International Workshop

The 6th Solar-B Science Meeting

8-11 Nov. 2005
Kyoto, JAPAN

Program & Abstracts

Organizer: Kwasan and Hida Observatories of Kyoto University
Sponsors: A Grant-in-Aid for the 21st Century COE "Center for Diversity and Universality in Physics"
Yukawa Institute for Theoretical Physics of Kyoto University
Solar Terrestrial Environment Laboratory of Nagoya University

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PROGRAM & ABSTRACTS

SCIENTIFIC ORGANIZING COMMITTEE

K. Shibata (co-chair), T. Sakurai (co-chair), M. Carlsson, J.L. Culhane, J. Davis, L. Golub, H.S. Hudson, T. Kosugi, B. Lites, T. Sekii, K. Shibasaki, A.M. Title, S. Tsuneta, T. Watanabe, T. Yokoyama

LOCAL ORGANIZING COMMITTEE

K. Shibata (chair), H. Kurokawa, R. Kitai, S. Masuda, S. Nagata, S. Ueno, T. Miyagoshi, T. Ishii, S. Tanuma, H. Isobe, A. Asai, M. Shimojo, H. Tonooka, C. Sampa, M. Oka, M. Uemura

CONTACT

solarb6@kwasan.kyoto-u.ac.jp

Program of the 6th Solar B Science Meeting

(Oct 24 version)

40 = 30 min talk + 10 min discussion
30 = 25 min talk + 5 min discussion
25 = 20 min talk + 5 min discussion
20 = 15 min talk + 5 min discussion

2005/11/7 (Mon)

15:00-19:00 registration
17:00-19:00 reception (snacks and drinks)
at Kyoto University Clock Tower Centennial Hall, 2nd floor, Conference Rooms

Note that only pre-meeting registration and reception will be held in Kyoto University Clock Tower Centennial Hall.
http://www.kyoto-u.ac.jp/english/eaccess/e07_acce/images/main2005.jpg

The meeting will be held in Kyoto International Community House.
http://www.kcif.or.jp/en/footer/05.html

2005/11/8 (Tue) 9:30-18:20

09:30 25min opening talk (K. Shibata)

1. Instrumentation : chair S. Tsuneta

10:00	15	T. Kosugi	overview
10:15	30	T. Tarbell	Observing the Photosphere and Chromosphere with the Solar Optical Telescope and its Focal Plane Package
10:45	15	K. Ichimoto	Optical Performance of the SOT: Test Report for the Flight Telescope
11:00	15	T. Sakao	The X-Ray Telescope aboard Solar-B: An Overview
	15	E. Deluca	XRT Calibration and Performance
11:30	15	L. Culhane	The Solar-B EUV Imaging Spectrometer : Instrument Overview and Performance
	15	H. Hara	Solar-B EUV Imaging Spectrometer
12:00	20	M. Shimojo	Archiving, Distribution and Analysis of Solar-B Data
12:20	90	(lunch)	

2. Convection, Sunspots & Dynamo : chair T. Sekii

13:50	40	G. Scharmer	Observations and interpretations of sunpots fine structure
14:30	40	R. Stein	Solar Magneto-Convection Simulations
15:10	20	A. Pevtsov	Helicity as the ultimate test to the surface dynamo problem
15:30	20	T. Berger	What are "Faculae"?
15:50	20	T. Shimizu	Supersonic downflows in the photosphere discovered in sunspot moat regions
16:10	30	(coffee break)	

3. Magnetism of Quiet Sun and Active Regions: chair K. Shibasaki

16:40	40	A. Title	Magnetism of the Quiet Sun
17:20	20	B. Schmieder	What we can learn from vector magnetic field measurements about filaments?
17:40	20	M. Kubo	Magnetic Correspondence between Moving Magnetic Features and Penumbral Magnetic Fields
18:00	20	H. Zhang	Observational Study of Solar Magnetic Active Phenomena

18:20 (adjourn)

2005/11/9 (Wed) 9:10-18:40

4. Waves and Shocks : chair M. Carlsson

9:10	40	V. Hansteen	Waves and shocks in the solar atmosphere
9:50	20	N. Narukage	Flare-associated shock waves observed in soft X-ray
10:10	20	K. Hori	Flare-associated oscillations in coronal multiple loops observed with the Norikura Green-Line Imaging System

10:30 10 (break)

5. Chromospheric Heating : chair M. Carlsson (continued)

10:40	40	B. De Pontieu	Chromospheric dynamics: Spicules and Waves
11:20	40	J. Chae	Chromospheric Magnetic Reconnection

- Special 12:00 10 H. Opgenoorth ESA's view on Solar-B

12:10 70 (lunch)

6. Coronal Heating : chair H. Mason

13:20	40	G. Doschek	Towards Understanding the Solar Atmosphere
14:00	40	B. Gudikson	Topological Dissipation and the Solar Corona
14:40	20	P. Heinzel	Limb prominences seen in UV, EUV and SXR
15:00	40	Y. Katsukawa	Observational analysis of the relation between coronal loop heating and photospheric magnetic fields

15:40 30 (coffee break)

16:10 60 poster

7. Local Helioseismology : chair J. Davis

17:10	40	D. Chou	Local Helioseismology
17:50	20	T. Sekii	SOT time-distance helioseismology in and around active regions
18:10	20	A. Kosovichev	Observations of the MHD and helioseismic responses to flare energy- release events

18:30 (adjourn)

18:40 (banquet)

2005/11/10 (Thu) 9:10-17:40 (including excursion)

8. Emerging Flux : chair L. Golub

9:10	40	F. Moreno-Insertis	Flux emergence into the solar atmosphere: buoyancy instabilities, current sheets and reconnection
9:50	20	H. Kurokawa	Observations of magnetic field reconnection at the base of EFR surges
10:10	40	H. Isobe	3D MHD simulations of emerging flux and associated reconnection
10:50	10	(break)	

9. Reconnection : chair T. Yokoyama

11:00	40	M. Yamada	Studies of Magnetic Reconnection in Laboratory and Space-Astrophysical Plasmas
11:40	30	J. Buechner	Solar Coronal Modelling Based on Observed Photospheric Magnetic Fields Including the Microphysics of Reconnection
12:10	20	D. Longcope	An Observational Technique for Quantifying the Rate of Magnetic Reconnection
12:30	20	M. Linton	3D Reconnection Simulations of Descending Coronal Voids
12:50	60	(lunch)	
13:50	120	excursion	
15:50	120	poster	
17:50		(adjourn)	

2005/11/11 (Fri) 9:10-17:30

10. Flares : chair H. Hudson

9:10	40	H. Wang	Observations of preflare conditions
9:50	20	A. Asai	Evolution H-alpha Flare Kernels and Energy Release
10:10	20	K. Kusano	A Holistic Modeling of the Transition Process from Pre-Flare Sigmoid to Flare Eruption
10:30	10	(break)	

11. Coronal Mass Ejections : chair H. Hudson (continued)

10:40	40	L. Harra	Solar Origins of Interplanetary Shocks
11:20	40	J. Karpen	3D Simulations of Large-Scale Coronal Dynamics
12:00	80	(lunch)	

12. Solar Wind : chair T. Watanabe

13:20	40	S. Cranmer	UVCS Observations of Solar Wind and Its Modeling
14:00	20	M. Kojima	What coronal parameters determine solar wind speed ?
14:20	40	T. Suzuki	Self-consistent MHD modeling of solar wind acceleration
15:00	30	(coffee break)	

13. Discussion and Summary :

15:30	60	Discussion on Initial Observing Plans (Discussion Leader S. Tsuneta)	
16:30	20	B. Lites	summary1
16:50	20	T. Sakurai	summary2
17:20		(adjourn)	

Posters

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No.	Title	The first author
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P02	Calibration of the plarization property of SOT	Ichimoto, Kiyoshi
P03	Calibration of SOT Dopplergrams	Katsukawa, Yukio
P04	Examinations of the relative alignment of the instruments on SOT	Okamoto, Takenori
P05	Estimate on SOT light level in flight with throughput measurements in SOT sun test	Shimizu, Toshifumi
P06	The SOLAR-B Science Center in Japan	Shimojo, Masumi
P07	Optical Performance of Optical Telescope Assembly of SOT: Confirmation of Diffraction-Limited Performance	Suematsu, Yoshinori
P08	On the Evaluation of Optical Performace of Observing Instruments	Suematsu, Yoshinori
P09	Temperature Analysis with XRT	Weber, Mark

2. Convection, Sunspots & Dynamo

No.	Title	The first author
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P11	Small scale magnetic cancellation driven by supergranular scale flows	Potts, Hugh

3. Magnetism of Quiet Sun and Active Regions

No.	Title	The first author
P12	Skew Angle and Magnetic Helicity in Solar Active Regions	Hagino, Masaoki
P13	H-alpha Polarimetry and Magnetic Field Structure in the Chromosphere	Hanaoka, Yoichiro
P14	Evolutionary Characteristics of Magnetic Helicity Injection in Active Regions	Jeong, Hyewon
P15	The use of spectro-polarimeter measurements to determine the plasma heating	Jurcak, Jan
P16	Scientific Plans for the Advanced Technology Solar Telescope	Keil, Stephen
P17	Determination of Magnetic Helicity of Solar Active Regions Using the Linear Force-free Field Model	Lim, Eun-Kyung
P18	The Community Spectro-Polarimetric Analysis Center	Lites, Bruce
P19	The spatial distribution of hot and cool coronal loops and asymmetiric Stokes profiles	Nagata, Shin'ichi
P20	The Visible-Light Imager and Magnetograph (VIM) on Solar Orbiter	Solanki, Sami
P21	SUNRISE: high-resolution UV/VIS observations of the Sun from the stratosphere	Solanki, Sami
P22	Helicity Injections in Regions of Various Magnetic Fluxes	Yamamoto, Tetsuya

4. Waves and Shocks

No.	Title	The first author
P23	Wave dynamics of the upper solar atmosphere	Heggland, Lars
P24	Solar B as a tool for coronal wave studies	Nakariakov, Valery
P25	Atmospheric Seismology: Observed co-temporal oscillations by CDS and TRACE and the implicatons for Solar-B instrumentation	Walsh, Robert
P26	Measurement of energies of MHD waves generated by a microflare by SOLAR-B	Yokoyama, Takaaki

5. Chromospheric Heating

No.	Title	The first author
P27	The Relation between EUV Brightenings and Dark Mottles in the Quiet Sun	Kamio, Suguru
P28	Micro-Flare and High-Speed Down-Flow observed with VTT	Kano, Ryouhei

6. Coronal Heating

No.	Title	The first author
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P30	Magnetic Twist of EUV Coronal Loops Observed by TRACE	Kwon, Ryun-Young
P31	Investigation of coronal loop temperatures using three EUV filters and implications for future work with Solar-B	Noglik, Jane
P32	Modelling the radiative signatures of turbulent heating in coronal loops	Parenti, Susanna
P33	Plasma diamagnetism and solar coronal activity	Shibasaki, Kiyoto
P34	Studying transition region phenomena with Solar-B	Young, Peter

7. Local Helioseismology

No.	Title	The first author

8. Emerging Flux

No.	Title	The first author
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P37	3-D Magnetohydrodynamics Simulation of the Solar Emerging Flux	Nozawa, Satoshi
P38	Three-dimensional disruption of coronal arcade fields by an emerging flux tube	Notoya, Shun
P39	MHD simulation of emerging magnetic flux by CIP-MOCCT method	Shimizu, Masaki
P40	Correlation between increases of magnetic fluxes and brightenings of coronal structures around emerging flux regions	Yoshimura, Keiji

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P42	Low Atmosphere Reconnections Associated With An Solar Eruption	Moon, Yong-Jae
P43	A statistical study of the reconnection rate in solar flares	Nagashima, Kaori
P44	MHD Simulation of Plasmoid-Induced-Reconnection in Solar Flares	Nishida, Keisuke
P45	Self-similar Reconnection: A new model for astrophysical application beyond the Petschek model	Nitta, Shin-ya
P46	The correlation among physical quantities in Masuda-type flares as indicated from the magnetic reconnection model	Shimizu, Masaki
P47	XRT and EIS Observations of Reconnection Associated Phenomena	Shiota, Daikou
P48	Internal Shocks in the Magnetic Reconnection Jet in Solar Flares: Dependence on Resistivity Model	Tanuma, Syuniti
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P51	TRACE and RHESSI observations of white-light flares	Hudson, Hugh
P52	High velocity Doppler shift observations of 10 MK flare plasma	Innes, Davina
P53	Observations of simultaneous retracting and expanding loops above a flaring arcade	Khan, Josef

P54	Morphology and Spectral Behavior of Solar Hard X-Ray	Lartey, Sophia
P55	Active Region and Flare Observations with SOHO-CDS, what can we learn for SolarB?	Mason, Helen
P56	Hard X-ray and radio observations of an arcade-type flare on the solar limb	Masuda, Satoshi
P57	Supra-Arcade Downflows: Results from Observational Analysis	McKenzie, David
P58	Quantitative analysis of nonthermal electrons in impulsive hard X-ray flares	Minoshima, Takashi
P59	Non-thermal Electrons at Quasi-Perpendicular Shocks: Statistical Properties and the Whistler Critical Mach Number	Oka, Mitsuo
P60	Change in Sunspot Proper Motion and Its Relation to Flare Onset	Suematsu, Yoshinori
P61	The Relation between Soft X-ray Ejections and Hard X-ray Emission on 2000 November 24 Flare	Takasaki, Hiroyuki
P62	Combining Hydrodynamics Modeling with Test Particle Tracking to Improve Flare Simulations	Winter, Henry

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P64	Observational evidence for the relationship between Halpha surges and large-scale coronal activities	Liu, Yu
P65	Origin of the Sheared Magnetic Fields that Erupt in Flares and Coronal Mass Ejections	Moore, Ron
P66	Studying the magnetic origin of solar eruptions with SOLAR-B data	Nindos, Alexander
P67	Observing Filament Eruptions with Solar-B	Sterling, Alphonse
P68	Three Dimensional Motion of Plasmas Associated with Coronal Mass Ejections Observed with NOrikura Green-line Imaging System (NOGIS)	Suzuki, Isao
P69	Evolution of the photospheric magnetic field in the source regions of coronal mass ejections	Tripathi, Durgesh
P70	Eruption of a Kink-unstable Filament in Region NOAA 10696	Williams, David

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No.	Title	The first author
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1 INSTRUMENTATION

Overview
T. Kosugi (ISAS/JAXA)

Observing the Photosphere and Chromosphere with the Solar Optical Telescope and its Focal Plane Package
T. D. Tarbell (Lockheed Martin Solar & Astrophysics Lab), for the SOT/FPP Team

This talk will briefly describe the Solar Optical Telescope (SOT) instrument and its Focal Plane Package (FPP). Then I will concentrate on the types of observations of the photosphere and chromosphere which can be collected. Great flexibility is possible, but constraints of cadence and data rate must be considered. I will describe several examples of realistic observing programs. Finally, I will touch on the SOT baseline science plan, which is under construction now.

