of Leicester, Leicester
2. NASA Goddard Space Flight Center, Greenbelt, MD 20771

In this study we present observations showing the relationship between charge exchanged neutral atom emissions from the magnetosheath and the appearance of cusp-like signatures in the ionosphere. The Low Energy Neutral Atom imager on IMAGE can be used to detect the magnetosheath neutral atom signature during strong southward IMF conditions. Correspondingly, under such conditions, dayside reconnection is enhanced and the ground based SuperDARN radars monitor the increase in the flow and backscattered power associated with enhanced activity in the cusp. We present data from the SuperDARN radars, showing typical cusp signatures during the period of enhanced neutral atom emissions observed by LENA. We show that there is a significant correlation between the backscattered power at high latitudes detected by the radar and the ENA emission recorded at LENA. As the magnetopause is eroded due to the increased reconnection activity, the neutral density near the reconnection site will be higher than under normal conditions, resulting in a higher flux of charge exchanged neutral atoms observed by LENA. Also there may be a greater influx of magnetosheath particles which can charge exchange in the magnetosphere resulting in an increase in neutral atom emissions observed by LENA. The particle precipitation also ionizes the high latitude ionosphere producing irregularities resulting in an increase in the radar backscattered power. We present the observations showing the relationship between the ENA emissions and the radar backscatter in the cusp region.

SUPERDARN SPECTRAL WIDTH BOUNDARIES WITH DMSP PARTICLE PRECIPIATION PROXIES FOR THE OPEN-CLOSED FIELD LINE BOUNDARY

G. Chisham[1], M.P. Freeman[1] and T. Sotirelis[2]
1. British Antarctic Survey, Natural Environment Research Council, Cambridge
2. Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland, USA

The boundary between quasi-dipolar (closed) geomagnetic field lines and those connected to the interplanetary magnetic field (open) is a key diagnostic for the magnetospheric system. The SuperDARN Doppler spectral width boundary has been shown to be a good proxy for this open-closed field line boundary in the cusp region ionosphere. In this study, we compare measurements of the spectral width boundary from a number of SuperDARN radars, covering a wide range of magnetic local times, with proxies for the open-closed field line boundary derived from DMSP particle precipitation data. The results show that the SuperDARN spectral width boundary agrees well with the DMSP proxies across much of the dayside ionosphere and in the pre-midnight sector. However, the boundaries appear to be systematically offset from one another in the dawn sector and the spectral width boundary scenario is very confused in the late afternoon sector. This paper will address the practicality and reliability of using the spectral width boundary as a proxy for the open-closed field line boundary at all magnetic local times.

A LARGE SCALE ULF WAVE OBSERVED IN THE DAWN SECTOR MAGNETOSPHERE USING THE SUPERDARN HF RADARS

L. J. Baddeley[1], T. K. Yeoman[1], K. A. McWilliams[2]
1. Dept. of Physics and Astronomy, Leicester University, Leicester
2. Dept. of Physics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

Preliminary findings will be presented from an investigation of a long-lived large-scale ULF wave event that was observed in the dawn sector of the magnetosphere. The wave was observed by several SuperDARN radars as well as ground magnetometer chains in both Scandinavia and Canada. The event lasted ~ 14 hours of UT, and hence involved a significant energy input from the solar wind to the upper atmosphere. Its MLT location remained fairly constant, with the wave being observed in progressively more westerly radar fields-of-view as they corotated with the Earth. The event coincided with a protracted period of northward IMF. The wave characteristics from the initial study will be discussed along with possible driving mechanisms for the wave.

A STATISTICAL INVESTIGATION OF MAGNETOSPHERIC PARTICLE POPULATIONS OVERLYING SPEAR

M.E. Wilson[1], T.K. Yeoman[1], L.J. Baddeley[1] and B.J. Kellet[2]
1. University of Leicester, Leicester
2. Rutherford Appleton Laboratory

The Space Plasma Exploration by Active Radar (SPEAR) experiment, located at 76° magnetic latitude on Svalbard, has recently become operational. One of the science goals of SPEAR is to investigate MHD waves driven by wave-particle interactions employing the artificial backscatter technique. Using data gathered by the POLAR satellite CAMMICE/MICS instrument, this analysis determines the Magnetic Local Time control of the conjugacy of SPEAR to the open-closed field line boundary and the probable occurrences and energies of positive gradients in the Ion Distribution Functions (IDFs) at a range of latitudes including that of SPEAR. These non-Maxwellian distributions, which occur due to gradient-curvature drift effects on particle injections in the midnight sector, provide the energy for wave growth via wave-particle interactions in the magnetosphere and are seen primarily in the morning sector, 0600MLT to 1300MLT.

MAPPING FRACTAL STRUCTURES TO THE IONOSPHERE

Iain Coleman, Mervyn Freeman
British Antarctic Survey

There has been interest in recent years in the fractal properties of structures in the magnetosphere, including reconnection structures, and in investigating these properties via ionospheric observations. This presentation concerns how fractal properties are affected by the magnetosphere-ionosphere mapping process, and how observed properties in the ionosphere relate to the source structures in the magnetosphere.

Tuesday 30th March 2004
11:00 - 12:30

UKSP Session 4 - Waves in the Solar Atmosphere
Chair: Bernie Roberts

11:00	Slow Wave Propagation in a 2D Coronal Loop Model	**I. De Moortel**
11:30	Turbulent Alfven wave-driven Coronal Loops: a Two Fluid Model	**I. J. O'Neill**
11:45	Modelling Standing Slow-mode Oscillations in Stratified Coronal Loops	**Y. Taroyan**
12:00	Short-Period MHD Waves in Coronal Structures	**V. M. Nakariakov**
12:15	Is Phase Mixing a Viable Mechanism of Damping of Kink Oscillations of Coronal Loops	**M. Ruderman**

SLOW WAVE PROPAGATION IN A 2D CORONAL LOOP MODEL

I. De Moortel, A.W. Hood, C.L. Gerrard, S.J. Brooks
University of St Andrews

An overview of observations of quasi-periodic intensity oscillations, propagating along coronal loops is given. A theoretical, 1D model of slow magneto-acoustic waves, incorporating the effects of gravitational stratification, the magnetic field geometry, thermal conduction and compressive viscosity is presented to explain the very short observed damping lengths. Additionally, the properties of slow MHD waves in a 2D model are investigated. Including a horizontal density variation causes phasemixing and coupling between slow and fast MHD waves. The effect of different density profiles, different values for the viscosity coefficient and the plasma beta is studied. Using numerical simulations, it was found that the behaviour of the perturbed velocity was strongly dependent on the values of the parameters. A strong interaction with the fundamental, normal modes of the system was found to play an important role. The coupling to the fast wave proved to be an inefficient way to extract energy from the driven slow wave and is unlikely to be responsible for the rapid damping of propagating slow MHD waves, observed by TRACE. The phasemixing of the slow waves due to the (horizontal) density inhomogeneity does cause a significant amount of damping.

TURBULENT ALFVEN WAVE-DRIVEN CORONAL LOOPS: A TWO FLUID MODEL

Ian James O'Neill, Xing Li
Solar Physics Group, University of Wales, Aberystwyth.

A thorough parameter study of the response of a range of quiescent coronal loops at various lengths is presented. The two-fluid coronal loops described have lengths from 10Mm to 600Mm. These loops are then treated with our unique, self-consistent, steady-state dynamic loop model to derive the basic parameters (as introduced by Li and Habbal, 2003). It is assumed that Alfven waves carry the necessary energy flux from the chromosphere to energize the coronal plasma. The waves are dissipated by a non-linear turbulent cascade, the energy of low frequency waves is cascaded into the high frequency range where wave energy can be readily absorbed by the proton gas. We have control over the independent variables, driving scale (l) and Alfven wave amplitude at the chromosphere (\xi), which influence the dissipation and flux of these resonant waves. Coulomb coupling allows energy to pass efficiently from protons to electrons. It is found that by `mapping' the loop parameter response to varying l and fixed \xi, a useful tool can be created to find where certain conditions for each loop length exists (i.e. optimised heating of T=2.5MK for an L=600Mm loop can be generated at l=1000km when \xi=10km/s). We also focus on a L=40Mm loop and vary both l and \xi so we can compare results with existing work. From this parameter mapping we can also categorise the loop heating profiles. Our model indicates the existence of footpoint, non-uniformly and uniformly heated coronal loops. It is also evident that we can simulate very focused footpoint heating, hence producing a local temperature minimum in the middle of loops at low l and high L. However, the flow velocity is significant at the temperature minimum and density condensation does not occur.

MODELLING STANDING SLOW-MODE OSCILLATIONS IN STRATIFIED CORONAL LOOPS

Y. Taroyan, R. Erdelyi, G. Doyle

Recent observations have revealed a new type of coronal loop oscillations interpreted as fundamental slow standing waves. A small fraction of these oscillations are believed to be triggered

by flares. Others are associated with footpoint brightenings which suggests excitation by pressure disturbances at the footpoint. In most of the cases the excitation mechanism remains unclear. Theoretical modelling of these oscillations in stratified loops is presented. It is shown that large-amplitude resonant standing waves can be driven by small-amplitude oscillations at the chromospheric footpoints of the loops. Depending on the period of the driver a fundamental mode or higher harmonics can be excited. The periods and the behaviour of these waves are different from those predicted by the classical theory of isothermal loop oscillations. The effects of gravity, thermal conduction, radiative losses and compressive viscosity are examined.

SHORT-PERIOD MHD WAVES IN CORONAL STRUCTURES

Nakariakov, V.M.
University of Warwick

Seismology of coronal structures with impulsively-generated short-period fast magnetoacoustic wave trains is demonstrated. In the developed stage of the evolution, the wave trains have a characteristic quasi-periodic signature. The quasi-periodicity results from the geometrical dispersion of the guided fast modes, determined by the transverse profile of the loop. A typical feature of the signature is a "tadpole" wavelet spectrum: a narrow spectrum tail precedes a broad band head. The instantaneous period of the oscillations in the wave train decreases gradually with time. The period and the spectral amplitude evolution are determined by the steepness of the transverse density profile and the density contrast ratio in the loop, providing us with a tool for estimation of the sub-resolution structuring of the corona. The propagating wave trains recently discovered with the SECIS instrument are pointed out to have similar wavelet spectral features, which strengthens the interpretation of SECIS results as guided fast wave trains.

IS PHASE MIXING A VIABLE MECHANISM OF DAMPING OF KINK OSCILLATIONS OF CORONAL LOOPS?

Michael Ruderman
Department of Applied Mathematics, Sheffield University

Kink oscillations of coronal loops observed by TRACE are strongly damped with the characteristic damping time equal to a few periods of oscillation. A few mechanisms of damping have been suggested, the most popular ones being phase mixing and resonant absorption. I argue that phase missing is irrelevant for explaining the damping of coronal loop oscillations. I start from considering a simple model of coronal loops, which is a straight magnetic tube with the density varying only in a radial direction. In this case I use a rigorous mathematical theorem stating that the solution of the initial value problem for the linearized dissipative MHD equations is unique. Ruderman and Robers [ApJ, 577, 475, 2002] obtained a solution describing the damping of a straight magnetic tube with the density varying only in a radial direction. This solution shows that the damping is due to resonant absorption. In accordance with the uniqueness theorem there is no second solution and, thus, there is no solution describing the damping due to phase mixing. Then I explain why phase mixing cannot be responsible for the damping of any coherent oscillations of a spatially bounded magnetic plasma configuration.

Tuesday 30th March 2004
14:00 - 15:30

Joint Session 1 - Fundamental Plasma Processes – Waves

Chair: Chris Owen

13:30	Review of Waves in the Solar Corona	**A. Hood**
14:00	Oscillations in Hydrogen Ly Alpha Intensity observed by UVCS/SoHO	**H. Morgan**
14:20	An investigation of the field-aligned current associated with a large-scale ULF wave using Cutlass and FAST data	**H. Scoffield**
14:40	Timescale for Electron Acceleration by Whistler Mode Waves in the Earth's Radiation Belts	**R. Horne**
15:00	Electron Scattering and Loss in the Earth's Magnetosphere using a new pitch-angle and energy diffusion code	**S. Glauert**

REVIEW OF WAVES IN THE SOLAR CORONA

A. Hood
University of St. Andrews

Abstract not received.

OSCILLATIONS IN HYDROGEN LY-A INTENSITY OBSERVED BY UVCS/SOHO

H. Morgan, S.Habbal, X. Li
University of Wales, Aberystwyth

We report on a search for significant oscillations in different coronal structures by applying a wavelet analysis to UVCS/SOHO observations of the Hydrogen Ly-a line intensity taken between 1.5 and 2.5 Rs. Significant periodic oscillations, unlikely to be a result of instrumental effects, are shown to exist in a coronal hole, the quiet sun and a streamer. Observations made sequentially at different heights but at the same latitude often share similar power spectra. Neighbouring pixels at the same radial distance also share similar power spectra. These results indicate both a localized structure to the periodicity, and a long-range preservation of oscillation patterns in the radial expansion of the solar wind. We show that a preference for significant oscillations of periods 7-8 minutes exists in 3 out of the 4 observations presented here.

