SH21A-03 0840h

A 3D Line-Tied Model of Flux Rope Eruptions

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We consider the 3D force-free flux rope configuration which was proposed by Titov and Demoulin [Astron. Astrophys., 351, 707, 1999] as an approximation to the observed topology of coronal structures leading to eruptive flares. This configuration consists of a toroidal flux rope, oriented vertically, which intersects the photospheric surface at some distance above the center of the torus, along with several other photospheric sources which make up the potential background field in the corona. We extend the analysis of this configuration to correctly implement the effects of photospheric line-tying. We then investigate the equilibrium properties of this configuration and the conditions which yield an ideal loss of equilibrium. We follow the subsequent eruption of the flux rope under the assumption that the coronal portion retains a circular arc structure. Ultimately, this model will provide a semi-analytic 3D description of the evolution of coronal magnetic structures during an eruptive flare.

SH21A-04 0855h

Magnetic Reconnection Rate and Mass Acceleration in Flare-CME Events

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To understand the role of magnetic reconnection in the early stage of coronal mass ejections (CMEs), an observational relationship is yet to be established between magnetic reconnection and the dynamical evolution of the mass acceleration. We present measurements of the magnetic reconnection rate, in terms of the electric field inside the reconnecting current sheet and the rate of magnetic flux convected into the diffusion region, in two well observed two-ribbon flares, which are compared with the dynamical evolution of filament eruption and CMEs associated with the flares. We find that there is a good temporal correlation between the magnetic reconnection rate, represented by E_{rec}, and the mass acceleration a in both events studied in this paper. With the given temporal resolution, E_{rec} and a rise and decay together, and reach the maxima coincidently. The time profile of E_{rec} also correlates well with the flare non-thermal emission, both peaking during the rise of soft X-ray emission. We also discuss the magnitude and time scales of magnetic reconnection and mass acceleration revealed in the observations, and explore the structure of the evolving flux rope with available observations.

SH21A-05 0910h

Flux Rope Acceleration and Enhanced Magnetic Reconnection

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Recent flare and CME observations have shown that flux ropes are accelerated in the low corona in the form of coronal mass ejections or filament eruptions or soft X-ray plasma ejecta. The conclusion from these observations is that the most intense peak in the flare hard X-ray emissions and the maximum rate of increase in soft X-ray emission occur at the time of maximum acceleration of the flux rope's rising motion. To understand these observations we present results of our 2-1/2D MHD simulations of arcade field evolutions by employing a nonuniform anomalous resistivity. The simulation results relate the flux rope's accelerated rising motion with an enhanced magnetic reconnection rate and thus an enhanced reconnection electric field in the current sheet during the flare rise phase. The simulation results provide good quantitative agreement with observations of the acceleration of flux ropes (CMEs) for several CME-flare events. For the X-class flare events the peak reconnection electric field is $\sim O(10^3\ \mathrm{V/m})$ or larger, enough to accelerate electrons to over 100 keV in a field-aligned distance of 0.1 km and produce impulsive hard X-ray emission observed during the flare rise phase, consistent with the estimated reconnection rate obtained from the magnetogram data and two-ribbon emissions. Comparisons of the flux rope height, velocity and acceleration between our simulation results and observed CME-flare events will be presented.

SH21A-06 0925h

Radio Observations of Rapid Acceleration in a Slow Filament Eruption/Fast CME Event

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We discuss a filament eruption/coronal mass ejection (CME) associated flare event of GOES class M2.8 that occurred on November 17, 2001. This event was observed simultaneously by Nobeyama RadioHeliograph (NoRH) at 17 and 34 GHz and by the Giant Meterwave Radio Telescope (GMRT) in India at 1060 MHz. The flare occurred in active region 9704 at S18E41. NoRH observes the filament during its eruption both as a dark feature against the solar disk and a bright feature above the solar limb. The filament eruption shows a very gradual onset and then a rapid acceleration phase coincident with the launch of a fast halo CME. The flare on the disk in microwaves has a gradual rise, a broad maximum and a gradual decay. At 1060 MHz, its time profile had three impulsive peaks. The NoRH height–time plot of the filament shows a roughly constant gradual acceleration for an hour, followed by a very abrupt acceleration coincident with the impulsive phase of the associated flare. Soft X–ray images show heating in a long loop underneath the filament prior to the flare. The impulsive behavior of 1060 MHz emission combined with high brightness temperatures indicated the existence of nonthermal electrons in loops that clearly are not the same as the loops containing the microwave-emitting electrons. The latter are dominated by thermal bremsstrahlung and agree well with the EUV and soft X–ray loops. This study is consistent with recent findings that the rapid acceleration of flare–associated CMEs is closely tied to the impulsive phase of the flare. A trigger is required to cause the rapid acceleration to occur at the same time as the flare even though the two events are spatially well separated. We speculate that this trigger is provided by some kind of reconnection in the multiple flux systems that exist between the flaring active region and the erupting filament.

SH21A-07 0940h

Acceleration of Fast CME: A Parametric Study

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The analysis of LASCO/SOHO, Skylab and Solar Maximum Mission (SMM) observations show that there are many CMEs initiated with streamer and flux-rope magnetic topology (Dere et al. 1999; St. Cyr et al., 1999; Plunkett et al., 2000). Two types of CMEs have been distinguished with different kinematic characteristics (MacQueen and Fisher, 1983; Andrews and Howard, 2001). These are fast CMEs with high initial speeds (i.e. constant speed) and slow CMEs with low initial speeds but gradual acceleration (i.e. accelerated CMEs). Efforts have been made to probe the underlying physics responsible for these dual characteristics. Low and Zhang (2002) proposed that fast and slow CMEs result from initial topology of the magnetic field characterized by normal and inverse quiescent prominences, respectively. Liu et al. have successfully performed a numerical MHD simulation for this scenario. In this presentation, we explore other possible processes using a 2.5D, time-dependent streamer and flux-rope MHD model (Wu and Guo, 1997) to investigate the dual kinematic properties of the CMEs by specifying the different initiation processes with a particular magnetic topology (i.e. inverse quiescent prominence magnetic topology). Two typical initiation processes are tested; (1) injection of the magnetic flux into the flux-rope causes additional Lorentz force to destabilize the streamer launching a CME (Wu et al., 1997) resulting in a category slow CME and (2) draining the plasma from the flux-rope together with flux injection leads to a balloon instability due to the magnetic buoyancy force which results in a impulsive eruption and launches a fast CME. References Andrews, M.D. and Howard, R.A., Space Sci. Rev., 95, 147, 2001 Dere, K.P. et al., Ap. J., 529, 575, 1999 Lin, et al., Proceedings of ICSC 2003: Solar Variability as an Input to the Earth's Environemnt, ESA-SP-535, 2003 (in press). Low, B.C. and Zhang, M., Ap. J., 564, L53, 2002. MacQueen, R.M. and Fisher, R.R., Solar Phys. 89, 89, 1983. Plunket, S., et al., Solar Phys. 194, 321, 2000. St. Cry., O.C. et al., J. Geophys. Res., 104, 12493, 1999. Wu, S.T. and Guo, W.P. in Coronal Mass Ejection, Geophys. Monogr. Ser. 99, (N. Crooker, et al. eds.), AGU Washington, DC 1997. Wu, S.T. et al., Solar Phys., 175, 719, 1997.

SH21B MCC: Level 1 Tuesday 0830h

Interplanetary Physics II Posters

Presiding: **S P Gary,** Los Alamos National Laboratory**; M Velli,** University of Firenze

SH21B-0106 0830h POSTER

Bow Shock's Geometry at the Magnetospheric Flanks

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During almost three decades of operation, the IMP-8 satellite collected an extensive amount of both plasma and magnetic field measurements. The entire dataset has been searched for all Earth's bow shock crossings observed by IMP-8 and more then 11,000 crossings were found. Due to the IMP-8's orbital trajectory, most of the bow shock crossings were observed at the magnetospheric flanks where the Xgse position was between 0 and -20 Re while the Zgse positions between -20 and 20 Re. About 5000 individual bow shock crossings were used in this study to investigate the bow shock's cross-section: deviations from the circular profile, IMF orientation and Mach number effects on its shape.

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SH21B-0107 0830h POSTER

Bow Shock in Interaction of Solar Wind with Dusty Cometary Coma

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The process of interaction of Solar wind with dusty cometary coma is considered. The description is performed on the basis of a self-consistent model which takes into account solar radiation; dust particle charging; evaporation and formation of neutral particles; photoionization; electric fields; the evolution of Solar wind ions, cometary ions and dust particles; as well as the dust charge variation. It is shown that the presence of dust in cometary coma can modify shock wave formed as a result of Solar wind interaction with a comet. The outer shock wave (bow shock) can be considered as an ion acoustic shock wave modified by dust particle charging process. Possible formation of dust structures in the region of the interaction of Solar wind with cometary coma is discussed. The developed model allows us to determine the shock front structure. For large enough dust densities (exceeding 10^6 cm^{-3} near the comet nucleus) at the region of bow shock front dust particles acquiring positive variable charges influence drastically the structure of the shock front. Its width is in accordance with the theory of dust ion acoustic shocks [1, 2]. The work is supported by the Russian Foundation for Basic Research (grants No. 02-02-17369, 03-02-16664, 03-05-64813). [1] S.I. Popel, M.Y. Yu, and V.N. Tsytovich, Phys. Plasmas 3, 4313 (1996). [2] S.I. Popel, A.A. Gisko, A.P. Golub', and T.V. Losseva et al. Phys. Plasmas 7, 2410 (2000).

SH21B-0108 0830h POSTER

NEW GEOMAGNETIC INDEX (IDV) MEASURING MAGNITUDE OF INTERPLANETARY MAGNETIC FIELD

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We present a new long-term geomagnetic index (the IDV index) which has the property that it is a proxy of the magnitude of the interplanetary magnetic field at the Earth. The index is constructed (for any given station) as the monthly (or yearly) average of the differences (taken without regard to sign) of the hourly mean values of the hour following local midnight between two consecutive days. It is similar to the classical u-measure except that the differences are between one-hour values rather than daily means. The IDV index has a strong correlation (r=0.88) with the magnitude, B, of the IMF, but is uncorrelated (r=0.09) with the solar wind speed, V. Because other indices (e.g. aa and our own IHV) are strongly correlated with BV**2, the IDV index fords a way of separating the influence of B and V and thus determining both.

