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We present X-ray evidence for the formation of large-scale current sheets in three flares observed by the Ramaty High Energy Solar Spectroscopic Imager (RHESSI) on 2002 April 14, 15 and 16 in NOAA region 9901 at the northwest limb. RHESSI images show clear flare loops and a separate coronal source above these loops in all three flares. The height of the loops decreased in the first few minutes during the impulsive rise in hard X-ray ( $> 25$  keV), then increased with time. We will focus on the event on April 15. The RHESSI images show a cusp-shaped flare loop in the rise phase. When the impulsive rise in hard X-rays began, the cusp part of the coronal source separated from the underlying flare loop and remained stationary for about 2 minutes. During this time the underlying flare loops shrank at  $\sim 9$  km s<sup>-1</sup>. The temperature of the underlying loops increased towards higher altitudes, while the temperature of the coronal source increased towards lower altitudes. These results suggest that a current sheet formed between the top of the flare loops and the coronal source during the early impulsive phase. After the hard X-ray peak, the loop source moved outward at  $\sim 8$  km s<sup>-1</sup>, and the coronal source moved outward at  $\sim 300$  km s<sup>-1</sup>, suggesting an upward motion and an elongation of the current sheet. About 30 minutes later, post-flare loops seen with the SOHO Extreme Ultraviolet Imaging Telescope 195 Å passband rose at  $\sim 10$  km s<sup>-1</sup>. A large coronal loop-like structure, observed by the SOHO Large Angle and Spectrometric Coronagraph C2 and C3 detectors, also propagated outward at  $\sim 300$  km s<sup>-1</sup>. These observations are all consistent with the continued elongation of the current sheet.

## SH21C-06 1145h

### Implications of RHESSI Flare Observations for Magnetic Reconnection Models

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The Ramaty High Energy Solar Spectroscopic Imager (RHESSI) observations of the 2002 April 15 solar flare and related flares provide compelling evidence for the formation of a large-scale, reconnecting current sheet in at least some flares. We describe the observed evolution of the April 15 flare in terms of magnetic reconnection models. We argue that the flare most likely evolved through magnetic geometries associated with super-slow reconnection (early rise phase), fast reconnection (impulsive phase), and slow reconnection (gradual phase). We also provide evidence for X-ray brightenings within the evolving current sheet, possibly induced by the tearing mode instability. This work was supported in part by the RHESSI Program and NASA's Sun-Earth Connection Program. This work would not have been possible without the dedicated efforts of the entire RHESSI team.

## SH21C-07 1200h

### The Relationship Between Large Solar Flares and Very Fast Coronal Mass Ejections - Physics and Causality

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The fastest coronal mass ejection observed to date by the LASCO coronagraph onboard SOHO was also the best observed thanks to the Max Millennium coordinated observation campaign running at the time. Data from RHESSI, TRACE and SOHO from April 21 2002 are presented which yield a clear timeline of the physical processes involved and their relationships to each other. The causality of the solar flare-CME system is discussed and implications for theory and modelling are presented. Other large flare/very fast CME events are analysed and agreement with the paradigm is studied. Particular attention is paid to the acceleration of such very fast CMEs and the nature, magnitude and timing of the acceleration process is characterised within the limits of the observations.

## SH22A MCC: Level 1 Tuesday 1330h

### Physics of Eruptions in the Low Solar Atmosphere IV Posters

Presiding: A Caspi, University of California, Berkeley; B Lynch, University of Michigan

## SH22A-0168 1330h POSTER

### Gamma-ray flare occurrence patterns

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As of 2003 September 4, RHESSI (the Reuven Ramaty High-Energy Spectroscopic Imager) had obtained coverage for the entire GOES duration ( $>95\%$ ) for 98 M- and 6 X-class flares, and for each of these we estimate the ratio of the 2.223 MeV line fluence to the GOES soft X-ray fluence. All are upper limits except for one M-class event and one X-class event. The GOES fluence is known to scale well with total flare energy. The statistics of these observations, considering as well the solar gamma-ray line observations from other spacecraft plus the statistics of proton events in the heliosphere, are not consistent with the hypothesis that ion acceleration scales proportionally with total flare energy.

