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We study the physical characteristics of diffuse protons in the region upstream of the earth's bow shock using the GEOTAIL data set of June-October 1994 which covers not only the nominal nose region (X>0) but also both the pre-dawn (X<0, Y>-70Re) and the post-dusk (X<0, Y<+60 Re) regions. (Note that the diffuse protons are observed in the post-dusk foreshock region when the IMF is in the 'anti-Parker' spiral direction.) What we have found are: (1) The diffuse protons in the pre-dawn and post-dusk regions have lower intensities and softer energy spectra than in the nose foreshock region. The exponential functional form of their energy spectra, exp(-E/Ec), which have been known from the earlier observations in the nose region, continue to the pre-dawn and post-dusk regions with reducing Ec. (As known in the nose region, we observe that Ec depends on the solar wind velocity and the IMF geometry. That Ec also depends on the spatial position is our new finding.) (2) These diffuse protons are more or less isotropic in the nose foreshock region but have anisotropic pancake distributions in the pre-dawn and post-dusk foreshock regions being convected with the ExB motion of the solar wind plasma. These observations provide important information on the acceleration and transport processes of diffuse protons in the foreshock region of the earth's bow shock.

SH32D-08 1745h

Large Scale Hybrid 2D Simulations of the Relaxation of an Initially Isotropic Spectrum of Alfven Waves

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In many situations observed in space plasmas, large MHD scales are believed to act as reservoir for a nonlinear cascade, bringing fluctuation energy to scales where kinetic processes (Landau or cyclotron resonnances) can transform them into thermal energy. These kinetic processes operate at smaller spatial scales and more rapid time scales, so that a numerical simulation describing both the nonlinear cascade and the kinetic processes were, untill recently, out of reach. The rapid increase of computing efficiency allows now to study the competition between these two processes in more realistic simulations. We present here 2D hybrid simulations (the protons are treated as particles and the electrons as a massless fluids) of the relaxation of an initially isotropic spectrum of Alfven waves. The dimensions achieved in these simulations can be as high as 1000x1000 cells in phsysical space (and 1000 particles per cell), with a resolution of a few tenth of proton inertial lentgh (the electric resistivity being chosen so that the "magnetic Reynolds" number is of the order of 50-100). By changing the plasma beta and the typical wavelength of the initial perturbations, we vary the relative efficiency of the cascade processes and the cyclotron absorption. The results shows a subtle interplay between these two processes, which depend on the initial level of fluctuations (which fixes the nonlinear overturning time). We shall also discuss the relvance of these simulations for the heating of the outer corona and solar wind.

SH41A MCC: 2010 Thursday 0800h

Coronal Magnetic Fields: Models to Measurements I

Presiding: **J Burkpile,** NCAR High Altitude Observatory**; J Kuhn,** University of Hawaii

SH41A-01 0800h INVITED

Pre-Eruptive and Eruptive Magnetic Structures in the Solar Corona

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One of the greatest difficulties in the development of models of coronal mass ejections (CMEs) and flares is the lack of information about the coronal magnetic field prior to its eruption. The situation is exacerbated by the fact that only the component of the magnetic field generated by currents flowing in the corona contributes to the energy release. The amount of energy released during a CME or flare implies that net change in the total magnetic field in the corona is no more than about 10 percent on average. However, there may be localized regions where the changes are significantly greater, perhaps on the order of 100 percent. The pattern of these localized changes can be used to distinguish between various models. For example, flux rope models of CMEs and eruptive flares imply that the transverse field at the base of the corona can reverse sign in the region immediately below the flux rope, but that the transverse field further away increases. Recent observational studies suggest that such CME and flare associated changes in the coronal magnetic field will not penetrate to the level of the photosphere, but will be confined to regions above an altitude of 400 km or higher. Thus, observations of the chromospheric and coronal fields are needed to make progress in understanding the mechanism of solar eruptions.

SH41A-02 0820h INVITED

The Coronal Magnetic Field Predicted by the Breakout Model

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Although there has been intense theoretical work in the past decade on coronal mass ejections/eruptive flares, the mechanism for their initiation is far from accepted. The problem is that the triggering of these events is believed to be magnetically-driven and to take place in the corona, but until very recently, the field there has not been observed directly. We discuss how the new developments in coronal field instrumentation will allow us to determine the mechanism for CME/eruptive flare initiation. We focus, in particular, on the so-called breakout model in which reconnection in the corona is postulated to be the triggering process. First, we present the latest numerical results on breakout. Then, we determine the predictions of the model for coronal magnetic observations, and discuss definitive tests of breakout that will be possible with the proposed new instrumental capabilities. This work was supported in part by ONR and NASA.