AN INVESTIGATION OF THE FIELD ALIGNED CURRENT ASSOCIATED WITH A LARGE SCALE ULF WAVE USING CUTLASS AND FAST DATA

H. C. Scoffield[1], T. K. Yeoman[1], D. M. Wright[1], S. E. Milan[1] and R. J. Strangeway[2]
1. University of Leicester, Leicester
2. IGPP, University of California, Los Angeles

On the 14th of December 1999, a large-scale ULF wave event was observed by the Hankasalmi radar of the SuperDARN chain. Simultaneously, the FAST satellite passed through the Hankasalmi field of view, measuring the magnetic field oscillations of the wave at around 2000 km altitude, along with the precipitating ion and electron populations associated with these fields. A simple field line resonance model of the wave was created and scaled using the wave's spatial and temporal characteristics inferred from SuperDARN and IMAGE magnetometer data. Here the model calculated field aligned current is compared with both the large- and small-scale field aligned current signatures derived from the FAST energetic particle spectra and magnetic field measurements.

TIMESCALE FOR ELECTRON ACCELERATION BY WHISTLER MODE WAVES IN THE EARTH'S RADIATION BELTS

R. B. Horne[1], R. M. Thorne[2], S. A. Glauert[1], N. P. Meredith[3] and J. M. Albert[4]
1. BAS
2. UCLA
3. MSSL
4. Boston

Acceleration by compressional MHD and whistler mode waves has been proposed to explain particle acceleration in solar flares and the Earth's radiation belts. A key factor for any acceleration process is that it must explain the observed timescale for acceleration. Here we focus on the Earth's radiation belts, and use data from the CRRES satellite to calculate the bounce averaged pitch angle and energy diffusion rates to obtain a timescale for acceleration. We show that whistler mode chorus emissions on the dayside accelerate electrons efficiently at latitudes above the equator, but only at equatorial pitch angles of 20-60 degrees or so. As particles drift around the Earth they are scattered to large pitch angles and further accelerated by chorus on the nightside in the equatorial region. We find the timescale to accelerate electrons by whistler mode chorus and increase the flux at 1 MeV is approximately 1 day, and agrees very well with satellite observations during the recovery phase of storms. During wave acceleration the electrons undergo many drift orbits and the resulting pitch angle distributions are energy dependent. We predict that the pitch angle distributions are either a flat topped, or, if wave acceleration at latitudes above the equator dominate, should have a characteristic butterfly shape. We suggest that similar signatures may be observed in the solar context if wave acceleration is effective.

ELECTRON ACCELERATION AND LOSS IN THE EARTH'S MAGNETOSPHERE USING A NEW PITCH-ANGLE AND ENERGY DIFFUSION CODE

S. A. Glauert and R. B. Horne
British Antarctic Survey

Electron acceleration and loss by wave-particle interactions plays an important role in the dynamics of the Earth's radiation belts. Here we present results from a new pitch angle diffusion code that is not restricted to high-densities as other codes are, and can calculate diffusion rates for any type of wave mode in a cold, multi-ion plasma. We show that the diffusion rates calculated with the high density approximation compare well with the exact calculations at high energies (1 MeV), even when the ratio of the plasma to the gyrofrequency (fpe/fce) is as low as 1.5, but there are large errors at low energies (10 keV). We find that whistler mode chorus is most efficient in accelerating electrons in low-density regions. Diffusion by Z mode waves is highly dependent on energy, with efficient scattering into the loss cone at low (100 keV) energies, but acceleration of trapped particles at high energies (1 MeV). Scattering by electromagnetic ion cyclotron waves only contributes to electron loss. The results suggest that the most efficient regions for electron acceleration during magnetic storms are in the low-density region outside the plasmapause, and at high latitudes.

Tuesday 30th March 2004
16:00 - 17:30

Joint Session 2 - Fundamental Plasma Processes – Reconnection

Chair: Peter Cargill

16:00	Magnetic Reconnection in the Magnetosphere - Problems, Progress and Perspective	**M. Freeman**
16:30	The Structure of 3D magnetic reconnection	**D. Pontin**
16:50	Anomalous resistivity and the non-linear evolution of the ion-acoustic instability	**P. Petkaki**
17:10	Proton versus Electron Heating in Solar Flares	**V. Zharkova**

MAGNETIC RECONNECTION IN THE MAGNETOSPHERE – PROBLEMS, PROGRESS, AND PERSPECTIVE

Mervyn Freeman
British Antarctic Survey, Cambridge

Magnetic reconnection is a universal phenomenon that occurs at the Sun, stars, accretion disks, planetary magnetospheres, etc. The earth's magnetosphere is the only natural environment in which reconnection can be observed both remotely (globally) and in-situ (locally). In this talk, I shall highlight some outstanding problems in magnetic reconnection research, review recent progress in the magnetospheric context, and discuss how the magnetospheric perspective may link to that of solar physics.

STRUCTURE OF 3D MAGNETIC RECONNECTION

D. Pontin[1]**,** Prof. E. R. Priest[1], Dr G. Hornig[2], Dr K. Galsgaard[3]
1. St Andrews University
2. Ruhr-Universität, Bochum
3. Astronomical Observatory, Copenhagen

Magnetic reconnection is a fundamental process in many areas of plasma physics, in the solar-terrestrial system and beyond. The basic properties of magnetic reconnection in three dimensions are very different from those of classical two-dimensional models. We discuss here some of these new features, by describing exact solutions of the kinematic equations as well as numerical experiments. Important new properties include the lack of a unique field line velocity in 3D, which results in field lines splitting and reconnecting everywhere within the non-ideal region. Thus the restructuring of magnetic flux by the process is very much more complicated than in 2D.

ANOMALOUS RESISTIVITY AND THE NON-LINEAR EVOLUTION OF THE ION-ACOUSTIC INSTABILITY

P. Petkaki[1], M.P. Freeman[1], T. Kirk[2], C. Watt[3] and R. B. Horne[1]
1. British Antarctic Survey, Cambridge
2. Now at University of Cambridge
3. University of Alberta, Canada

Magnetic reconnection requires the violation of ideal MHD by various kinetic-scale effects whose relative importance is uncertain. Recent research at the British Antarctic Survey has highlighted the potential importance of wave-particle interactions by showing that Vlasov simulations of unstable ion-acoustic waves predict an anomalous resistivity that is three orders of magnitude higher than a popular analytical quasi-linear estimate. We investigate the non-linear evolution of the ion-acoustic instability and its resulting anomalous resistivity by examining the properties of a statistical ensemble of Vlasov simulations. We compare the evolution to recent predictions and discuss how non-linearity may aid magnetic reconnection.

PROTON VERSUS ELECTRON HEATING IN SOLAR FLARES

Y.V.V.Zharkova[1], Yu.M.Voitenko[2] and M.Gordovskyy[1]
1. Cybernetics Department, Bradford University
2. Katholieke Universiteit Leuven, Belgium

Recently we have reported that protons and electrons accelerated by super Dreicer electric field in a current sheet with non-zero guiding magnetic field are ejected into different legs of a flaring loop either separately or as partially neutralized beams. This particle separation at ejection may have consequences onto the particle precipitation scenarios depending on electron versus proton abundances, energy and velocities. In the present paper we study heating of a flaring atmosphere by these fast protons and electrons in kinetic approach taking into account particle-particle interaction for electrons and wave-particle interaction for protons. In a presence of Ohmic heating the electron heating function has an increase at the transition region and/or upper chromosphere depending on the initial beam parameters. The protons were found to deposit their energy in the following two regions where they generate kinetic Alfven waves: the first in the upper corona not far from the reconnection site where initial proton velocity is higher that the local Alfven velocity; the second in the transition region and chromosphere where the difference between the proton velocity and the local Alfven velocity is increased owing to a fast decrease of the local Alfven velocity in the chromosphere.

Wednesday 31st March 2004
09:15 - 10:30

MIST Session 5

Chair: Farideh Honary

09:15	The Ionospheric Effects Of 2 Large X-Class Solar Flares	**Mathew Beharrell**
09:30	The Dayside, High-Latitude F-Region Trough Under Quiet Geomagnetic Conditions	**K L Dewis**
09:45	Why Is There More Ionosphere In January Than In July?	**Henry Rishbeth**
10:00	Polar Mesospheric Summer Echoes From Halley, Antarctica	**Martin Jarvis**
10:15	Remote Sensing Of The Natural Atmospheric Electrodynamic Environment	**Martin Füllekrug**

THE IONOSPHERIC EFFECTS OF 2 LARGE X-CLASS SOLAR FLARES

Mathew Beharrell
Ionosphere and Radio Propagation Group, Lancaster University

Two recent X-class solar flares (28th & 29th Oct 2003) have been studied with particular emphasis on their effects on the ionosphere, employing EISCAT, IRIS and satellite data. The flare on October 28, which occurred during the morning, resulted in over 200% increase in electron density uniformly across D, E and lower F region heights. This flare was also very noticeable in IRIS data and caused absorption across its field of view. The enhanced ionisation produced by the morning flare indicates that it has the same spectra as non-flare solar radiation, at least in EUV and X-Ray wavelengths. The Flare on October 29 occurred while EISCAT was on the nightside of Earth, therefore we report what was mostly a transported, rather than direct, effect of this flare.

THE DAYSIDE, HIGH-LATITUDE F-REGION TROUGH UNDER QUIET GEOMAGNETIC CONDITIONS

K L Dewis[1], R L Balthazor[2] S E Pryse[1] H R Middleton[1] and M H Denton[3]
1. University of Wales, Aberystwyth
2. University of Sheffield
3. Los Alamos National Laboratory

The high–latitude, dayside trough is believed to be a persistent depletion in the post–magnetic noon ionosphere, but observations of the feature have been limited because of its remote location. Solar photo–production, ionospheric convection and particle precipitation are all expected to play roles in its morphology, but their relative contributions are yet to be established. The extended viewing region of the UWA tomography experiment in the high Arctic spans the latitudinal extent of the trough, covering the trough minimum and both poleward and equatorward walls. Routine measurements by the system over extended time periods allow statistical parameterisation of trough features. Results are presented from tomography observations made during a two-month period in winter under quiet geomagnetic conditions. Trough densities, wall gradients and location are considered, with interpretation of the physical processes operating in the trough region being aided by comparisons with the Coupled Thermosphere–Ionosphere–Plasmasphere model.

WHY IS THERE MORE IONOSPHERE IN JANUARY THAN IN JULY?

Henry Rishbeth[1], Ingo C. F. Mueller-Wodarg[2]
1. School of Physics & Astronomy, University of Southampton, Southampton
2. Space & Atmospheric Physics Group, Imperial College, London

Taken over both hemispheres, there is about 20% more ionization in the F2-layer in December/January than in June/July. The difference is much greater than can be directly attributed to the 3.5% variation of Sun-Earth distance. Although the first evidence of this anomaly, which we call the 'annual asymmetry', was obtained 65 years ago, the only previous comprehensive study we know of is Yonezawa's in 1971. We briefly review available the data and possible causes. Having examined several possible explanations of the asymmetry, we suggest that the cause lies at lower levels in the atmosphere, perhaps in north-south differences in how the lower atmosphere influences the ionosphere.

POLAR MESOSPHERIC SUMMER ECHOES FROM HALLEY, ANTARCTICA

Martin Jarvis, Mike Rose, Shane Rodwell, Neil Cobbett, Mark Clilverd
British Antarctic Survey

During the recent summer relief of Halley research station, Antarctica, BAS extended the capability of their dynasonde (digital ionosonde) to detect Polar Mesospheric Summer Echoes (PMSE). We will describe how this was achieved and present the first results. Observations began in January 2004 and so captured the end of the austral summer. We will also discuss how this work fits into peer community efforts to compare Antarctic and Arctic mesospheres.

REMOTE SENSING OF THE NATURAL ATMOSPHERIC ELECTRODYNAMIC ENVIRONMENT

Martin Füllekrug
Telecommunications, Space, and Radio Group, Department of Electronic and Electric Engineering, University of Bath

Extremely-low frequency electromagnetic waves are used to explore the atmospheric electromagnetic environment of the Earth. Networks of magnetometers record the properties of natural electromagnetic fields on the global, regional, and on the local scale.

The global magnetometer network detects locations of lightning discharges around the globe and monitors the temporal and spatial evolution of particularly intense thunderstorms. Satellite based cloud cover recordings help to determine the effective charge density of thunderclouds and reveal the electrical nature of severe weather.

The regional magnetometer network detects mesospheric electrical breakdown between the troposphere and the ionosphere, optically imaged with an intensified video camera as a transient optical emission, denoted sprite. These sprites are pictured as red and bluish phenomena above thunderstorms, which enlighten a substantial volume of the mesosphere.

Local magnetometer measurements detect slowly varying oscillations after particularly intense sprite occurrences, associated with standing waves between the ionosphere and the maximum of the Alfven velocity in the magnetosphere, denoted ionospheric Alfven resonances.

The propagation speed of the electromagnetic radio waves is determined by the mesospheric conductivity. This variable conductivity is controlled by solar short wave radiation and energetic particle precipitation into the atmosphere, and can be monitored from the diurnal to the decadal time scale.