SH21B-0109 0830h POSTER

Kinetic Alfvén Waves: Linear theory and a Particle-in-cell Simulation

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An Alfvén-cyclotron fluctuation of sufficiently short wavelength has a strong proton cyclotron resonance at propagation parallel to the background magnetic field $\mathbf{B}_o$ in a collisionless electron-proton plasma. As θ, the angle between the fluctuation wavevector $\mathbf{k}$ and $\mathbf{B}_o$ increases, proton cyclotron wave-particle interactions become weaker and the electron Landau resonance becomes effective. Define the critical angle θ_o beyond which the proton cyclotron interaction becomes nonresonant. Here linear Vlasov theory shows that this critical angle is relatively independent of β_p over $0.001 \leq \beta_p \leq 0.10$, but that θ_o is a sensitive function of the damping rate. Also, a particle-in-cell simulation was carried out in a magnetized, homogeneous, collisionless plasma of electrons and one ion species to study the plasma response to the initial imposition of an Alfvén-cyclotron wave at $\theta > \theta_o$. The computation shows strong heating of the electrons in the direction parallel to $\mathbf{B}_o$ and the formation of a beam in the direction of parallel wave phase propagation.

SH21B-0110 0830h POSTER

Dust in Supernovae Shells: Evolution and Destiny

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It has been observed from visual and infrared spectra that fine dust particles could be condensed into the expanding shells of supernovae explosions. In that environment dust is charged by ion impact and injected in the interstellar medium (ISM) at high initial speeds. Traveling across the ISM, dust loses mass by sputtering and the magnitude of its charge, due to secondary electron emission, is modified continuously. We analyze the dynamical behavior of fine dust solving the charge, momentum and energy equations and taking into account high initial speeds as well as very small dust particles (micrometric size). From the results it is concluded that dust travels long distances and remains in the ISM for a long time. Probably its existence could be related to heavy ions formation.

SH21B-0111 0830h POSTER

Variation of Solar Activity during the Spoerer Minimum

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The radiocarbon content of tree rings gives information on the level of solar activity in the past. In order to clarify the variations of solar activity during the Spoerer Minimum (1416-1534 AD), we measured the annual radiocarbon content of Japanese-cedar-tree by using an accelerator mass spectrometer. We used a time-frequency analysis to investigate the frequency modulation and the amplitude variation of the 11-year cycle of the radiocarbon content. As a result, it was revealed that the 11-year cycle was stretched by several years and the amplitude was weakened in the period 1470-1520 AD, although the 11-year cycle was not modulated significantly in the other period of the Spoerer Minimum. As is well known, the length of the 11-year cycle and the intensity of solar activity have an anti correlation. Therefore, it became clear that solar activity was strongly suppressed in this 50-year interval.

SH21B-0112 0830h POSTER

Intermittent coronal heating due to heat flux generated ion cyclotron waves

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Recently, we suggested [Hollweg and Markovskii, JGR, 107, No. 6, 2002; Markovskii and Hollweg, GRL, 29, No. 17, 2002] that the source of ion heating in coronal holes is small-scale reconnection events (microflares) at the coronal base. The microflares launch intermittent heat flux up into the corona exciting ion cyclotron waves through a plasma microinstability. The ions are heated by these waves during the microflare bursts and then evolve with no energy input between the bursts. We show that the structure of the proton distribution in the relatively long time periods between the microflares is determined by collisions at small heliocentric distances. At greater distances, the collisional processes are replaced by similar processes due to secondary instabilities. These are excited by the distortion of the distribution under the action of the mirror force. At the same time, the heating during the microflare bursts is not considerably affected either by the collisions or by the secondary instabilities, because of the short duration of the bursts. The overall coronal heating by this mechanism is a summed effect of all microflare bursts during the expansion time of the solar wind and adiabatic cooling between the microflares. Our calculations for the collision-dominated region suggest that the overall heating is efficient enough to account for the acceleration of the fast solar wind in this region. Further development of the model including the collisionless region will be reported elsewhere.

SH21B-0113 0830h POSTER

Long-Term Decline of South Pole Neutron Rate

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The count rate recorded by a neutron monitor at South Pole, Antarctica displays a long-term decline over the 22-year span from 1965 to 1987. The neutron rate follows an 11-year cycle with maxima at times of low solar activity, but the 1987 peak rate was approximately 9% lower than the 1965 peak rate based on 27-day averages. This change is much larger than that recorded by any other neutron monitor. We suggest that the South Pole monitor, owing to its unique position at both high latitude and high altitude (2820 m), has enhanced sensitivity at ∼1-2 GV relative to a sea level monitor and may be responding to a change in the intensity of primary cosmic rays in this rigidity region. Measurements of cosmic rays made aboard stratospheric balloons and on the IMP 8 spacecraft support the possibility of a long-term change in cosmic ray intensity. This work was supported by NSF grant ATM-0000315.

URL: http://www.bartol.udel.edu/∼neutronm/

SH21B-0114 0830h POSTER

Complexity Induced Anisotropic Bimodal Intermittent Turbulence in Space Plasmas

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The "physics of complexity" in space plasmas is the central theme of this exposition. It is demonstrated that the sporadic and localized interactions of magnetic coherent structures arising from the plasma resonances can be the source for the coexistence of nonpropagating spatiotemporal fluctuations and propagating modes. Non-Gaussian probability distribution functions of the intermittent fluctuations from direct numerical simulations are obtained and discussed. Power spectra and local intermittency measures using the wavelet analyses are presented to display the spottiness of the small-scale turbulent fluctuations and the non-uniformity of coarse-grained dissipation that can lead to magnetic topological reconfigurations. The technique of the dynamic renormalization group is applied to the study of the scaling properties of such type of multiscale fluctuations. Charged particle interactions with both the propagating and nonpropagating portions of the intermittent turbulence are also described. Illustrative examples are provided.

URL: http://space.mit.edu/geocosmo

SH21B-0115 0830h POSTER

Non-WKB Alfven Wave Reflection from the Solar Photosphere to the Distant Heliosphere

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Magnetohydrodynamic (MHD) turbulence has been considered for several decades as a possibly substantial heat source for the solar chromosphere, corona, and

heliosphere. However, it is still not well understood how the turbulent fluctuations are generated and how they evolve in frequency and wavenumber. Although the dominant population of Alfvén waves near the Sun must be propagating outwards, one also needs waves propagating inwards in order to "seed" a turbulent cascade. As a part of an ongoing study of various aspects of solar MHD turbulence, we present a model of linear, non-WKB reflection of Alfvén waves that propagate in both directions along an open magnetic flux tube. Our work differs from previous models in the following ways. (1) The background plasma density, magnetic field, and flow velocity are constrained empirically from below the photosphere to distances past 1 AU. The successive merging of flux tubes on granular and supergranular scales is described using a two-dimensional magnetostatic model of a magnetic network element in the stratified solar atmosphere. (2) The amplitudes of horizontal wave motions are specified only at the photosphere, based on previous analyses of G-band bright point motions. Everywhere else in the model the amplitudes of outward and inward propagating waves are computed self-consistently. We compare the resulting wave properties with observed nonthermal motions in the chromosphere and corona, radio scintillation measurements, and in-situ fluctuation spectra. Quantities such as the MHD turbulent heating rate and the non-WKB wave pressure are computed, and the need for other sources of inward waves (e.g., nonlinear reflection or scattering off density inhomogeneities) will also be discussed. This work is supported by the National Aeronautics and Space Administration under grants NAG5-11913 and NAG5-12865 to the Smithsonian Astrophysical Observatory, by Agenzia Spaziale Italiana, and by the Swiss contribution to the ESA PRODEX program.

SH21B-0116 0830h POSTER

Cosmic Ray Steady-State Anisotropy Derived From "Spaceship Earth" Observations

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By analyzing data from a network of high-latitude neutron monitors,it is possible to derive the cosmic ray angular distribution with greater accuracy and much better time resolution than with the traditional method of analyzing diurnal variations observed by a single monitor. We report a new analysis of the cosmic ray steady-state anisotropy using the 11-station "Spaceship Earth" network (and subsets thereof in years before the full network was operational). From these measurements we extract detailed new information on radial and latitudinal gradients of cosmic ray density and the cosmic ray scattering mean free path near Earth. The anisotropy and its variation with the 11-year sunspot cycle and 22-year solar magnetic cycle provide a vital observational basis for testing theories of cosmic ray scattering and for understanding effects of drift and magnetic helicity in the solar modulation of Galactic cosmic rays. Supported by NSF grant ATM-0000315.

SH21B-0117 0830h POSTER

The Solar Wind Velocity at High Solar Activity: A Search for Latitudinal Effects

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Observations by Ulysses during its second out-of-ecliptic orbit have shown that at high solar activity the solar wind appears as a highly variable flow at all heliolatitudes. In the present study Ulysses data from southern latitudes greater than 50 degrees are compared to the contemporary ACE data on the ecliptic plane to search for the presence of latitudinal effects in the large-scale structure of the solar wind velocity. The comparison is performed through a multi-scale statistical analysis of the velocity fluctuations at scales from 1 to 64 days. The results indicate that, from a statistical point of view, no difference appears to exist between the wind velocity pattern at the highest latitudes of the Ulysses southern polar phase and that observed by ACE on the ecliptic.

