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

West equator of the Sun at locations chosen to be as close to the Sun as possible (typically 50 solar radii from Sun-center). Based on the LASCO and EIT data, we have identified CMEs whose extrapolated height-time measurements indicated that the events would cross the SWAN field during the campaign period. During 12 months' observation, there were ∼10 CMEs that met two criteria: (1) an event low in the corona near the solar limb could be unambiguously identified in EIT; and (2) the CME could be tracked beyond 20 R⊙ in LASCO C3. We consider these CMEs to be particularly well-observed since the speed measured in LASCO could be reliably extrapolated to the SWAN field-of-view. We will report preliminary results of this novel observing campaign.

SH41B-0463 0830h INVITED POSTER

IPS From LOFAR: A Complement to Thomson Scattering Studies

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Information about the large scale physical properties of the inner heliosphere plasma can only be obtained by employing remote sensing techniques. The two most useful measurement techniques for this are Thomson scattering, used by Solar Mass Ejection Imager (SMEI), and Interplanetary Scintillation (IPS). Both these techniques are sensitive to the distribution of properties of the solar wind plasma along the entire line-of-sight through the medium. The two measurement techniques are sensitive to different properties of the same physical plasma. IPS is sensitive to the fluctuations in the refractive index of the medium ($\propto \delta n_e^2$) and their spectral index, the perpendicular component of velocity of the solar wind, the anisotropy in electron density fluctuations caused by the magnetic field and their inner scale. Thomson scattering, on the other hand, is sensitive only to the distribution of the electron density along the line of sight. The data from both these techniques are suitable for tomographic reconstructions, yielding three dimensional visualisations of the inner heliosphere. Heliospheric tomography will benefit significantly from the denser sky coverage and the improved signal-to-noise IPS measurements promised by the upcoming instruments and the simultaneous use of Thomson scattering data. The unquestionable synergy between the information obtained from these two techniques should be exploited to arrive at significantly better constrained tomographic reconstructions. We are now assessing the potential for space weather applications, including IPS studies, of the Low Frequency Array (LOFAR), an aperture synthesis radio interferometer covering the 10-240 MHz range. The unique design of this instrument allows the possibility of high sensitivity observations of up to 4000 IPS sources a day. This unprecedented ability will increase the sampling of the inner heliosphere by ∼2 orders of magnitude compared to the present IPS instruments and improve the signal-to-noise of individual measurements. This paper will describe some aspects of the LOFAR design and outline its potential IPS measurement capabilities.

SH41B-0464 0830h POSTER

Remote Sensing of CMEs with Cosmic Rays

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A large geomagnetic storm and Forbush decrease often results when a CME-associated interplanetary shock impacts Earth. Recent observations and theories show that high-energy cosmic rays can have precursor anisotropies before the shock arrives at Earth. According to numerical modeling, charged particles which cross the IMF shock from downstream to upstream produce an intensity deficit in the small pitch angle region, and this "loss cone" anisotropy can exist ∼10% of an interplanetary scattering mean free path (λ) ahead of the shock front. This implies that observing a wide pitch angle distribution of high-energy cosmic rays can provide us with advance warning of CMEs before their shocks impact Earth. We report a survey of "loss cone" anisotropies observed with the different λ(s) corresponding to neutron monitors and muon detectors which have responses to primary cosmic rays of ∼10 GeV and ∼ 30GeV respectively. The data we use are from the 11-station "Spaceship Earth" network of high-latitude neutron monitors and from the ground-based muon detector network during large geomagnetic disturbances (Kp>7) that occurred after "Spaceship Earth" became fully operational in late 2000. This work is supported in part by U.S. NSF grants ATM-0207196 and ATM-0000315 and in part by the joint research program of the Solar-Terrestrial Environment Laboratory, Nagoya University.

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

SH41B-0465 0830h POSTER

Comparison between All-Sky Images Observed by Satellite SMEI and Simulations by using the HAF Solar Wind Model

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The Solar Mass Ejection Imager (SMEI) is a new satellite in sun-synchronous, low earth orbit with three wide-angle, white light photometers that provides a scan of the celestial sphere every orbit. By occulting the sun and correcting for other sources, the 0.1% of total light scattered from the increased plasma density associated with the flare-induced shock may be revealed. The first observations from SMEI were a series of eighteen frames acquired after two solar flares on May 27th and 29th, 2003. The interplanetary consequences of these flares were numerically modeled using the Hakamada-Akasofu-Fry (HAFv.2) kinematic solar wind model. Line-of-sight plasma densities due to the background solar wind and to the two shock fronts were calculated and displayed in the Hammer-Aitoff reference frame to enable direct comparison with the SMEI observations. Comparison of the HAFv.2 simulation with the SMEI observations clearly demonstrates that the model is necessary to aid in the identification of multiple shock-induced variations and to remove the contribution of the background solar wind from the SMEI observations.