URL: http://solartheory.nrl.navy.mil

SH41A-03 0840h INVITED

The Magnetic Fields of Quiescent Prominences

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Since the discovery of coronal mass ejections (CMEs) in the 1970s, we have known that they have a high association (> 70%) with prominence eruptions. This association is also reflected by the many three-part CMEs having the associated erupted prominence as the dense core trailing behind the leading dense shell of the CME. The magnetic fields in a quiescent prominence are thus an important observable clue to the hydromagnetic environment capable of producing a CME. This was not appreciated in the observational efforts in the 1970s and 1980s to detect prominence magnetic fields by spectro-polarimetric methods, largely because it was a discovery phase of this observational development. The current renewed efforts to observe magnetic fields both in prominences and in the million-degree corona will offer an unprecedented opportunity to probe the coronal origin of CMEs. This talk will center upon certain interesting prominence and related properties useful to keep in mind in anticipation of that opportunity. The National Center for Atmospheric Research is sponsored by the National Science Foundation.

SH41A-04 0900h

Eruptive Behavior Originating in Active Regions

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Coronal mass ejections (CMEs) are spectacular manifestations of solar acitivy. These immense eruptions of plasma and magnetic field are propelled outward from the sun with velocities as high as 2000 km/s. The fastest CMEs typically originate from active regions on the Sun. MHD models of the eruption of large scale coronal fields have demonstrated significant energy release in idealized 2D (Antiochos et al., ApJ 512, 985, 1999) and 3D (Linker et al., Phys. Plasmas 10, 1971, 2003) geometry. Eruptive behavior has also been shown for a 3D localized arcade (Amari et al., ApJ 529, L49, 2000). In active regions on the Sun, both the localized field due to the active region and the overlying fields in the large scale corona are important. We describe MHD computations of the eruptive behavior of a localized active region field (modeled as a localized bipole) within a large-scale dipolar configuration. We discuss the differences between this more realistic configuration and the idealized configurations that have been considered previously. Work supported by NASA and the Center for Integrated Space Weather Modeling (an NSF Science and Technology Center).

SH41A-05 0915h

Models of Three-dimensional Flux Ropes and Their Stability

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A crucial problem in the study of coronal mass ejections is the understanding of the evolution prior to the eruption and the development of initial configurations and boundary conditions that can produce an eruption of the field configuration and the identification of observable features from these configurations. We present a general framework to derive approximate equilibrium configurations suitable to describe pre-eruption states, using an approach originally developed for the Earth's magnetotail but including magnetic shear and gravity. We illustrate the approach by deriving configurations for both force-free and non-force-free states. The variable models contain a twisted flux rope, connected to the photosphere and anchored in the corona by an overlying arcade. The models may also include a magnetic configuration above the flux rope typical for helmet streamers. Using three-dimensional MHD simulations, we also ivestigate the models for their stability.

SH41A-06 0930h

Turbulent Diffusion of the Radial Magnetic Field at the Solar Surface.

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We discuss the physics of the diffusion of passive additives embedded within a turbulent fluid. Simple numerical experiments are performed. These are designed to determine the relevant diffusion equation associated with the additive's motions. Our results are compared with analytic theory. We find that for the case in which the fluid is incompressible (zero divergence) and spatially inhomogeneous, the standard diffusion equation describes the spatial distribution of passive additives. However, for the case in which the turbulent fluid has a nonzero divergence, a different "diffusion" equation is needed to describe their spatial distribution. For this case, the equation derived by Parker ("Interplanetary Dynamical Processes", 1963) and more recently by Fisk and Schwadron (Astrophys. J., 560, 425, 2001) is applicable. Implications of these results will be discussed, particularly how they relate to the transport of the radial magnetic field at the solar surface due to photospheric motions.

SH41A-07 0945h

Low Density Magnetic Structures (Cavities) in the Solar Corona

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Some helmet streamers in the low corona contain a density depleted region known as a cavity. Cavities form over magnetic polarity inversion lines, often referred to as filament channels, which frequently contain prominences. CMEs often erupt from helmet streamers, and are well associated with erupting prominences. The most common CME morpholgy is the well known loop cavity. Models have been proposed that identify these coronal cavities as low coronal manifestations of twisted magnetic flux ropes, which are then ejected into the solar wind as part of a CME. In order to begin to understand the magnetic structure of coronal cavities, this poster will first examine the frequency of quiescent cavities in the corona using white light observations from the Mark IV coronameter and eclipse photographs.

SH41B MCC: Level 1 Thursday 0830h

The Solar Mass Ejection Imager (SMEI) and Related Remote-Sensing Heliospheric Observations I Posters

(joint with SM)

Presiding: **B V Jackson,** Center for Astrophysics and Space Physics, University of California, San Diego**; G M Simnett,** University of Birmingham

SH41B-0457 0830h INVITED POSTER

The Solar Mass Ejection Imager (SMEI) Mission

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We have designed, built and launched into near-Earth orbit a Solar Mass Ejection Imager (SMEI) capable of observing sunlight that has Thomson-scattered from heliospheric structures of time-varying density. SMEI is designed to observe heliospheric structures such as coronal mass ejections, corotating structures and shock waves, to elongations greater than 90° from the Sun. The instrument was inspired by the heliospheric imaging capability demonstrated by the zodiacal light photometers of the Helios spacecraft. The instrument makes effective use of *in situ* solar wind data from spacecraft in the vicinity of the imager by extending observations to the surrounding environment and back to the Sun. A near-Earth imager can provide up to three days warning of the arrival of a mass ejection from the Sun. In combination with other imaging instruments in deep space, or alone by making some simple assumptions about the outward flow of the solar wind, SMEI can provide a tomographic analysis of the heliospheric structures surrounding it.