SH21B-0118 0830h POSTER

A Statistical Study of Interplanetary Shocks and Pressure Pulses Internal to Magnetic Clouds

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We have canvassed the Wind magnetometer data from launch in November of 1994 through May of 2002 searching for cases of interplanetary shocks and pressure pulses internal to magnetic clouds. An internal shock or pressure pulse is defined as an unbalanced (in a pressure sense), sharp (quicker than 12 minutes), large ($\Delta B/B > 0.23$) change in the magnitude of the magnetic field within the boundaries of a magnetic cloud. We have found nine cases in 68 clouds, so that these shocks and pressure pulses occurred in about 13% of the Wind magnetic clouds. Of those nine cases, six occurred during the 1995-1998 period when the average sunspot number was less than 90 while only three occurred during the 1999-2002 period when the average sunspot number was greater than 90, although roughly equal numbers of magnetic clouds were observed over the two periods (38 versus 30). These "internal" shocks tend to occur in the latter half of the clouds, i.e., timewise, about two-thirds of the way through. In every case, the field change is highly compressive at the shock showing little or no change in angle during or after the magnitude jump. In three of the nine cases, potential external sources for these internal shocks and pressure pulses have been identified, but in at least one of these three cases, which identified a flare, no evidence for associated ejecta or shocks could be found [Collier et al., JGR, 106, 15,985, 2001].

SH21B-0119 0830h POSTER

Comparisons Between Noise Storm Emissions and CME Events

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In this poster, we present preliminary comparisons between noise storm emissions and CME occurrences as observed with the Nançay Radioheliograph and the LASCO coronagraph on board SOHO. We looked for modifications of the noise storm parameters (flux) and possible appearances or disappearances temporarily associated with CME initiation and propagation in the low corona. On-disk EUV images have also been used to locate the area where the CMEs were originating from.

SH21B-0120 0830h POSTER

Nature of the Solar Wind Electron Distribution Functions at 1 AU: Wind Observations.

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The characteristics of the solar wind electron distribution functions (EDFs) at 1 AU are of great importance in many aspects, for instance in understanding heat conduction, plasma microinstabilities and transport, and origin and acceleration of the solar wind plasma. It has been known for a long time that, in the free solar wind, EDFs display both thermal ("core") and suprathermal ("halo" and "strahl") populations; more recently a "super-halo" population has also been identified. The usual simplified model used to characterize the observed solar wind EDF is a sum of two bi-Maxwellians -the core-halo model-, with a core-halo drift velocity oriented along the interplanetary magnetic field. Other recent works have emphasized the Lorentzian nature of EDFs, i.e. the importance of their suprathermal tails, which should play a crucial role in the exospheric expansion of the slow and fast solar wind. Based on either the core-halo or the Lorentzian (or Kappa) models, kinetic instabilities in space plasma have been discussed in the literature and wave growth rates have been calculated. However neither model correctly characterizes the different features of the observed EDFs, in particular their suprathermal tails, which are well underestimated by the core-halo model and on the contrary well overestimated by the Kappa model. It is therefore important to determine and characterize more precisely the nature of the EDF suprathermal tails. The 3DP experiment on the WIND spacecraft provides measurements of the full 3D electron distributions from energies of the order of few eV to above 100 keV, with a high-sensitivity, wide dynamic range, good energy and angular resolutions, and high time resolution (3s). Wind's in-ecliptic orbits cover prolonged periods in the ambient -slow and fast- solar wind near L1, during the last minimum of solar activity. New characteristics of EDFs are established and their consequences in different field of space plasma processes are discussed.

SH21B-0121 0830h POSTER

Wind Observations of Whistler Waves in the Solar Wind at 1 AU and Their Role on the Regulation of the Electron Heat Flux.

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A weak but persistent level of electromagnetic noise with frequencies between the ion ($f_{ci} \sim 0.08$ Hz) and the electron ($f_{ce} \sim 150$ Hz) cyclotron frequencies has been observed in the ambient solar wind for more than 25 years. It is commonly believed that these fluctuations are due to whistler mode emissions, as their frequency range suggests. Yet, the origin and the properties of that "background level" of waves and its role in the electron heat flux regulation in the solar wind at 1 AU is still poorly understood. We present observations from the WAVES experiment on WIND, near L1 during 50 days close to the last minimum of solar activity, using the FFT (Fast Fourier Transform) spectral receivers and the TDS (Time Domain Sampler) waveform analyzer. Magnetic spectra and waveforms observed between f_{ci} and f_{ce} are used to determine the properties of the waves. We analyze also the electron heat flux measured by the 3D-Plasma experiment, in relation to the background level of magnetic fluctuations. First, the nature of the wave mode is discussed: are they effectively whistler waves or, for example, kinetic Alfvén waves? Then, we show that these waves are likely to play a role in the regulation of the heat flux in the solar wind. According to recent theories, whistler waves reduce the intensity of the heat flux through wave-particle scattering associated with a heat flux instability. The possible source(s) of the waves are finally discussed : are they the result of a heat flux instability or the result of an existent nonlinear cascade of Alfvénic-like fluctuations?

SH

SH21B-0122 0830h POSTER

New Insights Gained From the Study of the PDF of Small Scale IMF Fluctuations

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Interplanetary MHD fluctuations are strongly affected by the solar wind radial expansion. In a previous investigation we studied the radial evolution of the probability distribution function (PDF) of magnetic field and velocity fluctuations within the inner

heliosphere and found that the behaviour of these fluctuations tended to resemble a Levy-flight statistics, especially with increasing heliocentric distance from the sun. We concluded that the observed behaviour is mainly due to a competing action between stochastic, propagating fluctuations and convected structures, both contributing to solar wind turbulent fluctuations. These two ingredients, which experience a different radial evolution, are represented by propagating Alfvénic fluctuations and convected flux tubes, respectively. In the present analysis we looked in more detail at the PDF of high resolution magnetic field fluctuations within the inner heliosphere gaining new interesting insights about the nature of these fluctuations and the topology of interplanetary magnetic field at small scale. We finally discuss initial results from a simple model which tries to resemble observations within fast and slow wind with some success.

SH21B-0123 0830h POSTER

Observations of a sharp boundary between field-aligned beams and gyrating ions in the foreshock

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We report an observation by Cluster-CIS of an energetic (2–30 keV) upstream ion event presenting a clear double-peak spectrum. The lower-energy ($E \sim$ 3.5 keV) peak is associated with an ion beam propagating along the magnetic field direction, while the higher-energy peak is associated with gyrating ions. Our analysis indicates that the gyrating ions had guiding centers on field lines downstream of the field-aligned component, but that both populations could be sampled simultaneously due to gyroradius effect. We find that downstream limit of the field-aligned beams is populated with protons having a speed 1.5 times the solar wind velocity, which is inconsistent with any known shock-related emission mechanisms. The spatial boundary separating the field-aligned beams from the gyrating ion guiding centers corresponds well with the ULF and intermediate ion foreshock boundary reported in previous studies. Like the field-aligned beams, the gyrating ions reported here have streaming speeds inconsistent with any known shock emission mechanisms. They probably result from instabilities excited by the propagation of field-aligned beams present just upstream. Our interpretation of these observations provides a refinement of the usual framework for foreshock morphology.

SH21B-0124 0830h POSTER

MH4D: an Algorithm for MHD on a Tetrahedral Grid

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MH4D (Magnetohydrodynamics on a TETRAhedral Domain) is a massively-parallel, device-independent numerical code for the solution of the resistive and viscous MHD equations on an unstructured grid of tetrahedra. The unstructured grid allows the computational domain to be of arbitrary shape and the resolution to be increased in the regions of physical interest. Consequently, a wide range of spatial scales can be studied at the same time, for example active regions can be embedded in the large scale corona. A variational formulation of the differential operators ensures accuracy and the preservation of the analytical properties of the operators ($\nabla \cdot \mathbf{B} = 0$), and self-adjointness of the resistive and viscous operators. The combined semi-implicit treatment of the waves and implicit formulation of the diffusive operators can accommodate the wide range of time scales present in the solar corona. The capability of mesh refinement and coarsening is also included. We have recently implemented the MHD operators and the semi-implicit solve in the momentum equation and will present preliminary results.

SH21B-0125 0830h POSTER

NASA's Integrated Development of Solar Sail Propulsion

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Solar sails have been studied for a variety of missions and have the potential to provide cost effective, propellantless propulsion that enables longer on-station operation, increased scientific payload mass fraction, and access to previously inaccessible orbits (e. g., non-Keplerian, high solar latitudes, etc.). Research being conducted by the In-Space Propulsion (ISP) Technologies Projects is at the forefront of NASA's efforts to mature propulsion technologies that will enable or enhance a variety of space science missions. Solar sail propulsion systems will be required to meet the challenge of monitoring and predicting space weather by the Office of Space Science's (OSS) Living with a Star (LWS) program. Near-to-mid-term mission needs include monitoring of solar activity and observations at high solar latitudes. Work currently funded by the ISP's Solar Sail Propulsion (SSP) project is centered around the quantitative demonstration of scalability of present solar sail subsystem designs and concepts to future mission requirements through ground testing of hardware, computational modeling and analytical simulations. This talk will give an overview SSP's flagship development tasks, how this work will lead to a flight validation and will scale to the size needed for the Solar Polar Imager and L1-Diamond SEC roadmap missions

SH21B-0126 0830h POSTER

CME Signature Survey

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We present results from a statistical study of coronal mass ejection (CME) signatures. This study will address the often complex and imprecise identification of CME events in the heliosphere, particularly in terms of ejecta boundaries. CME signatures include: a descending velocity profile, a low in situ temperature, a rotating and elevated magnetic field, bidirectional suprathermal electrons, and enhanced composition parameters. CMEs rarely contain all of these signatures and the boundaries of observed signatures are rarely well aligned. In this paper various CME signatures will be statistically examined, both independently and in combination with one another. We hope to more accurately define periods of CME ejecta and to better understand the relationships between the various signatures.