## SH22A-0169 1330h POSTER

### RHESSI Observations of Coronal Hard X-Ray Sources in August 2003 Solar Flares

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Although the general level of solar activity was relatively low during August 2003, several active regions produced a large number of small (GOES class C or smaller) solar flares during this period. The high energy spectroscopic imager aboard the RHESSI spacecraft imaged many of these flares at X-ray energies greater than 10 keV. A preliminary analysis of these observations has revealed the presence of coronal hard X-ray sources in flares which occurred behind the solar limb as well as in those flares which were apparently located on the visible disk of the Sun. X-ray images and spectra of these coronal hard X-ray sources will be presented and their implications with respect to the models of solar flares will be briefly discussed. This research at the University of California, Berkeley is supported by NASA under Contract NAS 5-98033.

## SH22A-0170 1330h POSTER

### RHESSI Observations of High-Temperature Plasmas in Solar Flares

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Solar flare plasmas are multi-thermal, and in particular may contain high-temperature components above  $\sim 20$  MK. While other solar instruments (e.g. TRACE, GOES SXI) are sensitive to low-temperature plasmas below  $\sim 20$  MK, the *Reuven Ramaty High Energy Solar Spectroscopic Imager* (RHESSI) observes photons with energies above 3 keV, and thus is especially sensitive to high-temperature plasmas above  $\sim 10$  MK. High-temperature plasma emission includes the Fe/Ni line complexes at  $\sim 6.7$  and  $\sim 8$  keV, and both the equivalent widths and the fluxes of these line complexes are strongly temperature-dependent. In many flares, RHESSI detects emission in both of these line complexes, as well as emission in the thermal continuum, with spectral resolution of  $\sim 1$  keV FWHM. Through imaging and spectroscopy with RHESSI, and by comparison with other solar instruments, we can thus constrain the temperatures and emission measures over the entire range of thermal plasmas. We present a spectroscopic analysis of a variety of flares, including the X1.5 event on 21 April 2002, to determine the time-varying characteristics of the thermal electron populations. We estimate the energy contained in thermal electrons and compare with the energy contained in the time-varying non-thermal electron population. Finally, we discuss the implications for heating and energy transport in flares with high-temperature components.

URL: <http://sprg.ssl.berkeley.edu/~cepheid/agu2003>

## SH22A-0171 1330h POSTER

### The Unusual Hard X-ray Spectrum of the Flare of 20 August 2002

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An M3 Class flare was observed in x-rays with RHESSI and in H-alpha with the Kanzelhöhe Solar Observatory. The event was observed to several hundreds of keV in X-rays and was marked by an unusually flat spectrum observed from 20-70 keV. The measured power-law exponent of this component was about 1.7, very close to the theoretical limit for a thick-target injection of energetic electrons implying a near cutoff below 80 keV. We will bound any systematic effects that may be contributing to this result by analyzing the spectrum using multiple techniques. We will also forward model the spatial/spectral x-ray sources to further validate these observations.

## SH22A-0172 1330h POSTER

### Non-thermal Coronal Hard X-ray Emission Observed During a Partially Occulted Flare

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We will present an analysis of RHESSI hard X-ray imaging and spectroscopy of a GOES M1.5 class flare which occurred on 1 June 2003 0210-0700 UT in NOAA active region 0375 and was located 9 degrees behind the east limb of the Sun. Flare footpoints were thus occulted from view by 9000 km, allowing for a relatively unobstructed detection of emission from the associated coronal sources. Throughout the duration of the flare, a thermal hard X-ray source can be seen rising with a velocity of 7 km/s above GOES SXI soft X-ray and EIT ultraviolet (304Å) loops. During the impulsive phase of the flare (0237-0310 UT), a non-thermal source is additionally seen above 15 keV with a relatively soft power law spectrum with an index around -5. This non-thermal source is displaced from the thermal source by up to 10,000 km and shows greater variations on a time scale of tens of seconds. We will present total energy estimates and a detailed analysis of the source motions during the flare. We will also discuss implications for models that postulate above-the-loop-top sources.