Wednesday 31st March 2004
09:00 - 10:30

UKSP Session 5 - A Heating of the Solar Corona
Chair: Robert Erdelyi

09:00	Scaling Laws in Magnetic Active Regions (review)	**R. Jain**
09:30	Determining the Spatial Variation of the Local Coronal Heating Function: Comparison of SoHO/CDS Observations and Modelling of Electron Density along a Coronal Loop	**R. W. Walsh**
09:45	Localized Heating, Siphon Flow and Shocks in Coronal Loops	**X. Li**
10:00	RHESSI microflare Statistics	**I. G. Hannah**
10:15	Non-Equilibrium Ion Populations and the Consequences for Observable Quantities	**S. Bradshaw**

SCALING LAWS IN MAGNETIC ACTIVE REGIONS (REVIEW)

Rekha Jain
Department of Mathematics, University of Sheffield, Sheffield

The talk is a review of the scaling laws describing the relationship between the thermal and magnetic properties of solar coronal active regions (by observational and theoretical investigations) with particular emphasis on the powerful diagnostic that they can provide of the underlying heating mechanism.

DETERMINING THE SPATIAL VARIATION OF THE LOCAL CORONAL HEATING FUNCTION: COMPARISON OF SOHO/CDS OBSERVATIONS AND MODELLING OF ELECTRON DENSITY ALONG A CORONAL LOOP

Robert W Walsh[1], Ignacio Ugarte-Urra[2], Gerry Doyle[2]
1. Centre for Astrophysics, University of Central Lancashire
2. Armagh Observatory

Recent interest in the heating of solar loop plasma has concentrated upon efforts to determine observationally the thermal structure along a loop structure and then mimic the resulting temperature profile via one-dimensional, hydrostatic simulations. The approach outlined in this work differs from others in this area in that it employs SOHO/CDS density diagnostics along an isolated long-lived loop on the limb. The observational density structure calculated is then compared with a density profile generated by relaxing a hydrodynamic loop model with a prescribed spatially varying heat input. Following a statistical analysis over a wide parameter space, the resulting, best fit energy release profile is clearly base dominant heating. How future instrumentation on SolarB, SDO and Solar Orbiter will further our determination of loop plasma conditions will also be discussed.

LOCALIZED HEATING, SIPHON FLOW, AND SHOCKS IN CORONAL LOOPS

Xing Li, Ian O'Neill

To interpret the observed temperature profiles of coronal loops, it has been widely believed that dominant heating near the chromosphere and transition region is necessary. In this paper, a two fluid steady-state coronal loop model is presented. It is assumed that the material in a coronal loop is the result of chromospheric evaporation due to a localized heating near one foot point. The temperature at the two foot points is kept at constant (20000K) while the densities at the two foot points are free to change. When an energy flux is applied, radiation loss and thermal conduction will naturally produce an energy balance and certain amount of material is lifted to the loop after a steady state is achieved. It is found that a localized heating may produce a much higher local proton temperature if the heating is only applied to the proton gas. However, if the localized heating is only applied to electrons, the proton and electron gas will have the same temperature. A localized heating produces a significant pressure gradient, and subsequently generates a strong plasma siphon flow (as fast as 100km/s). In a long loop (600Mm), a localized heating near a foot point can produce a local temperature minimum (a dip) between the two foot points. The plasma temperature increases again after the dip due to the loss of plasma kinetic energy. However, at the temperature minimum, a density condensation is not observed. When the temperature at the dip is sufficiently low (about 0.6MK), the plasma flow may become supersonic and a stationary shock is produced.

RHESSI MICROFLARE STATISTICS

I. G. Hannah[1], S. Christe[2], H. Hudson[2], S. Krucker[2], M. A. Hendry[1] and L. Fletcher[1]
1. Department of Physics and Astronomy, University of Glasgow, Glasgow
2. Space Science Laboratory, University of California, Berkeley, CA, USA.

We present the preliminary results of the first microflare survey using the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI). RHESSI is ideally suited for observing microflares due to its unprecedented sensitivity and spectral resolution of the low energy X-rays (3-15 keV) produced by the thermal and non-thermal electron bremsstrahlung emitted by microflares. We have developed automated code that can survey a large sample of microflares, providing thermal (temperature and emission measure) and non-thermal (power-law index) characterisation of each event.

We are also considering the effect of threshold selection bias on the observed microflare distributions and working on semi-analytical techniques to correct for the discrepancy between observed and intrinsic distributions - so far this has been tested on TRACE micro- and nanoflare observations. The improved sensitivity of RHESSI and consideration of bias in the microflare statistics will provide us with a more accurate estimate of the power input into the corona from microflares. This work is supported by PPARC.

NON-EQUILIBRIUM ION POPULATIONS AND THE CONSEQUENCES FOR OBSERVABLE QUANTITIES

Stephen Bradshaw[1&2], Helen Mason[2], Giulio Del Zanna[2]
1. Imperial College, London
2. DAMTP, Cambridge

Imaging instruments provide very high-resolution EUV images of the solar atmosphere and have revealed an enormous amount of information regarding the dynamical nature of the magnetic field and the plasma. However, in the search for the all-important heating mechanism imaging instruments may miss vital observational clues that only spectroscopic instruments are equipped to detect.

By carrying out numerical simulations of solar loop heating by nanoflares, accounting for the non-equilibrium behaviour of the population of emitting ions and their associated radiative emission, we demonstrate that even factor of two increases in the plasma temperature could potentially be missed due to the insufficient spectral range and resolution.

Wednesday 31st March 2004
11:00 - 12:30

MIST Session 6

Chair: Nigel Meredith

11:00	Thunderstorms And Sporadic E	**Chris Davis**
11:15	Numerical Modelling Of VLF Perturbations Near The Antarctic Peninsular	**D. Nunn**
11:30	INTERMAGNET: Worldwide Near-Real-Time Magnetic Observatory Data For Space Weather Research And Services	**David Kerridge**
11:45	Reconstructing The Long-Term aa Index	**Mark Clilverd**
12:00	Co-Estimation Of Internal And External Geomagnetic Fields For 2001	**Susan Macmillan**
12:15	MIST Announcements	**Andy Smith**

THUNDERSTORMS AND SPORADIC E

Chris Davis, Sarah James
Rutherford Appleton Laboratory

Anecdotal evidence of a connection between thunderstorms and enhancements in sporadic E have been widespread amongst the radio amateur community for many years. Such a connection would provide important evidence for energy flow between the lower and upper atmosphere. Discharges between clouds and the upper atmosphere(Sprites) were predicted by C.F.Wilson as long ago as 1925 and with their relatively recent observation there now appears to be a mechanism for such a connection. This talk will review the historical evidence and present results from a comparison of Chilton ionosonde data and data from the Met Office's lightning detection system.

COMPARISON OF THE CHARACTERISTIC ENERGY OF PRECIPITATING ELECTRONS
NUMERICAL MODELLING OF VLF PERTURBATIONS NEAR THE ANTARCTIC PENINSULAR

C.R. Rodger[1], **D. Nunn**[2], M. Clilverd[3]
1. University of Otago, Dunedin, New Zealand
2. University of Southampton
3. British Antarctic Survey, Cambridge

This work is concerned with the accurate numerical modelling of Trimpis observed at Faraday, Antarctica from the VLF transmitter NPM in Hawaii. Using data from the SEEP satellite on energetic electron precipitation due to a whistler, the modified electron density profile due to a LEP event is determined. An ionospheric chemistry relaxation model is used to determine the density profile as a function of time. The LEP dimensions are derived from previous studies in which simultaneous Trimpis are analysed on multiple paths in the Antarctic peninsular region. Using a 3D linear Born weak scattering model, the time profile of the resultant Trimpis are computed. The code considers all modes allowed in the earth ionosphere waveguide, and also permits inter modal scattering. Trimpi time profiles observed at Faraday for two models of precipitated electron energy spectra are computed. These bear excellent agreement with observations, in that scatter phase drifts towards 90 degrees as the Trimpi dies away, and the scatter amplitude vs log(t)plot is almost linear as noted by Dowden and co-workers. We have also considered the initial 4 secs of the Trimpi, taking account of the fact that the particle precipitation consists of a series of bursts as 'precipitated' electrons bounce repeatedly between hemispheres. Observations are not currently available to verify these results. Finally we have taken an observation of a 'double' Trimpi at Faraday due to two consecutive precipitation bursts, and modelled this successfully with some precision.

Detailed modelling of Trimpis not only increases understanding of the physics involved, but also enables VLF Trimpis to act as a tool for the remote sensing of WEP bursts.

INTERMAGNET: WORLDWIDE NEAR-REAL-TIME MAGNETIC OBSERVATORY DATA FOR SPACE WEATHER RESEARCH AND SERVICES

David Kerridge
British Geological Survey

Space weather science and services benefit from the availability of near-real-time data to monitor and predict the Earth's response to changes in solar activity and conditions in the near-Earth space environment. Geomagnetic field data is one type of relevant measurement, and the INTERMAGNET project provides easy and rapid access to high-quality globally-distributed data from permanent magnetic observatories. This is achieved by encouraging and assisting observatories to adopt modern standards for data measurement, capture and processing, by making recommendations on standards for observatory instrumentation and data quality, and by defining formats for data transmission and distribution. In 2004, sixteen years after INTERMAGNET started, more than 80 magnetic observatories, about half of the total number in operation worldwide, are participating in the project. Six Geomagnetic Information Nodes have been established to act as data collection and dissemination centres, and data can be selected and downloaded from the INTERMAGNET web site (*http://www.intermagnet.org*). The number and distribution of INTERMAGNET observatories, and the capability to deliver data, means that the project is well positioned to play a significant role in supporting space weather services. For example, the majority of the observatories producing data for the official IAGA magnetic activity indices are INTERMAGNET members, and INTERMAGNET co-operates with the agencies responsible for the production of the indices to promote efficient publication of them.

RECONSTRUCTING THE LONG-TERM AA INDEX

Mark Clilverd[1], Ellen Clarke[2], Thomas Ulich[3], Joachim Linthe[4], and Henry Rishbeth[5]
1. British Antarctic Survey (NERC), Cambridge
2. British Geological Survey (NERC), Edinburgh
3. Sodankyla Geophysical Observatory, Finland
4. GeoForschungsZentrum Potsdam, Germany
5. University of Southampton, Southampton

There is still some debate concerning the validity of the long-term trend apparent in the aa geomagnetic index. This debate links into discussions on trends in solar activity and potential effects on Earth's climate.

To test the robustness of the trend in aa we have reconstructed the index using two independent long-running European stations to provide data for the northern component of the index i.e., Sodankyla and Neimegk. The two reconstructions were scaled to the official aa-north values at the start of their data series by comparing the first full solar cycle of data. Both of the fully reconstructed aa series, based on Sodankyla and Neimegk data in combination with the southern hemisphere data, confirm the increasing trend in the index. We have also reconstructed the aa index just using data from the long running UK station, Eskdalemuir, following a technique known as inter-hourly variation (IHV) proposed recently by Svalgaard and Cliver. This series is designed to be primarily sensitive to solar wind conditions. The reconstructed aa_IHV index also shows an increasing trend with time, and high consistency with the official aa index. These results provide confirmation of the long-term trend in the aa index, and allow additional comparison to be made with other long-running data series such as the radiocarbon index in order to explore future trend possibilities.

CO-ESTIMATION OF INTERNAL AND EXTERNAL GEOMAGNETIC FIELDS FOR 2001

Susan Macmillan, Vincent Lesur and Alan Thomson
British Geological Survey

A spherical harmonic model of the internal and large-scale external geomagnetic fields is computed for 2001 from Ørsted satellite and observatory geomagnetic measurements. Only measurements on the night-side and when Dst index is between -60 nT to +20 nT are used. The altitude of the satellite data is 640-870 km. The time variations of the spherical harmonic degree one internal and external terms are parameterized with a cubic B-spline with a node per day. Despite this freedom there is an approximate 26-day periodicity in the east component residuals for both observatory and satellite data. The origin of this signal is unlikely to be internal or in the ionosphere as the phase and amplitude are approximately the same for both types of data. It is also unlikely to be generated in the distant magnetosphere as the model should fit this. A more likely origin is a non-potential field arising from field-aligned currents.

Wednesday 31st March 2004
11:00 - 12:15

UKSP Session 6 - Structure of the Corona and Outer Atmosphere
Chair: Lyndsay Fletcher

11:00	New Insights into Stellar Coronae with XMM-Newton and CHANDRA	**H. Kay**
11:30	A Quantitative Method to Optimise Magnetic Field Line Fitting of Observed Coronal Loops Observable Quantities	**L. Carcedo**
11:45	Large-Scale Structure of the Fast Solar Wind During the Last Solar Minimum from EISCAT IPS Measurements	**M. Bisi**
12:00	Detection of Silicon Nanoparticle Dust Grains in the Inner Corona	**S. Habbal**

NEW INSIGHTS INTO STELLAR CORONAE WITH XMM-NEWTON AND CHANDRA

H. Kay
Mullard Space Science Laboratory, University College London

Solar-like coronae and activity have long been observed on other late-type stars. The high-resolution spectroscopy provided by the XMM-Newton and Chandra Observatories provides us with the opportunity to study the coronae of these other stars in unprecedented detail. I will review selected results from XMM-Newton and Chandra observations of main-sequence cool stars, focusing on coronal structure, composition and dynamics and the complex processes occurring in stellar flares.