SH41B-0466 0830h POSTER

Near Real Time Prediction of Magnetic Storm Intensity and Timing from Measurements of North to-South Interplanetary Magnetic Clouds

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The importance of interplanetary magnetic clouds to the study of geomagnetic activity has been known for many years, and because of the general characteristics of these large structures, such activity is often major. A program is developed from which we are able to predict the Dst index based on real-time measurements of a magnetic cloud passing Earth, as well as from guidance from previously modeled magnetic clouds (MCs) from WIND observations. The scheme could be applicable to ACE data, for example, or to that of any near real-time field and plasma monitoring platform. The program consists of five stages: (1) identification of the proximity of a cloud-complex (i.e., MC and immediate upstream region), (2) finding, relatively accurately, the front boundary of the MC, (3) estimating the MC's 'center time,' (4) predicting the speed and minimum IMF-BZ and the latter's timing within the MC (based on these earlier findings), and finally (5) estimating the associated Dst, based on reliable IMF-BZ vs. Dst relations. The initial identification of the cloud-complex is carried out by examining proton plasma beta, degree of smoothness of the magnetic field's directional change, and field strength. These alone will help to pin down the front boundary of the MC to within about ± 2 hr. This identification then triggers an attempt to determine this boundary to within ± 1/2 hr using finer scale field data After viewing about 2/3 of a MC-passage and properly estimating the MC's center time, for North-to-South types of MCs, which are expected to be most common in the near future [Bothmer and Rust, 1997], we have sufficient information to predict min-Bz within the MC, provided reasonable front-to-back MC symmetry exist. Application of the scheme to MCs that occurred over the period 1995 through 2002 is used to determine its effectiveness in predicting Dst, as well as to simply determine the program's ability to identify MCs of any type (i.e., including S-to-N types) and their front boundary times. In the prediction mode (i.e., for N to-S types) the scheme does not strictly require that the observing spacecraft be upstream of Earth, since 7 or so hours lead-time, for the prediction, is gained for most MCs in Earth's vicinity, provided only that the spacecraft is outside the bow shock. However, for L1 based spacecraft, approximately an extra hour of 'prediction-time' is gained. As a test of its fidelity and consistency, the program is applied to many years of WIND data and some of the results are presented. Bothmer and Rust, in Coronal Mass Ejections, AGU Geophys. Monog. Ser, vol. 99, p 139, Washington DC., 1997.

SH41B-0467 0830h POSTER

A Simple Method for Determining the Time of Closest Approach to the Center of a Magnetic Fluxrope

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A simple test can be used to determine *when* a spacecraft passing through a flux rope is closest to the center of that rope. The test consists of determining the angular change between successive magnetic field vectors as the spacecraft passes through the flux rope. Using a Bessel function model, it can be shown that the interior vectors rotate more slowly than the exterior vectors. Thus, the spacecraft is closest to the center of the rope where the angle between successive vectors is a minimum. This is consistent with our intuitive picture of a flux rope in which the exterior fields are tightly wound a round the axis and the central field is parallel to the rope axis. We show that this technique works for both stationary and expanding ropes. Finally, we examine the sensitivity of the technique to the impact parameter and noise in the magnetic field.

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SH41B-0468 0830h POSTER

Variability of N/O in the Solar Wind

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The Solar Wind Ion Mass Spectrometer (SWIMS) on ACE has successfully measured the elemental abundance of nitrogen in the solar wind, N/O $\approx$ 0.121 $\pm$ 0.014, in excellent agreement with the photospheric value of N/O $\approx$ 0.123 and with the SEP-dervied coronal value. The abundance of nitrogen in the heliosphere is an enigma. Laboratory analysis of lunar soils shows that trapped nitrogen is overabundant in them by about one order of magnitude relative to the heavy noble gases, which in turn are efficiently trapped in the lunar regolith. In this work we investigate the variability of N/O in the solar wind. Since Ne/O is known to vary little, variations in N/O would translate directly to variations of N with respect to noble gases. Small variations in N/O will therefore provide further evidence for a non-solar origin of most of nitrogen in lunar soils. Nitrogen is not readily measured in the solar wind because it is not very abundant and it is neighbored in mass and in mass per charge by the most abundant heavy ions, oxygen and carbon. For this reason, previous elemental abundance determinations of nitrogen in the solar wind have had large intrinsic uncertainties. However, with SWIMS, nitrogen is cleanly separated from its neighbors and its abundance can be accurately measured.