SH22A-0173 1330h POSTER

## Multifractality of Solar Magnetic Fields

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Eruptive phenomena in the solar atmosphere are thought to be caused by reconnection processes in complex magnetic structures. Therefore, the complexity of the magnetic field is closely related to the eruption activity. We propose to determine the measure of the magnetic complexity in terms of multifractality (intermittency) of a given magnetic structure. Our choice of a mathematical approach was stimulated by the fact that a multifractal, in time and in space domains, structure displays a burst-like (catastrophic) behavior which is consistent with catastrophe-like eruptions in the solar atmosphere. We propose a new multifractal method for quantitative estimation of the degree of complexity of solar magnetic fields. We discuss results of the application of the method to SOHO/MDI and ground-based measurements of solar magnetic fields.

SH22A-0174 1330h POSTER

## The Active Region 8210: Observations, Coronal Magnetic Fields and Energetics

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The active region 8210 observed on May 1, 1998 is the site of several flares (3 C-class flares from 17:00 UT to 22:00 UT and one M-class flare at 22:40 UT). In this study, we analyse the causes and consequences of these flares inside the coronal magnetic configurations (magnetograms,  $H\alpha$ , EUV, Soft X-rays) and the nonlinear force-free reconstructed magnetic fields reveals that the sites of activity are related to the topological skeleton (null points, separatrix surfaces, separators): field lines crossing a separatrix surface reconnect in an other connectivity domain and produce an  $H\alpha$  brightening at the footpoints. We also determine the free magnetic energy budget (difference between nonlinear and potential field magnetic energy) and the relative magnetic helicity. The photospheric increase (or decrease) of magnetic flux is related to the evolution of the magnetic energy in the corona above the active region as well as to the occurrence of flares. The main photospheric changes occur between the times of flaring activity. AR 8210 is a case study for the Solar MURI project.

SH22A-0175 1330h POSTER

## Radiative Hydrodynamic Models of Solar White Light Flares

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We report on theoretical radiative hydrodynamic simulations of solar white light flares. The solar atmosphere is modeled in detail from the transition region to the photosphere. The coronal pressure and X-ray backheating are included self-consistently. Flare heating is assumed to be from an electron beam which is modeled for several white light flares using data from RHESSI, TRACE and Yokoh. We also investigate the possibility that the 511 keV line width is produced from a significant column depth of atmosphere at transition region temperatures. We compare our new solar flare models to previous results, and to models of M dwarf stellar flares.

SH22A-0176 1330h POSTER

## An Energy Build-up Process of Flares on a Continuously Emerging Active Region

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This is a preliminary report of a possible model of an energy build-up process of flares for the case where flares occur on continuously emerging and developing active region. In March 2003, about 40 flares occurred in the same active region NOAA10314 within 6 days (March 15 – March 20). These flares include two X-class flares, six M-class flares, and some sub-M-class flares. Many of them had some common characteristic features. This particular active region has a dual bipolar magnetic configuration that emerged on March 13, and was continually growing through this period. We report the characteristics of these flares using SoHO/EIT images, and pay attention to the evolution of the active region NOAA10314 since its emergence using SoHO/MDI magnetograms. We found: (1) Separating motions between positive and negative polarities of both the dipoles of this active region are seen in a time series of MDI magnetograms. This suggests that these dipole areas are currently emerging flux regions. (2) The photospheric magnetic neutral line (“main neutral line”) between both expanding eastern and western dipoles is rotating but stable. This line is the contact line between both expanding dipoles, thus magnetic intensities on the photosphere in this active region were strongest on both sides of the “main neutral line”, and the line was stable throughout this period. (3) At least 26 events occurred along the “main neutral line”. Another 11 events also showed correspondence to this “main neutral line”. (4) We see structures resembling dual separatrix surfaces on both sides of the flaring structures in EIT images before March 17. (5) In TRACE images, we frequently see a lot of tiny brightenings and mass motions near the photosphere in the area outside of the flaring region. This area corresponds to the eastern dipole area in item (1). Based on these observations, we present a possible model of an energy build-up process in flares. We also find similar properties in other flares, which occurred on another growing active region. Acknowledgment: This research is supported by the National Research Council.