Optical Performance of the SOT: Test Report for the Flight Telescope
K. Ichimoto (NAOJ)

Wavefront error of the Optical Telescope Assembry (OTA) of SOT in the final flight configuration was extensively measured, by canceling the gravitation, under the thermal condition in orbit, or after applying mechanical launch loads. Other critical aspects like the pointing stability against the microvibration in the spacecraft or polarization characteristic of entire SOT were also verified. I will report the results from these testing and demonstrate the superb performance of SOT for diffraction limited polarimetory of the sun.

The X-Ray Telescope aboard Solar-B: An Overview
T. Sakao (ISAS/JAXA) and the XRT Team

The X-Ray Telescope (XRT) aboard the Solar-B satellite is a joint US-Japan project which aims to observe the solar corona in X-rays with high angular resolution (1 arcsec) and with wide temperature coverage (ranging from <1 MK up to >20 MK) ever achieved as a grazing-incidence imager for the Sun, thus plays a key role in accomplishing the science objective of Solar-B. The XRT will observe wide variety of coronal activities with such advanced capabilities and is expected to reveal, in an unprecedented detail, transport, storage, and dissipation processes of magnetic energies originating from the photosphere.

We present brief description on the instrumentation followed by an overview on science with the XRT.

XRT Calibration and Performance
E. Deluca

The Solar-B EUV Imaging Spectrometer - Instrument Overview and Performance
J. L. Culhane (Mullard Space Science Laboratory, University College London)

The Solar-B mission includes an Extreme-UV Imaging Spectrometer (EIS). It detects photons in the wavelength ranges 170 - 210 A and 250 - 290 A which include emission lines from several highly ionised species that exist over the temperature range of 4.7 to 7.3 in Log T. In this summary, we will describe the design and operation of the instrument and present its performance parameters e.g. spectral and spatial resolution and sensitivity. Its role in the Solar-B mission will be illustrated with reference to some key science topics. The anticipated observing strategy for the first three months of the mission will be outlined.

Solar-B EUV Imaging Spectrometer
H. Hara (NAOJ)

The performance of Solar-B EUV Imaging Spectrometer is briefly introduced. It covers two spectral ranges of 17 - 21 nm and 25 - 29 nm which contain emission lines from highly ionized species at temperatures of log T = 4.7 - 7.3. Target spatial and spectral resolutions as well as high throughput have been confirmed through calibration measurements. Science outputs from this instrument will strongly depend on on-orbit science operations because of its versatility.

Archiving, Distribution and Analysis of Solar-B Data
M. Shimojo (Nobeyama Solar Radio Observatory/NAOJ)

2 CONVECTION, SUNSPOTS AND DYNAMO

Observations and Interpretations of Sunspots Fine Structure
G. Scharmer (The Institute for Solar Physics, Sweden)

Solar Magneto-Convection Simulations
R. F. Stein (Michigan State University), D. Benson, A. Nordlund, D. Georgobiani

We review the recent solar magneto-convection simulations and comment on their implications for dynamo action. Magneto-convection has been simulated in the deep convection zone on global scales, as well as near the solar surface (including realistic physics) on small (meso-granule) scales. The emergence of magnetic flux through the solar surface into the corona has begun to be modeled. In addition, realistic, non-magnetic simulations on supergranule scales (48 Mm x 20 Mm) including f-plane rotation have begun and will, once magnetic fields are included, provide information of the origin and maintenance of the magnetic network.

Helicity as the ultimate test to the surface dynamo problem.
A. A. Pevtsov (National Solar Observatory, USA), D. W. Longcope

It has become widely accepted that large-scale magnetic structures on the Sun, such as active regions, are the product of a dynamo of periodicity approximately 22 years situated at or near the base of the convection zone. There has been speculation that the intermixed, small-scale photospheric magnetic field is generated by a second dynamo operating at or near the solar surface. Numerical simulations have shown that such dynamo could work, although it would not be as effective in generating flux as the more conventional deep-seated dynamo. Since they are driven by flows of different sizes operating on different time scales, the magnetic fields generated by these two dynamos should be quantiatively different. In particular, there are well-studied helical trends in the large-scale magnetic which could be imprinted on them by the deep, slow flows of the dynamo which generates them; these helical trends would be absent from a field generated by a surface dynamo. We propose that observations of magnetic/current helicity at very small scales can be used to establish the role of the second, surface dynamo on the Sun.

What are "Faculae"?

T. Berger (Lockheed Martin Solar and Astrophysics Lab, Palo Alto, CA, USA), A. Title, T. Tarbell, Luc Rouppe van der Voort, M. Lofdahl, G. Scharmer

We present very high resolution filtergram and magnetogram observations of solar faculae taken at the Swedish 1-meter Solar Telescope on La Palma. The data clearly show the three-dimensional structure of faculae seen near the limb of the sun. Three datasets with line-of-sight angles of 16, 34, and 53 degrees are analyzed to show that the contrast versus magnetic flux density function of faculae is constant, in stark distinction from that of "magnetic bright points" identified in near-disk-center images which show a strong change in brightness as a function of magnetic flux density. It is clear that "faculae" are not "flux tubes" - they are granules seen through the transparency caused by groups of flux tubes in front of the granules. The results are compared to recent numerical simulations that arrive at essentially the same conclusion. Previous results which show a strong dependency of facular contrast on magnetic flux density were caused by insufficient spatial resolution leading to a mixture of the signal from bright facular walls and the dark micropores immediately in front of them. The findings are relevant to studies of total solar irradiance (TSI) that use facular contrast as a function of disk position and magnetic field in order to model the increase in TSI with increasing sunspot activity.

Supersonic downflows in the photosphere discovered in sunspot moat regions

T. Shimizu (ISAS/JAXA), V. Martinez-Pillet, M. Collados, B. Ruiz-Cobo, R. Centeno, C. Beck, Y. Katsukawa

Stokes measurements of sunspot moat regions were made with a good seeing condition in 2005 July, by using infrared and visible-light Stokes polarimeters (TIP and POLIS) operating at German VTT at Tenerife, Spain. Extremely red-shifted signals are newly found in Stokes V profiles of photospheric lines. The shifted component is located 300-400mA (in Si 10827A) at red side apart from zero velocity wavelength, suggesting existence of supersonic downflows with 8-11 km/s at the photosphere. About 20 events were found in three successive scanning maps of 35 x 45 arcsec field of view. The downflows are seen not only in photospheric Si 10827A line observed by TIP but also in photospheric Fe I 6301.5/6302.5A lines. The size of downflows is in order of less than a few arcsec. This component might be a signature of magnetic reconnection at the photospheric level. Moreover, they might play important role in forming moving magnetic features well observed around sunspots. We expect that such extreme Stokes profiles will be found in higher-resolution Stokes data from Solar-B.

3 MAGNETISM OF QUIET SUN AND ACTIVE REGIONS

Magnetism of the Quiet Sun
A. Title (Stanford Lockheed Institute for Space Research, LM Advanced Technology Center, Palo Alto, CA USA), Karel Schrijver

Although historically we have used the term Quiet Sun with the thought that outside of active regions there is little interesting happening, the opposite is the case. Away from active regions new magnetic flux is constantly emerging. This new flux is responsible for the mixed polarity seen over the entire solar disk. The constant emergence of magnetic flux replaces the Quiet Sun field in less than a day and even the active region flux in less than a month. There is increasing evidence that this flux is the result of dynamo action occurring on the scales of the flux emergence rather than reprocessing of the active region flux. It is now been appreciated that statistical fluctuations and scale mixing of magnetic structures allows energy transport and energy conversions of scales much larger than the scales of magnetic flux emergence.

What we can learn from vector magnetic field measurements about filaments?
B. Schmieder(Observatoire de Paris-Meudon), A. Lopez, G. Aulanier

Theoretical models of filaments have predicted the existence of dips in the magnetic field lines to support the cool material. Condensation would be the mechanism of formation of filaments. Are threads of footpoints or barbs really vertical or is it just due to the accumulation of material in dips one over the other one? The controverse is still alive, filament fine structures are of dynamics nature and injection of cold material (or surges) from the phtosphere would be the proposed mechanism. Measurements of the vector magnetic field in filament channels will be possible with SOLAR B and answer to these questions.

Preliminary results have been obtained recently with THEMIS magnetograph, suggesting that dips are really present in filament channel leading to the conclusion that filament should be due to plasma condensation.

Magnetic Correspondence between Moving Magnetic Features and Penumbral Magnetic Fields
M. Kubo (Univ. of Tokyo) and T. Shimizu

Moving magnetic features (MMFs) are small magnetic elements moving outward in the moat region surrounding mature sunspots. We investigate vector magnetic fields and horizontal motion of MMFs including non-isolated MMFs in addition to the classical isolated MMFs around a simple sunspot observed with the Advanced Stokes Polarimeter and SOHO/MDI. The non-isolated MMFs occupy most of the moat region, and have nearly horizontal magnetic fields with both polarities. We find that the isolated MMFs located on the lines extrapolated from the horizontal components of the penumbral fluted structure, in which horizontal fields and relatively vertical fields are alternately located, have magnetic fields similar to the non-isolated MMFs. This suggests that such MMFs are part of horizontal fields extended from the penumbra. We find that the isolated MMFs located on the lines extrapolated from the vertical components of the fluted structure have vertical fields with polarity same as the sunspot. This is clear evidence that such MMFs are detached from the vertical components of the penumbra. Their flux transport rate is estimated to be 1-3 times larger than a flux loss rate of the sunspot. The isolated vertical MMFs alone can be responsible for decaying the sunspot.

Observational Study of Solar Magnetic Active Phenomena

H. Zhang (National Astronomical Observatories, Chinese Academy of Sciences)

The following problems would like to discussed:

1. The diagnostics of vector magnetic fields in the solar atmosphere and the corre sponding researches at Huairou.
2. The configuration of magnetic field and the relationship with electric current and magnetic (current) helicity in solar atmosphere inferred from the observational data.
3. The possible processes on the storage, development and relax of non-potential magnetic energy in solar active regions and the relationship with solar eruptive phenomenon, such as flares and coronal mass ejections.
4. Some possible questions on the high spatial resolution observations of vector magnetic field

4 WAVES AND SHOCKS

Waves and Shocks in the Solar Atmosphere
V. Hansteen (Institute of theoretical astrophysics, University of Oslo)

There is a large volume of observations showing wave phenomena in the solar chromosphere and corona. These waves affect the very structure of the atmosphere, and may contribute to the heating of both the chromosphere, transition region and corona. They also provide powerful diagnostics using seismological techniques. In this talk we will review the observations of waves and compare these with simulations of wave excitation in the solar convection zone and of wave propagation and mode conversion in realistic magnetic field topologies.

Flare-associated shock waves observed in soft X-ray
N. Narukage (Kwasan Observatory, Univ. of Kyoto) and K. Shibata

In H-alpha, a flare-associated chromospheric wave (called a Moreton wave) was discovered in 1960, and after that such waves are sometimes observed. Uchida (1968, 1974) identified the Moreton wave as the intersection of a coronal MHD fast-mode shock and the chromosphere. Recently, the Soft X-ray Telescope (SXT) on board Yohkoh observed coronal wave-like disturbances (X-ray waves). Narukage et al. (2002, 2004) showed two X-ray waves are MHD fast-mode shock, i.e., coronal counterparts of the Moreton waves, and estimated the Alfven Mach number of the X-ray waves. The Solar-B has X-Ray Telescope (XRT) on board and will be launched in 2006. We expect XRT will detect coronal X-ray waves. In preparation for Solar-B, we examine the detectable possibility of waves with XRT and suggest methods for observation.

Flare-associated oscillations in coronal multiple loops observed with the Norikura Green-Line Imaging System
K. Hori (Solar Observatory, NAOJ), K. Ichimoto, and T. Sakurai

We report a standing Kink oscillation in coronal loops that was observed in the coronal green line emission (Fe XIV 5303A, 2MK) by the Norikura Green-Line Imaging System (NOGIS), a 2D Doppler coronagraph at the Norikura Solar Observatory, NAOJ.

Similarly to the TRACE observations in EUV lines, our event was induced by flare-associated disturbances, i.e., an MHD wave and a mass expansion. The oscillation started in Doppler shifts among an aggregate of face-on coronal loops near the solar limb. Thanks to the favorable loop configuration, we could investigate the difference in oscillation profiles (e.g., period, amplitude, decay time) among the inner loops and outer loops, which can give a hint to understand trigger and damping mechanisms of coronal loop oscillations. We compare the parameters with those obtained from recent numerical simulations and other observations of coronal loop oscillations and examine our flare-oscillation scenario.

Because the NOGIS observation is sensitive to the plasma temperature, we need imaging spectroscopic observations with a wide temperature range. In this point, Solar-B/EIS will be a good partner for a further investigation of coronal disturbances.