SH21B-0127 0830h POSTER

Understanding Electron Heat Flux Dropouts

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Electron heat flux dropouts occur relatively frequently in the solar wind. While they are a necessary signature of flux that is disconnected from the Sun, and knowledge of just how much flux is disconnected is vital for discriminating between models of how the Sun reverses its magnetic field, it is now becoming increasingly clear that most dropouts are caused by some other mechanism. We report on progress in understanding that mechanism. Two factors contribute to electron heat flux in the solar wind: total flux integrated over pitch angle, and pitch angle isotropy. The latter correlates well with plasma beta, but the former does not, implying that heat flux and isotropy are to some degree independent and that pitch angle scattering in high-beta plasma may contribute to isotropy. However, drops in total integrated flux do seem to correlate with the pitch angle isotropy but at scale sizes larger than those of beta variations.. We use Wind data to perform correlations between total flux, isotropy and beta to determine at which scales they are best correlated. If total flux and beta are independent, we would expect their respective correlations with isotropy to occur at different scales. The scale at which each correlation maximises provides valuable information on the processes involved in heat flux dropouts and on the interdependence between total flux, isotropy and plasma beta.

SH21B-0128 0830h POSTER

Penetration of Meridional Circulation into a Stably-Stratified Region

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Several recent solar dynamo models have been proposed which require the axisymmetric component of the solar meridional circulation (MC) to penetrate substantially below the convective envelope, well into the stably-stratified interior. In this poster we investigate this possibility using a thin-shell approximation which has recently been developed to study the stably-stratified portion of the solar tachocline. Analytic and numerical results are presented for the extent of MC penetration as a function of amplitude and background stratification (represented in the nondimensional thin-shell system as the Rossby and Froude numbers). The results indicate that substantial penetration of the meridional circulation below the convective envelope is unlikely. Furthermore, the analysis is closely related to the classical Ekman layer analysis and may have additional geophysical applications.

SH21B-0129 0830h POSTER

Spatial Structure of Solar Electron Bursts: Two-Point Observations using ACE and Genesis

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Recent ACE studies have found that solar electron bursts associated with solar type III radio bursts are commonly observed at energies below 1.4 keV. Solar electron bursts are typically recognized by their characteristic energy-time and pitch angle-time dispersion. Durations of burst events from onset to decay can vary from 1 hour to more than 30 hours, during which time a single L1 halo-orbit spacecraft has swept across 0.5 to 17 degrees of solar longitude. The true spatial extent of a solar burst event cannot be established from single spacecraft time-series measurements, because such

measurements carry an inherent spatial-temporal ambiguity. In order to address spatial-temporal ambiguity, we examine solar burst events from two spatially separated spacecraft. We compare measurements using Genesis GEM and ACE SWEPAM-E, which are nearly identical electron spectrometers. The Genesis and ACE spacecraft both occupy L1 halo orbits and can be separated by up to 1 million km. Most burst events are strikingly similar at both spacecraft, suggesting spatial extent much greater than the usual ACE-Genesis separation distances. However, a number of events show different onset times and distinctly different rise-time/decay-time behavior, consistent with spatially varying structure. We present analysis of several solar bursts in which the Genesis observations clearly differ from the ACE observations, thereby giving evidence of spatial structure for those bursts.

SH21B-0130 0830h POSTER

Statistical Analysis of Solar Electron Bursts at Energies Below 1.4 keV

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The SWEPAM experiment aboard the ACE spacecraft has observed approximately 300 solar electron bursts below 1.4 keV. These low energy solar electron bursts are detected on interplanetary field lines connected to, or surrounding, solar active regions and are usually associated with solar type III radio bursts. Detailed statistical analysis can aid in understanding the physical mechanisms governing the acceleration and transport of these suprathermal electrons. Here we report the statistics of the rise and decay times, as well as the energy and angle dispersion, of these bursts.

SH21B-0131 0830h POSTER

Whistler wave turbulence in astrophysical plasmas

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In certain circumstances, astrophysical and laboratory plasmas are characterized by time and spatial length scales that are relatively fast and small compared to ion gyro-periods and gyro-radii which can not be explained by magnetohydrodynamical (MHD) description of plasmas (accruing on Alfven transit time). A theory best suited for describing rapid electron time scale phenomena is known as electron magnetohydrodynamics (EMHD) in which Whistler waves are the characteristic modes propagating along a self-consistent or mean magnetic field. Whistler waves and electron dynamics are critical to many aspects of astrophysical plasmas, such as the structure of collisionless quasi-perpendicular shocks, to our understanding of magnetic reconnection, dissipation and heating processes in the solar wind, fast plasma opening switches, anomalous diffusion of field in plasma, and others. In this work, we investigate spectral transfer processes in the presence of a self-consistent or mean magnetic field in a two dimensional EMHD model. Our investigation, based upon fluid simulations, reveal that an initially isotropic turbulent spectrum evolves into an anisotropic spectrum in the presence of a mean magnetic field. The anisotropy varies systematically with the strength of the external magnetic field. A particularly simple relationship between the anisotropy of the turbulence and the external mean magnetic field emerges from the simulations. We find that the anisotropic cascades in the EMHD turbulence acquire an almost linear relationship with the magnitude of the external magnetic field. Based on weak turbulence theory, we confirm that the whistler waves mediate anisotropic cascades by suppressing the spectral transfer in their direction of propagation.

SH21B-0132 0830h POSTER

STOCHASTIC WAVE GROWTH in DIVERSE SPACE PLASMAS: THEORY, SIMULATION, DATA

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Burstiness of observed wave emissions in space plasmas has been addressed via stochastic theories of wave growth. These include elementary burst theories (EBT) of solar microwave spike burst, for example, and stochastic growth theory (SGT) of type II and III radio bursts and other planetary and heliospheric sources. These theories are unified here, the EBT and SGT regimes are elucidated, and a new SGT regime is uncovered. It is predicted that all the regimes have lognormal wave-intensity statistics, but that EBT regimes will have smaller numbers of random fluctuations than SGT. This is consistent with published data. Simplified equations for the dynamics of generalized SGT, covering both regimes, are proposed and their results are compared with quasilinear and PIC simulations, and with theory. This is the first direct evidence of SGT from simulations.

SH21B-0133 0830h POSTER

What Defines an Interplanetary Coronal Mass Ejection?

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Because the majority of spacecraft that observe Interplanetary Coronal Mass Ejections (ICMEs) have been in the neighborhood of the Earth while the best observations of Coronal Mass Ejection (CME) are of ejections orthogonal to the Earth-sun line, the observation of a CME is not a prerequisite for defining an ICME. Several observers (e.g. D. Larson, R. Lepping and ourselves) have compiled lists of ICMEs based on somewhat subjective criteria but derived from a common database, Wind and ACE solar wind and IMF measurements. Some of the criteria include a stronger than ambient magnetic field, a rotating magnetic field, low beta, low ion temperature, declining velocity profile and others. We examine these lists to determine what properties are possessed by consensus ICMEs and what produces an ambiguous ICME. Not all ICMEs that have been identified are low beta structures, not all of them are expanding and not all produce shocks. At times even the magnetic profile of ICMEs is quite flat. One of the major objectives of the in-situ investigations on STEREO should be to use quadrature data to understand the variety of apparent manifestations of ICMEs at 1 AU.

SH21B-0134 0830h POSTER

Evolution of Two Ion component Plasma In a Random Magnetic Field: Numerical Study

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Wave spectra at frequencies near and below the proton cyclotron frequency can develop in coronal and solar wind plasmas via turbulence and nonthermal particle processes. These spectra can often be described by a decreasing power law in wave frequency (or wavenumber). Ions can cyclotron resonate with these waves and experience significant heating. Although protons are dominant in the solar wind, other species can have important effects because with their lower cyclotron frequencies they can resonate with waves of greater amplitude. We address the issue of how energy is distributed between different ion populations, particularly how much energy passes to a minor species relative to cases with only protons. We present hybrid numerical simulations with particle ions and fluid electrons of the heating of protons alone and compare this to cases with both protons and alpha particles. Wave spectra are treated as phase random fields. We consider a range of relative alpha number densities, temperatures, and streaming speeds as well as different power law spectra.

SH21B-0135 0830h POSTER

Generation of the Foreshock Field-Aligned Beam Observed by Geotail

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From the intensive measurements achieved during the 1980s, a general consensus has been developed for the generation mechanism of the field-aligned beams (FABs) in the foreshock region of the earth's bow shock. For the shock with a shock angle between 30 and 60 degrees, a fraction (∼2%) of the incoming solar wind ions (∼1keV) are considered to be semi-trapped at or near the shock front and gets accelerated to about 10keV through multiple reflection process. However, there has been no observational evidence of the multiple reflections, although many theoretical attempts by test-particle and hybrid simulation have supported the idea of the multiple reflection. In this paper, we present shock crossing events obtained by Geotail on October 19, 1995. This day is known for an encounter of a large magnetic cloud with the earth, preceded by an interplanetary shock passage on October 18. The shape of the bow shock was such that Geotail could skim along the surface of the shock and experienced about 30 shock crossings during the cloud passage. By focusing on a particular shock event ($M_A \sim 3.2$, $\theta_{Bn} \sim 57^\circ$), we will report an observational evidence of the multiple reflection with a help of test-particle simulation. Moreover, a shock angle dependence of the FAB flux will be shown from the statistical analysis utilizing the particle data obtained during the events. Some implications from hybrid simulations will also be presented in order to interpret the observed features.

SH21B-0136 0830h POSTER

Exploring the particle-wave coupling during intervals of the distant upstream ion foreshock: up to the first Earth's Lagrange (L1).