SH22A-0177 1330h POSTER

 $I + LCT$ : A Method for Determining Photospheric Flows from MagnetogramsBrian T. Welsch<sup>1</sup> (510-642-9650; welsch@ssl.berkeley.edu)George H. Fisher<sup>1</sup> (510-642-8896; fisher@ssl.berkeley.edu)William P. Abbett<sup>1</sup> (510-642-6880; abbett@ssl.berkeley.edu)<sup>1</sup>Space Sciences Lab, UC Berkeley, 7 Gauss Way, Berkeley, CA 94720-7450

Coronal mass ejections (CME's) are magnetically-driven reconstructions of plasma in the low- $\beta$  solar corona; they are the primary drivers of space weather. One way to investigate coronal field evolution before and during such events involves driving MHD simulations of the coronal magnetic field using data from time series of vector magnetograms. Doing so requires specification of a three-component velocity field at the simulated photosphere, consistent with the observed magnetic field evolution in that layer. Unfortunately, such velocity data are not generally available. We have developed a method that finds photospheric plasma velocities consistent with both the flows derived by the familiar technique of local correlation tracking (LCT), and the field evolution described by  $z$ -component of the induction equation. We present results obtained by applying this “ $I + LCT$ ” technique to vector magnetograms, and to “false” magnetograms obtained from MHD simulations of photospheric field evolution.

SH22A-0178 1330h POSTER

## Eruption of a Buoyantly Emerging Magnetic Flux Rope

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We present a three-dimensional numerical ideal magnetohydrodynamic simulation designed to model the emergence of magnetic flux passing from below the photosphere into the corona. For the initial state, we prescribe a plane parallel atmosphere that comprises the convection zone, isothermal photosphere and chromosphere, and isothermal corona. Embedded in this system is a isolated horizontal magnetic flux rope located 10 photospheric pressure scale heights below the photosphere. The flux rope is uniformly twisted with plasma temperature inside the tube reduced to compensate for the magnetic pressure. Density is reduced in the middle of the rope so that this section buoyantly rises. The early evolution of precedes with the middle of the rope rising to the photosphere and expanding into the corona. Just as it seems the system might approach equilibrium, the upper part of the flux rope begins to separate from the lower, mass laden part. The separation occurs by stretching of the field to form a current sheet where reconnection severs the field lines to form a new system of closed flux. This flux then erupts into the corona. Essential to the eruption process are shearing motions driven by the Lorentz force which naturally occurs as the rope expands in the pressure stratified atmosphere. The shearing motions transport axial flux and energy to the expanding portion of the magnetic field which contributes to the eruption. Once the axial flux is largely transported from the submerged field, the expansion of the magnetic field in the corona begins to decelerate.

SH22A-0179 1330h POSTER

## Density Structure in a Pre-Eruption Coronal Flux Loop

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A density model is developed for a coronal loop, extending from the collisionless corona ( $\nu_i \ll \Omega_i$ ) down to foot points in the highly-collisional chromosphere ( $\nu_i \gg \Omega_i$ ), under the approximation that neighboring flux surfaces within the flux loop are “non interacting”. This model, valid if the characteristic fluid-element speed is large enough ( $v > v_c$ ), results in a density enhancement at the edge of the loop which is a function of its specified magnetic field. Here,  $v_c$  is the critical fluid-element speed: for  $v < v_c$ , the number of collisions occurring during a single transit of the loop is large enough to diffuse away the density enhancement that exists in the limit of zero collisions in coronal segment of the loop. For solar parameters,  $v_c \approx 1$  km/s. It is shown that this model can explain the post-eruption density enhancement (the bright rim) observed in coronal mass ejections. This result is distinct from coronal loop models in which the fluid elements making up the plasma are assumed to be static and collisionally-coupled (such models have been used to address thermal properties, rather than the three-dimensional density structure, of coronal loops). Work supported by ONR and NASA.

SH22A-0180 1330h POSTER

## Homologous large-scale activity in solar eruptive events of November 24-26, 2000

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We study large-scale activity on the solar disk associated with a November 24-26, 2000 series of six recurrent major flares and “halo” coronal mass ejections (CMEs). The analysis is based mainly on the SOHO/EIT data, particularly by using properly rotated difference full-disk images with 12-min intervals at 195Å as well as with 6-hour intervals at 171, 195, 284, and 304Å. We demonstrate that these eruptive events were homologous not only by their flare and CME characteristics, as Nitta and Hudson [2001] showed, but also in terms of their large-scale CME-associated

manifestations in the EUV corona. These include long and narrow channeled dimmings, some transequatorial; anisotropic coronal waves, propagating in a restricted angular sector; and additional quasi-stationary emitting fronts. As a whole, in all of these six events, the homologous CME-associated disturbances covered a considerable portion of the solar disk. The homology tendency appears to be due to significant disturbance, partial eruption and relatively fast restoration of the same large-scale structures involved in the repeating CME events. We briefly discuss the implications of the analysis in connection with the coronal equilibrium as indicated by recent TRACE observations of oscillating loop systems.