5 CHROMOSPHERIC HEATING

Chromospheric Dynamics: Spicules and Waves
B. De Pontieu (Lockheed Martin Solar & Astrophysics Lab)

The dynamics of the chromosphere are dominated by waves and spicules, jet-like features that are propelled upwards at speeds of 20 km/s from the photosphere into the low magnetized atmosphere. Spicules have been a significant challenge to both observers and theorists, mostly because of their highly dynamic nature and small size, which are close to current observational limits. The advent of Solar-B will enable the first seeing-free observations that are of high enough spatial and temp resolution to reveal the intricate links between photospheric magnetic field and elements, the photospheric flowfield and waves and chromospheric waves and spicules. The main focus of this talk will be the advances Solar-B will be able to make in our understanding of the formation of spicules and their impact on transition region and corona. To illustrate the issues and methods needed to tackle this difficult problem, I will present recent work on a synthesis of very high resolution observations of spicules in active region plage using the Swedish Solar Telescope (SST, La Palma, Spain) combined with theoretical modelling of spicule formation.

Chromospheric Magnetic Reconnection
J. Chae (Seoul National University, Astronomy Program/SEES)

There has been increasing observational evidence that magnetic reconnection often occurs in the low atmosphere of the sun. I will give a review of recent observational results on canceling magnetic features in the photosphere and jet-like events in the chromosphere. Then I will discuss the expected physical properties of magnetic reconnection occurring in the photosphere and chromosphere based on an adiabatic current sheet model of Sweet-Parker type.

The ESA Contribution to Solar-B
H. Opgenoorth (ESA/ESTEC)

The European Spce Agency ESA and the European science community recognise the importance of the Solar-B mission for the future advancement of Solar physics and space plasma physics in general. In order to maximise the outcome of this important mission ESA has decided to facilitate a considerably increased data-return from the Solar-B. By placing an internal European contract with the Norwegian Space Centre in Oslo, ESA will make use of the Svalbard satellite receiving station to provide downlink-contact to all 15 daily orbits of Solar-B. This will allow a doubling of the original baseline contacts with the satellite and considerably improve the availibility of Solar-B data. The exact use of this extra downlink time will have to be discussed in the SWG of Solar-B, but it is clear that it will considerably improve either the cadence of some measurements or the overall data delivery from the mission as a whole. In addition to the ground-station the ESA contract with the Norwegian Space Centre also includes the construction of a full European mirror datacenter in Oslo, to provide all the European downlink data to the international collaboration partners and to cater the European community with high quality mission data. ESA hopes that these measures will benefit Solar-B as a mission in particular and the international Solar science community in general. ESA sees this contribution as a part of the International Living With a Star initiative, in which over 25 space agencies around the world try to optimise Sun-Earth connection science over the coming decade.

6 CORONAL HEATING

Topological Dissipation and the Solar Corona

B. Gudiksen (Institute of theoretical astrophysics, University of Oslo)

It has been established that Parkers (1972) idea of topological reconnection takes place in the solar corona. Observations have identified small scale heating events of energies ranging from the largest flares to what in Parkers terminology would be micro flares. Assuming the flares are a result of a cascade process, then the number of flares per energy interval is a powerlaw agreeing with observations from TRACE, SOHO and YOHKO. Our poor knowledge of the details of the reconnection process itself may lead to substantial bias in the estimated energy contained in observed flares. As the distribution of energy between non-thermal particle motions, heat and radiation is most likely a function of energy, a first estimate of the functional shape can be gained from Solar-B, observing large number of flares at different energies. This shape may determine if the energy contained in the small scale flares are sufficient to heat the corona, as seems to be the result from recent numerical simulations(Gudiksen+Nordlund, 2005).

Limb prominences seen in UV, EUV and SXR

P. Heinzel (Ondrejov Observatory, Czech Republic; MPA Garching, Germany), F. Farnik, U. Anzer and I. Dammasch

We use SOHO/SUMER,EIT and Yohkoh SXT prominence observations to study the absorption and/or volume blocking (see Anzer and Heinzel, ApJ 622, 714, 2005) of UV, EUV and SXR radiation by cool prominence plasma. As an example for his type of behaviour we study the limb prominence observed on 5 Sept. 1996. The SUMER spectrograph has detected two coronal lines, MgX at 625 A which is absorbed by the hydrogen Lyman continuum and blocked within a volume occupied by cool prominence plasma, and FeXII at 1242 A where the prominence appears dark due to blocking only (since there is negligible absorption at this wavelength). A similar behaviour is visible also in the EUV images taken by EIT. We find that a darkening comparable to that detecetd in the FeXII line can be seen in the SXR images obtained by Yohkoh/SXT. Since the absorptions by the Lyman continuum, the resonance continua of HeI and HeII and also by the metals are all small in the energy range of SXT we explain the darkening seen by SXR as being entirely due to volume blocking. Based on a quantitative analysis of these data, we discuss the physical conditions in cool prominences and in their coronal environment. Finally, we propose new high- resolution EUV and SXR observations of prominences and filaments by Solar-B, using the EUV imaging spectrometer (EIS) and the X-ray telescope (XRT) as a basis for a more detailed investgation of such cool structures.

Observational Analysis of the Relation between Coronal Loop Heating and Photospheric Magnetic Fields

Y. Katsukawa (National Astronomical Observatory of Japan)

The solar corona and the photosphere are linked through magnetic field lines, and heating energy is supposed to be supplied from the footpoints of each coronal loop alog magnetic field lines. Thus it is important to examine properties of photospheric magnetic fields at the footpoints of the coronal loops in order to understand heating of the coronal loops. We performed simultaneous observations of photospheric magnetic properties and coronal loop structures with Advanced Stokes Polarimeter (ASP) and TRACE. We found that (1) the difference between hot and cool coronal loops was related with number density of elemental magnetic elements at the loop footpoints in the photosphere (Katsukawa and Tsuneta 2005), and (2) the cool coronal loops emanating from a sunspot had their footpoints at the positions where there was highly interlaced magnetic structure around an umbra (Katsuakwa et al. 2005). These observational results suggest that critical magnetic properties are not yet spatially resolved to understand the coronal heating. Solar-B will provide an opportunity to perform direct investigation of the correlation between fine magnetic structures located at loop footpoints.

7 LOCAL HELIOSEISMOLOGY

Local Helioseismology
D. Chou (National Tsing Hua University, Taiwan)

Local helioseismology uses the solar p-mode waves to study the physical conditions of a local region below the solar surface. Here we will review the methods used in local helioseismology including ring-diagram analysis, time-distance analysis, and acoustic imaging, and some of results from local helioseismology. We will also mention some of prospects of using Solar-B data in local helioseismology.

SOT time-distance helioseismology in and around active regions
T. Sekii (NAOJ), J. Zhao and A. G. Kosovichev

Dopplergrams produced by the MDI instrument, aboard the SOHO spacecraft, have been used extensively for time-distance helioseismology to probe sub-surface flow and soundspeed anomaly. The Solar Optical Telescope aboard Solar-B also has capability of producing high-resolution Dopplergrams, which can be used for time-distance analysis. One problem with Doppler measurement, however, is that it is not very reliable in active regions, since the algorithm of converting filtergrams to Dopplergrams is tuned for quiet regions, though how this should affect time-distance measurement in active regions is not readily known. Intensity data, though known to be noisier than Doppler velocity data, are less likely to be affected by magnetic field. We have analyzed MDI Doppler as well intensity data, in a quiet region and in an active region, to make a comparison. The travel-times from intensity data are systematically longer than the ones from Doppler data. This is understood to have arisen largely from different power distributions for two signals and does not necessarily indicate any fundamental difference. However, we have noted that the difference in travel times increases in active region. Implication on inversions for sub-surface velocity field, which will be carried out for SOT data, is discussed.

Observations of the MHD and helioseismic responses to flare energy-release events
A. Kosovichev (Stanford University)

Recent observations of solar flares with SOHO/MDI led to discovery of new powerful helioseismic events ("sunquakes"), caused by the impact of high-energy particles. These observations provide important information about the physics of the interaction between high-energy particles and plasma, hydrodynamics of the energy release, and interaction of MHD waves with sunspots, as well as opportunities for developing new helioseismic diagnostics of flaring active regions. The MDI observations have revealed new unexpected features of these events, such as a strong anisotropy of the wave amplitude, extended and multiple sources correlated with hard X-ray and white-light emission. However, the relatively low spatial and temp resolution of the MDI instrument does not allow us to investigate many interesting details of the sunquake sources and MHD wave propagation. The initial shocks, generated by high-energy particles, are developed on the time scale of 1-2 min, and spatial scales of 1-2 arcsec, also the seismic response waves have significant power above 6 mHz well above the standard helioseismology range. I present the recent results of the sunquake investigations using MDI and RHESSI data, and propose a program of simultaneous observations with SOT, XRT and EIS for investigation of the energy-release events and their impacts.

8 EMERGING FLUX

Flux emergence into the solar atmosphere: buoyancy instabilities, current sheets and reconnection
F. Moreno-Insertis (Instituto de Astrofisica de Canarias)

Numerical experiments concerning the emergence of magnetic flux into the solar atmosphere and the associated dynamical phenomena are now being routinely carried out thanks to the advances in MHD codes and the new supercomputation facilities in the world. In recent years, three-dimensional simulations of the process of eruption of magnetic flux from the solar interior into the corona have been carried out, albeit with strongly simplified assumptions concerning the thermodynamics and with limited resolution. Yet, many phenomena are being reproduced in the experiments that are amenable to a qualitative (to a limited extent, also quantitative) comparison with observations in the photosphere, chromosphere and corona. Also, the numerical experiments permit new insights into the theory of coronal and photospheric magnetic fields, including buoyancy instabilities and reconnection.

In this review, a summary of the history of the subject will be given together with a briev overview of relevant observations. A number of recent experiments of the interaction of the emerging fields with pre-existing coronal fields have been obtained by different groups and will be discussed. Particular attention will be given to the formation of current sheets, reconnection phenomena taking place in them and the emission of high-velocity jets. The availability of data from the Solar-B mission promises a new era in understanding flux emergence into the solar atmosphere: their importance will also be discussed as part of this review.

Observations of magnetic field reconnection at the base of EFR surges
H. Kurokawa (Kwasan & Hida Observatories ,Graduate School of Science, Kyoto University), Y. Liu, S. Sano, and J. Kiyohara

We found conspicuous Halpha surge activities at the earliest stage of some active regions and suggested that the Halpha surge is one of the first manifestations of the active region birth (Kurokawa 1988). We call such Halpha surges as EFR surges. From the morphological studies of EFR-surges, we presented a schematic model of surge production where the surge is produced by the reconnection between the emerging magnetic flux and the pre-existing surrounding magnetic field of opposite magnetic polarity (Kurokawa and Kwai 1993). Yokoyama and Shibata (1996) succeeded to reproduce it by their numerical simulation. As for the magnetic field of surge region, we found longitudinal magnetic field flux of an isolated polarity increased at the bases of most surges during and after the surge activities (Sano and Kurokawa 2005). We also found magnetic field cancellation between one polarity of emerging flux and the surrounding opposite polarity at the surge base (Yoshimura et al. 2003, Brooks and Kurokawa 2005). Those observational evidences are all compatible with the reconnection model of the EFR surge. We will challenge to find the first clear evidences of changes in transverse magnetic field at the base of the EFR surges to give proof of the magnetic field reconection with the vector magnetograph of the SOT.

3D MHD simulations of emerging flux and associated reconnection

H. Isobe (Department of Earth and Planetary Science, University of Tokyo), T. Miyagoshi, K. Shibata, and T. Yokoyama

Emerging flux plays important role in the energy accumulation and the trigger of flares and coronal mass ejections. It also has some information of the structure of the magnetic field below the photosphere. Hence it is obviously one of the principal targets of Solar-B observations. We carried out three-dimensional MHD simulations of an emerging flux region with high resolution using the unprecedented computational power of the Earth Simulator, a vector-parallel super computer installed at the Earth Simulator Center. The main results are summarized as follows: (1) Filamentary structure similar to an arch filament system is spontaneously formed in the emerging flux due to the magnetic Rayleigh-Taylor instability. (2) Filamentary current sheets are formed in the emerging flux as a result of the nonlinear development of the magnetic Rayleigh-Taylor instability. This naturally explains the intermittent heating of emerging flux regions observed in EUV images. (3) Magnetic reconnection between the emerging flux and the coronal field occurs in spatially intermittent way, because of the interchanging of the current sheet due to the Rayleigh-Taylor instability.

9 RECONNECTION

Studies of Magnetic Reconnection in Laboratory and Space-Astrophysical Plasmas

M. Yamada (Princeton Plasma Physics Laboratory, Princeton University)

Recently magnetic reconnection phenomenon have been recognized to have wide-ranging importance in space and astrophysical plasmas, as a key process in the interaction of the solar wind with the dipole field of the earth 's magnetosphere, in the evolution of solar and stellar flares and in the formation process of stars. The recent advances in laboratory reconnection physics, along with the surge of space physics data from satellites, have made cross-discipline research very useful for obtaining new physics understanding of its key processes [1]. The recent rapid advance of numerical simulation has played an important role in bridging between laboratory data and space-astrophysical observations [2]. One of the most fundamental questions is why reconnection occurs much faster than predicted by the classical MHD (Magnetohydrdynamic) theory. MRX (Magnetic Reconnection Experiment), together with other laboratory experiments, is dedicated to the study of reconnection physics in a controlled manner [1,3]. Many important findings to date include 1) the measured reconnection rate decreases notably with presence of guide field, 2) resistivity is classical in the collisional regime but is strongly enhanced at low collisionality, 3) the presence of electromagnetic turbulence in the lower-hybrid frequency range during fast reconnection, and 4) first clear measurements of the predicted quadrupole out-of-plane magnetic field. The results from dedicated laboratory experiments depict many striking commonalities with observations in the magnetosphere sheath [3,4]. The recent experimental verification of Hall MHD effects in a neutral sheath of the width of the ion skin depth depicts a good example [5]. This talk provides a brief review of primary results from laboratory experiments by addressing both the global and local issues for magnetic reconnection together with comparison of the laboratory data with recent space astrophysical observations. Finally possible collaborative research subjects with the Solar-B program will be discussed. Collaboration with H Ji, S. Gerhardt, R. Kulsrud, M. Inomoto, A. Kuritsyn, Y. Ren,

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Solar Coronal Modelling Based on Observed Photospheric Magnetic Fields Including the Microphysics of Reconnection

J. Buechner (Max-Planck-Institut Fuer Sonnensystemforschung)

Photosphere, chromosphere and corona are coupled by the solar magnetic field. Since direct measurements of chromospheric and coronal magnetic fields usually are not available most investigations of the solar atmospheric magnetic field mathematically extrapolate the photospheric magnetic field to chromosphere and corona. In order to solve the mathematical problem the assumption of force-free fields is used. This excludes Lorentz-forces, i.e. the extrapolation approach neglects a major physical mechanisms of, e.g., coronal heating or solar wind acceleration. Contrary, realistic models have to take into account the plasma pressure and dynamics as well as perpendicular currents (Lorentz-forces!).