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Several events have been identified of an ion foreshock extending up to 250 RE upstream of the Earth. These events occur mostly during periods of slowly drifting radial interplanetary magnetic field (IMF) when the 1-min average values of the strengths of the IMF and the solar wind (SW) speeds are mostly steady (Berdichevsky et al., 1999*). Here we study the frequency content, the polarization and the particle-wave coupling using a cross-spectrum analysis. We do a qualitative analysis of the origin of this wave-activity using the linear theory of plasma instabilities and explore the possibility of trapping of these strongly scattered particle fluxes. In this study we present results for observations on June 11, July 13, and Aug 25, 1995. For the study we use sampling times of waves and electron data of 12 sec or higher resolution energetic particle data. Solar wind plasma and magnetic field are collected by the MFI, SWE, WAVES, and 3DP instruments on Wind, and MGF and EPIC in GEOTAIL spacecraft. The spectral technique used is based on a set of Instrisic Modes resulting from an Emperical Decomposition Method inspired by the EMD method developed

by Huang (Huang et al., 1998**) *Berdichevsky, D., G. Thejappa, R. Fitzenreiter, R. Lepping, T. Yamamoto, S. Kokubun, R. McEntire, D. Williams, and R.P. Lin, Widely spaced wave-particle observations during GEOTAIL and WIND magnetic conjunctions in the Earth's ion foreshock, J. Geophys. Res., 104, 463-482, 1999 **Huang, NE, Sheng, S, Long, SR, A new view of nonlinear water waves: The Hilbert Spectrum, Annu. Rev. Fluid Mech., 1999, 31, 417-57

SH21B-0137 0830h POSTER

Spatial Intensity Gradients of Impulsive Particle Events and Supradiffusive Magnetic Fields

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The low-energy ion intensity profiles of impulsive solar energetic particle (SEP) events display both sharp (< 2.5 min) local gradients and larger scale ($\approx 1-6$ hour) dropouts, indicative of fast cross-field transport on the larger scales in spite of restricted short-scale transport. Rapid variations and modulations within the few-hour long channels of enhanced intensity are also observed. We show that the sharp gradients observed in the intensity profiles of impulsive particle events exist only because of the very strong supradiffusion of the field lines on the short and medium scales, due to the steep spectrum of magnetic turbulence measured on these scales. We also argue that these intermediate scales of magnetic turbulence may produce the substructures observed by Mazur et al. (2000) within the larger channels.

SH21B-0138 0830h POSTER

Three-Dimensional MHD Modeling of the Solar Corona and Solar Wind

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We present simulation results from a fully three-dimensional MHD solar wind model with a tilted-dipole magnetic field on the Sun, resembling conditions near solar activity minimum. The polytropic single-fluid MHD equations, which incorporate Alfvén wave momentum and energy addition in the WKB approximation, are solved in the corotating frame by a combination of time-relaxation and marching-along-radius methods. Boundary conditions are prescribed at the coronal base and the computational region extends out to 1 AU. We show that simulation results are in agreement with the latitudinal profiles observed by Ulysses during its first fast south-to-north transition in 1994-1995.

SH21B-0139 0830h POSTER

A Simulation Study of the May 10-11, 1999 Low Density Anomaly

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On May 10-11, 1999 solar wind density dropped to anomalously low values of $\sim$0.1 cm^{-3}. The density depletion occurred on a relatively slow wind background in between of faster flows and was apparently not associated with a coronal mass ejection or a fast corotating stream. While magnetic field intensity did not show a notable variation across the depletion, the SWEPAM analyzer on the ACE spacecraft revealed an abnormally strong non-radial flow component, with the azimuthal speed peaking at $\sim$100 km s^{-1}. *Usmanov et al.* [2000] suggested that the density anomaly was in fact a rarefaction on the trailing edge of a relatively faster flow and that the rarefaction formed as a result of suppression of coronal outflow from a region that earlier provided the faster solar wind. The suppression in turn was supposed to appear due to a quick restructuring of solar magnetic fields during polar field reversal. In present work, we show results of a two-dimensional time-dependent MHD simulation in the equatorial plane with initially longitude-homogeneous Parker solar wind and spiraling magnetic being disturbed by a slower velocity/higher density pulse on an inner computational boundary at 20 solar radii. We follow the development and propagation of the rarefaction out to Earth orbit and compare pseudo-time series with ACE measurements. We show that a strong rarefaction indeed can develop behind faster flow and that simulation results and ACE observations are in good agreement. The simulated radial magnetic field shows a relatively small variation across the density anomaly compared to that in density. The stream interaction generates strong azimuthal velocities in the slow flow region, as observed. The simulation shows also a sub-Alfvénic flow region embedded into the low density region. The sub-Alfvenic region does not extend all the way to the Sun, but gets disconnected as the depletion propagates to Earth orbit.

SH21B-0140 0830h POSTER

Generation of Suprathermal Electrons by Resonant Interaction with Whistler Waves in the Solar Corona and Wind

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Observations of solar wind electron velocity distribution functions (VDFs) show pronounced deviations from a Maxwellian. The number of suprathermal electrons is strongly enhanced even under quiet solar conditions. An assessment of the relaxation of a non-Maxwellian coronal electron VDF shows that a coronal origin of these suprathermal electrons is possible. A model for the acceleration of suprathermal electrons based on resonant interaction with whistler waves is presented. This interaction is characterized by pitch-angle diffusion of the electrons in the reference frame of the waves. In the plasma rest frame, this leads to a significant acceleration of electrons from small sunwards velocities parallel to the background magnetic field to high speeds perpendicular to it. A kinetic model is developed to study this mechanism in detail and to investigate the overall evolution of an electron VDF from the transition region into the interplanetary space. Simulation results for the open magnetic structure of a coronal funnel are presented. In the energy range of several keV, they show a focussing of the suprathermal electrons in interplanetary space towards a narrow "strahl" and a strong enhancement of suprathermal electron fluxes due to whistler waves. Simulation results for higher energies of several 10 keV are also presented, and effects of other wave modes than whistler waves on the electron VDF are discussed.

SH21B-0141 0830h POSTER

Sky Brightness and Transparency at the National Solar Observatory at Sacramento Peak

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Records of sky brightness and transparency have been kept at the National Solar Observatory at Sacramento Peak in Sunspot, NM, for the past 20 years. Annual variations and long-term trends will be analyzed and presented.

URL: http://www.nso.edu/nsosp/

SH21B-0142 0830h POSTER

Evolution of Large-scale Solar Magnetic Fields in a Flux-Transport Model Including a Multi-cell Meridional Flow

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Advances in helioseismology over the past decade have enabled us to detect subsurface meridional flows in the Sun. Some recent helioseismological analysis (Giles 1999, Haber et al. 2002) has indicated a submerged, reverse flow cell occurring at high latitudes of the Sun's northern hemisphere between 1998 and 2001. Meridional circulation plays an important role in the operation of a class of large-scale solar dynamo, the so-called "flux-transport" dynamo. In such dynamo models, the poleward drift of the large-scale solar magnetic fields and the polar reversal process are explained by the advective-diffusive transport of magnetic flux by a meridional circulation with a poleward surface flow component. Any temporal and spatial variations in the meridional flow pattern are expected to greatly influence the evolution of large-scale magnetic fields in a flux-transport dynamo. The aim of this paper is to explore the implications of a steady, multi-cell flow on the advection of weak, large-scale, magnetic flux. We present a simple, two-cell flux transport model operating in an r-theta cross-section of the northern hemisphere. Azimuthal symmetry is assumed. Performing numerical flux-transport simulations with a reverse flow cell at various latitudes, we demonstrate the effect of this cell on the evolutionary pattern of the large-scale diffuse fields. We also show how a flux concentration may occur at the latitude where the radial flows of the two cells are sinking downward. This work is supported by NASA grants W-19752, W-10107, and W-10175. The National Center for Atmospheric Research is sponsored by the National Science Foundation.

SH21B-0143 0830h POSTER

Mirror Mode Structures in the Solar Wind

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High thermal particle pressure-to-magnetic pressure ratio plasmas, called high-beta plasmas, are ubiquitous in space science. Often the energization processes such as cross-field compression leads to temperature anisotropies $T_\perp/T_\| > 1$ that drive the mirror instability. For the nonuniform magnetic field, as in the solar wind, the critical value of the temperature anisotropy $(T_\perp/T_\|)_{\rm crit}$ is calculated as a function of the background mirror ratio. The solar wind and the central sheet in the Earth's magnetosphere are two high beta plasmas where pressure anisotropies occur such that the mirror mode, or the firehose mode, can be a key large scale plasma instability. The mirror mode instability generates strong changes to the magnetic field strength in contrast to the firehose mode which is a perpendicular magnetic perturbation to the ambient magnetic field. Both signatures are observed in the solar wind and the central plasma sheet. Here we present new theoretical results the threshold of the mirror mode in a local minimum of the magnetic field based on gyrokinetic equations. From these results, we are motivated to re-examine the issue of what is the critical condition from the kinetic physics framework for the mirror mode instability. The collisionless plasma breaks the MHD assumption of zero divergence of the parallel heat flux that is essential to obtain the classical double adiabatic MHD theory stability criterion. When the divergence of the thermal flux is included in a kinetic stability analysis for a uniform background magnetic field anisotropy $p_\perp/p_\|$ the threshold for instability drops dramatically from a factor of 6 to 1 for a high beta solar wind plasma. We show that a deep mirror field significantly reduces the divergence of the parallel thermal flux compared with that in the uniform B field, and thus restores the critical anisotropy to a value between 1 and 6. By a variational principle we report the critical anisotropy threshold is approximately 1.86 for deep wells. Nonlinear saturation of a mirror mode starting in a uniform magnetic field will create a strong mirror

field. Since the threshold shifts significantly toward the CGL-MHD result as the mirror ratio increases, we can estimate the saturation amplitude by using the kinetic threshold. This work was supported by the National Science Foundation Grant ATM-0229863 and the National Institute for Fusion Science.

SH21B-0144 0830h POSTER

Interplanetary Disturbances With High Values of the Solar Wind Quasi-Invariant

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The solar wind quasi-invariant (QI) has been introduced as the energy density ratio $QI = (B^2/8\pi)/(\rho v^2/2)$ [Osherovich, Fainberg and Stone, GRL, 26, 16, 2597, 1999]. B is the interplanetary magnetic field strength, v is the bulk velocity and ρ is the plasma density. The significance of this result has been supported by the studies of QI from 0.7 AU to 28 AU, using data from Pioneer-Venus Orbiter and the Voyagers [Fainberg, Osherovich and Stone, GRL, 28, 8, 1447, 2001; Fainberg and Osherovich, Proc. 10th European Sol. Phys. Mtg, ESA SP-506, vol. 1, 43, 2002]. Magnetic clouds have anomalously large values of QI of 10-100 times higher than QI_{median} because of their larger than average B and lower ρ due to the expansion. We report the contribution of high QI events (not only magnetic clouds) to the yearly QI based on hourly values of QI. The geomagnetic effectiveness of individual high QI events and their impact on geomagnetic indices will be discussed.