URL: <http://helios.izmiran.troitsk.ru/lars/Chertok/001124-26/index.html>

## SH22A-0181 1330h POSTER

### Acceleration of Prominences in the Low Corona

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We show examples of prominence eruptions as observed in the low corona and present preliminary results of an observational study aimed to investigate the relationship between the acceleration of eruptive prominences and the speed of their associated CMEs. For this study, we have selected events near the limb when we can identify eruptive prominences in Mauna Loa ground based observations that show a clear association with CMEs during the period 1998-present. MLSO/CHIP images in the He I 1083nm line and the MLSO/PICS images in the H $\alpha$  656.3nm line are used to identify the eruptive prominences and to determine its projected radial velocity and acceleration. SOHO/LASCO and MLSO/MK4 observations are used to determine the trajectory of the corresponding CME.

## SH22A-0182 1330h POSTER

### Tether-Cutting Energetics of a Solar Quiet Region Prominence Eruption

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We study the morphology and energetics of a slowly-evolving quiet region solar prominence eruption occurring on 1999 February 8–9 in the solar north polar crown region, using Fe XV EUV 284 Å data from the EUV Imaging Telescope (EIT) on SOHO and soft X-ray data from the soft X-ray telescope (SXT) on Yohkoh. After rising at  $\approx 1 \text{ km s}^{-1}$  for about six hours, the prominence accelerates to a velocity of  $\approx 10 \text{ km s}^{-1}$ , leaving behind EUV and soft X-ray loop arcades of a weak flare in its source region. Intensity dimmings occur in the eruption region co-spatially in EUV and soft X-rays, indicating that the dimmings result from a depletion of material. Over the first two hours of the prominence's rapid rise, flare-like brightenings occur beneath the rising prominence which may correspond to "tether cutting" magnetic reconnection. These brightenings have heating requirements of up to  $\sim 10^{28}$ – $10^{29}$  ergs, and this is comparable to the mechanical energy required for the rising prominence over the same time period. If the ratio of mechanical energy to heating energy remains constant through the early phase of the eruption, then we infer that coronal signatures for the tether cutting may not be apparent at or shortly after the start of the faster-rise phase of the prominence in this or similar low-energy eruptions, since the plasma-heating energy levels would not exceed that of the background corona. Our findings have strong implications for the correct use of observations in testing theoretical ideas for the onset of solar eruptions.

## SH22A-0183 1330h POSTER

### Flares, CMEs and solar energetic particles

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The relationship between coronal mass ejections and solar flares has been debated for a long time. While earlier studies (e.g., Munro et al., 1979) found most CMEs are not associated with solar flares, recent studies have revealed that CMEs are usually accompanied by solar flares (e.g., Harrison (1995) found a 48% association rate). The sequence of the onset of CME and accompanying flare is, however still unclear. Evidence, (e.g. Khan & Hudson (2000)) exists that flare may be the drivers for CMEs. However, Zhang et al. (2001) using C1 of LASCO, performed a study of four CME events, and found in all four cases that CMEs precede the accompanying flares. Furthermore, a recent study of soft X-ray characteristics of solar flares, both with and without associated CMEs (Kay et al. 2003) verified that flares that occur alone are distinct from those with associated CMEs. The former appear to exhibit a clear relationship between peak intensity and duration while the latter does not. Whether CMEs occur with an associated flare and whether the CMEs occur before or after associated flares is important for observations of SEP events. Cane et al. (2003) show the existence of a clear signature of flare material at the early phase of those SEP events which have associated flares originating from the Sun's western hemisphere. The composition and abundance of SEP events is likely to be influenced by the nature of the association between flares and CMEs since the injection or seed particle population that a CME driven shock accelerates may well be determined by the flare. We present a series of simulations with different onset time differences between CMEs and flares and explore possible distinguishing feature in the particle intensity profile and spectra that may result from different configurations.