We review current achievements in the approach to a physical solar magnetic field modelling and to solar magnetic reconnection by numerical simulation which couples MHD to plasma microphysics, based on solar magnetic field observations. For the introduction of we investigate comparatively LCT, ILCT and MEF methods to derive the photospheric plasma motion.

Solar-B with its opportunities for vector magnetic field measurements and rich onboard plasma diagnostics will provide excellent opportunities to fully utilze the new achievement of solar magnetic field and plasma modelling

An Observational Technique for Quantifying the Rate of Magnetic Reconnection

D. W. Longcope (Dept. of Physics Montana State University), D. E. McKenzie, J. Cirtain and J. Scott

Magnetic reconnection is evidently at work restructuring the solar corona and possibly even heating its plasma. To better quantify its contribution to heating it is essential to quantify the rate of magnetic reconnection in some context. Defining reconnection narrowly and topologically, as a change in the footpoints of a coronal field line, makes its quantification a problem of counting coronal field lines connecting a pair of opposing photospheric regions. We have conducted a prototype measurement of this kind involving one bipolar active region (AR9574) emerging in the immediate vicinity of an existing one (AR9570) over 2001 August 10-11. Shortly after emergence begins TRACE 171A images show coronal loops interconnecting the two regions; these are necessarily the result of coronal reconnection. We use 41 hours of high-cadence TRACE data to quantify the rate interconnecting loops appear. Using a magnetic model we conclude the reconnection rate averaged 35 megavolts over the entire period. Most of the reconnection occurs in a brief interval (3-6 hrs) beginning 24 hours after emergence onset. During this interval the reconnection rate was as high as 260 MV. The reconnection episode appears to coincide with a period of heating observed in soft X-ray images of Yohkoh SXT.

3D Reconnection Simulations of Descending Coronal Voids

M. G. Linton and D. W. Longcope (Naval Research Laboratory)

We will present simulations of a highly localized, finite duration burst of 3D reconnection in a post-CME current sheet. Such reconnection forms a pair of 3D reconnected flux tubes piercing the current sheet. These tubes retract from the reconnection region, pushing their way through the surrounding magnetic field to form a post-reconnection arcade below the reconnection region. We will discuss how the evolution of these reconnected flux tubes can form the descending, post-eruption voids which have been seen in the high corona by the Yohkoh, TRACE and LASCO instruments. We will discuss how observations of these voids by EIS, coupled with further simulations, could help us to better understand the generation and dynamics of these voids, and of coronal reconnection in general.

10 FLARES

Observations of Preflare Conditions
Haimin Wang (Big Bear Solar Observatory)

In this talk, I will review the observations of preflare conditions. The following topics will be discussed: (1) Magnetic topology before flares, such as magnetic gradient, magnetic shear, current structure, helicity injection and new flux emergence. (2) Flow fields before flares, such as shear flows, converging flows and apparent active region rotation. (3) upper atmospheric signature such as filament activation, sigmoid structure and pre-cursor heating of flares. In addition, I will discuss the evolution of these magnetic structures leading to and following the flares.

Evolution H-alpha Flare Kernels and Energy Release
Ayumi Asai (Nobeyama Solar Radio Observatory), Takaaki Yokoyama, Masumi Shimojo, Satoshi Masuda, Kazunari Shibata

The investigation of the evolution of H-alpha kernels allows us to derive some keys of the energy release and the particle acceleration mechanisms during a flare. We report a detailed examination about the relationship between the evolution of the H-alpha flare ribbons and the released magnetic energy during an X2.3 solar flare which occurred on 2001 April 10. In the H-alpha images, several bright kernels were observed in the flare ribbons. Based on the magnetic reconnection model, we could calculate quantitatively the released energy by using the photospheric magnetic field strengths and separation speeds of the fronts of the H-alpha flare ribbons. We confirmed that the estimated energy release rate well corresponds to the bursts in the lightcurves of nonthermal emission and the spatial distribution of the radiation sources. We also examined the downward motions which are observed at the H-alpha kernels. The "red-asymmetry" is generated by the precipitation of the nonthermal particles and/or thermal conduction into the chromospheric plasma. We found that the stronger the red-asymmetry is, the brighter the H-alpha kernel is.

A Holistic Modeling of the Transition Process from Pre-Flare Sigmoid to Flare Eruption
K.Kusano (The Earth Simulator Center, JAMSTEC), S.Inoue, D.Shiota, T.Yamamoto, T.Yokoyama, and T.Sakurai

Although the satellite observations for the last decade strongly support the reconnection scenario for the energy liberation mechanism of solar flares, the transition process from pre-flare to the onset of flare is not yet well understood. The realization of the three-dimensional (3D) structure of magnetic field in pre-flare phase is believed to be able to shed light upon this long-standing problem. The combination of the high-precision vector magnetograms provided by Solar-B/SOT and the large scale numerical simulation using high-speed super computers must be a powerful tool for this purpose. In this paper, first, we present the recent results of our 3D simulations, which indicate that the causal process from the formation of pre-flare sigmoid to the onset of flare eruption can be explained as a consequence of the tearing mode instability growing on thin current sheet, where magnetic shear is steeply reversed. Second, we discuss the prospect and the problem in the 3D numerical modeling to reconstruct the structure and the dynamics of active regions using the Solar-B data and the state-of-the-art numerical technique.

11 CORONAL MASS EJECTIONS

Solar Origins of Interplanetary Shocks
L. K. Harra (UCL-MSSL)

Solar-B will provide unprecedented detail of the changes in the solar atmosphere leading up to the eruption of coronal mass ejections. The SOT will provide measurements of flows and shear in the photospheric magnetic field, XRT will provide high resolution full Sun images to track global responses, and EIS will provide measurements of flows and dynamics in the solar atmosphere. I will discuss the recent observations made with the array of space and ground-based observations currently available on the sources of coronal mass ejections, and will discuss how Solar-B will be able to push forward our understanding of these dramatic events.

3D Simulations of Large-Scale Coronal Dynamics
J. Karpen (NRL)

Understanding the origins of solar activity is one of the primary science objectives of Solar B. Although great strides have been made during the past decade toward a comprehensive picture of coronal mass ejections (CMEs) and flares, we still do not fully understand one of the most fundamental aspects: the evolution of filament channels, the highly sheared magnetic fields that produce large-scale eruptions on the Sun. A multi-faceted approach is required to tackle this crucial problem, involving coordinated observations, analytic theory, and computational studies. Both observing and modelling coronal eruptions are particularly challenging, due to the enormous range of relevant spatial scales. Energy storage and dynamics affect structures as large as transequatorial loops, while the release process probably occurs on the miniscule scales of current sheets and nulls.

The NRL Solar Theory group has been using theory and numerical simulations to understand the complete process: the development of filament-channel magnetic structure (sheared-arcade model), the dynamic generation of condensations constituting a prominence within this structure (thermal nonequilibrium model), and the explosive onset of CMEs and associated flares (breakout model). Thanks to recent hardware and software advances, we can now critically evaluate theories of filament-channel evolution, prominence formation, and CME initiation, and predict key signatures for comparison with observations. I will summarize the results of our simulations and their implications for filament-channel evolution and eruption. I will also discuss how the powerful combination of high-resolution/large FOV instruments on Solar B, complemented by overlapping STEREO coverage, will be essential for detecting specific observable signatures predicted by these models, from detecting reconnection-driven flows to deciphering the 3D magnetic structure of prominences and CMEs.

12 SOLAR WIND

UVCS Observations of Solar Wind and its Modeling
Steven R. Cranmer (Harvard-Smithsonian Center for Astrophysics)

This presentation will review the dramatic new understanding of the solar wind that has come from the past decade of UVCS/SOHO observations, analysis, and theoretical work. In many ways, there is a key synergy between the two very different kinds of remote-sensing measurements discussed here. (1) The high-resolution solar disk measurements of Yohkoh and Solar-B reveal the complex lower boundary conditions for solar mass loss. (2) Coronagraph measurements in the wind's acceleration region (especially in combination with spectroscopy) allow the highly dynamic nonequilibrium evolution of the plasma to be followed as the asymptotic conditions in interplanetary space are established. Both kinds of observations are needed for a complete understanding of the expansion of the Sun's atmosphere. This presentation gives a brief survey of UVCS/SOHO results, including evidence for preferential acceleration of heavy ions in coronal holes, ion temperatures exceeding 100 million K at large heights, and extreme departures from Maxwellian velocity distributions in both fast and slow solar wind streams. UVCS also provided the first detailed plasma diagnostics of coronal mass ejections in the extended corona, yielding new insights into the roles of shock waves, current sheets, and helicity conservation in the evolution of solar eruptions.

What coronal parameters determine solar wind speed?
M. Kojima (STEL, Nagoya University), M. Tokumaru, K. Fujiki, H. Itoh, T. Murakami, and K. Hakamada

We have been studying physical coronal parameters which determine solar wind velocity. Coronal hole scale size is one of them. A large-scale polar coronal hole is a source of fast solar wind, and medium and slow speed streams originate in smaller coronal holes. Not only the coronal hole scale size but also the flux expansion rate and magnetic field energy determine the wind velocity. However we have revealed that an individual parameter of the flux expansion rate (f) or the magnetic field energy (B) does not determine the velocity, but a combination of them in a ratio B/f determines the velocity.

Self-consistent MHD modeling of solar wind acceleration
T. K. Suzuki (Kyoto University) and S. Inutsuka

We show that the coronal heating and the solar wind acceleration in the coronal holes are natural consequence of the footpoint fluctuations of the magnetic fields at the photosphere, by performing one-dimensional magnetohydrodynamical simulation with radiative cooling and thermal conduction. We impose transverse photospheric motions corresponding to the granulations with velocity 0.7km/s and period between 20 seconds and 30 minutes, which generate outgoing Alfven waves. After attenuation in the chromosphere by 85energy flux, the outgoing Alfven waves enter the corona and contribute to the heating and acceleration of the plasma mainly through nonlinear generation of the compressive waves. Finally, we discuss relations between the photospheric magnetic fields and the above coronal properties predicted from our simulations, which can be directly tested by observations of various coronal holes by Solar-B.

13 POSTERS

13.1 Instrumentation

P01 **Application of CHIANTI to Solar-B**

K. Dere (George Mason University), E. Landi, G. Del Zanna, P. Young, H. Mason, M. Landini

CHIANTI (http://wwwsolar.nrl.navy.mil/chianti.html) has been developed to support the interpretation of solar and astrophysical spectroscopic measurements. The most recent release, version 5.0 (Landi et al., 2005) presenet an improvement over previous versions by including new large scale datasets for Fe ions from Fe XVII to Fe XXIV for X-ray emission and improved atomic data for EUV line emission. We will demonstrate how this can be applied to the analysis of XRT and EIS data, in particular. For example, new excitation rates for Fe XII have resolved a long standing problem in the use of Fe XII line ratios as accurate density diagnostics. Current work involves improvements to ionization and recombination rates which will also be useful in the interpretation of Solar-B data.

P02 **Calibration of the plarization property of SOT**

K. Ichimoto (NAOJ), Y. Suematsu, T. Shimizu, Y. Katsukawa, M. Noguchi, M. Nakagiri, M. Miyashita, S. Tsuneta, T. Tarbell, D. Shine, C. Hoffumann, D. Elmore, B. Lites and SOT team

An end-to-end testing of SOT using natural sunlight was conducted in June 2005 with a heliostat at Mitaka. During the testing, we performed the calibration of the polarization characteristics of SOT. Well calibrated sheet polarizers (linear and circular) was placed on the OTA to controle the incident Stokes vector, and the polarimeter response matrix, X, was determided for the spectropolarimeter (SP) and the narrowband filter instrument (NFI), where X is defined by by S_{out} = X S_{in} with S_{in} is the Stokes vector incident to the OTA and S_{out} is the Stokes vector produced by the onboard demodulation. It is found for SP that the X matrix can be regarded as uniform over each left and right CCD and for scan positions. X matrix for NFI shutterless mode can be regarded as uniform in each left and right half of the CCD, but they have a mutual rotation of about 2.8deg. which should be corrected in the data reduction. We suggest to determin the first colums of the X matrix more accurately after launch using the continuum in data obtained in orbit. The sensitivity of SOT on polarization (and also on magnetic fields) for all wavelengths observed by NFI are also discussed.

P03 **Calibration of SOT Dopplergrams**

Y. Katsukawa (National Astronomical Observatory of Japan), K. Ichimoto, T. Sekii, T. Tarbell, and SOT team

Narrowband Filter Imager (NFI) on SOT provides Dopplergrams which are images of Doppler velocity and critically important in observations of photospheric dynamics and helioseismology. The Doppler shift of a spectral line is derived with 4 narrow-band images uniformly spaced through the line. The primary photospheric line used for Dopplergrams is Fe I 5576 A which is a line insensitive to Zeeman effect. We made a LUT for the 5576A Dopplergrams to get actual Doppler velocities from outputs of the Dopplergrams using an atlas spectrum and simulated transmission profiles of the tunable filter on SOT. Using data sets taken in the Sun light test, we evaluated accuracy of the Dopplergrams by comparing the rotational speed of the Sun with the predicted one. There was a little systematic error in the velocity obtained by SOT, but the error was less than 20We will also report the effects of Doppler motion of the sattellite and temperature variation in orbit.