A QUANTITATIVE METHOD TO OPTIMISE MAGNETIC FIELD LINE FITTING OF OBSERVED CORONAL LOOPS

L. Carcedo, D.S. Brown, A.W. Hood, T. Neurkirch and T. Wiegelmann
School of Mathematics and Statistics, University of St Andrews, St Andrews

Many authors use magnetic field models to extrapolate the field in the Solar Corona from magnetic data in the photosphere. The accuracy of such extrapolations are usually judged qualitatively by eye, where a less judgemental quantitative approach would be more desirable. In this talk, a robust method for obtaining the best fit between a theoretical magnetic field and intensity observations of coronal loops on the solar disk will be presented. The method will be applied to Yohkoh data using a linear force-free field as an illustration. Any other theoretical model for the magnetic field can be used, provided there is enough freedom in the model to optimise the fit.

LARGE-SCALE STRUCTURE OF THE FAST SOLAR WIND DURING THE LAST SOLAR MINIMUM FROM EISCAT IPS MEASUREMENTS

Mario Bisi, Andy Breen, Shadia Habbal and Richard Fallows.
Institute of Mathematical and Physical Sciences, University of Wales, Aberystwyth.

Measurements of Interplanetary Scintillation (IPS) from the EISCAT facility have been used to study the solar wind over almost a complete solar cycle. The existence of a gradient in the fast solar wind over the polar crown at solar minimum has been known since the first Ulysses polar pass; more recently it has been suggested that a "step" in the velocity and the density of the fast wind exists at a latitude close to the boundary between the EUV coronal holes and the quiet Sun. In this talk we present the results of a re-analysis of EISCAT data from solar minimum where the IPS raypaths were overwhelmingly dominated by fast flow and examine the evidence for a two-mode fast wind. We also consider the wider issues of the large-scale structure of the solar wind in the inner heliosphere.

DETECTION OF SILICON NANOPARTICLE DUST GRAINS IN THE INNER CORONA

Shadia Rifai Habbal[1], Martina B. Arndt[2], Munir H. Nayfeh[3]
1. University of Wales, Aberystwyth
2. Bridgewater State College, MA, USA
3. University of Illinois at Urbana-Champaign, IL, USA

Polarized intensity measurements in the near-infrared line of Fe XIII 1074.7 nm were made during the total solar eclipse of 21 June 2001 to infer the direction of the coronal magnetic field. While the measurements yielded a predominantly radial direction for the coronal magnetic field, as had been found in the first eclipse measurements of 1966 and in coronagraph observations in the late 1970s, they yielded a surprising polarization signature in coronal holes which could not be attributed to Fe XIII emission. This abnormal polarization signature is attributed to fluorescence from silicon nanoparticle dust grains in the inner corona.

Wednesday 31st March 2004
13:30 - 15:40

Joint Session 3 - The Space Plasma Environment
Chair: Richard Harrison(tbc)

13:30	Recent and Current Work of the PPARC Science Committee	**M. Ward**
14:00	Cluster after 3 years	**P. Cargill**
14:30	Sampling a Coronal Mass Ejection at the Sun and Earth	**A. Fazakerly** **L. Culhane**
15:00	EISCAT observations of interplanetary Coronal Mass Ejections	**R. Jones**
15:20	Ionospheric scintillations at high latitudes during the storm of October 2003	**C. Mitchell**

RECENT AND CURRENT WORK OF THE PPARC SCIENCE COMMITTEE

M. Ward
PPARC

No Abstract Received.

CLUSTER AFTER THREE YEARS

Peter Cargill
Imperial College London

Cluster has been making multi-point measurements of the space plasma environment. Of special interest are the observations of the terrestrial bow shock, magnetopause and the cusp, as well as associated measurements of the ionosphere. This talk will focus on a few highlights, with emphasis on work done by UK groups.

SAMPLING A CORONAL MASS EJECTION AT THE SUN AND EARTH:

I. SOLAR ORIGINS OF THE EVENT

L.K. Harra, S.A. Matthews, L. van Driel-Gesztelyi, **J.L. Culhane**, A.N. Fazakerley, C.J. Owen.
Mullard Space Science Laboratory, University College London

In two contributions, we describe I) the emergence of a coronal mass ejection and II) its in-situ detection by instruments on near-Earth spacecraft. Active region NOAA540 which appeared on the Sun in January 2004,was flare productive. On January 20th, when it was close to the centre of the disk, it produced a large M-class flare which was related to a coronal mass ejection. We analysed the solar origin using multi-spacecraft datasets from SOHO, TRACE and GOES-SXI. We have also examined the related evolution of the photospheric magnetic field using SOHO MDI magnetogram observations. The event had associated type II and type III radio bursts, observed by the WIND/WAVES instruments, which have allowed us to study the shock propagation through the interplanetary medium. The solar properties of the event and the nature of its impact on the Earth will be examined. This contribution will focus on the solar properties.

II NEAR-EARTH IMPACT OF THE EVENT

A. N. Fazakerley[1] C.J. Owen[1], Pierrette Decreau[2], E. Lucek[3], C. Mazelle[4], L.K. Harra[1], S.A. Matthews[1], L.van Driel-Gesztelyi[1], J.L. Culhane[1]
1. Mullard Space Science Laboratory, University College London (MSSL)
2. Laboratoire de Physique et Chimie de l' Environnement (LPCE)
3. Space and Atmospheric Physics Group, Imperial College
4. Centre d' Etude de Spatiale des Rayonnements (CESR)

In Paper I, we describe the solar origins of a coronal mass ejection (CME) released from the Sun on January 20th 2004. The passage of the ejecta was detected by instruments on the Cluster spacecraft beginning with an interplanetary shock at about 01:30 UT on January 22nd Behind the shock, the plasma pressure was elevated for several hours. The anticipated displacement of the Earth's magnetopause and bowshock from their typical positions is confirmed using observations made by the Double Star TC-1 spacecraft. The passage of the CME en route to the Earth was also registered by in-situ instruments on SOHO and ACE. The ACE data indicates that rather stable conditions reminiscent of a magnetic cloud prevailed during a 24 hour period, beginning about 12 hours after

the interplanetary shock was seen. During this interval, Cluster was in the magnetosphere, able to examine the consequences of an unusually steady solar wind. We bring these data sets to bear to examine the CME as it approaches and then engulfs the Earth's magnetosphere, complementing our study of the origin of the CME on the Sun.

EISCAT OBSERVATIONS OF INTERPLANETARY CORONAL MASS EJECTIONS

Richard Jones[1], Alison Canals[1], Andy Breen[1], Richard Fallows[1],Gareth Lawrence[2]
1. University of Wales, Aberystwyth.
2.*Department of Solar Physics, Royal Observatory of Belgium*

Coronal Mass Ejections (CMEs) have been observed using white-light instruments for over 30 years. The structure appears different when observed by white-light instruments in the corona - where a three-part structure comprising leading edge, void and core is frequently seen - and as detected by in-situ plasma and field instruments which suggest a two-part structure of shock and ejecta. Interplanetary scintillation (IPS) observations are uniquely capable of determining solar wind parameters over a distance range extending from within the field of view of white-light instruments out into the interplanetary space. In this presentation we discuss the characteristic signatures which allow us to determine whether a CME is present in the ray-path during an IPS observation, before going on to describe a series of case studies of interplanetary coronal mass ejections (iCMEs), in which we combine extreme ultra-violet observations from EIT, white-light images from LASCO and IPS results from the EISCAT facility with in-situ measurements from Wind, ACE and Ulysses.

IONOSPHERIC SCINTILLATIONS AT HIGH-LATITUDES DURING THE STORM OF OCTOBER 2003

Cathryn N Mitchell[1], Giorgiana De Franceschi[2], Lucilla Alfonsi[2] and Mark Lester[3]
1. University of Bath
2. I.N.G.V., Rome, Italy
3. University of Leicester

The role of the auroral/polar ionosphere in producing small-scale irregularities in electron-concentrations is well known. High-energy particles from the solar-wind can enter the Earth's ionosphere and create field-aligned irregularities by impact ionisation. Such structures create strong gradients in total electron content (TEC) and these gradients can cause rapid phase and amplitude fluctuations in the carrier signal of the radio-waves which pass through them. These events are particularly important when they impact upon satellite-to-ground communication and navigation links. In this work a multi-instrument approach is taken to investigating the scintillations, in order to relate the physical processes through to the impact on a particular system.

A GPS Ionospheric Scintillation and TEC Monitor (GISTM) was installed at Ny-Ålesund (78.9° N, 11.9° E,) in September 2003 by INGV, Rome. The GISTM System consisting of a NovAtel OEM4 dual-frequency receiver with special firmware, comprises the major component of a GPS signal monitor, specifically configured to measure and automatically record amplitude and phase scintillation from the L1 frequency GPS signals, and ionospheric TEC from the L1 and L2 frequency GPS signals. In conjunction with scintillation measurements, MIDAS (Multi-Instrument Data Analysis System) is used to map the ionisation distribution from multiple observations of GPS differential phase. The convection of the plasma across the polar-cap, observed indirectly from the apparent movement of huge enhanced regions of TEC, is related to the plasma velocities observed from the CUTLASS and SuperDARN radars. It is shown that the regions of the ionosphere causing

GPS scintillation can be related to the convection of large-scale enhancements containing small-scale irregularities across the polar cap under these highly disturbed conditions. Origins of the enhanced ionisation regions are explored.

Wednesday 31st March 2004
16:00 - 17:40

Joint Session 4 - The Sun-Earth System
Chair: Alan Rodger

16:00	Satellite Vulnerability to Geomagnetic Storms	**R. Horne**
16:20	International Heliophysical Year 2007	**R. Harrison**
16:40	EGSO: Solving Science Use Cases That Relate To The Sun And Heliosphere	**R. D. Bentley**
17:00	Predicting the Next Solar Cycle	**B. Bromage**
17:20	Astrogrid: Developing the UK's virtual Observatory, New Capabilities for the MIST and UKSP communities	**N. Walton**

SATELLITE VULNERABILITY TO GEOMAGNETIC STORMS

R. B. Horne, M. P. Freeman, D. Riley, M. Daws, and K. Rutten
British Antarctic Survey

There are several examples where satellite on orbit have failed or partially failed during geomagnetic storms resulting in large insurance claims. Whether the storm is directly responsible for the failures is very controversial, commercially sensitive, and difficult to prove conclusively since there are so few examples. However, there are many non-fatal errors, or anomalies, that occur during the lifetime of spacecraft that enable a statistical analysis. Here we present an analysis of over 5000 satellite anomalies that shows for the first time a statistically significant link between satellite anomalies and geomagnetic storms. We find that the period of highest risk lasts for six days after the start of a magnetic storm. Approximately 40% of anomalies could be due to a random occurrence, but in addition there are between 0 and 35% of satellite anomalies that we attribute as being directly related to geomagnetic storms. We show that the risk depends on satellite prime contractor, orbit type, and age of satellite.

INTERNATIONAL HELIOPHYSICAL YEAR 2007

Richard A. Harrison
Rutherford Appleton Laboratory

Marking the 50th anniversary of the highly successful International Geophysical Year (IGY), in 1957, several groups world-wide are making plans for multidisciplinary and multinational campaigns, mainly as part of an International Polar Year (IPY). As part of this, it is proposed that there be an International Heliophysical Year (IHY) in which we provide some co-ordination of the many solar, heliospheric and near-Earth spacecraft and ground-based observatories, for specific scientific campaigns. Plans for IHY have been under discussion since 2001, with sessions at the 2002 World Space Congress in Houston and the 2003 EGU/AGU meeting in Nice. IHY is NOT designed to be another red-tape activity. It is being set up as an enabling activity for the grass-roots scientist to drive co-ordinated observations and one of the basic concepts under discussion is a grander version of the SOHO Joint Observing Programme approach in which individuals can quite easily 'apply' for time on multiple instruments. The IHY organising committee has set up a Web site at *http://ihy.gsfc.nasa.gov/* and a UK IHY coordinating committee has been established. We are in the process of setting up arrangements for the running of the IHY project and for this we need the community to say what it wants. How would you like to see such a project run? What should it include in terms of topical areas, instrumentation, facilities etc...? How can the UK make the best use of this opportunity? In short, the activities for 2007 provide an opportunity which has great potential. Anyone who had experience of the IGY is well aware that the impact was far reaching, so we must not underestimate the possibilities. However, the time to influence the activities is NOW.

EGSO: SOLVING SCIENCE USE CASES THAT RELATE TO THE SUN AND HELIOSPHERE

R.D.Bentley[1], V.V.Zharkova[2] and C.D.Pike[3]
1. Mullard Space Science Laboratory, University College London
2. Department of Cybernetics, University of Bradford
3. Space Science and Technology Dept., Rutherford Appleton Laboratory

The European Grid of Solar Observations (EGSO) is a grid testbed funded by the EC's Fifth Framework Programme under its Information Society Technologies (IST) thematic priority. The project started in 2002 years and is designed to provide enhanced access to solar and related data around the world.