## SH22A-0184 1330h POSTER

### Modeling Vertical Plasma Flows in Solar Filament Barbs

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Speeds of observed flows in quiescent solar filaments are typically much less than the local Alfvén speed. This is why the flows in filament barbs can be modeled by perturbing a local magnetostatic solution describing the balance between the Lorentz force, gravity, and gas pressure in a barb. Similarly, large-scale filament flows can be treated as adiabatically slow deformations of a force-free magnetic equilibrium that describes the global structure of a filament. This approach reconciles current theoretical models with the puzzling observational result that some of the flows appear to be neither aligned with the magnetic field nor controlled by gravity.

## SH22A-0185 1330h POSTER

### Reconnection driven by natural flows in the solar corona

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Reconnection in the solar corona is believed to be important for a series of processes from flares and CMEs to coronal heating. However, theoretical understanding of the reconnection process still remains elusive. The reconnection rate predicted by the Sweet-Parker model is determined by resistivity and is very many orders of magnitude too small to explain the observations. A possible mechanism that can provide fast reconnection rate is driven reconnection. When flows drive field lines together, the rate of reconnection is determined by the driving mechanism and is independent of resistivity. In the present work we consider two possibilities: converging flows created by the long term evolution of coronal structures and converging flows due to flow instabilities. While the first mechanism has been invoked in the flux rope model of coronal mass ejections (CME) [1], the second mechanism has been proposed recently in studies of the evolution of helmet streamer configurations in presence of velocity shears [2]. Velocity shear induces the onset of the Kelvin-Helmholtz instability that leads to the compression of field lines in localized zones. Localized compression, in turn, leads to reconnection driven by the flow. The presence of the Kelvin-Helmholtz instability can be due to super-Alfvénic field aligned flows or even to sub-Alfvénic flows across the field lines. [1] T.G. Forbes, J. Geophys. Res. 95, 11919 (1990). [2] G. Lapenta, D.A. Knoll, Solar Phys., 214, 107 (2003)

## SH22A-0186 1330h POSTER

### Evolution of Active Regions in the Solar Interior

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Using data from SOHO and TRACE, we investigate the emergence, evolution and dissipation of magnetic active regions in the solar interior and atmosphere by comparing 3D maps of subsurface structures and plasma flows, obtained by acoustic tomography, with the corresponding photospheric magnetograms and coronal EUV images. We find that the growth of active regions is characterized by multiple emergence of magnetic flux structures propagating very rapidly in the upper convection zone and by the formation of large-scale converging flows. During the decay, we have observed mostly diverging flows, and have attempted to detect submergence of magnetic flux. We look at some details of the dynamics of active regions, and discuss initial results of a search for the relationship between subphotospheric shearing flows, and changes in magnetic topology and flaring activity in the corona.

URL: <http://sun.stanford.edu>

## SH22A-0187 1330h POSTER

### Origins of the Solar Polar Jets - Coordinated SOHO and TRACE Observations

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The polar jets are dynamic coronal eruptions originating in the low solar atmosphere, in flaring UV bright points within polar coronal holes. They were first observed by SOHO instruments (EIT, LASCO) during last solar minimum in 1996 when the polar holes were dominating coronal structures. UVCS/SOHO obtained ultraviolet spectroscopy of the jet providing us with estimates of the jet plasma conditions, evolution of the electron temperature and heating rate required to reproduce the observed ionization state. As the Sun is currently at the declining phase of its activity, the polar holes again became permanent structures. The SOHO Joint Observing Program (JOP 155) was designed to identify and study the jet phenomena that would be counterparts of the solar minimum polar jets. The jets are believed to be triggered by field line reconnection between emerging magnetic dipole and pre-existing unipolar field. Existing models predict that the hot jet is ejected together with another jet of a cool material. The particular goal of the coordinated SOHO and TRACE observations was to look for possible association of the hot and cool plasma ejections. We present first results of the campaign and discuss their implications.