P04 **Examinations of the relative alignment of the instruments on SOT**

T. Okamoto (Kwasan Observatory, Kyoto University), Y. Katsukawa, T. Shimizu, K. Ichimoto, Y. Suematsu, S. Tsuneta, T. Tarbell, and SOT team

We report the results of the examination about the relative plate scales and the alignment of the instruments on SOT using a data set which has a grid pattern over the entire FOV. SOT has the filtergrams (FGs) and the spectro-polarimeter (SP). The FGs consist of six broadband filter imagers (BFIs) and six narrowband filter imagers (NFIs). We examined the displacements among the filters to an accuracy of less than 0.1 pixel. It is important to know relative displacements and plate scales of these instruments for accurate alignment of observational data. The main contents in this presentation are in the following:

1. Relative alignment of FG images a. Displacements and plate scales among BFIs and NFIs b. Dependence on focus position 2. Relative alignment of SP Images a. Displacements and plate scales between SP and NFI b. Uniformity of scanning steps

P05 **Estimate on SOT light level in flight with throughput measurements in SOT sun test**

T. Shimizu (ISAS/JAXA), T. Tarbell, Y. Suematsu, M. Kubo, K. Ichimoto, Y. Katsukawa, M. Miyashita, M. Noguchi, M. Nakagiri, S. Tsuneta, D. Elmore, B. Lites and SOT team

Solar-B SOT (solar optical telescope) consists of optical telescope (OTA) and focal plane instruments (FPP). The solar light into the telescope penetrates through many numbers of optical elements located in OTA and FPP before illuminating CCDs. Natural sun light was fed to the integrated SOT in two sun-test opportunities. CCD exposures provide the number of photons accumulated in an exposure duration in clean room test condition. To estimate one solar light level in flight (without earth atmosphere attenuation), a pinhole-PSD (position sensitive detector) sensor (525 nm band) was used to monitor the light level simultaneously. This sensor was pre-calibrated with continuous monitoring the solar light level in a day long under a clear constant sky condition, giving what is the voltage for one solar light level. Transmissivity of heliostat two flat mirrors plus clean-room entrance window glass was also measured as a function of wavelength. This throughput measurement with solar light has confirmed expected number of photons and suitable exposure durations in flight.

P06 **The SOLAR-B Science Center in Japan**

M. Shimojo (Nobeyama Solar Radio Observatory/NAOJ), S. Tsuneta, and SOLAR-B Project/NAOJ

We are proposing to establish the Solar-B science center (SBSC) at NAOJ. The concept of the proposal is that SBSC be a platform for joint research to maximize scientific return from SOLAR-B. The concept was accepted both by NAOJ and JAXA, though funding is pending at this point. The computer system of SBSC includes the PC-cluster for the inversion of the vector magnetogram and the local helioseismology. The mass-storage system at NAO is mainly for the higher-level data, while JAXA/ISAS maintains lower-level data. We plan to provide methodology to make DVD Movie disc etc for simultaneous browse of SOT, XRT and EIS data. We are discussing with JAXA/ISAS for the easy-to-use data search system based on the existing ISAS DARTS data archive system. We recognize that these plans are ambitious. SBSC invites both domestic and international visitors, and provide scientifically comfortable environment for joint data analysis.

P07 **Optical Performance of Optical Telescope Assembly of SOT: Confirmation of Diffraction-Limited Performance**

Y. Suematsu, K. Ichimoto, T. Shimizu, M. Otsubo, M. Nakagiri, M. Noguchi, T. Tamura, Y. Katsukawa, Y. Kato, H. Hara, M. Miyashita, S. Tsuneta (NAOJ), M. Kubo, Y. Sakamoto (Univ. of Tokyo), T. Matsushita, N. Kawaguchi, T. Nakaoji, K. Nagae, S. Shimada (MELCO), N. Takeyama (GENESIA), and SOT team

Integration and optical test of Optical Telescope Assembly (OTA) flight model of SOLAR-B Solar Optical Telescope (SOT) has been completed in a clean room of NAOJ. The main structure of OTA is an aplanatic Gregorian telescope of a 50 cm effective aperture. In the optical test simulating a zero-gravity condition, we confirmed that the OTA has a diffraction-limited performance in all the range of observable wavelengths (388 - 668 nm), and this performance does not change after an acoustic and vacuum thermal cycling test. We also confirmed that thermal deformation of OTA on-orbit observing condition of the Sun is small, still keeping the diffraction-limited performance with negligibly small orbital focus change. We present the method and result of the tests in detail.

P08 On the Evaluation of Optical Performace of Observing Instruments

Y. Suematsu (NAOJ)

It is useful to represent an optical performance of observing instruments with a single figure such as the Strehl ratio or rms wavefront error. For this aim, we investigated the relationship between the Strehl ration and MTF curve; the latter is easily obtained with MTF chart observation by observing instrument. Using model instrument whose wavefront aberration is represented with random combination of low order Zernike polynomials, we found a definite linear relation between the Strehl ratio and an average MTF area which is an integration of average MTF curve with spatial frequency; the linear relation is applicable for the region where the Strehl ratio is higher than about 0.3. We describe the method and compare the results with those derived with a phase diversity method. We expect to apply the method here to evaluate the optical performance of the filter channels of Focal Plane Package of SOLAR-B Solar Optical Telescope.

P09 Temperature Analysis with XRT

M. Weber (Smithsonian Astrophysical Observatory)

The X-Ray Telescope will have an array of diagnostic filters with which to analyse the temperature and differential emission measure of coronal plasma. We discuss how the combination of the XRT capabilities with analysis techniques determines the information we can learn about the temperature structure of the corona.

13.2 CONVECTION, SUNSPOTS AND DYNAMO

P10 **Properties of G-band bright points**

Y. Kitakoshi (Department of Astronomy, University of Tokyo), S. Tsuneta, Y. Katsukawa, J. A. Bonet, S. Vargas T. Ebisuzaki, and T. Iitaka

We had performed coordinated observations with Swedish, Dutch, and German telescopes in Canaries and TRACE, and present high resolution observations of the G-band bright points for two contrasting active regions; a complex plage region and a simple region. G-band bright points are believed to represent elemental magnetic fields. Its lifetime is relatively short, and its shape is complex. Its evolution involves appearance, fragmentation, merging, elongation, and disappearance. If they faithfully represent elemental magnetic fields, whole evolution raises a fundamental issue related to generation and disappearance of solar magnetic fields. We show various evolution cases of G-band bright points to see their variety, dependence of shape and distribution on environment by comparing the contrasting two regions, and relationship with simultaneous polarization signals.

P11 **Small scale magnetic cancellation driven by supergranular scale flows**

H.E.Potts (University Of Glasgow), J.L.Khan, D.A.Diver

We have developed a highly efficient method for tracking solar photospheric flows from continuum data. We are currently using SOHO MDI continuum data, tracking the barely resolved granulation pattern. Our method is sufficiently fast that it will be able to calculate flow fields in real time from Solar-B BFI continuum data. Coupled with this we have an algorithm that accurately maps out the boundaries and upwelling points of supergranular convection cells. Using this flow data, and combining it with MDI magnetograms we can identify areas when the supergranular flow drives together the smallest resolvable magnetic elements. If we correlate this data with Yohkoh SXT soft x-ray images we can see the sites of small scale energy release due to flow driven magnetic cancellation. The resolution of SXT data however does not allow the smallest events to be imaged, and there are very few data sets of quiet sun data where SXT and MDI overlap. With the data from high resolution vector magnetograms and continuum images from the Solar-B FPP, combined with soft x-ray images from XRT we should be able much more accurately evaluate the energy release from these small, quiet sun events.

13.3 MAGNETISM OF QUIET SUN AND ACTIVE REGIONS

P12 **Skew Angle and Magnetic Helicity in Solar Active Regions**

M. Hagino (Korea Astronomy and Space Science Institute), Y-J. Moon and T. Sakurai

The skew angle and magnetic helicity are important to understand magnetic structures in solar active regions. In this study, we have made the first attempt to examine the relationship between the skew angle and magnetic helicity. For this we select 129 events whose longitidues are less than 30 degrees. The skew angle is defined as the angle between the polarity inversion line (PIL) and the coronal loop direction, which is defined as the soft X-ray coronal loop axis in Yohkoh/SXT images. The coronal helicity is determined from the coronal shear angle that is defined as the angle between the coronal loop axis and the direction from a positive to a negative sunspot. Photospheric helicities were computed from vector magnetograms of the Solar Flare Telescope at Mitaka. We confirmed that the coronal and photospheric helicity shows a positive correlation, supporting Pevtsove et al.(1997). We found that an active region which has a small skew angle tends to have a large helicity value. This result implies that while a strong twist coronal loop is nearly parallel to a PIL axis, a weak twist coronal loop is perpendicular to a PIL, like a potential field structure.

P13 **H-alpha Polarimetry and Magnetic Field Structure in the Chromosphere**

Y. Hanaoka (National Astronomical Observatory of Japan)

We have developed a high-precision polarimeter with ferroelectric liquid crystals, and it enables us to get full-Stokes polarization data of the chromosphere in the H-alpha line with the precision of the order of 10^{-4}. It revealed that polarization data taken at different wavelengths in the H-alpha wing show the magnetic field information at different height in the chromosphere. This means that three dimensional magnetic field structure in the chromosphere can be inferred from the H-alpha polarimetry data.

P14 **Evolutionary Characteristics of Magnetic Helicity Injection in Active Regions**

H. Jeong (Seoul National University) and J. Chae

Magnetic helicity is now regarded as an important physical quantity in understanding the magnetic activities of solar active regions such as flares and coronal mass ejections. A common wisdom is that magnetic helicity is transported from the interior to the corona, and then to the interplanetary space. In the present study, we are interested in examining temp behavior of helicity injection through the photospheric boundary that divides the interior and the corona. Specifically we aim to see whether magnetic helicity is supplied to the corona in a more or less steady way or not. We determined the rate of helicity injection in each active region applying Chae's method to the full-disk, 96 minute-cadence magnetograms taken by SOHO/MDI. Using these data, each active region could be followed without interruption for about 5 days while they were away from the limb. Some active regions were followed at next rotations, too. We found that magnetic helicity was supplied intensively during the period of flux emergence, especially during the growth of active regions. The amount of helicity injected during the growth period ranged from 2 x 10^{42} Mx^2 to 40 x 10^{42} Mx^2, depending on the active region flux. These values are much larger than the estimated contributions of differential rotation at the photospheric level. Our result suggests that most of the magnetic helicity in active regions may be supplied for several days during the early phase of the active regions.

P15 The use of spectro-polarimeter measurements to determine the plasma heating

J. Jurcak, V. Martinez Pillet, M. Sobotka

We present the possible use of spectro-polarimeter measurements on similar set of data recorded with La Palma Stokes Polarimeter attached to the Swedish Vacuum Solar Telescope. The stratification over the solar atmosphere of different physical parameters is retrieved from these data using the Stokes Inversion based on Response functions (SIR). Coming out from the stratification of the magnetic field strength and orientation of the magnetic field vector, we derive the vertical component of electric current density. We also found spatial and height correlation between the temperature enhancement and increase of electric current density, this could be caused by the energy dissipation stored in the magnetic field configuration.

P16 Scientific Plans for the Advanced Technology Solar Telescope

S. Keil (National Solar Observatory), T. Rimmele, J. Wagner and the ATST Team

The ATST is a 4-m aperture, off-axis solar telescope with integrated adaptive optics, low-scattered light, infrared, coronagraphic, and polarimetric capabilities. It will resolve the essential, fine-scale magnetic features and their dynamics that dictate the varying release of energy from the Sun's atmosphere. The ATST is being designed to optimize throughput, scattered light, and instrumental polarization properties to perform precision vector magnetic field measurements down to its diffraction limit (0.03 arcsec at 500 nm) and throughout the solar atmosphere. Its collecting area will provide the sensitivity to measure both weak fields and rapidly evolving stronger fields. It will provide the sensitivity and coronagraphic capability needed to measure the weak, fine-scale coronal magnetic fields. With adaptive optics and a set of facility class instrumentation the ATST will be the world's leading resource for studying solar magnetism and will provide a complete view of the solar atmosphere when used in conjunction with high-energy and other planned space missions.

We present a brief overview of the ATST program, how it fits into the broader picture of solar facilities and capabilities, opportunities for participation in the project, and plans for constructing and commissioning the ATST.

P17 **Determination of Magnetic Helicity of Solar Active Regions Using the Linear Force-free Field Model.**

Lim Eun Kyung (Seoul National University) , Chae Jongchul

Magnetic helicity is a useful quantity in characterizing the magnetic system of solar active regions. We aim to measure the helicity of the coronal magnetic field of an active region based on the linear force-free field assumption. With a value of the force-free , the coronal field is constructed from the extrapolation of SOHO/MDI magnetograms, and the constructed field lines are compared with the coronal loops in the EUV images taken by SOHO/EIT. The force-free that best fits the loops is used to calculate the helicity of the active region. We have applied this method to AR 10696 during its first rotation so that obtained the range of value and the temp variation of magnetic helicity. We have compared our results with the accumulated amount of the helicity transferred to the corona via the photosphere which is determined independently. We find that the two different methods yielded helicity values that are consistent within the difference of about 30 40coronal helicity decreased one day while the injected helicity steadily increased all the time. The decrease was due to a couple of CMEs that occurred during the same day.

P18 **The Community Spectro-Polarimetric Analysis Center**

B. Lites, R. Casini, J. Garcia, H. Socas-Navarro (HAO/NCAR)

The National Center for Atmospheric Research (NCAR) has undertaken a new 3-year initiative to develop the Community Spectro-polarimetric Analysis Center (CSAC). The goal of this effort is to provide the community with standardized tools for extracting the solar magnetic field vector and related atmospheric parameters from spectro-polarimetric observations. The emphasis will be to develop portable, efficient, and well-documented procedures for analysis of data from the many new and upcoming observational facilities, both ground- and space-based. The initial focus of CSAC will be the development of robust methods for inversion of Stokes spectral data, starting with a standard Milne-Eddington inversion that has been the workhorse for analysis of data from e.g. the Advanced Stokes

Polarimeter. Upon completion of that code, the program will move to more sophisticated methods that embrace more realistic and detailed models of the solar atmosphere. Very fast methods for inversion (neural networks or pattern recognition techniques, for example) are also candidates. Finally, the CSAC is intended to eventually provide standardized methods for resolution of the 180-degree field azimuth ambiguity, and for visualization of the resulting magnetic field vector maps.