SH41B-0469 0830h POSTER

Second Encounter of Ulysses With Jupiter

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Between November 2003 and April 2004, the Ulysses spacecraft will again be in the proximity of Jupiter creating an opportunity for more in-situ and correlated remote -sensing observations. The first encounter in February 1992 took place at a distance of closest approach of 6 Jupiter radii (Rj) and changed the inclination of the Ulysses trajectory so that it would pass above the sun's polar regions. Twelve years later, Jupiter has returned to near its previous location and Ulysses is again approaching aphelion near the orbit of Jupiter at 5.3 AU. This encounter is at much larger distances and Ulysses does not enter, but remains upstream of, the Jovian magnetosphere. However, the spacecraft travels from high to low Jovigraphic latitudes and covers a wide range of local times. On 19 November 2003, the Jovigraphic latitude is 75.5 deg at a distance of 2128 Rj and a local time (LT) near noon. The closest approach of 1683 Rj occurs on 4 February 2004 at 49.5 deg latitude near 17 hours LT. The formal encounter ends on 1 April 2004 at 1926 Rj, a latitude of 21.5 deg and a LT near 17:30. Jupiter is a prolific source of radio waves, energetic charged particles, dust and neutral gas, all of which can be detected by Ulysses. Simultaneous measurements of the solar wind and magnetic field will provide the nearly instantaneous conditions affecting Jupiter's magnetosphere and influencing the production of these emissions. Remote sensing observations by other missions or observers are encouraged to investigate the effect of changing solar wind conditions and structures on Jupiter's dynamic magnetosphere.

SH41B-0470 0830h POSTER

What do Measurements of Abundance Variations Tell us About the Origin and Evolution of the Solar Wind

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Connections between the Sun and solar wind have recently been made based on observations of density, velocity, and magnetic field. These have led to fundamental changes in our understanding of coronal magnetic topology and the origin and evolution of the solar wind. During solar minimum, polar coronal holes are neither the only regions of open magnetic field lines nor the sole source of fast solar wind. Instead, open magnetic field lines thread the entire corona, and solar wind flowing along them carries the imprint of coronal holes, quiet Sun, and active regions into interplanetary space. The purpose of this paper is to show how measurements of abundance variations in the corona and solar wind reinforce and complete this picture, providing key insight into where and how the solar wind, especially the slow wind, is produced.

SH41B-0471 0830h POSTER

Macroscopic Instability of the Ion Shell Distribution Function in the Divergent Solar Wind

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As a result of cyclotron interaction with Alfven waves propagating from the sun, pitch angle diffusion of resonant particles takes place and shell-like distribution function of resonant ions (protons) is formed at each distance from the sun [V. Galinsky and V. Shevchenko, Phys. Rev. Lett., 85, 90, 2000]. Stability of the solar wind ion shell-like distribution function with respect to excitation of waves at larger distances is addressed. It is shown in linear approximation, that in case when the phase velocity of Alfven waves decreases with distance, ions with shell distribution excite outward propagating Alfven waves with smaller phase velocities when they advance to larger distances. The real problem, how the shell distribution, created at some distance from the sun, is changed due to interaction with Alfven fluctuations with smaller phase velocities at larger distances in the divergent solar wind, is studied in quasi-linear approximation and by numerical simulations.

SH41C MCC: 3020 Thursday 1020h

The Solar Mass Ejection Imager (SMEI) and Related Remote-Sensing Heliospheric Observations II *(joint with SM)*

Presiding: **B V Jackson,** Center for Astrophysics and Space Physics, University of California, San Diego**; S Kahler,** Air Force Research Laboratory

SH41C-01 1020h INVITED

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

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The Solar Mass Ejection Imager (SMEI) is a proof-of-concept instrument intended to demonstrate the feasibility of space-based heliospheric imaging for detecting and tracking coronal mass ejections (CMEs) and other dense structures in the solar wind. SMEI is a joint effort of the Air Force Research Laboratory, the University of Birmingham (UK), the University of California at San Diego, Rutherford Appleton Laboratory (UK), and Boston College, funded by the AF, NASA and the University of Birmingham. SMEI was launched aboard the DoD Coriolis spacecraft on January 6, 2003, and began returning images in early February. Since launch, the SMEI team has invested considerable effort toward producing photometric all-sky maps of heliospheric brightness from the SMEI data. For the purpose of providing input for space weather forecasting, the SMEI team intends to start making these maps available to the scientific community and the public in near real time. Early quick-look, subtraction sky maps from SMEI's cameras demonstrate that SMEI can detect CMEs and image their structure as they move outward from the Sun, in some cases beyond 1 AU. This special session will include both presentations of initial SMEI results, and related papers on present and future remote sensing heliospheric observations.

SH41C-02 1035h INVITED

The Solar Mass Ejection Imager (SMEI)

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The Solar Mass Ejection Imager (SMEI) has been designed to detect and forecast the arrival of solar mass ejections and other heliospheric structures which are moving towards the Earth. We describe the instrument, which was launched into a Sun-synchronous polar orbit on 6 January, 2003 on board the US DoD Coriolis spacecrafth. SMEI contains three CCD cameras, sensitive over the optical waveband, each with a field-of-view of 60 degrees x 3 degrees. The sensitivity is such that it will detect changes in sky brightness equivalent to a tenth magnitude star in one square degree of sky. Each camera takes an image every 4s and the normal telemetry rate is 128 kbits/s. SMEI has a photometric accuracy of around 0.1%. In addition to solar mass ejections, images of stars and the zodiacal cloud are measured to this photometric accuracy once/ orbit (102 minutes).

URL: http://www.sr.bham.ac.uk

SH41C-03 1050h INVITED

SMEI: First Results and Future Capabilities

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