## SH22A-0188 1330h POSTER

### Coordinated UVCS/SOHO and VLA Observations of the Solar Corona

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Coordinated UVCS/SOHO and VLA coronal observations took place during August 16–19, 2003. The radio source 3C 228 passed behind a streamer in the northeast at a heliocentric distance of about 7 solar radii, and behind the north coronal hole at about 4 solar radii in the latter part of the radio observation. The goal of this campaign is to combine the analysis of radio polarimetric sounding measurements of the corona with ultraviolet spectroscopy of the same regions, in order to obtain qualitatively new information about the properties of the solar coronal plasma. The Ultraviolet Coronagraph Spectrometer (UVCS) aboard SOHO observed O VI (103.2 and 103.7 nm) and H I Lyman alpha (121.6 nm) emission lines to determine kinetic temperatures, average densities and outflow speeds in the corona. UVCS observations provide unique information on the heating and acceleration processes in the corona. The Very Large Array (VLA) observations reveal the Faraday rotation of polarized radio waves due to passage through the magnetized plasma of the corona. These measurements provide limits on the coronal magnetic field strength and constrain the properties of magneto-hydrodynamic (MHD) waves. Radio propagation techniques are a useful complementary tool to ultraviolet coronagraphic spectroscopy in determining the physical processes that are responsible for the heating of the extended corona and the acceleration of the solar wind. This work is supported by NASA under Grant NAG5-12865 to the Smithsonian Astrophysical Observatory, by the Italian Space Agency and by PRODEX (Swiss contribution).

## SH22A-0189 1330h POSTER

### Statistical Study of Hard X-ray Footpoint Region

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We show statistical characteristics of hard X-ray footpoint sources derived from THE YOHKOH FLARE IMAGE CATALOGUE. We use many hard X-ray images over the whole YOHKOH mission period (1991/08 - 2001/12) and the study is concentrated on following two points. 1) Average height of hard X-ray footpoint sources in the four HXT (Hard X-ray Telescope) energy bands (14-23, 23-33, 33-53, 53-93 keV). 2) Spectral characteristics of hard X-ray footpoint sources. We mainly revealed that A) the hard X-ray emission comes from just above the H $\alpha$  emitting region and the accelerated electrons lose their energy within 1000 km length leading to the high density around footpoints, and that B) Many hard X-ray footpoint sources show a broken power-law spectrum with very hard spectrum in the low energy range (20-30 keV), suggesting a cut off energy of accelerated electrons is around 20 keV - 30 keV at least.

## SH22A-0190 1330h POSTER

### Shear-Flow Reconnection Causing EUV Bright Point Heating

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EUV/X-ray Bright Points indicate permanent heating processes in the solar atmosphere. We used the information of observed magnetic fields and photospheric motion to simulate numerically by a global MHD approach, coupled to an appropriate kinetic model describing dissipation, the physical processes behind the heating of the solar atmosphere. It appears that shear flow reconnection near the transition region is the main candidate to understand the localized heating behind Bright Points.

## SH22A-0191 1330h POSTER

### Multiple Flux-Rope Magnetic Ejecta in the Solar Wind: Separated Flux Ropes

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Recent studies (Hu et al., 2003a,b) have shown that multiple flux-rope configuration of magnetic ejecta in the solar wind at 1 AU is not rare. Those authors examined ACE magnetic and plasma data for the years 1998-2000. They found about 4 double flux-rope ejecta events and 1 triplet among 31 events which were identified by primarily looking at magnetic field measurement for flux rope signatures. The data analysis technique employed is capable of generating a two and a half dimensional cross-section of the structure connecting past the spacecraft by solving the plane Grad-Shafranov equation directly utilizing spacecraft data as spatial initial input. The results showed multiple non-axisymmetric cylindrical flux ropes nested within a boundary surface. They were assumed to have exactly the same axis orientation. Further analysis will be carried out by examining the individual flux rope in a multiple rope system separately. The individual field line twist and relative orientation between flux-rope axes will be reported. Implications of X-point formation in a presumably twisted multiple flux-rope system will be discussed. Multi-spacecraft validation of these results will be presented. Possible solar connections of these systems, such as the comparison of the signs of magnetic helicity, will be explored.

## SH22B MCC: 3006 Tuesday 1340h

### Physics of Eruptions in the Low Solar Atmosphere III

*Presiding:* J Krall, Naval Research Laboratory; B J Thompson, NASA Goddard Space Flight Center

## SH22B-01 1340h

### A Survey of Coronal Dimmings and EIT Wave Transients

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We present the results of a comprehensive catalog of EIT wave transients and coronal dimmings. We will compile a set of more than 170 events, and we present strong evidence for the association of the co-development of coronal dimmings and EIT waves. Both limb and disk events are included in this study. We also include the speeds, locations, and associated flare timing in this study.