URL: http://cassfos02.ucsd.edu/solar/smei_new/smei.html

SH41B-0458 0830h POSTER

Interactive Visualization of Transient Solar Wind Phenomena for Space Weather Applications

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We present a volume rendering system developed for the visualization and manipulation of 3D heliospheric volume data such as solar wind density, velocity and magnetic field. Our system exploits the capabilities of the VolumePro 1000 board from TeraRecon, Inc., a low-cost 64-bit PCI board capable of rendering a 512-cubed array of volume data in real time at up to 30 frames per second on a standard PC. Many operations have been implemented such as stereo/perspective views, animations of time-sequences, and determination of CME volumes and masses. We will show examples of three-dimensional heliospheric volumes from tomographic reconstructions of density and velocity using real-time interplanetary scintillation (IPS) data. In the near future we expect to add reconstructions based on the all-sky observations from the recently launched Solar Mass Ejection Imager and employ our system to interactively analyze and visualize the abundant information embedded in these data.

URL: http://cassfos02.ucsd.edu/solar/index.html

SH41B-0459 0830h POSTER

Space Performance of the Multistage Labyrinthine SMEI Baffle

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The Solar Mass Ejection Imager (SMEI) was launched on 6 January 2003, and shortly thereafter raised to a nearly circular orbit at 840 km. Three SMEI CCD cameras on the zenith-oriented CORIOLIS spacecraft cover most of the sky beyond about 20° from the Sun, each 102-minute orbit. Data from this instrument will ultimately provide precision visible-light photometric sky maps. Once starlight and other constant or slowly varying backgrounds are subtracted, the residue is mostly sunlight that has been Thomson-scattered from heliospheric electrons. These maps will enable 3-dimensional tomographic reconstruction of heliospheric density and velocity. This analysis requires 0.1% photometry and background-light reduction below one S10 (the brightness equivalent of a 10th magnitude star per square degree). Thus 10^{-15} of surface-reduction is required relative to the solar disk. The SMEI labyrinthine baffle provides roughly 10^{-10} of this reduction; the subsequent optics provides the remainder. We analyze data covering a range of angles between the SMEI optical axis and the Sun, or the Moon, to evaluate the full system's stray-light rejection performance.

SH41B-0460 0830h POSTER

Masses and Energetics of CMEs Observed by SOHO/LASCO

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The LASCO data base contains over 5000 CMEs, observed from 1996-2001. We have developed an automated procedure to calibrate the associated LASCO images and to calculate the CME properties. Of the total number of CMEs, we have been able to calculate the mass and energetics of about 80% of the total number of events. Here we report on the analysis of the mass and energy properties of over 3000 CMEs and compare them to previous observations of CMEs.

SH41B-0461 0830h POSTER

LASCO C2 and C3 Level-1 Images: Calibration and Pipeline Processing

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The LASCO C2 and C3 coronagraphs have provided coronal observations since May, 1996. Initial calibrations have been available during most of this time period. We have subsequently completed a re-evaluation and refinement of these calibration procedures. We are now able to present the final version of the level-1 data using the latest improvements from in-flight calibration results. Further details on the LASCO calibration and level-1 data access are presented at http://lasco-www.nrl.navy.mil/level_1/lascocal_index.html. In this presentation we will sum up the different aspects of the LASCO C2-C3 image corrections such as vignetting, absolute photometry, time corrections, geometric distortion, sun center position, and spacecraft orientation.

URL: http://lasco-www.nrl.navy.mil/

SH41B-0462 0830h POSTER

Can SOHO SWAN Detect CMEs?

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We have investigated the possibility that the Solar Wind Anisotropies (SWAN) remote sensing instrument on SOHO may be able to detect coronal mass ejections (CMEs) in neutral Hydrogen Lyman-α emission. We have identified CMEs near the Sun in observations by the SOHO LASCO white-light coronagraphs and in extreme ultraviolet emissions using SOHO EIT. There are very few methods of tracking CMEs after they leave the coronagraph's field-of-view, so this is an important topic to study. The primary science goal of the SWAN investigation is the measurement of large-scale structures in the solar wind, and these are obtained by detecting intensity fluctuations in Lyman-α. SWAN consists of a pair of sensors on opposite panels of SOHO. The instantaneous field-of-view of each sensor unit is a 5° x 5° square, divided into 1° pixels. A gimbaled periscope system allows each sensor to map the intensity distribution of Lyman-α, and the entire sky can be scanned in less than one day. This is the typical mode of operation for this instrument (Bertaux et al., Solar Physics, 162, 403-439, 1995). Beginning in May 2002 the sky-scan mode of the SWAN detectors was interrupted, and they were held stationary for one-or-more 15-hour campaigns each week. During those campaigns the SWAN sensors were positioned above the East or