EGSO is working closely with other virtual observatory (VO) projects in the solar physics and related domains. Initially this only including the US Virtual Solar Observatory (VSO) and the Collaborative Sun-Earth Connector (CoSEC) - both funded by NASA - but more recently we have been working with the Virtual Space Plasma Observatory (VSPO) and are in contact with the Virtual Heliospheric Observatory (VHO). Through LWS and the new IAU Working Group on "International Data Access" (Solar and Heliospheric), the VOs are studying ways of ensuring interoperability from the "sun to dirt".

The EGSO project was first demonstrated at the IST2003 Exhibition in Milan in October 2003. The current release, Release 3 (R3), provides access to common solar datasets and makes use of some special providers to enhance the projects search capabilities. We will describe how the Solar Event and Feature Catalogues, coupled with the unified cataloguing of solar observations allow the user to identify datasets of interest and the retrieve them. Science Use Cases related to flaring activity will used to highlight EGSO's current capabilities, but other Use Cases that span the solar and solar-terrestrial physics domains will be discussed to illustrate services that are still being developed.

EGSO R3 is now being Beta-tested by users and anyone interested in helping with this should contact one of the authors. More information about EGSO can be found under *http://www.egso.org*

PREDICTING THE NEXT SOLAR CYCLE

Barbara Bromage
University of Central Lancashire

A look back at what is known about the variability of the sunspot cycle, a comparison of some of the techniques used to predict future activity and some of the likely outcomes, in particular, the possibility of an overall reduction in activity levels. How might this affect our plans for future observations, for example, during IHY/IPY (2007).

ASTROGRID: DEVELOPING THE UK'S VIRTUAL OBSERVATORY
NEW CAPABILITIES FOR THE MIST and UKSP COMMUNITIES

Dr Nicholas A Walton
Institute of Astronomy, University of Cambridge on behalf of the AstroGrid Consortium

In this presentation I will provide a progress update on the development of the AstroGrid project - *http://www.astrogrid.org*. AstroGrid is developing a standardised framework enabling seamless access to a diverse range of astronomical datasets, and also access to user selected tools with which to manipulate and mine those data resources. AstroGrid is at the forefront of international efforts ensuring that appropriate interoperability standards (in for instance data exchange), are developed (see http://www.ivoa.net). Together with our partners in the French-VO, AstroGrid represents the interests of the Solar and STP communities within the Euro-VO (*http://www.euro-vo.org*).

I will describe how AstroGrid has been designed to meet the needs of a wide user base ranging from cosmologists through to the MIST community. I will show the current release of the AstroGrid system, and indicate the future rollout through to the end of 2004. This will include features and data access which particularly focus on MIST/ STP science use cases, such as Magnetic Storm Onsets.

I will briefly note how AstroGrid has been awarded continuing funding through to end 2007 to ensure the wide scale rollout of the system across the UK community. AstroGrid will continue to meet the demands of the UKSP/MIST communities with, for instance, the incorporation of the SSVO initiative into the AstroGrid consortium.

Thursday 1st April 2004
09:00 – 10:00

Poster Session

- A Survey Of Flux Transfer Events Observed By Cluster — **R.C. Fear**
- A Cutlass Multi Frequency Study Of Atmospheric Waves In The High And Mid Latitudes — **T. Karhunen**
- The Interaction Between Atmospheric Gravity Waves And Tides In The CMAT Model — **S. England**
- The Response Of Saturn's Thermosphere To A General Polar Heat Source — **C.G.A. Smith**
- Tracking Of UV Flare Footpoints — **L. Fletcher**
- Mean And Accelerated Electron Flux Spectra In Solar Flares — **E.P. Kontar**
- Synchronised High-Cadence Imaging Of The Solar Chromosphere — **D. Williams**
- Background Determination In Post-Recovery Synoptic CDS Spectra — **S. Chapman**
- Mhd Waveguide Modes In Structured Magnetic Flux Tubes — **B. Carter**
- Non-Axisymmetric Oscillations Of Thin Prominence Fibrils — **M. Dymova**
- Initial Results Of Coronal Active Region Oscillations From Grazing Incidence Spectrometer (GIS) — **C-H. Lin**
- Variation Of Line Widths In Coronal Hole Offlimb Regions — **E. O'Shea**
- The Solar UK Research Facility http://surfwww.mssl.ucl.ac.uk/surf/ — **C. Foley**
- Steady State MHD Magnetic Flux Tubes — **M.Terra-Homem**
- Magnetic Reconnection Along Coronal Hole Boundaries — **M.S. Madjarska**
- New Insight Into The Blinker Phenomena — **J.G. Doyle**
- Proton Temperature Anisotropy In Alfven-Turbulence-Driven Solar Wind Models: 1D And 2D Results — **B. Li**
- The Return Current Effect And The Observed Rhessi Hard X-Ray Photon Spectra Flattening At Lower Energies In Solar Flares — **M.Gordovskyy**
- Fast Electron Slowing-Down And Diffusion In A High Temperature Source — **R. K. Galloway**
- Preliminary, Simple Numerical Simulations Of The Flux Tube Tectonics Model For Coronal Heating — **C.L. Gerrard**
- Investigations Of The Dynamics Of Trace Euv Flare Loops — **J. Noglik**
- Modellling The Effects Of Space Weather At The Earth's Surface: A UK Geoelectric Field Model — **A.J. McKay**
- Three-Mode Resonance Between MHD Waves In Low-B Plasmas — **G. Botha**
- Electron Dynamics And Wave Emissions Close To Magnetic Reconnection Sites: Examples Of Observations By The Cluster Spacecraft — **A.M. Buckley**
- Charged Particles And Alfven Wave Resonances In The Solar Terrestrial Environment — **E.A. Evangelidis**
- Absolute And Convective Instabilities Of Circularly Polarized Alfvén Waves (Decay Instability) — **D. Simpson**
- Flow Deflections Ahead Of Fast Magnetic Clouds Observed By Ulysses — **A. Rees**
- Magnetic Field Measurements By Cassini Of Jupiter's Magnetosheath Region — **N. Achilleos**
- Evidence For Electron Acceleration To Relativistic Energies By VLF/ELF Whistler-Mode Chorus Waves — **N.P. Meredith**
- On The Occurrence Patterns Of Magnetic Storms — **M. Freeman**
- Algorithm Preparation And UK Data Availability For The Solar Dynamics Observatory (SDO) Investigations In The Context Of The UK Virtual Observatory — **J.L. Culhane**
- The Effect Of Strong Magnetic Fields On Acoustic Power At The Surface Of The Sun As Analysed By MDI — **C. J. Nicholas**

A SURVEY OF FLUX TRANSFER EVENTS OBSERVED BY CLUSTER

R.C. Fear[1], A.N. Fazakerley[1], C.J. Owen[1], A. Balogh[2]
1. Mullard Space Science Laboratory, University College London
2. Imperial College of Science, Technology and Medicine

During Cluster's dayside magnetopause season (November - June), the four spacecraft cross the magnetopause near the magnetospheric cusps permitting high-latitude observations of Flux Transfer Events (FTEs), a signature of transient magnetopause reconnection. The combination of instruments available on Cluster, particularly the electron spectrometer PEACE and the Flux Gate Magnetometer, allow a range of FTE types to be identified. These observations include shallow flux tube crossings, where the draped magnetic field causes a bipolar signature in the magnetic field component normal to the magnetopause, but where there is essentially no signature observed in the plasma data. Other observations demonstrate field-aligned electron flows which are faster than the local Alfvén speed, so no magnetic signature is observed.

We present preliminary results of a compilation of a catalogue of FTEs observed by Cluster in the 2002/3 dayside season. In future we hope to use these observations to compare the different models of FTE formation.

A CUTLASS MULTI FREQUENCY STUDY OF ATMOSPHERIC WAVES IN THE HIGH AND MID LATITUDES

Tommi Karhunen, Terry Robinson and Neil Arnold
RSPP group, Department of Physics and Astronomy, University of Leicester

One of the main problems when using oblique incidence radar systems is that there is an ambiguity between the height and the ground range of an observation. However, a consequence of the way in which the radars in the SuperDARN network operate is that the sine of the elevation angle of the main lobe is inversely proportional to the operating frequency.

It was shown using ray tracing techniques that the height at which the downward reflection of the beam occurs in a horizontally stratified ionosphere is roughly constant. This effect can be used to dispel some of the ambiguity as the peak power of the ground scatter at different frequencies have their reflections at the same altitude.

To take advantage of this a new mode for the CUTLASS radars was designed and run between February 11th and 22nd, 2004. In the data signatures of atmospheric waves are seen over a thousand kilometres of ionosphere from the high to the mid latitudes. Preliminary results of the experiment will be presented.

THE INTERACTION BETWEEN ATMOSPHERIC GRAVITY WAVES AND TIDES IN THE CMAT MODEL

Scott England[1], Alison Dobbin[2], Alan Aylward[2], Neil Arnold[1]
1. University of Leicester
2. *University College London*

Both atmospheric gravity waves and tides affect the background wind structure of the equatorial middle atmosphere. The interaction of these waves can be simulated using global scale atmospheric models. However, due to their relatively small scale size, atmospheric gravity waves are not

resolved by such models, so their effects must be parameterised. The effect of two different gravity wave parameterisations on the tides and background winds in the equatorial middle atmosphere has been studied using the UCL CMAT model and the results will be presented.

THE RESPONSE OF SATURN'S THERMOSPHERE TO A GENERAL POLAR HEAT SOURCE

C.G.A.Smith[1], A.D.Aylward[1], S.Miller[1], I.C.F.Mueller-Wodarg[2]
1. Atmospheric Physics Lab, UCL
2. Space and Atmospheric Physics Group, Imperial College

The temperature of Saturn's thermosphere is observed to be much higher than expected. If solar EUV is the only heat source an exospheric temperature of <200K is predicted; Voyager observations indicate it is probably >400K, and possibly as high as ~800K.

The missing energy is thought to be supplied either from the lower atmosphere or from the magnetosphere. Magnetospheric energy sources may take a number of forms, but are likely to be concentrated largely in the polar regions of the planet.

This study uses a global circulation model of Saturn's thermosphere to study the effect of a general polar heat source on the global temperature distribution.

TRACKING OF UV FLARE FOOTPOINTS

Lyndsay Fletcher, Jennifer Pollock and Hugh Potts
Department of Physics and Astronomy, University of Glasgow

Solar flares produce bright, compact sources of UV emission in the lower atmosphere, identified as flare footpoints. Observed with the Transition Region and Coronal Explorer, groups of UV footpoints define flare `ribbons' which move as the flare progresses. We have developed a procedure to track individual bright kernels within flare ribbons, enabling us to study the motion of these sites of excitation through the solar chromosphere as the flare progresses. We have applied this to a flare observed by TRACE in the 1600A passband at 2s cadence. In this event, the footpoints have an average speed of 15 km/s with a superposed random `meandering' component, consistent with the footpoint magnetic field being anchored around the edges of granular cells. Examining the brightness as a function of time, we find that the timing of peaks in brightness is significantly correlated with the timing of peaks in the product of the footpoint speed with the line-of-sight magnetic field strength at the footpoint location; in other words with a measure of the coronal reconnection rate. We suggest also how these observations can be used to empirically constrain the coronal magnetic field in the flaring region.

MEAN AND ACCELERATED ELECTRON FLUX SPECTRA IN SOLAR FLARES

Eduard P. Kontar[1], A. Gordon Emslie[2], Michele Piana[3], Anna Maria Massone[3] and John C. Brown[1]
1. Department of Physics and Astronomy, University of Glasgow
2. Department of Physics, The University of Alabama in Huntsville, Huntsville, AL 35899, USA
3. INFM, UdR di Genova, via Dodecaneso 33, I-16146 Genova, Italy

Hard X-ray spectra in solar flares permit, through knowledge of the bremsstrahlung cross-section, inference of the mean source electron spectrum that results from acceleration and propagation of electrons in the solar atmosphere. Here we develop and apply an enhanced regularization algorithm for this process which makes use of a variety of physical constraints on the possible form of the electron spectrum. The algorithm incorporates various features not heretofore employed in the solar flare context, such as the use of Generalized Singular Value Decomposition (GSVD), a rectangular representation of the discretized problem (so that the electron and photon energy ranges used are not necessarily the same), regularization using various smoothing operators. The use of non-square inversion techniques, with physical properties of the spectra to achieve the most meaningful solution to the problem. We apply these techniques to data from a few solar flares observed by RHESSI. Results using different regularization are presented and compared for various time intervals. We further note that such analyses may be used to infer properties of the electron energy spectrum that lie at energies well above the maximum photon energy observed. We also show how the construction of the accelerated (injected) electron spectrum (assuming that Coulomb collisions in a cold target dominate the electron energetics) is facilitated by the use of higher-order regularization methods. Clear evidence is presented for a change in the value of the high-energy cutoff in the mean source electron spectrum with time.

SYNCHRONISED HIGH-CADENCE IMAGING OF THE SOLAR CHROMOSPHERE

David Williams[1], James McAteer[2], Peter Gallagher[3,2], Thanassis Katsiyannis[2,4], Mihalis Mathioudakis[2] and Francis Keenan[2]
1. UCL/Mullard Space Science Laboratory
2. Queen's University Belfast
3. NASA/Goddard Space Flight Centre
4. Royal Observatory of Belgium

A novel high-cadence imaging system designed to obtain synchronised dual-band images of the solar atmosphere was tested at Big Bear Solar Observatory. The system consists of two identical CCD cameras which can, for the first time, obtain truly simultaneous images at up to 80 frames per second per channel, in two wavelength or polarization bands. We also present and discuss observations made with this system, of both the quiet Sun and an M-class flare, in H-alpha and H-alpha - 0.5 A.

