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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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^{-1}. 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^{-1}, and the coronal source moved outward at $\sim$ 300 km s^{-1}, 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^{-1}. 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^{-1}. 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 coronagrph onboard SOHO was also the best observed thanks to the Max Millenium 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 Kanzelhohe 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 (304A) 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.