SH21B-0145 0830h POSTER

Relativistic proton acceleration by magnetosonic shock waves

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Shock surfing acceleration of protons to relativistic energies by the magnetosonic shocks is analyzed. For relativistic energies, contrary to the non-relativistic case, the kinetic energy with which the accelerated particle bounces in the direction of shock normal decreases during the acceleration. Therefore the particle, being initially trapped in front of the shock, can not overcome potential barrier at the shock front and can remain in the acceleration region indefinitely . Another possibility for particle to escape downstream from the acceleration region is due to the erosion of the electric repulsive force of the shock by the normal component of the Lorentz force. This is why for effective acceleration, the electric field at the shock front must be sufficiently large which is possible when the ambient magnetic field is strong enough (electron cyclotron frequency exceeds plasma frequency). Following this idea, an application for the relativistic proton acceleration in the solar corona is discussed in the paper.

SH21B-0146 0830h POSTER

Solar Wind Discontinuity Observations Using Simultaneously FGM Magnetic Field Data and CIS Plasma Data From the Four Cluster Spacecraft

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Discontinuities are known to be fundamental features of the solar wind. Using both, magnetic field data from all four Cluster spacecraft and plasma data from the cis hia instrument on board spacecraft 1 and 3 a detailed analysis of interplanetary discontinuities is accomplished. Having four close-by Minimum Variance Analysis (MVA) normal estimates and one additional estimate from relative timings (triangulation) the determination of the discontinuity orientation is superior to past single spacecraft attempts. Serious consequences of misleading interpretations of single spacecraft MVA results are assessed in our analysis. The relative number of discontinuities being clearly identified as rotational is far less than past estimates suggest. For the majority of discontinuities a definite classification into RDs and TDs using magnetic field data only is not possible. Therefore the use of plasma data is inevitable. Necessary conditions for a discontinuity to be rotational, as e.g. the polarization relation, are not fulfilled by many of these discontinuities. Our analysis allows the interpretation that the solar wind is dominated by tangential and not by rotational discontinuities.

SH21B-0147 0830h POSTER

Interplanetary Field Enhancements: Further evidence of an interaction between the solar wind and interplanetary dust

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Interplanetary field enhancements (IFEs) are highly unusual, sharply-peaked increases in the magnitude of the heliospheric magnetic field. They have been found in the solar wind over a wide range of heliocentric distances. Spatial clustering of IFEs detected near Venus led to a link being found between some IFEs and dust particles co-orbiting with asteroid 2201 Oljato. This link suggested that the solar wind's characteristics are affected by its passage through localized concentrations of dust. Here, evidence is presented of an association between other IFEs and comet 122P/de Vico. Other evidence in support of a dust-induced source for IFEs is also described, including the draping of discontinuities seen at many of the events, and the spatial coincidence of some IFEs and locations where high-density meteor streams are thought to exist. Possible processes responsible for IFE formation are discussed, as well as implications for the remote study of cometary dust trails.

SH21B-0148 0830h POSTER

Effect of Sun's Magnetic Field Polarity on Interplanetary Magnetic Field Bz

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The results of a statistical study of IMF Bz are presented for two minima of solar activity for the periods of 1985-1987 and 1995-1997, related to negative and positive polarity of the Sun's magnetic field, respectively. We found that IMF Bz is dependent on the magnitude of IMF horizontal (Bx) component, IMF orientation, and Sun's magnetic field polarity. 1) The correlation between IMF Bz and Bx is positive for positive polarity and negative for negative polarity. 2) Positive and negative IMF Bz tends to occur predominantly during IMF orientations significantly different from the Parker spiral: for positive polarity, positive IMF Bz tends to occur around f less than 40 degree and negative IMF Bz around f =-60 degree where f is the minimal angle measured counterclockwise from Parker spiral direction to IMF vector in the horizontal plane. For negative polarity, IMF Bz has the opposite behavior. 3) The effect of Sun's magnetic field polarity is especially evident for IMF Bx more than 4 nT. In this case, IMF Bz are predominantly negative for negative polarity and positive for positive polarity, and the difference between average IMF Bz for positive and negative Sun's magnetic field polarities is about 2 nT. Correlation coefficient characterizing the dependence of IMF Bz on Sun's magnetic field polarity is about 0.5 and increases with increasing IMF Bx. The observed features of IMF Bz may be caused by decreasing solar wind speed near the HCS. As a result, portions of disturbed magnetic field lines slow down while approaching the HCS. This leads to the rotation of IMF vector in the vertical and horizontal planes. The observed dependences of IMF Bz on IMF Bx, IMF orientation, and Sun's magnetic field polarity are qualitatively consistent with this hypothesis.

SH21B-0149 0830h POSTER

Test Particle Acceleration by Turbulent MHD Fields on Alfvenic Timescales

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We study the short time acceleration of charged particles in turbulent fields obtained from direct numerical solutions of the compressible 3D MHD equations. Different test particle simulations are performed, varying the ratio between the typical turbulent timescale and the nominal gyroperiod of the particles. Starting from monoenergetic particles moving at the characteristic plasma Alfven speed, we find consistent acceleration to high energies in times of the order of the turbulent timescale. Extended power laws in the distribution of particle energies are obtained, with different slopes at intermediate and high energies. Linear scaling laws of the maximum and mean energy of the particles with the turbulent time / nominal gyroperiod ratio are observed and mechanisms based on reconnecting fields are proposed to explain them.

SH21B-0150 0830h POSTER

A Hybrid Heliospheric Modeling System: I. Background Solar Wind

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We present results of project to improve geomagnetic forecasts using physics based models driven by solar observations. The Hybrid Heliospheric Modeling System (HHMS) is a Sun to Earth system composed of four models. The system is based on two existing (well used) physics-based models, connected by a new empirical model and followed by a second new empirical model. The physics-based models are a Source Surface (potential field) Current Sheet Model for the corona, and a time dependent 3D MHD solar wind model. The system is driven by a time series of photospheric magnetic maps composed from daily magnetograms. An empirical relationship between magnetic flux tube expansion factor and solar wind speed at 0.1 AU is the key element of the system. The solar wind model gives a predicted time series of MHD parameters at the Sun-Earth L1 Lagrange point and is verified against Omni, Wind or ACE satellite data, depending on the time period. The predicted time series at L1 is input to the second empirical (data based) model to predict the geomagnetic Ap index. Verification results for predicted solar wind and Ap for the years 1993 through 2002 are shown and compared with forecast skill of the official Ap forecasts that were issued by the NOAA Space Environment Center. Results show the HHMS should be able to provide some useful numerical guidance to the human forecasters in the declining phase of solar cycle 23, now underway.

SH21B-0151 0830h POSTER

150 Day Periodicities in the Voyager 2 Plasma Data

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Launched over 26 years ago, Voyager 2 is now at a radial distance greater than 71 AU and a latitude of -28.7 degrees out of the ecliptic plane. Voyager 2 and the MIT Plasma Spectrometer continue to return measurements daily. Periodicities with T $\approx$ 150 days have been observed in the solar wind by several authors. Fourier and Lomb-Scargle periodograms of the uniquely long Voyager 2 plasma density and bulk-speed data sets (1978-2003) similarly show a strong component at periods of approximately 150 days. Dividing the data into two (1978.0-1990.5 and 1990.5-2003.0) and taking periodograms of the subsets shows a strong 150 day component in the earlier data but not the latter. Periodograms of further sub-divisions of the data demonstrate a definite time-variation in the spectral power at periods around 150 days. To give a more quantitative view of time-variation of the periodicities, wavelet-analysis was employed. Initial results showed little or no power in the wavelet power spectra around 150 days. By using unusually (temporally) large wavelets, we demonstrate the existence of episodes of persistent but low-power periodicities in the Voyager plasma data, not detected by the smaller scale wavelets. Using large-scale wavelets reveals two episodes of power at $\approx$ 150 day periods (both several years long) in the density data and one episode in the bulk-speed data. We compare the bulk-speed and density results and discuss the relationship of the episodes to spacecraft position (radial distance and latitude) as well as to the solar cycle. Results are also compared to measurements of 150 day periodicities by other authors. Voyager observations are sponsored, in part, by NASA/JPL.

SH21B-0152 0830h POSTER

Orientations of Correlated Wind and ACE Features

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In August 2000 Wind entered a unique orbit with excursions in Y_{GSE} of $\pm 300 R_E$. ACE, in a standard L1 halo orbit, frequently observes solar wind features that correlate well with those seen by Wind. By comparing maximum-correlation lag times of features seen by ACE and Wind in 2000-2001, we show the front normals of these features are bounded by the radial direction and the normal to the Parker spiral. Interplanetary shocks are frequent and prominent features in the solar wind during this period, consequently we separate shock normals from front normals of other well-correlated features. We find that, on average, shocks travel in the radial direction in agreement with shock normal analysis using Rankine-Hugoniot relations. In contrast, normals of the other well-correlated features are distributed between the radial direction and the ortho-Parker direction. Wind observations are supported, in part, by NASA/Goddard Space Flight Center

SH21B-0153 0830h POSTER

A study of interplanetary propagation of solar impulsive 1-100keV electron events

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We study solar impulsive 1-100keV electron events that exhibit clear velocity dispersion, as observed by the 3D Plasma and Energetic Particle (3DP) instrument on the WIND spacecraft. At the onset of those impulsive electron events, the outward travelling electrons are observed first, then the backward travelling electrons are detected, mostly in high energy range (>20keV) and sometimes in low energy range (<20keV). The backward population must be produced by scattering and/or magnetic mirroring in the interplanetary medium beyond 1 AU. For one impulsive event observed on December 5,1997, we determine the delay between the onset of the outward travelling electrons and the onset of the backward travelling electrons in different pitch angle ranges. We find that the delays for 27, 40 and 66 keV electrons, respectively, are 10, 5.8 and 7.3 minutes at 10° pitch angle; 1.7,1.8 and 3 minutes at 30° pitch angle; 10.5, 6 and 7.2 minutes at 55° pitch angle; 6.2, 3.2 and 4.2 minutes at 80° pitch angle.Those time differences are not inversly proportional to parallel velocity along the magnetic field B, so the simple magnetic mirror is unlikely to be an explanation. We investigate pitch angle scattering by magnetic field fluctuations as a possible mechanism.