BACKGROUND DETERMINATION IN POST-RECOVERY SYNOPTIC CDS SPECTRA

Steven Chapman, Barbara Bromage
University of Central Lancashire

When SOHO was lost temporarily in 1998, the post-recovery spectra were found to have changed. The wings of the line profiles in the CDS NIS data were now more pronounced and the lines were broadened. As a result, the spectral windows employed for some of the synoptic (SYNOP) observations were no longer broad enough to span the full profile. This has led to problems in determining the background level to be used with such data. This has been investigated using full spectral data to better determine the background. It was found that the background level for NIS-1 lines can be found from a relationship involving the peak values of Fe XVI and Mg IX, whilst the fitted background level of the Mg X profiles can be used as the background level for other NIS-2 lines used in SYNOP. The background levels estimated for both NI detectors are shown to be in good agreement with those found from the full spectral data. Examples of improvements in the analysis of the SYNOP lines are presented.

MHD WAVEGUIDE MODES IN STRUCTURED MAGNETIC FLUX TUBES

R. Erdelyi and **B. Carter**
University of Sheffield

The propagation of MHD waves in a structured magnetic flux tube embedded within a straight vertical magnetic environment is studied analytically. The motivation behind this study comes from the fact that existing models of damping of loop oscillations show that only part of the loop is homogeneous. The magnetic tube considered contains two characteristically distinct parts, namely an internal untwisted core, and a surrounding uniformly twisted magnetic annulus envelope. The general dispersion relation is derived. Modes of oscillation are examined from this general dispersion relation that is suitable for obtaining not just oscillations but some instability properties of this complex tube structure. Both short and long wavelength approximations are considered for the symmetrical mode with small twist.

NON-AXISYMMETRIC OSCILLATIONS OF THIN PROMINENCE FIBRILS

Dr. Mikhail Ruderman, **Maria Dymova**
Applied Mathematics, Sheffield University

We study non-axisymmetric oscillations of thin prominence fibrils. A fibril is modelled by a straight magnetic tube with the edges frozen in dense plasmas. The density inside and outside the tube varies only along the tube and it is discontinuous at the tube boundary. Adopting the cold plasma approximation we obtained the solutions inside and outside the tube. Using the condition of the continuity of the total pressure and the normal component of the velocity at the tube boundary we obtained the Sturm-Leuville problem for the second order differential equation determining the spectrum of the tube oscillations. We studied the dependence of this spectrum on the parameters of the unperturbed state for two different cases: one with discontinuous background quantities and one with continuous background quantities.

INITIAL RESULTS OF CORONAL ACTIVE REGION OSCILLATIONS FROM GRAZING INCIDENCE SPECTROMETER (GIS)

Chia-Hsien Lin, Gerry Doyle
Armagh Observatory

Grazing Incidence Spectrometer (GIS) is one component of Corona Diagnostic Spectrometer (CDS) on-board Solar Helioseismic Observatory (SoHO). Unlike the other component, Normal Incidence Spectrometer(NIS), which observes a region of solar surface, GIS observes temporal variation of only one pixel. One advantage of GIS is that the 4 detectors cover a wide range of wavelengths.

Among all the GIS observations, we chose Coronal Active Region Study observed on 19-Jul-2003, which is a 90-minute observation. We have chosen 9 spectral lines to study the oscillations at various temperatures, ranging from logT=5 - 6.3. In this report, we present our first results.

VARIATION OF LINE WIDTHS IN CORONAL HOLE OFFLIMB REGIONS

Eoghan O'Shea, Gerry Doyle, Dipankar Banerjee
Armagh Observatory

Using a number of different coronal lines, measured with CDS/NIS, we examine the variation of line widths with height above the solar limb in a coronal hole region of the Sun. The measurement of the variation of line widths with height allows us to determine whether there is, in fact, any evidence for a narrowing of these line widths above or at a certain height, which would indicate the dissipation of upwardly propagating Alfven waves in these regions. In this work we will present the results of our study and offer some conclusions as to the likely nature of the processes causing the expected line width variations.

THE SOLAR UK RESEARCH FACILITY http://surfwww.mssl.ucl.ac.uk/surf/

Carl Foley et al.,
Mullard Space Science Laboratory, University College London

The Solar UK research Facility, primarily offers an easy access point to solar data which is held at the Mullard Space Science Laboratory. We produce our own derivative data which can be browsed online to help selecting or planning solar observations. We also support the community through producing software for Solarsoft, as well as associated analysis guides.

STEADY STATE MHD MAGNETIC FLUX TUBES

Miguel Terra-Homem, Robert Erdelyi
University of Sheffield

The nature of oscillations in a magnetic cylinder embedded in a magnetic environment with field-aligned steady flow is investigated. The various well-known MHD modes are analysed depending on the strength of the equilibrium bulk motion. The flow induces shifts in the cut-off values and phase-speed of the waves. It is also shown that a strong enough flow can drag the backward (forward) propagating waves and change their direction of propagation. It is shown that these waves may have negative energy. Two equilibrium cases are studied, in particular: flux tubes under (i) photospheric, and (ii) coronal conditions. It is proved that these negative energy waves can be present in the Sun's atmosphere.

MAGNETIC RECONNECTION ALONG CORONAL HOLE BOUNDARIES

M.S. Madjarska[1], J.G. Doyle[2] and L. van Driel-Gesztelyi[1,3,4]
1. Mullard Space Science Laboratory, UCL
2. Armagh Observatory, College Hill, Armagh
3. Konkoly Observatory, Budapest, Hungary
4. Observatoire de Paris, LESIA, FRE 2461 (CNRS), France

Our study reveals for the first time the existence of bi-directional jets, which are signature of magnetic reconnection, occurring along coronal hole boundaries. The SUMER observations in the Ne VIII 770 A and N IV 765 A in an equatorial extension of a polar coronal hole, know as the "Elephant Trunk" coronal hole, show small regions of a few arcseconds size with strong blue- and redshifted emission reaching Doppler shifts up to 150 km/s, i.e., bi-directional jets. The jets' number density along coronal hole boundaries was found to be around 4-5 times higher with respect to the quiet Sun.

NEW INSIGHT INTO THE BLINKER PHENOMENA

J.G. Doyle[1], M.S. Madjarska[2] & I.I. Roussev[3]
1. Armagh Observatory
2. Mullard Space Science Laboratory
3. University of Michigan

We present, for the first time, blinker phenomena being associated with brightenings in pre-existing coronal loops. The brightenings occur during the emergence of new magnetic flux. We suggest that the blinker activity is triggered by interchange reconnection, serving to provide topological connectivity between newly emerging flux and pre-existing flux. The EIT images show the existence of loop structures prior to the onset of the blinker activity, which based on the available spatial resolution the blinker occurs within, or nearby, an existing coronal loop. The temperature interfaces created in the reconnection process between the cool plasma of the former and the hot plasma of the latter are what we suggest to cause the observed activity seen in both the SUMER and CDS data. As the temperature interfaces propagate with the characteristic speed of a conduction front, they heat up the cool chromospheric plasma to coronal temperatures, an increasing volume of which brightens at transition region temperatures.

PROTON TEMPERATURE ANISOTROPY IN ALFVEN-TURBULENCE-DRIVEN SOLAR WIND MODELS: 1D AND 2D RESULTS

B. Li[1] X. Li[1], Y. Q. Hu[3], S. R. Habbal[1,2]
1. Institute of Mathematical and Physical Sciences, University of Wales, Aberystwyth
2. Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA
3. School of Earth and Space Sciences, University of Science and Technology of China, Hefei 230026, China

We present, for the first time, a 2-dimensional(2D) turbulence driven solar wind model which takes proton temperature anisotropy into account. Alfven waves are assumed to carry most of the energy necessary for both the acceleration and heating of the solar wind plasma. Numerical results show that: 1. The model yields the observed outflow speed and effective proton temperature in the inner corona above coronal holes. The predicted mass flux and velocity at 1AU in both the fast and slow solar wind streams essentially match in situ measurements. 2. For the fast wind, the temperature anisotropy develops rapidly in the inner corona and reaches its maximum at around 3 solar radii. Throughout interplanetary space, protons are hotter in the perpendicular than in parallel direction. The proton temperature anisotropy at 1AU is comparable to the typically observed anisotropy of the core component of proton velocity distributions. However, the proton temperatures are only about half of that observed. For the slow wind, the proton temperature anisotropy is less pronounced in interplanetary space. 3. A dip in outflow speed profile for a typical slow wind is found near the cusp at the top of the helmet streamer. It reduces the effect of transverse expansion, leading to a realistic electron temperature at 1AU, although no explicit external heating is applied to electrons.

Furthermore, detailed comparisons of models with and without anisotropy show that the inclusion of the proton anisotropy does not significantly influence the global distribution of flux tube geometries but rather has some effects on the wind properties, for instance, it cools the protons in the fast wind. In addition, we compare model results of 1D and 2D computations for both isotropic and anisotropic cases. The comparison shows that in both cases, 1D and 2D calculation give essentially the same results. An immediate implication is that once the flux geometry is established from a 2D model, then 1D calculations, which enable a more thorough investigation of underlying physical processes, can be used.

THE RETURN CURRENT EFFECT AND THE OBSERVED RHESSI HARD X-RAY PHOTON SPECTRA FLATTENING AT LOWER ENERGIES IN SOLAR FLARES

V.V.Zharkova and **M.Gordovskyy**
University of Bradford

In many solar flares hard X-ray spectra reveal a broken energy power law with spectral indices being different for lower and higher energy parts and varying depending on a flare significance and phase. The lower energy spectra reveal a substantial flattening at the break energies of 40-60 keV. In the present paper an attempt is made to explain this effect by Ohmic energy losses caused by the electric field induced by a precipitating beam in addition to Coulomb collisions with the ambient plasma particles in a converging magnetic field. The electron beam distribution functions as well as beam densities, the energy fluxes and hard X-ray bremsstruhlung emission spectra are calculated for different energy fluxes (10^8 ...10^12 erg/cm 2 /s) and electron spectral indices (3...7). The return current effect was found to appear in hard X-ray spectra flattening at the lower energies (<50keV for 10^10 erg/cm 2 /s and <65keV for 10^12 erg/cm 2 /s). The photon spectral index in the high-energy range (80-300 keV) is about 2.5 higher than those of electron spectra. At the same time, a difference between the spectral indices in a low-energy range of photon spectra and spectral indices of the electron spectra is about 2-2.5 for initial energy flux of 10^8 erg/cm 2 /s, then decreases to -0.5...-1 for initial flux 10^10 erg/cm 2 /s, and decreases to -2...-2.5 for initial flux 10^12 erg/cm 2 /s. The calculated spectral indices are compared with those observed by RHESSI for a few flares of different significance.

FAST ELECTRON SLOWING-DOWN AND DIFFUSION IN A HIGH TEMPERATURE SOURCE

R. K. Galloway[1], A. L. MacKinnon[1], E. Kontar[1] and P. Helander[2]
1. University of Glasgow
2. UKAEA, Culham Science Centre

We investigate the behaviour of injected fast electrons undergoing systematic slowing-down and velocity diffusion in a Maxwellian target, as a model for the behaviour of such particles in solar flares. The effects of the variation of a number of model parameters, such as the relative magnitudes of the background and injected populations, the injected distribution power-law spectral index and low-energy cutoff are studied. Simulated bremsstrahlung photon spectra are generated, and are shown to be in good agreement with RHESSI spectral observations. We comment on the implications for the determination of the total energy content of the fast electrons from fits of model spectra to RHESSI data.

PRELIMINARY, SIMPLE NUMERICAL SIMULATIONS OF THE FLUX TUBE TECTONICS MODEL FOR CORONAL HEATING

C. Mellor[1], **C.L. Gerrard**[1], K.Galsgaard[2], A.W. Hood[1], E.R. Priest[1]
1. *Solar Theory Group, St Andrews*

2. Astronomical Observatory, Niels Bohr Institute for Astronomy, Physics and Geophysics, Copenhagen

In this talk we will present results from 3D MHD numerical simulations based on the flux tube tectonics method of coronal heating proposed by Priest et al (2002). They suggested that coronal loops connect to the photosphere in different magnetic flux fragments and that separatrix surfaces will form between the fingers connecting a loop to the photosphere and between individual loops. Simple lateral motions of the flux fragments could then cause currents to concentrate along the separatrices and drive reconnection contributing to coronal heating. In this talk we will describe a simple configuration with four flux patches on the top and bottom of the numerical domain and and a small background axial field. We will show the effect of moving two of the flux patches on the base between the other two using periodic boundary conditions such that when they leave the box they re-enter it at the other end. We will show that this simple motion soon causes the current to build up along the quasi-separatrix layers separating regions of connectivity and that there are indications that subsequently reconnection occurs.