P19 The spatial distribution of hot and cool coronal loops and asymmetiric Stokes profiles

S. Nagata. (Hida Observatory, Kyoto Univeristy)

Asymmetric Stokes V profiles emerge from the dynamical interaction between flux tubes and surrounding medium at the photosphere. Such interaction can excite Alfven waves or can form current sheets in the flux tubes; these are considered to be promising mechanisms for coronal heating. In this study, we investigate the spatial distribution of the Stokes V asymmetries and the coronal temperature with the Advanced Stokes Polarimeter(ASP) and the Transition Region and Coronal Explorer (TRACE). We find that the larger asymmetries and zero crossing velocity occur at the footpoints of hot loops (T>2NK) as compared with those of cool loop footpoints (T=1 2MK). We discuss the coronal heating model based on the relation between the observed asymmetries and the coronal temperature distribution.

P20 The Visible-Light Imager and Magnetograph (VIM) on Solar Orbiter

S. K. Solanki (MPS, Katlenburg-Lindau, Germany), V. Martinez Pillet, J. Woch and the VIM Team

Solar Orbiter is the next solar mission of ESA, scheduled for launch in 2013. It will explore the uncharted innermost regions of our solar system, from as close as 0.22 AU from the Sun. In the first, near-Sun phase, Solar Orbiter will examine the Sun from a nearly co-rotating vantage point. The Orbiter will then progress to orbits as high as 35deg, and obtain observations of the Sun's polar region. The spacecraft will carry a comprehensive payload consisting of in-situ and remote sensing instruments, among those the Visible-Light Imager and Magnetograph (VIM). VIM will measure magnetic and velocity fields in the photosphere with a resolution of 150 km. With its vector magnetic field capabilities VIM will allow the morphology, dynamics, and strength of the magnetic elements to be studied. It will also enable the quantitative inference of the magnetic field in the chromosphere and corona which are vital for the interpretation of the data obtained with the other remote sensing and in situ instruments onboard Solar Orbiter. Furthermore, Dopplergrams and magnetograms will be used to deduce, through local helioseismology techniques, subsurface flows. The internal structure and dynamics of the near-polar regions of the Sun is of considerable importance for our understanding of the solar cycle.

P21 SUNRISE: high-resolution UV/VIS observations of the Sun from the stratosphere

Solanki, Sami K., Gandorfer, Achim M.; Schuessler, Manfred; Barthol, Peter (Max-Planck-Institut for Solar System Research); Lites, Bruce W.; Martinez Pillet, Valentin; Schmidt, Wolfgang; Title, Alan M.; and the SUNRISE team

SUNRISE is a balloon-borne solar telescope with an aperture of 1m, working in the UV/VIS optical domain. The main scientific goal of SUNRISE is to understand the structure and dynamics of the magnetic field in the atmosphere of the Sun. SUNRISE will provide diffraction-limited images of the photosphere and chromosphere with an unpredecented resolution down to 35km at wavelengths around 220nm. Focal-plane instruments are a spectrograph/polarimeter, a Fabry-Perot filter magnetograph, and a filter imager. Stratospheric long-duration balloon flights of SUNRISE over Antarctica and/or the North Atlantic are planned. SUNRISE is a joint project of the Max-Planck-Institut fuer Sonnensystemforschung (MPS), Katlenburg-Lindau, with the Kiepenheuer-Institut fuer Sonnenphysik (KIS), Freiburg, the High-Altitude Observatory (HAO), Boulder, the Lockheed-Martin Solar and Astrophysics Lab. (LMSAL), Palo Alto, and the spanish IMaX consortium. In this paper we will present an overview on the mission and give a description of the instrumentation, now, at the beginning of the hardware construction phase.

P22 Helicity Injections in Regions of Various Magnetic Fluxes

T. Yamamoto (Department of Astronomy, Graduate School of Science, The University of Tokyo), K.Kusano, T.Yokoyama, and T.Sakurai

In this study, we investigate the amount of magnetic helicity injection (hereafter, helicity flux) among active region of various sizes (having different magnetic fluxes). We analyzed 78 active regions (more than 600 magnetograms), using the vector magnetograms obtained with the Solar Flare Telescope of NAOJ and SOHO/MDI magnetograms with the method proposed by Kusano et al. (2002). Ten active regions are tracked for several days, while other regions are studied based on single-day observation. The time cadence of data is 96 minutes. The magnetic flux of these regions ranges from 2.e+12 Wb to 4.e+14 Wb, and the absolute values of the helicity flux are from 1.e+17 Wb^2/s to 2.e+22 Wb^2/s.

From a scatter plot of magnetic flux and helicity flux, we found that the helicity flux has an upper limit for a given value of the magnetic flux, and the upper limit is nealy proportional to the magnetic flux. We can interpret these results with the model of helicity injection due to helical turbulence (Sigma-Effect; Longcope et al. 1998).

13.4 WAVES AND SHOCKS

P23 **Wave dynamics of the upper solar atmosphere**
L. Heggland (Institute of Theoretical Astrophysics, University of Oslo), V. Hansteen, T. Bogdan, K. Shibata

We study the propagation of simulated waves in the upper solar atmosphere. Particular emphasis is placed on the interplay between the three different wave modes (slow, Alfv 駭 ic and fast), which we study by identifying regions of conversion between them and examining their differing wave paths. The conditions for conversion into the Alfv 駭 mode are investigated, and are of special interest because that mode may have an easier time penetrating the transition zone and reaching the corona.

P24 **Solar B as a tool for coronal wave studies**
V. M. Nakariakov (University of Warwick)

Direct observational evidence of the wave and oscillatory activity of the = solar corona is abundant in all observational bands and includes recent = discoveries of propagating compressible waves in polar plumes and near = loop footpoints, flare-generated transverse oscillations of loops, and = longitudinal and sausage standing oscillations within loops. These = phenomena are confidently interpreted in terms of magnetohydrodynamic = (MHD) waves. This observational breakthrough gave rise to the rapid = development of a new method for the remote diagnostics of the coronal = plasma, MHD coronal seismology, allowing for estimation of the absolute = value of the magnetic field in coronal loops, Alfvén speeds, transport = coefficients, fine structuring, heating function and other important = coronal parameters. EIS and XRT instruments provide us with an excellent = tool for the further development of coronal wave studies and especially = flare generated oscillations and waves. We present the recent findings, theoretical estimations of the observabilit= y of different MHD modes with Solar B instruments, theory-based observation= al and data analysis strategies and some ideas about the utilisation of = the results for coronal seismology. The expected results are of particular = interest for the revealing of coronal heating mechanisms.

P25 **Atmospheric Seismology: Observed co-temporal oscillations by CDS and TRACE and the implicatons for Solar-B instrumentation**
R. W. Walsh (University of Central Lancashire) and M. Marsh

This paper focuses upon a sunspot active region that was imaged with the CDS wide slit

(with high time resolution in He I , O V, Mg IX) and also co-temporally in TRACE 171. 3-min oscillations were observed above the sunspot umbra in He I and O V.These oscillations are then observed to propagate along the active region loops observed in TRACE with both displaying resonance-like multiple frequencies. It appears clear that these propagations are the same wave phenomena travelling through the chromosphere and transition region before dissipating in the corona. As a consequence of this work, the characteristics of these propagations will be much better defined when observed with the instrumentation onboard Solar-B. For example, observations using the EIS slots in different temperature lines coupled with high time resolution XRT images will provide the ideal data set to build upon these CDS/TRACE observations. Simultaneously, direction observations of the source of these waves will be undertaken using SOT. Typical exposure times and line lists for EIS oscillation studies will be outlined as well as a brief discussion on the extent to which Solar-B will further develp our of understanding of solar atmospheric seismology.

P26 Measurement of energies of MHD waves generated by a microflare by SOLAR-B

T. Yokoyama (University of Tokyo)

The dissipation of MHD waves is suggested as a possible mechanism of the coronal heating. The measurement of the wave energy and its dissipation rate is one of the most important subjects that have to be studied during the SOLAR-B project. In this paper, we will discuss how to measure by SOLAR-B the wave energy generated by a flare or a microflare. By using the three-dimensional simulations of propagation of linear MHD waves, the predicted profiles of SOLAR-B/EIS data as a function of the wavelength, time, and space are presented.

13.5 CHROMOSPHERIC HEATING

P27 The Relation between EUV Brightenings and Dark Mottles in the Quiet Sun

S. Kamio (Kwasan Observatory, Kyoto University), H. Kurokawa and D. H. Brooks

During the coordinated observation between Hida/DST and SOHO/CDS in July-August 2002, quiet Sun was observed with Hida/DST H-alpha filtergram and SOHO/CDS high cadence (46s) observational program. We found several examples of EUV brightenings in He I and O V associated with elongated jets in H-alpha wing images. We present the temp evolution of dark mottles in H-alpha and EUV intensities, and discuss the possible mechanism of EUV brightenings in the quiet Sun network.

P28 Micro-Flare and High-Speed Down-Flow observed with VTT

R. Kano (National Astronomical Observatory of Japan), Y.Katsukawa, Y.Kitakoshi, T.Shimizu, S.Tsuneta and V.Martinez Pillet

In this July, we took the observation time for solar telescopes (VTT, SST and DOT) in Canary islands, and carried out the campaign observation with TRACE and SoHO satellites. On July 9, around the proceeding spot in NOAA 10789 many transient brightenings appeared in EIT images. We continuously observed this spot with spectropolarimeters in Vacuum Tower Telescope (VTT), and made a movie of spectrogram. VTT has two spectropolarimeters, POLIS and TIP2. We observed Fe-6302/6303A with POLIS, and Si-10827A and He-10830A with TIP2. At 13:14UT, a B5.4 flare occurred in the field-of-view. There is a small brightening in EIT image, and small activities in H-alpha images taken with SST. In He-10830A map taken with VTT, high speed (about 20km/s) down-flow transiently appeared near the magnetic neutral line. It seems to be accociated with coronal activity of the micro-flare. In this paper, we study the relation among coronal activities, chromospheric high-speed down-flow observed in He-10830A, and photospheric and chromospheric magnetic structures.

13.6 CORONAL HEATING

P29 **The Unresolved Active Region Corona**

J. Cirtain (High Energy Astrophysics Division Harvard-Smithsonian Center For Astrophysics)

Recent results of the intensity decrease as a function of altitude in Active regions have found that hydrostatic scaling laws can accurately model the observed decrease in intensity. Furthermore, the scale height temperature derived from the observations for Quiescent Active regions is found to be both constant in space and time. However, flaring Active Region emission has been found to have a multithermal background, and the scale height temperature has been observed to increase just prior to the onset of a flare. This observation may be a useful technique to predict solar flares, and the instruments on Solar-B may prove ideal for this type of investigation.

P30 **Magnetic Twist of EUV Coronal Loops Observed by TRACE**

RyunYoung Kwon (Astronomy Program, School of Earth and Environmental), Jongchul Chae

EUV images taken by TRACE clearly display a number of thin coronal loops that represent one million degree plasma tracing magnetic field line in the corona. We estimate the magnetic twist of coronal loops that can explain the constriction of plasma into a loop without dispersion. We assume that the segment of a coronal loop taken by TRACE 171 image is a part of a straight, non-force-free twisted flux tube and that the variation of the axial field strength along the tube is determined by the large scale three- dimensional configuration of the coronal magnetic field calculated by linear force-free extrapolation of photospheric magnetic field observed by SOHO/MDI. We selected a number of conspicuous loops which are bright enough and well separated from other adjacent loops on TRACE EUV images so that we can fit a magnetic field line to each loop from one footpoint to the other footpoint. We have applied our method to several coronal loops and found that these loops have twist values from 1.5 to 2.5, which suggest that the winding number of EUV coronal loop may be around one.

P31 **Investigation of coronal loop temperatures using three EUV filters and implications for future work with Solar-B**

J. B. Noglik (University of Central Lancashire), R. W. Walsh, J. Ireland

In 2002 Chae et al. proposed a two filter ratio method for determining unambiguous temperature values for the plasma in the solar corona. When applying this method to SOHO/EIT and TRACE data it was found that outside the range of 0.7 - 4 MK the errors for the instrument response functions were so large that the values could not be trusted. With this limited temperature range, this paper uses this technique to analyse a SOHO/EIT data set of loops at the solar limb. It is found that none of the points taken from along the coronal structure sat on the colour-colour curve. This could be due to a number of different reasons such as the time lapse between the three EUV images, the fairly poor resolution of EIT, plasma flows along the loop or perhaps we are looking through a multi-thermal atmosphere. Considering the latter, using a simple two temperature approach, it was found that it is possible to reproduce our results in this way.

P32 Modelling the radiative signatures of turbulent heating in coronal loops
S. Parenti (Institut d'Astrophysique Spatiale)

In this work we study the statistical properties of a coronal loop subject to turbulent heating. The results obtained here have been obtained with a model which simulates the heating and cooling of a multi-strand loop and its radiative emission. We investigate the effects of the loop sub-structure on the statistical properties of the total thermal energy and radiative emission. Our results are then used to discuss the prospects and limitations of such diagnostic methods when these quantities are derived from observations.

P33 Plasma diamagnetism and solar coronal activity
K. Shibasaki (Nobeyama Solar Radio Observatory)

Gyration of charged particles around magnetic lines of force creates ring current. The equivalent magnet is anti-parallel to the surrounding magnetic field. This is the origin of diamagnetism of plasma. The magnetic moment of thermal plasma is proportional to plasma pressure and is inversely proportional to magnetic flux density (M = P/B). When magnetic field has gradient, plasma particles are pushed toward weak field region (F = - M dB/dr). In closed magnetic loops, plasmas are confined around the loop top. In open magnetic field, plasmas are pushed outwards against the gravity. Even in the closed magnetic loop, plasmas tend to get out from the loop top when the plasma beta value is high (high-beta disruption). In general, magnetic field strength decreases outwards; hence plasmas are pushed outwards against gravity by magnetic force. This is the origin of solar coronal activity.