## SH22B-02 1355h

### The Relation Between Coronal Mass Ejections and Outward Motions in the Low Corona

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Outward motions are frequently observed in the low corona, especially in the early phase of solar flares. Some of these motions, observed in X-ray, EUV, and radio wavelengths, appear to be intimately linked to coronal mass ejections (CMEs) as observed by white-light coronagraphs, typically above 2 Rsun. In principle, a combination of X-ray/EUV/radio and coronagraph data should give many constraints on models of CME initiation and early propagation. However, such attempts are not straightforward because of the diversity of low coronal motions, which often have unclear relationships, if any, to the CME. In this presentation, we compare many examples of low coronal motions observed by TRACE and Yohkoh with CMEs observed by LASCO, and discuss what we can objectively conclude from the data. Errors resulting from the inclusion of different and possibly incompatible data in a single so-called height-time plot are discussed. We also study the reality of the flare association of CMEs, which, according to the height-time plots, precede the flare and hence the low coronal motions by more than an hour.

## SH22B-03 1410h

### The Three-Dimensional Velocity Fields Of Solar Disappearing Filaments And Their Relations To Coronal Activities

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Solar filament disappearance (Disparition Brusque: DB) is often accompanied by a great magnetic activities such as flares and transient shock waves on and near the solar surface as well as enormous disturbances in interplanetary space due to the associated coronal mass ejection (CMEs). Thus, DBs are of great interest not only to solar physics research, but also to space science, and solar-terrestrial study. Since it is impossible to measure the velocity field of DBs with ordinal observations in the H $\alpha$  line center alone, most previous studies have focused on the morphological signatures of DBs. In order to obtain the physical characteristics of DBs and relate them to other active phenomena, much effort is put into the calculation of their three-dimensional (3-D) velocity fields. Using the H $\alpha$  line center, blue and red wing (H $\alpha$   $\pm$  0.8 Å) images obtained by the Flare Monitoring Telescope (FMT) at Hida Observatory, Kyoto University, and based on the Beckers' cloud model, we developed a new method to obtain the line-of-sight velocity of disappearing solar filaments. The line-of-sight velocity is obtained (i) by calculating the H $\alpha$  line profile of the filament, and (ii) by measuring the Doppler shift which best fits the observed temporal variations of contrasts of the filament. The tangential velocity is obtained by tracing the motions of internal structures on successive images, and both line-of-sight and tangential velocities are combined to yield the 3-D velocity field of DBs. In this method, corrections for the effective filter bandwidths of the instrument, stray light and Doppler brightening effect, are performed. Using the 3-D velocity field of DBs, we also developed a method to judge whether the DB was ejected into interplanetary space (eruptive) or remained in the corona (quasi-eruptive). The type of DBs are compared with the type of the associated coronal activities such as arcade formations observed in soft X-rays and EUV. CMEs and we conclude that the calculation of the three dimensional vector trajectories of disappearing filaments with our method can enhance the quality of space weather forecast and improve its accuracy.

## SH22B-04 1425h

### Evolution of Morphological Features of CMEs Deduced from Catastrophe Model of Solar Eruptions

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We investigate the evolution of morphological features during a coronal mass ejection (CME) occurring in a specific magnetic configuration in the present work. The results indicate that part of the magnetic flux and plasma ejected into the heliosphere by a CME exist in the flux rope or prominence prior to the eruption. For the parameters we chose for the present work, our calculations show that more than one third of the ejected plasma is continuously brought by magnetic reconnection from the corona during the eruption, and around a half amount of the poloidal flux, together with the plasma, is collected by reconnection from the coronal magnetic field and then is sent into interplanetary space via the upper tip of the current sheet. The reconnected magnetic flux is able to account for the fast expansion of the ejecta. The temperature of the reconnected plasma is fairly high (up to  $\sim 10^7$  K), and blending of this hot plasma with cold prominence material may drive the prominence from absorption to emission in the EUV. This process constitutes a natural and straightforward mechanism for prominence heating during the eruption.