INVESTIGATIONS OF THE DYNAMICS OF TRACE EUV FLARE LOOPS

Jane Noglik, Robert Walsh
University of Central Lancashire

High time resolution TRACE 171 and 195 Angstrom observations of a solar flare on 1999 March 18 have been investigated. Given the location of the post flare loop on the north east solar limb, an estimation of the possible outflow velocity from the flare reconnection region was undertaken. This was achieved by calculating the velocity at which successive loops brighten in the emission lines during the post-flare phase. An outflow velocity of <3km/s is obtained and, when applied to Petshek's model for magnetic reconnection, a reconnection rate of ~0.035 is determined.

MODELLLING THE EFFECTS OF SPACE WEATHER AT THE EARTH'S SURFACE: A UK GEOELECTRIC FIELD MODEL

A.J. McKay, E. Clarke, S. Reay and A.W.P Thomson
British Geological Survey

Geomagnetically Induced Currents (GIC), which can flow in technological systems such as power transmission grids, are a consequence of the geoelectric field induced at the surface of the Earth during geomagnetic storms. This poster describes the development of a new 3D 'Thin-Sheet' geoelectric field model which covers the whole of the UK, and includes the influence of the surrounding shelf seas. The model can be used to compute the response of the geoelectric field to geomagnetic storms. In conjunction with a power grid model this enables us to estimate GIC flow in power networks. As an example, we consider the major geomagnetic storm of October 2003 and compare measured and calculated GIC. It is envisaged that the model will form one component of a near real time GIC warning package which is currently being developed by BGS in conjunction with Scottish Power Plc. The magnetic field associated with the induced geoelectric field is easily calculated. Thus, the electric field model may also be of interest to those studying the effect of internal (induced) geomagnetic field signals on the total measured geomagnetic field.

THREE-MODE RESONANCE BETWEEN MHD WAVES IN LOW-β PLASMAS

Gert Botha[1], Sean Oughton[2]
1. Department of Applied Mathematics, University of Leeds
2. Department of Mathematics, University of Waikato, Hamilton, New Zealand

Interactions between Alfvén, fast and slow magnetosonic waves are studied in a compressible, polytropic, low-β plasma. Here β is the ratio of the gas and magnetic pressure. Waves with a small amplitude are considered in the presence of a strong uniform magnetic field. The nonlinearities present in the MHD equations mandate that the interaction of two Fourier modes drive a third mode. Some of these so-called triad interactions could be resonant. We examine the 27 possible interactions between the three MHD waves and define the resonant manifolds, i.e. the set of wavevectors for which three-wave resonances occur.

ELECTRON DYNAMICS AND WAVE EMISSIONS CLOSE TO MAGNETIC RECONNECTION SITES: EXAMPLES OF OBSERVATIONS BY THE CLUSTER SPACECRAFT

A.M. Buckley[1], T.C. Carozzi[1], E.C.Chambers[1], M.P. Gough[1] and P.M.E.Decreau[2]
1. University of Sussex, Brighton
2. Universite d'Orleans, Orleans, France

Several events have been observed by the Cluster spacecraft passing close to magnetic reconnection sites in the magneto-tail and at the magnetopause. These events are studied in the context of corresponding short time scale electron behaviour which contribute to and result from the reconnection process. This is done using Particle Correlator data from the DWP instruments on Cluster in conjunction with other data sets, especially those of high frequency wave measurements (2 - 80 KHz) from the WHIPSER instrument. The particle correlators use captured time series of electron particle counts accumulated in 12 microsecond time bins measured over the stepped energy range of the PEACE HEEA sensor (typically 40 eV to 26 KeV). Auto-correlation of these captured time series is then performed on board the spacecraft. The phenomena studied concerns beam properties, electron acceleration, interaction with waves and any indications of the electron diffusion processes that are occurring. These phenomena are quantified using measures of the strength of particle-particle interactions (general second order statistics on the electrons) and the Index of Dispersion (variance to mean ratio) indicating possible bunching or scattering processes occurring in the electron population.

CHARGED PARTICLES AND ALFVEN WAVE RESONANCES IN THE SOLAR TERRESTRIAL ENVIRONMENT

E.A. Evangelidis[1], G.J.J. Botha[2]
1. Lab. of Non-Conventional Sources of Energy, Demokritos University, Xanthi, Greece
2. Dept. of Applied Mathematics, University of Leeds, Leeds

The possible interactions between plasma waves and relativistic charged particles are considered. An electromagnetic perturbation in the plasma is formulated as an elliptically polarised wave, and the collisionless plasma is described by a distribution in phase space, which is realised in cylindrical coordinates. The linearised Vlasov equation is solved to obtain the distribution function in the rest frame of the plasma. The perturbed currents supported by the ionized medium are then calculated,

so that an expression can be written for the total amount of energy available for transfer through the Landau mechanism.

These general expressions are then applied to a thermalised plasma, interacting with the special case of Alfven waves. The direction of the energy flow is determined by a number of parameters, such as the polarisation of the wave, the state of the plasma, and the relative levels of the thermal energy density with respect to the wave energy. The final expressions are presented in terms of Stokes parameters.

ABSOLUTE AND CONVECTIVE INSTABILITIES OF CIRCULARLY POLARIZED ALFVÉN WAVES (DECAY INSTABILITY)

Michael Ruderman and **David Simpson**
University of Sheffield

We study the absolute and convective instabilities of a circularly polarized Alfvén wave (Pump wave) propagating parallel to an ambient magnetic field using analytical methods under the restriction of small pump wave amplitude and with the plasma beta less than 1. We find intervals for the reference frame velocity such that absolute instability can occur and find when spatially amplifying waves exist in the convectively unstable case. Our results are used to interpret observational data obtained in space missions.

FLOW DEFLECTIONS AHEAD OF FAST MAGNETIC CLOUDS OBSERVED BY ULYSSES

Adam Rees[1] and Mathew Owens[2]
1. Imperial College London
2. Boston University

Single spacecraft observations of a subset of Interplanetary Coronal Mass Ejections, termed Magnetic Clouds (MCs), have yielded many insights into their structure. However, single spacecraft observations are limited. For example, the cross-sectional morphology cannot be readily determined. In this work, we examine sheath regions formed ahead of fast MCs, by sweeping up and compressing the ambient solar wind plasma. Flow deflections within this sheath region, coupled with approximations of the axis orientations determined by flux rope models, have given clues as to the ellipticity of the cross-section of these MCs. Presented here are some examples of a technique developed to determine the cross-sectional morphology of fast MCs by examining flow deflections in sheath regions ahead of fast MCs.

MAGNETIC FIELD MEASUREMENTS BY CASSINI OF JUPITER'S MAGNETOSHEATH REGION

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Imperial College

Cassini's encounter with Jupiter (Dec 2000 - Jan 2001) yielded a rich set of magnetic field data which is still being analysed. The periods during which the spacecraft was in the planet's magnetosheath show field signatures associated with the 'draping' of field lines about the magnetopause; and with the dynamics of the magnetosheath plasma as it progresses further downstream of the planet. An overview of these field measurments will be presented and discussed in this context.

EVIDENCE FOR ELECTRON ACCELERATION TO RELATIVISTIC ENERGIES BY VLF/ELF WHISTLER-MODE CHORUS WAVES

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1. Mullard Space Science Laboratory
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The flux of relativistic electrons (E >1 MeV) in the Earth's outer radiation belt (3 < L < 7) varies substantially during geomagnetically-disturbed periods. Much of this variability is associated with non-adiabatic processes that cause enhanced acceleration and loss. Here we investigate the viability of a local stochastic electron acceleration mechanism to relativistic energies driven by Doppler-shifted cyclotron resonant interactions with VLF/ELF whistler-mode chorus waves. We present the results of a survey of the plasma wave and particle data from the CRRES satellite during 26 geomagnetically-disturbed periods and find that the most significant relativistic electron flux enhancements occur outside of the plasmapause and are associated with periods of prolonged substorm activity with AE greater than 100 nT for a total integrated time of greater than 2 days. These events are also associated with enhanced fluxes of seed electrons and enhanced lower-band chorus wave power with integrated lower-band (0.1 < f/fce < 0.5) whistler-mode chorus wave intensities of greater than 500 pT^2day. These results are consistent with a local, stochastic, chorus-driven electron acceleration mechanism involving the energization of a seed population of electrons with energies of a few hundred keV to relativistic energies operating on a time-scale of the order of days. The pitch angle and energy diffusion rates for scattering by whistler-mode chorus waves are proportional to the wave magnetic field intensity and are strongly dependent on the frequency distribution of the waves and to the ratio between the electron plasma frequency (fpe) and the electron gyrofrequency (fce). The seed and relativistic electron populations interact most readily with lower-band chorus and energy diffusion leading to local acceleration to relativistic energies is most effective in regions of low fpe/fce. We perform a statistical study of data from the CRRES mission and show that, outside of the plasmapause, both fpe/fce and lower-band chorus activity are dependent on magnetic activity with regions of low fpe/fce and enhanced lower-band chorus activity occurring over a wide range of geospace during active conditions (AE > 300 nT). Enhanced VLF/ELF whistler-mode chorus waves in these regions could thus play a major role in electron acceleration to relativistic energies during periods of prolonged substorm activity.

ON THE OCCURRENCE PATTERNS OF MAGNETIC STORMS

Mervyn Freeman, Richard Horne, Matthew Daws, and Paul Wilson
British Antarctic Survey, Cambridge

A statistical description of magnetic storm occurrence is derived, for two objective definitions of a magnetic storm based on historical precedent. In the first definition, an extreme magnetic storm is defined as the interval for which the Dst index is below a given threshold, c. The probability density function (PDF) of storm duration, non-storm duration, and waiting time between storm onsets are all found to be truncated power laws, independent of threshold. Thus, under this definition, magnetic storms have no characteristic duration or recurrence time between 1 h and 100 h. In the second definition, a repeatable magnetic storm is defined as the interval for which the Dst index is below a given threshold b and the minimum Dst is below a second, lower threshold c. Over a region of the two-threshold parameter space {b, c}, the PDF of waiting times between storm onsets in 3-year samples is found to be a random stationary (Poisson) process with a Poisson statistic that varies with the solar cycle. Within this region, the PDF of storm durations is peaked, at 20-30 h for {b = -20, c = -50} nT and 70-80 h for {b = -20, c = -100} nT.

ALGORITHM PREPARATION AND UK DATA AVAILABILITY FOR THE SOLAR DYNAMICS OBSERVATORY (SDO) INVESTIGATIONS IN THE CONTEXT OF THE UK VIRTUAL OBSERVATORY

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As part of its Astrogrid e-Science initiative, the UK Particle Physics and Astronomy Research Council will support an activity that will develop Grid-compatible tools for handling SDO data in the UK, with particular reference to the Atmospheric Imaging Array (AIA) and Heleiosesimic and Magnetic Imager (HMI) investigations. The work will be undertaken by a UK-based group of AIA and HMI Co-investigators. It will include i) collaboration with the US PI teams in the preparation of specialist algorithms for local and global Heleioseismology data products and for feature recognition in HMI and AIA images, ii) development of a Grid-compatible software infrastructure to enable distributed processing and storage of SDO data, and iii) development of data summaries to aid high speed searches within a virtual observatory environment. The nature of the SDO mission and the background to the project will be described and an account of the proposed development programme will be presented.

THE EFFECT OF STRONG MAGNETIC FIELDS ON ACOUSTIC POWER AT THE SURFACE OF THE SUN AS ANALYSED BY MDI

C. J. Nicholas, Prof. M. J. Thompson, Dr S. P. Rajaguru

The Michelson Doppler Imager (MDI) is a high resolution helioseismology instrument on board the SOHO satellite. MDI measures line-of-sight Doppler velocities of either 1024x1024 full disk CCD images, or higher resolution images of smaller regions of the solar disk, at a cadence of one minute. The data used in this work are high resolution (0.42 Mm/pixel).

A pixel by pixel analysis has been made of a time series of MDI Dopplergrams containing a sunspot. Power spectra have been obtained from a Fourier transform of the data. These power spectra are then binned by magnetic field strength and compared to derive the effect of the magnetic field on the oscillations. Results are presented that show the modulation of the acoustic power by the magnetic field in the sunspot and its vicinity. This includes the severe suppression of power at low frequencies (2-5 mHz), corresponding to the main frequency range of p-modes, and the increase in power at high frequencies (5-7 mHz). An unexpected variation of power in ostensibly 'quiet-sun' (low magnetic field) regions is particularly notable. Also presented is a comparison of these results with helioseismic ring diagram analysis work. The results generated in this study are used to make predictions of the degree of suppression in the ring results.