URL: http://sprg.ssl.berkeley.edu:80/~windsound/

SH21B-0154 0830h POSTER

Solar Cycle Changes of Coronal Streamer Properties

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We have measured UV spectroscopic parameters, as a function of height for more than 30 coronal streamers in order to identify similarities between streamers at different phases of the solar cycle. For the period from 1996-2002, we provide line intensities, line widths, and line ratios for the O VI 1032/1037 doublet and intensities and line widths for the H I Ly-alpha line for these streamers. From such measurements we can derive plasma parameters (densities, temperatures, and outflow velocities) for O^5+ and protons as a function of heliocentric height ($1.5 > r/R_o > 5$) in the streamers. This information is useful for setting empirical constraints on coronal heating and solar wind acceleration in streamers. This work is supported by NASA Grant NAG5-12781 to the Smithsonian Astrophysical Observatory and NASA subcontract OGSP21010200061SAO awarded to SAO through a grant to Southern Universty at Baton Rouge.

SH21B-0155 0830h POSTER

Induced electric field and cross helicity in solar wind fluctuations

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Solar wind turbulence at 1 AU exhibits, on the one hand, a frequent high degree of Alfvenicity (or, cross helicity) and on the other hand, indications of a strong magnetohydrodynamic (MHD) cascade. The former is associated with a high degree of correlation of velocity and magnetic field – in the limiting case they would be aligned – while the latter requires nonzero values of $\mathbf{v} \times \mathbf{b}$ so that the cascade is suppressed when the fluctuation fields are aligned. Here we examine the statistics of the induced MHD-scale electric field at 1AU, to demonstrate how the degree of Alfvenicity is consistent with the observed induced electric field. The statistics support the view (Roberts et al, JGR, 92, 12023, 1987) that there remains at 1 AU some preference for an Alfvenicity associated with outward traveling fluctuations. However there is a dominance of non-Alfvenic turbulence that is sufficient to account for the observed distribution of induced electric field. A generic result is obtained that explains the sin(v,b) distribution, which is observed to peak at values corresponding to 90 degrees, even when some Alfvenic fluctuations ("0 degrees" or "180 degrees") are present. This helps to understand how Alfvenic fluctuations and turbulence can coexist in the solar wind.

SH21B-0156 0830h POSTER

Cassini UVIS Time-Series Observations of Interplanetary H Lyman-alpha Emissions

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The Cassini Ultraviolet Imaging Spectrograph (UVIS) has been routinely obtaining high signal-to-noise ratio measurements of interplanetary H Lyman-alpha, H Lyman-beta, and He 58.4 nm emissions during the cruise phase of its mission to Saturn. We report here on the time-series Lyman-alpha data obtained to date. These data can be compared to a model of the interstellar H flowing through the heliosphere and illuminated by the Sun. Of particular interest in these data is the presence of modulations due to the rotation of solar active regions that strongly emit Lyman-alpha radiation. We compare the observed modulations to those predicted from our model. If the observed modulations are damped compared to the model predictions, this may be evidence for multiple scattering of solar photons in the heliosphere. The amount of multiple scattering is an indicator of the heliospheric H density, a quantity that remains poorly constrained. Additional background measurements are planned for the orbital phase of the Cassini mission (2004-2008).

SH21B-0157 0830h POSTER

Alfvén Wave Reflection and Turbulence in the Solar Corona and Solar Wind

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We solve the equations for Alfvén wave propagation along the magnetic field from the base of the solar corona into the solar wind using a phenomenological term for nonlinear interactions and dissipation, along the lines of Dmitruk et al. 2002. Wave reflection due to the gradients in the Alfvén and solar wind speed is explicitly taken into account as a source for the nonlinear interactions, and regularity boundary conditions at the Alfvénic critical point are imposed. Within the corona, most of the wave reflection and nonlinear interactions occur close to the solar base, though the dependence on outward wave amplitude is non-trivial. Models in which interacting waves have comparable frequencies are considered as well as models in which the interaction depends on the full spectrum of inward and outward propagating modes. The relevance of Alfvén wave reflection as a source for turbulent heating of coronal holes and the fast solar wind is discussed, and our results are compared to previous work on the same topic. Dmitruk,P.; Matthaeus,W.H.; Milano,L.J.; Oughton,S.; Zank,G.P.; Mullan,D.J., 2002, "Coronal Heating Distribution Due to Low-Frequency, Wave-driven Turbulence", ApJ 575, 571.

SH21B-0158 0830h POSTER

Simulations of Wave Particle Interactions in the Expanding Solar Wind in 1 and 2 Dimensions.

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We present hybrid simulations of the interaction of Alfvén and ion cyclotron waves with protons and helium in the accelerating solar wind using the expanding box model. We study how mirror force and wave-particle interactions compete in shaping the distribution function both for protons and minor ions for a range of initial fluctuation spectra and propagation directions in 1 and 2 dimensions. The simulations are discussed within the context of analytical and numerical models of the evolution of MHD turbulence in the outer corona and accelerating solar wind, with the aim of constraining the possible initial conditions leading to the observed in situ evolution.

SH21B-0159 0830h POSTER

Radial Evolution of the Non-thermal Character of Electron Distribution Functions in the Solar Wind

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Observed electron distribution functions of the solar wind permanently exhibit three different components : a thermal core and a supra-thermal halo, which are always present at all pitch angles, and a sharply magnetic field aligned "strahl" which is usually antisunward-moving. If the Coulomb collisions could explain the relative isotropy of the core population, the origin of the halo population and more specifically the origin of its sunward-directed part remains unknown. Processes invoking scattering of strahl electrons by shocks, corotating interaction regions or other wave/particle interactions have been invoked. We look for possible observationnal constraints on these processes by examining the radial evolution of the various populations of the electron distribution functions in the solar wind. For this purpose we combine HELIOS (0.3 to 0.7 AU), WIND (1 AU) and ULYSSES (1.3 to 3 AU) observations performed during fast solar wind periods at minimum of activity.

SH21B-0160 0830h POSTER

Structure of slow shocks and intermediate shocks in a magnetized plasma with heat conduction

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The structure of slow shocks in the presence of a heat conduction parallel to the local magnetic field is simulated from the set of MHD equations. In our study, a pair of slow shocks is formed through the evolution of a current sheet initiated by the presence of a normal magnetic field. At first we consider the case that the tangential magnetic fields on the two side of initial current sheet are exactly antiparallel ($B_y = 0$) to understand the effect of heat conduction, and the case that the tangential magnetic fields are not excctly antiparallel ($B_y \neq 0$). When $B_y = 0$ it is found that the slow shock consists of two parts: the isothermal main shock and foreshock. Across the main shock, jumps in plasma density, velocity and magnetic field are significant, but the temperature is continuous. The plasma density downstream of the main shock decreases with time, while the downstream temperature increases with time, keeping the downstream pressure constant. The foreshock is featured by a smooth temperature variation and is formed due to the heat flow from downstream to upstream region. Finally the foreshock is found to reach a steady state with a constant width in the slow shock frame. When $B_y \neq 0$ the process develops additional discontinuity, the time-dependent intermediate shock (TDIS), which is different from the rotational discontinuity. The plasma density and pressure increase and the magnetic field decrease across this TDIS. As in the $B_y = 0$ case, the plasma density downstream of the main shock decreases with time, while the downstream temperature increases with time, keeping the downstream pressure constant. In some cases, the TDIS is embedded in the slow shock's foreshock structure initially, and then moves out of the foreshcok region. Define Ψ as the initial anngle between the tangential magnetic fields on the two sides of current sheet. The propagation speed of foreshock leading edge decreases with smaller Ψ, and the steady state of foreshock width is reached earlier. Both pressure and temeprature downstream of the main shock increase with Ψ. The rotation angle of tangential magnetic field across TDIS develops with time, gradually reaching the final state. The results can be applied to the heating in the solar corona and solar wind.

SH21B-0161 0830h POSTER

SOHO Observations of the Perihelion Passage Comet C/2002 V1 NEAT

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During mid-February the Comet C/2002 V1 (NEAT) passed through the field-of-view of the LASCO C3 coronagraph on SOHO. The comet passed within 0.1 AU (about 20 solar radii) and displayed complex dust and ion tails. The comet exhibited the brightest and largest SOHO dust tail to date, with a peak gas production rate similar to the huge rates calculated for C/1995 O1 Hale-Bopp and 96P/Machholz 1 at perihelion. Additionally, a coronal mass ejection may have crossed the comet's tail at about the time the comet was predicted to cross the heliospheric current sheet, and this may have been responsible for splitting the ion tail. We discuss these observations and consider likely physical mechanisms such as: solar wind charging of the dust by the CME ion burden, dust disruption or dust emission enhancement. We also compare solar wind speeds derived from the ion tail measurements with theoretical values.