P34 **Studying transition region phenomena with Solar-B**

P. Young (Space Science and Technology Department CCLRC Rutherford Appleton Laboratory)

Spectrometers onboard SOHO have revealed a wealth of dynamic phenomena occurring in the Sun's transition region, with CDS and SUMER demonstrating rapid intensity fluctuations, high velocities and non-thermal broadening in blinkers and explosive events. The high spatial resolution of the SOT and vector magnetograph capability of the FPP potentially allow the transition region phenomena to be related to variations in the magnetic field, however the EUV spectrometer (EIS) has been optimised for coronal observations. This presentation will argue that good transition region science is possible with EIS in active regions and that, coupled with coronal observations from XRT and EIS, and photospheric observations with SOT/FPP, excellent opportunities exist to expand upon the work with SOHO and place the transition region phenomena in context. In particular I consider possibilities for studying loop footpoints, and active region blinkers.

13.7 LOCAL HELIOSEISMOLOGY

13.8 EMERGING FLUX

P35 **Flux cancellation associated with flux emergence on the Sun**

T. Magara (Univ. of California Berkeley/Naval Research Lab.), S. K. Antiochos, C. R. DeVore, and M. G. Linton

We study the mechanism for flux cancellation that occurs in the photosphere when a twisted flux tube emerges from below the photosphere. We use a three-dimensional, flux emergence MHD simulation in which magnetic field evolves through a highly stratified atmosphere extending from the subphotosphere to the corona. We find that different mechanisms work for flux cancellation at different stages of flux emergence. When the flux tube starts to emerge into the photosphere, Omega-shaped field lines (Omega-loops) appear on the surface to form a bipolar region. As emergence further proceeds, U-shaped field lines (U-loops) originally distributed at the lower part of the flux tube appear on the surface, and the emergence of these U-loops causes flux cancellation at the neutral line in the bipolar region. At the late stage of the simulation the dipped part of emerging U-loops is vertically stretched by strong downflows, which produces a deep dip with a strong current enhancement inside it. This might lead to magnetic reconnection occurring at this dip, followed by the submergence of reconnected Omega-loops which is another mechanism for flux cancellation.

P36 **MHD Numerical Simulations of an Emerging Flux Tube for studying effects of twist intensity and associated Active Phenomena in the Solar Atmosphere**

T. Miyagoshi (Kwasan Observatory, Kyoto University), H. Isobe, T. Yokoyama, K. Shibata

It is suggested that emerging flux build up magnetic energy in the solar corona that could become the source of flares or CMEs. Emerging flux also plays an important role in active region formation and disappearance. To investigate these phenomena, it is necessary to study the evolution of an emerging flux from the convection zone to the corona. Photosphere is gas pressure dominant (high plasma beta) region. So a magnetic flux tube in there could have some twists. To study emerging process of twisted flux tube, three dimensional MHD simulation is necessary. However, in almost all past numerical simulations for studying emerging process of twisted flux tube from convection zone to the upper

corona, very strong twist (more than one times round in half wavelength at initial state) is approximated. On the other hand, from observation, more weak twist flux tubes are often seen. So in this paper we will show the results of our three-dimensional MHD simulations of emergence of a twisted flux tube for studying effects of twist intensity, especially for weak twist case. We found that in weak twist case (including no twist case), a tube fragments once around the photosphere, and is extended to horizontal direction. Then emerging motion is rapidly suppressed. However, new emergence starts after fragmented magnetic field and continuously emerged flux from the bottom of the tube filling the solar surface. Also magnetic energy brought into the corona by emerging flux tube depends on twist intensity. We will also show that active phenomena, jet or surge caused by interaction between emerging flux tube and overlying active region magnetic fields.

P37 **3-D Magnetohydrodynamics Simulation of the Solar Emerging Flux**

S. Nozawa (Ibaraki Univ.)

A series of three-dimensional magnetohydrodynamic simulations are used to study the nonlinear evolution of the magnetic buoyancy instability of a magnetic flux sheet with magnetic shear. A horizontal flux sheet that is initially placed below the solar photosphere is susceptible to both the interchange instability and the Parker instability. The growth rate in the linear stage of the instability in the numerical simulation is consistent with that predicted by the linear theory. In the nonlinear stage, the development depends on the initial perturbation as well as the initial magnetic field configuration. When an initial perturbation is assumed to be periodic, the emerging flux rises to the corona and the magnetic field expands like a potential field, as observed in 2D simulations. When an initial non-periodic perturbation or random perturbations are assumed, the magnetic flux expands horizontally when the magnetic field emerges a little into the photosphere. The distribution of the magnetic field and gas tends to be in a new state of magnetohydrostatic equilibrium. When magnetic shear is present in the initial magnetic flux sheets, the interchange mode is stabilized so that the emerging loop is higher than in the no magnetic shear case.

P38 **Three-dimensional disruption of coronal arcade fields by an emerging flux tube**

S. Notoya (University of Tokyo), T. Yokoyama, K. Kusano, T. Sakurai, T. Miyagoshi, H. Isobe, T. Yamamoto

We present the results of three-dimensional numerical MHD simulations designed to model the process of the eruption in the corona. For the initial state, we prescribe an atmosphere that comprises a convective zone, photosphere, transition region, and corona. As a model of magnetic fields, we locate the flux tube that is uniformly twisted in the

convective zone, and the arcade fields that are sheared relative to the magnetic neutral line in the corona. In our simulations, the emerging flux triggers the eruption in the following way. First, the flux tube embedded in the convective zone moves upward when perturbed, and reaches the photosphere, and then expands to the corona by the magnetic buoyancy. In the process of the expansion, the coronal arcade fields are strongly deformed by the magnetic pressure of the emerging flux, and the current sheets are made inside the arcade fields. Then reconnection process of the arcades begins and generates strong upward motions of the reconnected field lines of the arcades. Our results suggest that emerging flux may initiate a coronal mass ejection.

P39 MHD simulation of emerging magnetic flux by CIP-MOCCT method

M. Shimizu (Kwasan Observatory, Kyoto Univ.), K.Uehara, T.Miyagoshi, D.Shiota, K.Nishida, K.Shibata

Many kinds of solar activities are caused by the release of magnetic energy, which is supplied from the solar interior as the magnetic flux injection which is observed as "emerging flux". On the other hand, observations show that various kinds of solar activities such as jets, flares and filament eruptions often occur in emerging flux regions. This suggests that emerging flux is not only significant for magnetic energy injection, but also significant for triggering other solar activities by the interaction with the ambient coronal magnetic field.

In this study, we simulate solar emerging magnetic flux by CIP-MOCCT method. By using this method we can do MHD simulation at higher resolution than previous simulation methods; this method has big advantage to save machine power. The porpose of using CIP-MOCCT method is to simulate whole active reigion and interaction between ambient magnetic field and emerging magnetic flux. Though we are still in an experimental stage, we report our current results.

For example we reproduce results of Yokoyama and Shibata (Nature, 1995). Though we simulate their model with smaller number of grid points, our results are even better than theirs, showing sharper dicontinuities. When magnetic reconnection occurs between emerging flux and coronal field, some plasmoids are created and ejected from the reconection region. Then the plasma confined in the plasmoids is released and surge like structures are created as many as the plasmoids.

P40 Correlation between increases of magnetic fluxes and brightenings of coronal structures around emerging flux regions

K. Yoshimura (Montana State University)

One of the main topics about Solar-B sciences should be, of course, relationships between various magnetic features on the photosphere and coronal diverse structures. I found examples of some correlation between total magnetic fluxes in emerging flux regions (EFRs) and brightness of coronal structures around the EFRs. The bright coronal structures appeared at the side of the EFRs in TRACE EUV images along with the increases of magnetic fluxes in the EFRs. The structures were visible in 171 angstrom images, but not in 195 images. They persisted on a time scale of hours and spread laterally to the widths of the EFRs. They were likely bunches of loops which were partially visible.

13.9 RECONNECTION

P41 **Simulation Study of Three-Dimensional and Nonlinear Dynamics of Flux Rope in the Solar Corona**

S. Inoue (Hiroshima University) and K.Kusano

We numerically investigated the three-dimensional (3D) stability and the nonlinear dynamics of flux rope embedded in magnetic arcade. As a results, we found that the flux rope is unstable to the kink mode instability, as the system approach to the loss-of-equilibrium state. The 3D simulation shows that when the flux rope is long enough, it can escape from the arcade with an almost constant speed after the accelerated launching due to the kink instability. This constant ascending is driven by magnetic reconnection on the current sheet, which is formed above the magnetic neutral line as a consequence of the instability. However, when the flux rope is short enough, the current sheet can not be maintained, so that the ascending is failed at some height. These results imply that the nonlinear effect mainly influenced by magnetic reconnection may determine whether the flux rope is ejected or not.

P42 **Low Atmosphere Reconnections Associated With an Solar Eruption**

Yong-Jae Moon (Korea Astronomy and Space Science Institute), Jongchul Chae, Young-Deuk Park

We studied an X1.8 flare and its associated filament eruption that occurred in AR 9236 on November 24, 2000. For this work we have analyzed high temp (about 1 minute) and spatial (about 1 arcsec) resolution images taken by SOHO/MDI, BBSO H-alpha centerline and blue wing, and TRACE 1600 UV images. We found that there were several transient brightenings seen around the preflare phase. They took place near one end of the erupting filament and were associated with canceling magnetic features (CMFs). The flux variations suggest that the flux cancellation may have been drive by the flux emergence. For this event, we estimated the ejection speeds of the filament ranging from 10 to 160 km/s for the first twenty minutes. It is noted that the initiation of the filament eruption (as defined by the rise speed less than 20 km/s) coincided with the preflare activity characterized by UV brightenings and CMFs. Our results support that the initiation of the filament eruption and the preflare phase of the associated flare be physically related to low-atmosphere magnetic reconnection.

P43 **A statistical study of the reconnection rate in solar flares**

K. Nagashima (Kyoto University) and T. Yokoyama

Magnetic reconnection is now generally believed to play a key role in energy release process in solar flares.The physics of reconnection, however, is not established completely. Therefore we study the reconnection rate statistically to put some restrictions on the reconnection model. This reconnection rate is an important value as the index of the energy release rate and is defined as the inflow velocity normalized by Alfven velocity. Using YOHKOH/SXT partial-frame images, SOHO/MDI magnetograms, and GOES X-ray flux data, we get the spatial scale, temp scale and the magnetic field of each flare. We survey flares which occurred in the year of 2000 and select 482 flares whose GOES class is above C6.0. After excluding limb events due to uncertainty of photospheric magnetgrams at the limb, there remain 84 flares with all required data. We assume that the inflow velocity is approximated to the size of each flare devided by the lifetime of it. From these data we find the reconnection rate is of the order of 10^{-2} under the assumption that the coronal field is about one-tenth of the photospheric one. Using color temperature and emission measure calculated from GOES X-ray data and the pressure balance across the shock, we also estimate the reconnection rate. By this method, the value is 10^{-4} - 10^{-3}.

P44 **MHD Simulation of Plasmoid-Induced-Reconnection in Solar Flares**

K. Nishida, M. Shimizu, D. Shiota, H. Takasaki, and K. Shibata

Recent space observations have revealed various evidence of magnetic reconnection and common properties in flares (plasmoid ejection, cusp shaped loops, etc.), leading to unified view of various flares (Shibata 1996, 1999). However, the detailed physics of magnetic reconnection has not been established yet. Especially it is not revealed what determines the speed of reconnection, i.e. reconnection rate. Based on many observation, Shibata et al. (1995), Shibata (1999), Shibata and Tanuma (2001) proposed the plasmoid-induced-reconnection model, which suggests that reconnection rate, inflow speed, plasmoid ejection velocity are closely related each other. In this study, we performed MHD simulations of solar flares with different resistivity model and different plasmoid velocity, and examined how the reconnection rate depends on the parameters. In the case in which reconnection occurs easily, reconnection rate becomes larger and consequently plasmoid velocity becomes larger. In contrast the case in which plasmoids are accelerated by an external force, i.e. in larger plasmoid velocity case, larger inflows are induced by mass conservation, and consequently reconnection rate also becomes lager. These results are consistent with observations (Shimizu et al. 2005, in preparation) and support plasmoid-induced-reconnection model strongly.

P45 **Self-similar Reconnection: A new model for astrophysical application beyond the Petschek model**

S. Nitta (The Graduate University for Advanced Studies)

I present a new model for time evolution of the fast magnetic reconnection in a free space, which is specialized for astrophysical applications and is characterized by self-similarity. The possibility of this type of evolution is verified by numerical simulations. We also find an analytical solution which is consistent with the numerical result. The reconnection rate of this model is spontaneously determined by the reconnection system itself through the process to form the outflow structure.In many cases of astrophysical problems, e.g., solar flares or geomagnetospheric substorms, the spatial scale of the reconnection system significantly expands as time proceeds. The resultant spatial scale of the reconnection system is much larger than the initial scale (its dynamic range is typically 7 orders of magnitude). Such evolution should be treated as a spontaneous evolution in a free space. In spite of this, most previous works focused on the character of evolution strongly affected by artificial boundary conditions (so-called "driven reconnection"). The focus of this work is on this spontaneous expanding phase. Our theoretical contribution is to establish a new model for magnetic reconnection and to clarify a realistic evolution and spontaneous structure formation in the free space.