Thursday 1st April 2004
10:30 – 12:15

MIST Session 7
Chair: Allan McKay

10:30	A Simple Model Of The Flux Content Of The Distant Magnetotail	**Steve Milan**
10:45	A Comparison Of Observed Statistical Properties Of Substorms With Those Predicted By A Minimal Substorm Model	**S.K. Morley**
11:00	A Statistical Test Of The Assumptions Used To Form A Minimal Substorm Model	**G. A. Abel**
11:15	Variations Of Cut-Off Energy During Selected Polar Cap Absorption Events	**K.F. Kaal**
11:30	Electron Acceleration In The Downward Auroral Current Region	**Alexandra Cran**
11:45	2-D Hybrid Simulations Of An Alfven Wave Pulse	**P.A. Damiano**
12:00	Mirror Instability In Space Plasmas: Finite Ion Larmor Radius Effects	**M. A. Balikhin**

A SIMPLE MODEL OF THE FLUX CONTENT OF THE DISTANT MAGNETOTAIL

Steve Milan
University of Leicester

A simple model is presented which allows the profile of open flux within the magnetotail lobes to be determined from a knowledge of the present size of the polar cap and the past-history of low-latitude and high-latitude dayside reconnection. The model shows that the length of the tail is dependent on the elapsed time since reconnection of the oldest open field lines, and does not depend on the size of the polar cap. The model is applied to two 8-hour intervals of observations, which indicate that the length of the tail can vary by almost a factor of 10, between about 400 and 4000 RE, in just a few hours. In addition, differing rates of lobe reconnection in the northern and southern hemispheres are shown to lead to considerable differences in the lengths of the two magnetotail lobes.

A COMPARISON OF OBSERVED STATISTICAL PROPERTIES OF SUBSTORMS WITH THOSE PREDICTED BY A MINIMAL SUBSTORM MODEL.

S.K. Morley[1], M.P. Freeman[1], E.I. Tanskanen[2]
1. British Antarctic Survey, Natural Environment Research Council, Cambridge
2. NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

A minimal substorm model has been developed involving only three simple rules: (1) The substorm is driven by power from the solar wind, which causes energy in the magnetotail to accumulate. (2) At any given time, there exists an energy state that the magnetotail would like to exist in, which is determined by the solar wind boundary condition. (3) The magnetotail is constrained by its magnetic topology from adopting the energy state until it becomes sufficiently stressed. At this point, substorm onset occurs and the magnetotail moves to the lower energy state. The model has been shown to produce a probability distribution of times between substorm onsets that compares favourably with observation. We have used over 5 years of solar wind data to drive this minimal model and produce simulated substorm bays that are comprised of a loading-unloading component and a directly-driven component. We compare the statistical properties of the model with corresponding observed properties published in the literature. In particular, the distribution of substorm bay magnitudes and the integrated energy output are compared with the observations of Tanskanen et al. (2002).

A STATISTICAL TEST OF THE ASSUMPTIONS USED TO FORM A MINIMAL SUBSTORM MODEL

G. A. Abel, M. P. Freeman, and A. J. Smith
British Antarctic Survey, Natural Environment Research Council, Cambridge

A minimal model for the evolution of the global dynamical state of the magnetotail during the substorm, involving only three simple rules has been developed. The model considers the general state of the magnetospheric system rather than concentrate on the physical nature of the substorm instability. The substorm is modelled as an integrate-and-fire process in which integrated solar wind power input during the substorm growth phase is eventually released in whole or in part by a firing mechanism at substorm onset. Substorm onset occurs in the model when a fixed energy threshold is exceeded. Following onset energy is released from the system such that the magnetosphere moves to a minimum energy state, which is determined by the solar wind conditions at onset. When driven by a real solar wind power input, the minimal substorm model produces a

probability distribution of times between substorm onsets that compares favourably with the distribution of 1001 inter-substorm intervals found by Borovsky et al. from observation. In this paper we examine the validity of the assumptions behind the model, specifically how the energy accumulated by the magnetospheric system relates to the solar wind state at time of onset. We do this using pairs of contiguous substorm onsets identified from Substorm Chorus Events observed at Halley, Antarctica, and solar wind observations made using the Wind and ACE spacecraft.

VARIATIONS OF CUT-OFF ENERGY DURING SELECTED POLAR CAP ABSORPTION EVENTS

K.F. Kaal, F. Honary, A. Senior, R.A. Makarevitch.
Department Of Communication Systems, Lancaster University

Cut-off energies are studied for several polar cap absorption (PCA) events employing absorption data from the IRIS and SGO chain situated below the northern polar cap. The results found are compared with the cut-off energy as predicted by the Tsyganenko 2001 model. The cut-off energy ranges were found to vary by an order of magnitude. This variation is investigated with regard to different parameters that are entered into the Tsyganenko model. The motion of the cut-off latitude near noon is also discussed.

ELECTRON ACCELERATION IN THE DOWNWARD AURORAL CURRENT REGION

Alexandra Cran and Andrew Wright
University of St. Andrews

Global magnetospheric Alfven waves form a current circuit that closes in the ionosphere. Part of this circuit is composed of ionospheric electrons that are accelerated to 100's of eV by a field-aligned component of the electric field. Our calculation solves for the variation of electrostatic potential along a dipolar field line, and identifies the altitude at which energisation occurs. Ohm's Law in the form of a current-voltage relation is determined from the solution of the quasi-neutral Vlasov equation.

2-D HYBRID SIMULATIONS OF AN ALFVEN WAVE PULSE

P.A. Damiano and A.N. Wright,
Mathematical Institute, University of St. Andrews

Observations have linked Shear Alfven waves on the earth's dipolar magnetic field lines to the formation of auroral arcs. Associated with these waves is a parallel current density carried primarily by electrons. We use a self-consistent 2-D hybrid MHD-kinetic model incorporating kinetic electrons to simulate an Alfven wave pulse propagating in a constant density plasma and magnetic field. The pulse is rectangular in shape so that the perpendicular and parallel current regions are distinct. The structure of the electric field in the pulse and plasma frames will be highlighted along with the evolution of the electron distribution function in the parallel current region. Comparisons between the calculations and theory will be presented as well.

MIRROR INSTABILITY IN SPACE PLASMAS: FINITE ION LARMOR RADIUS EFFECTS

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A fully kinetic theory of magnetic mirror instability in a high-beta uniform space plasmas accounting for the finite ion Larmor radius (FLR) effects is developed. It is shown that incorporation of the FLR effects leads to a substantial modification of both the instability growth rate and the instability threshold. This modification is due to the fact that for the wavelengths of the order the ion Larmor radius the effective elasticity of the magnetic field lines is substantially enhanced which results in the increase in the instability threshold. A compact expression for the growth rate of the fastest growing mode in a fully kinetic limit is derived. Furthermore, it is shown that the presence of the FLR effects leads to the appearance of the noncoplanar component of the magnetic field perturbations usually observed in satellite data.

Thursday 1st April 2004
11:00 – 12:15

UKSP Session 7 - Fast Particles in Flares

Chair: Shadia Habbal

11:00	High Energy Flare Physics With RHESSI	**E. Kontar**
11:30	Particle Acceleration from Stochastic Current Sheets Driven by Photospheric Motion	**R. Turkmani**
11:45	Electron Acceleration at Reconnecting X-points in Solar Flares	**B. Hamilton**
12:00	The Dynamics Associated with Radio Spike Bursts	**J. I. Khan**

HIGH ENERGY FLARE PHYSICS WITH RHESSI

E. Kontar
University of Glasgow

It is more than two years Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) provides us with unprecedented quality energy, spatial and time observational data. The analysis of the data has enriched our understanding of flare phenomena. Some expected and unexpected physical results based on RHESSI data will be highlighted in solar flare context. Solar flare H-ray spectroscopy and imaging results are emphasised.

PARTICLE ACCELERATION FROM STOCHASTIC CURRENT SHEETS DRIVEN BY PHOTOSPHERIC MOTION

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We examine particle acceleration in a developed 3D MHD turbulent environment through numerical experiments. We use magnetic and electric field profiles obtained from a 3D MHD experiment of photospherically driven slander magnetic flux tubes as the background for the test-particle dynamics. The test particles are traced using standard numerical integration techniques for relativistic particle dynamics. We find considerable acceleration of the particles in relatively short time scales (after a few thousands of gyro periods).

ELECTRON ACCELERATION AT RECONNECTING X-POINTS IN SOLAR FLARES

B. Hamilton[1], L. Fletcher[1], K. G. McClements[2]
1. Department of Physics and Astronomy, University of Glasgow, Glasgow
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The acceleration of electrons in solar flares is simulated using an extended version of a full orbit test particle code previously used to compute losses of fusion alpha particles from tokamaks and to study flare proton acceleration. The magnetic and electric fields in the model are obtained from solutions of the linearised MHD equations for reconnecting modes at a magnetic X-point with zero equilibrium current. The magnetic field is assumed to have a small finite component perpendicular to the plane of the X-point. The version of the code used in the simulations is fully relativistic and includes Coulomb collisions. It is demonstrated that electrons cross the system boundary at distinct footpoints with the relative numbers and energy distribution at each footpoint sensitive to the perpendicular magnetic field component. These results can be related to recent flare observations showing asymmetric hard X-ray emission from the chromospheric footpoints of magnetic loops.

THE DYNAMICS ASSOCIATED WITH RADIO SPIKE BURST EMISSION

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2. Dept. of Physics & Astronomy, University of Glasgow, Glasgow

Radio spike bursts, are a collection of narrow-frequency, short-duration bursts sometimes observed during the primary energy release phase of a solar flare. They are generally believed to be an emission signature of particles close to, or at, the energy release site itself. To date, the source locations of such bursts have been determined for only a few cases and without a clear understanding of the dynamics leading up to the production of these bursts.

We present the results of an analysis of data for a radio spike burst which was observed on 1997 November 14 by the Solar Radio Spectrometers of the Astrophysikalisches Institut Potsdam. We are able to determine the location of the spike bursts for this event using imaging data from the Nancay Radioheliograph. Examination of images from the Yohkoh Soft X-ray Telescope (SXT) and the Solar and Heliospheric Observatory (SOHO) Extreme Ultraviolet Imaging Telescope (EIT) reveal interesting dynamics associated with the radio spike burst production. With this event it is now possible to understand clearly spike burst emission in relation to the underlying dynamics.

For this event we find that an earlier flare-associated coronal mass ejection in the vicinity caused the compression of highly inclined active region loops resulting in repeated remote small-scale flaring. On one occasion of flaring, spike burst emission was observed. The spike burst emission originated high in the corona far from the hard X-ray emitting regions. Moreover, the SXT and EIT imaging observations clearly show that the spike burst emission occurred at the site of compression, and probable reconnection, of the coronal magnetic field lines. However, our results indicate that the spike burst emission results as a side-show to the main energy release --what might be considered to be a type of sympathetic flaring caused by a large coronal mass ejection.

Thursday 1st April 2004
14:00 – 14:45

UKSP Session 8 - Multi-Wavelength Flare Observations

Chair: Barbara Bromage

14:00	Imaging Spectroscopy of the Fawkes X28 Flare	**C. Foley**
14:15	Multi-wavelength Observations of Compact Solar Flares	**G. Del Zanna**
14:30	Tracking of the Active Regions 484 and 486 with the EGSO Solar Features Catalogue	**V. Zharkova**

IMAGING SPECTROSCOPY OF THE FAWKES X28 FLARE

Carl Foley et al.,
Mullard Space Science Lab, University College London

We present imaging spectroscopy of the X28 flare which occurred on the 4/5th November 2003. We have combined the images obtained in the TRACE 195A channel with spectroscopic observations made with the SOHO CDS/GIS spectrometer on SOHO. We identify ions from the hottest plasma (Ni XXVI, Ni XXV, Fe XXV) ever to be seen with the CDS spectrometer. This plasma is located above and outside the loops observed by TRACE. We reconcile these observations with classical models of reconnection and prior observations of flares, such as those with the Yohkoh Spacecraft.

MULTI-WAVELENGTH OBSERVATIONS OF COMPACT SOLAR FLARES

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1. DAMTP, University of Cambridge, Cambridge
2. Observatoire de Paris, Meudon, France

The SOHO/Coronal Diagnostic Spectrometer provides essential spectroscopic information to understand the characteristics and dynamics of solar coronal features. CDS observations of solar flares, complemented with observations from other instruments (such as high-resolution images from TRACE and magnetograms from SOHO/MDI) are presented. We give a description of the main observational features and what types of measurements (densities, temperatures, flows) are obtained. These provide important observational constraints for flare modeling. In particular, we describe CDS observations of a compact M1 flare that occurred on October 22 2002, also observed from the ground in chromospheric lines and by RHESSI. Strong blue-shifts in lines emitted in the 1-8 MK range are observed at the bases of hot Fe XIX structures. These structures are seen in detail in the TRACE 195 A band, and match the thermal emission as seen by RHESSI. The flare occurred in a region of strong and mixed magnetic polarity, was compact and lasted only a short time.

TRACKING OF THE ACTIVE REGIONS 484 AND 486 WITH THE EGSO SOLAR FEATURE CATALOGUES

V.V.Zharkova[1], R.D.Bentley[2], A.K.Benkhalil[1], S.I.Zharkov[1] and S.S.Ipson[1]
1. Department of Cybernetics, University of Bradford
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This paper presents a searchable Solar Feature Catalogues developed for the **European Grid of Solar Observations** (EGSO) using various image processing and pattern recognition techniques. The techniques were applied to solar images of different wavelengths for the automated detection of sunspots, active regions, filaments and magnetic field - data used for this study include images in Ca II K1, Ca II K3 and H-alpha from the Meudon Observatory and the SOHO/MDI white light images and magnetograms. A structured database of the recognised parameters for each feature type was built within a MySQL server.

The database was used to track NOAA active regions 484 and 486 and changes in their associated magnetic field – these regions produced many flares in October and November 2003. We try to define the key parameters for active region activity and relate them to the parameters recognised with SFC for the future activity forecast.

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