SH21B-0162 0830h POSTER

The Non-flare Emisson Measure Above 5 MK Observed By RHESSI and SXI

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Since RHESSI was launched in February 2002, it has observed thousands of solar flares. It also observes solar emission above 3 keV when there are no observeable flares present. In this work we present measurements of the non-flare Temperature and Emission Measure for the period from October 2002 through July 2003. The temperature is relatively stable in the 6 - 8 MK range (this is not surprising considering that RHESSI cannot reliably measure temperatures less than about 5 MK). The Emission Measure varies in the range from approximately 1.0e49 to 1.0e50, with higher values associated with periods of more solar activity. Since RHESSI is an imaging spectrometer, we locate the source of the emission when possible. Preliminary results show that the source can be associated with active regions. We also present comparisons with SXI data, and measure the Differential Emission Measure for the range from 1 MK to 10 MK.

SH21B-0163 0830h POSTER

Sensitivity of Time-Distance Measurements to Local Changes in Sound Speed and Source Properties

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In order to interpret time-distance measurements of travel times it is important to understand the sensitivity of these measurements to different types of perturbations to a solar model. We will show example sensitivity functions for local perturbations to the sound-speed, source strength, and source correlation time. These examples show that the effect of a sound-speed perturbation on the time-distance travel-times depends on the details of the filtering. In particular, for narrow phase-speed filters, the sensitivity functions do not resemble the now traditional banana-doughnut kernels.

SH21B-0164 0830h POSTER

The Relation Between the Solar Wind Velocity and the Magnetic Conditions of Coronal Holes

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It is thought that interplanetary space is filled by solar wind, which originates from coronal holes of various sizes and that the structure of each coronal hole is approximately uniform. Using this idea, we have performed a correlation study between solar wind velocity originating from coronal holes and photospheric/coronal magnetic fields from coronal holes. Interplanetary scintillation (IPS) observations allow us to estimate the global velocity structure in the solar wind for each Carrington rotation. We applied a tomographic analysis using IPS data to obtain 2-dimentional velocity distributions at 2.5 solar radii and then determined the average solar wind velocity, u, originating from each coronal hole. Coronal holes are identified using FeI and HeI observation from the NSO/Kitt Peak and the average magnetic field strength, B, of each coronal hole is calculated. Coronal magnetic fields above the coronal hole are computed using a potential-field source-surface model and the flux tube expansion rate, f, is calculated for each coronal hole. We have calculated the correlation coefficient between u and a combination of B and f (i.e. B^m/f^n) for 41 coronal holes.

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As a result, we have found that the value B/f shows a higher correlation with u than the value B (deduced by Fisk et. al. model, 1999) and the value f (deduced by Wang and Sheeley model, 1991). We propose that the parameter, B/f, is an important indicator of the solar wind velocity originating from various kinds of coronal holes.

URL: http://stesun5.stelab.nagoya-u.ac.jp/index-e.html

SH21B-0165 0830h POSTER

Interplanetary Electric Field and Solar Open Magnetic Flux: no Increase Since 1926.

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A correlation analysis between the interplanetary electric field and the magnetograms recorded at Godhavn (Qeqertarsuaq), a polar cap geomagnetic observatory, is performed. A direction, along which the latitudinal dependence of the geomagnetic perturbation is minimum, is found, and allows us to apply the correlation results to pre-satelite data, back to 1926. The findings indicate no secular trend in the cross-polar cap electric field, in the interplanetary electric field, and by inference in the sun's open magnetic flux, since 1926. The result is independent of the aa geomagnetic index.

SH21B-0166 0830h POSTER

Comparison of ICME Leading Edge Orientations Determined by Single Spacecraft Techniques

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In this investigation we examine the leading edge orientation and morphology of ICMEs observed by interplanetary spacecraft. In particular we compare and contrast three independent techniques for determining this leading edge orientation. First, if a magnetic cloud is associated with an ICME then it is possible to fit a constant alpha, force-free magnetic flux rope model to the data. This allows the determination of axis orientations and chiralities. If planar magnetic structures are present in the sheath region, general ahead of faster ICMEs, then the orientations of these planes give insights into the axis orientation and the shape of the leading edge of the ICME. Finally, examining plasma flow deflections, again in the sheath region, will also give clues to the cross-sectional morphology as the deflections are linked to the leading edge morphology of the ICME and its axis orientation.

SH21B-0167 0830h POSTER

RHESSI Microflares Statistics

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The Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) provides unique sensitivity in the 3-15 keV energy range with an effective area ~100 times larger then similar past instruments. Microflares have been observed with little emission above 15 keV due to extremely steep spectra (spectral index of 8 with a low energy cutoff near 8 keV). Since the energy in non-thermal electrons is very sensitive to the value of the power law and the low energy cutoff, observations by RHESSI will give a better estimate of the total energy input into the corona. We present the first statistical analysis of RHESSI microflares during times with activity below GOES C Class and without solar type III radio storms. Currently, we have analyzed June 2002 and May 2003. Microflares are found through searching for peaks 3σ above background in the 6-12 keV data range. The fluxes in the 3-6 keV 12-25 keV, and 50-100 keV bands are also recorded. Statistics on the following flare characteristics are presented; max counts, total counts, duration, GOES level. We have also analyzed the equivalent WIND data set in search of correlated solar type III radio bursts. Initial results show that only a small number of RHESSI microflares are associated with interstellar type III radio bursts. This work was supported by NASA contract NAS5-98033.

SH21C MCC: 3006 Tuesday 1020h

Physics of Eruptions in the Low Solar Atmosphere II

Presiding: **P Gallagher,** NASA Goddard Space Flight Center**; S Hill,** NOAA

SH21C-01 1020h INVITED

Magnetic Configuration in Low Solar Atmosphere Prior to Eruptions

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Vector magnetograph observations of active regions prior to large flares often show strongly sheared magnetic fields, and the associated Hα filaments show long threads parallel to the neutral line. This suggests that the filament is embedded in a horizontal flux tube that is basically untwisted. In contrast, eruptive prominences often show helical structures, suggesting a flux rope with multiple twists. To reconcile these observations, we propose a model of the pre-eruptive state in which an untwisted horizontal flux tube is held down by an overlying magnetic arcade. Unlike in previous models, electric currents flow mainly at the interface between the two flux systems. The two ends of the flux tube are anchored in the photosphere. We use 3D MHD modeling based on NSO/KP magnetograph data to demonstrate that such a system can be in stable force-free equilibrium, provided the arcade field is sufficiently strong to restrain the flux tube. A weakening of the arcade or interaction with a neighboring filament can cause loss of magnetostatic equilibrium, resulting in the eruption of part of the flux tube (Sturrock et al. 2001, ApJ 548, 492). Magnetic reconnection during the early phase of the eruption causes the arcade field to be wrapped around the filament flux, creating the unstable flux rope seen in erupting prominences. The model is applied to Hα observations of a filament obtained at the Swedish Vacuum Solar Telescope (La Palma) and TRACE observation of its eruption on June 21-22, 1998.

SH21C-02 1040h INVITED

Early Stages of Eruptive Solar Events

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A brief review will be given of our current knowledge of those eruptive solar events that involve both a flare and a coronal mass ejection. The early initiation and acceleration phases of the CME will be discussed together with the manifestations of the associated flare. Emphasis will be placed on obervations of the eruptive event on 21 April 2002 observed in X-rays with the Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) and in the 195-Å EUV band with the Transition Region and Coronal Explorer (TRACE). In particular, the altitudes of the coronal X-ray and EUV sources and their variations with time and energy will be presented. Also discussed will be the relative timing and spatial locations of the coronal and footpoint emissions, and the detailed relation between the flare and CME time lines. Possible interpretations of these observations will be presented in terms of various magnetic reconnection models.

SH21C-03 1100h

Coronal hard X-ray source accompanying a flare plasma ejection

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In many of flares occurring near the solar limb, a hot-plasma ejection is observed in soft X-rays during the impulsive phase. This is a piece of evidence to support flare models which are based on the cusp-type magnetic reconnection in the corona. Sometimes a compact hard X-ray source is observed above the soft X-ray flaring loop at the same time. This clearly indicates that the flare-energy release, probably magnetic reconnection, occurs above the soft X-ray loop. Fast reconnection downward flow impinges on the closed magnetic loops and high-energy electrons are produced there. In this scenario, the above-the-looptop hard X-ray source is closely related to the reconnection downward flow. How is the reconnection upward flow observed? Recently it is found in the impulsive phase of an M-class flare that a hard X-ray (above 20 keV) source exists slightly below a soft X-ray ejected feature which is located far above the soft X-ray flaring loop. This hard X-ray source might be a counterpart of the hard X-ray source mentioned above. This is caused by interaction between the reconnection upward flow and the hot-plasma ejection. We discuss how such high-energy electrons are produced there.

SH21C-04 1115h

The Polar Crown Filament Eruption and Associated CME of 2003 February 18

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On 2003 February 18, a polar crown filament dramatically erupted, becoming the core of a classic three part Coronal Mass Ejection (CME). The event was well observed from the disk to 30 solar radii in multiple bands, some of which were at high cadence. Phenomena observed include: high-latitude filament eruption, the formation of two bright ribbons, soft X-ray coronal dimmings, post-eruption arcade evolution, and a classical three-part CME. Specifically, the filament eruption was seen on the disk and out to 1.3 solar radii in soft X-rays, extreme ultraviolet, H-alpha, and He I 1083 nm. The CME was visible in white light coronagraph images from 1.08 to 30 solar radii. Though post CME reconnection arcades reached only the B5 level in GOES XRS measurements, they were observed in hard X-rays (at energies less than 12 keV), soft X-rays, extreme ultraviolet, and a two-ribbon flare structure was seen in H-alpha and in He I 1083 nm. The observations were conducted using GOES SXI, SOHO EIT and LASCO, RHESSI, and the MLSO ACOS suite. We present the results of our initial timing, height vs. time, and light curve analyses of this event. The timing results address issues of the simultaneity and sequence of filament motion, coronal dimming, CME 'launch', and arcade formation. The height versus time results are presented for both the filament/CME core and the CME front to provide observational constraints for CME acceleration models. Finally, the arcade light curve results support estimation of the magnetic reconnection rate for further discrimination between model predictions.

SH21C-05 1130h

Evidence for the Formation of Large-Scale Current Sheets in Three Solar Flares

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