P46 **The correlation among physical quantities in Masuda-type flares as indicated from the magnetic reconnection model**

M. Shimizu (Kwasan Observatory, Kyoto University), K. Nishida, H. Takasaki, D.Shiota, K. Shibata

Masuda et al. (1994) discovered a hard X-ray (HXR) source above a soft X-ray (SXR) loop in impulsive compact-loop flares. After this discovery, Shibata et al. (1995) found that X-ray plasma ejections were associated with these flares and proposed that these phenomena are well explained, if magnetic reconnection occurs above the loop, similar to the classical model for two ribbon flares. Using images taken by the soft X-ray telescope and the hard X-ray telescope aboard Yohkoh, we searched for impulsive compact-loop flares with a HXR source above a SXR loop and found seven examples Then we examined the correlation among physical quantities in these flares, such as the height of the HXR source above the SXR loop, the apparent rise velocity of the SXR loop and the velocity of plasma ejections. Consequently, we found a positive correlation among these quantities, as expected from the magnetic reconnection model (Shibata at al., 1995). We will report this result from Yohkoh data analysis and discuss quantitatively based reconnection model why the correlation is seen in Masuda-type flares. Forthermore we will propose a way to measure inflow velocity to reconnection point or reconnection rate from measurement of such quantities.

P47 **XRT and EIS Observations of Reconnection Associated Phenomena**

D. Shiota (Kwasan and Hida Observatories, Kyoto University), H. Isobe, D.H. Brooks, P.F. Chen, and K. Shibata

Magnetic reconnection is widely believed to play an important role in various solar activities such as solar flares, because Yohkoh has observed many peices of evidence for reconnection. However, most of that evidence is indirect and the theory of magnetic reconnection has not been established. Hence our understanding of reconnection is incomplete. Imaging and spectroscopic observations with the EUV Imaging Spectrometer (EIS) and X-ray Telescope (XRT), the new instruments aboard Solar-B, will obtain physical quantities and the spatial structure of the different temperature solar plasmas. This will improve our understanding of the basic processes of magnetic reconnection in the solar atmosphere. In this paper, we present predicted EIS and XRT observations, which are synthesized from the results of 2.5-D magnetohydrodynamic simulations of a coronal mass ejection and a cusp-shaped arcade, and examine how the reconnection associated phenomena can be observed.

P48 **Internal Shocks in the Magnetic Reconnection Jet in Solar Flares: Dependence on Resistivity Model**

S. Tanuma (Kwasan Observatory, Kyoto University) and K.Shibata

Space solar missions such as Yohkoh and RHESSI observe the hard X- and gamma-ray emission from energetic electrons in impulsive solar flares. Their energization mechanism, however, is unknown. In this paper, we suggest that the internal shocks are created in the reconnection jet and that they are possible sites of particle acceleration. We examine how magnetic reconnection creates the multiple shocks by performing two-dimensional resistive magnetohydrodynamic simulations. In this paper, we use a very small grid to resolve the diffusion region. As a result, we find that the current sheet becomes thin due to the tearing instability, and it collapses to a Sweet-Parker sheet. The thin sheet becomes unstable to the secondary tearing instability. Fast reconnection starts by the onset of anomalous resistivity immediately after the secondary tearing instability. During the bursty, time-dependent magnetic reconnection, the secondary tearing instability continues in the diffusion region where the anomalous resistivity is enhanced. As a result, many weak shocks are created in the reconnection jet. Furthermore, we also find that the many strong oblique shocks are created because the reconnection jet starts to oscillate by Kelvin-Helmholtz-like instability with some parameters (for example, resistivity model). This situation produces turbulent reconnection. We suggest that multiple fast shocks are created in the jet and that the energetic electrons can be accelerated by these shocks.

P49 **Coronal Heating By Forced Magnetic Reconnection**

G. Vekstein (School of Physics and Astronomy, The University of Manchester, United Kingdom) and N. Bian

Although it is now generally accepted that magnetic reconnection is responsible for coronal heating as well as for various other manifestations of the solar coronal activity (flares, mass ejections, etc), many important details of these processes are still poorly understood. Therefore, clarifying them is one of the major scientific objectives of the upcoming Solar-B mission.

A likely scenario of explosive events in the solar atmosphere looks as follows. The photospheric convection shuffles footpoints of coronal magnetic loops, causing in this way continuous deformation of the coronal magnetic field. In response, regions of high electric currents (current sheets) readily form within the corona. Then, even a very small electric resistivity, which is typical for hot coronal plasma, leads to fast current sheets dissipation, thus bringing about magnetic reconnection and efficient release of an excess magnetic energy accumulated in the corona.

This type of reconnection, which is not due to an intrinsic plasma instability such as the tearing mode, but is triggered by some external perturbation, is generally called 'forced reconnection'. The latter is of significant importance for the solar corona, since even a weak external perturbation can cause a substantial magnetic relaxation. Here we demonstrate this by considering two particular models of forced magnetic reconnection. The first one, which deals with a sheared force-free magnetic field, is relevant to coronal reconnection triggered by emerging new magnetic flux. The second model studies forced reconnection at a neutral magnetic X-point.

13.10 FLARES

50 **Energy Conversion in the Solar Flare due to Direct Electric Fields as a Result of the Sheared Magnetic Reconnection**

T. Hirayama (National Astronomical Observatory, Japan)

We propose a new mechanism of the main energy conversion of the solar flare. Because the rising velocity of a flare inducing prominence, or a magnetic flux tube is <300km/s, plasmas below it cannot eject with Alfven velocities of 3000km/s throughout the early phase of flares, but only with V_z ∼100km/s. Hence we need other than the slow shock mechanism. When there is a substantial sheared field as expected in every flare, the main energy conversion region cannot be within a plane with horizontal x and vertical z-components to the solar surface; there should be y-components parallel to a long direction of photospheric magnetic neutral line. Then Gauss law leads non-zero electric chargess: $4\pi\sigma = divE = -div(V \times B)/c \sim B_y \partial V_z / c\partial x$. Field-aligned electric fields calculated from the Coulomb law using this σ is far greater than the Dreicer field ($B_y \sim B_z \sim 40G$ and $dx \sim 10^{3-4}$ km), and accelerate electrons and protons. Due to large electric fields, incoming horizontal Poynting energy flux in area S_x are immediately converted to a kinetic energy of electron beams along the magnetic field in S_z; $V_x B^2 S_x / 4\pi = 1/2 m_e N_{beam} V_{beam}^3 S_z$ and e.g. $S_x/S_z \sim 3$. The total flare energy can be supplied by 10-20keV electrons of 1/2 me V_{beam}^2 and $N_{beam} = 2 \times 10^7$ cm^{-3} for $V_x = 40$km/s. This V_x ensures short time scales of flares.

P51 **TRACE and RHESSI observations of white-light flares**

H. Hudson (UCB), J. Wolfson, and T. Metcalf

The TRACE instrument includes a "white light" (WL) imaging capability with novel characteristics. Flares down to GOES class C1.3 with WL emission have been detected, and this paper provides an introductory overview of these data. These observations have 0.5" pixel size and use the full broad-band response of the CCD sensor. The spectral response of the TRACE white-light passband extends into the UV, so these data capture, for the first time in images, the main radiative energy of a flare. This initial survey is based on a sample of flares observed at high time resolution for which RHESSI had complete data coverage, a total of 11 events up to the end of 2004. We characterize these events in terms of source morphology and contrast against the photosphere. We confirm the strong association of the TRACE white-light emissions - which in clude UV as well as visual wavelengths - with hard X-ray sources observed by RHESSI. The images show fine structure at the TRACE resolution limit, and often show this fine structure to be extended over large areas rather than just in simple footpoint sources. The white-light emission shows strong intermittency both in space and in time and commonly has features unresolved at the TRACE resolution.

P52 **High velocity Doppler shift observations of 10 MK flare plasma**

D. Innes (Max-Planck-Institut fuer Sonnensystemforschung), Tongjiang Wang

With the SUMER spectrometer on SOHO, we have observed Doppler shifts in 10 MK flare lines. The shifts have been associated with (i) a fast outward moving coronal shock wave seen at flare onset in high time cadence coronagraph data, (ii) the top of a post flare supra-arcade at the time of hard X-ray emission and X-ray downflows and (iii) oscillating post flare loops. All these observations were made in sit-and-stare in the corona above flare sites. This presents a summary of the SUMER observations, discusses the limitations of SOHO-SUMER observations and the hugh advantages offered by the Solar-B observatory.

P53 **Observations of simultaneous retracting and expanding loops above a flaring arcade**

J. I. Khan (University of Glasgow), L. Fletcher, N. V. Nitta

We present imaging observations from the Yohkoh Soft X-ray Telescope (SXT) which show the retraction of a coronal loop above a flaring arcade. The shrinking loop was observed face-on in emission during the decay phase of a solar flare. At the same time we also observe a faint outward moving loop-like feature above the flaring arcade and retracting loop. We interpret the shrinking loop and simultaneous outward moving loop as direct evidence for reconnected magnetic field lines during a flare.

P54 **Morphology and Spectral Behavior of Solar Hard X-Ray**

Lartey A. S. (African Information Technology Holdings), Ekwueme L.

Images of the 17 solar flares, corresponding to 61 individual X-ray bursts observed in four energy ranges (14-23,23-33,33-53 and 53-93 keV) by hard X-ray telescope (HXT) experiment on board of *Yohkoh* satellite have been investigated. The images suggested the dimension of hard X-ray sources is of the order of 20 arc sounds and they are of three types: single isolated source (∼30%), double sources (∼ 41 %), with typical minimum separation of 30 arc seconds and multiple sources (∼29%). We have adjusted single power law spectrum for the X-ray emissions in the range of (20-830keV) using data of Hard X-ray Spectrometer (HXS) experiment. Spectral time of these bursts has been also investigated. Typical spectral index behavior is " soft-hard-soft ".

P55 **Active Region and Flare Observations with SOHO-CDS, what can we learn for SolarB?**

H. E. Mason (University of Cambridge) and G. Del Zanna (MSSL)

Over the past decade, the group at Cambridge has carried out many co-ordinated observational campaigns with the SOHO - CDS (Coronal Diagnostic Spectrometer) and other instruments. Much has been learnt about the nature of solar active regions and flares. These results can be used to plan scientific observations with SolarB, in particular co-ordinated observations involving EIS.

P56 **Hard X-ray and radio observations of an arcade-type flare on the solar limb**

S. Masuda (STEL, Nagoya University), Kyo Akita, Kyoko Watanabe, Kaori Nagashima, Naoto Nishizuka

In order to investigate vertical structure of solar flares, especially vertical distribution of high-energy electrons and super-hot plasmas, we analyzed an M-class flare which occurred just on the west solar limb on June 2, 2003. The rising phase of this flare was well observed with Nobeyama Radio Heliograph and RHESSI. Nonthermal radio emissions are observed from the whole arcade system. Intense emission comes from lower region of this arcade. On the other hand, low-energy ($\sim$10 keV) hard X-ray emission, probably super-hot thermal emission, is located along the ridge of the arcade. Higher-energy ($>$ 25 keV) hard X-rays are mainly emitted at the footpoint regions. A weaker compact hard X-ray source is also observed above the low-energy hard X-ray source. The high-energy had X-ray coronal source has a softer spectrum than that of the footpoint source. Integrating these multi-wavelength observational results, we try to reveal the behavior of the high-energy electrons and the evolution of the super-hot plasma in this arcade-type flare.

P57 **"Supra-Arcade Downflows: Results from Observational Analysis"**

D. E. McKenzie (Montana State University-Bozeman), S. Savage, J. E. Tolan

Downward motions above post-CME flare arcades are an exciting discovery of the Yohkoh mission, and have subsequently been detected with TRACE, SOHO/LASCO, SOHO/SUMER, and GOES SXI. These supra-arcade downflows have been interpreted as outflows from flux tube reconnection, consistent with a 3D generalization of the standard reconnection model of solar flares. We will present results from our observational analyses of downflows, including some automated schemes for detection, distributions of measured speeds, and other aspects related to 3D patchy reconnection. We will also indicate the limitations of present observations, and motivations for utilizing the Solar-B instruments for measurements of these reconnection signatures.

P58 Quantitative analysis of nonthermal electrons in impulsive hard X-ray flares

T. Minoshima (University of Tokyo) and T. Yokoyama

We present a quantitative study of nonthermal electrons in solar hard X-ray flares. In this study, the lower energy cutoff (Ec) in the spectrum of nonthermal electrons is a key variable. Instead of adopting the usual assumption of Ec to be a fixed value (20 keV or 30 keV), we derive the lower energy cutoff by assuming that the total energy of nonthermal electrons released during the impulsive phase equals the increase in the thermal energy of the soft X-ray emitting flare plasma during the impulsive phase. We successfully estimate several physical variables of nonthermal electrons in the impulsive phase of the flares. What we find in this analysis are as follows: (1) The values of the derived Ec are ranging in 20 - 45 keV. (2) There is a positive correlation between the nonthermal electron rate in the impulsive phase and the number density of the soft X-ray emitting flare plasma in the pre-impulsive phase. (3) There is a positive correlation between the derived lower energy cutoff and hard X-ray sources separation distance. We discuss electron acceleration in solar flares based on these results.

P59 Non-thermal Electrons at Quasi-Perpendicular Shocks: Statistical Properties and the Whistler Critical Mach Number

Oka, M. (Kwasan Observatory, Univ. of Kyoto), T. Terasawa, Y. Seki, Y. Kasaba, H. Kojima, H. Matsui, M. Fujimoto, H. Matsumoto, Y. Saito, and T. Mukai

It has theoretically been expected that whistler waves are emitted upstream of shocks whenever Mach number falls below a critical Mach number. By performing statistical analysis of the upstream waves, we have observational evidenced the 'whistler critical Mach number' at the Earth's bow shock using the GEOTAIL spacecraft. We have further found that the critical Mach number regulates electron acceleration. The obtained result suggests different acceleration mechanism for below and above the critical Mach number. We will apply the results to the loop-top environment of solar flares and discuss on possible acceleration mechanisms.

P60 Change in Sunspot Proper Motion and Its Relation to Flare Onset

Y. Suematsu (NAOJ) and C.Y. Yatini (LAPAN)

From the detailed measurements of motion of sunspots in six active regions, we found

that some spots, which are located on flaring area, underwent a particular motion when compared with other spots in the same active region. These spots showed a 'turn' in their moving direction before flare started. The change in motion started in 0.5 to 2.5 hours before flare onset. We found the relation that if the spot shows a 'particular'motion, a flare occurs on this particular spot region. On the other hand, any sunspots in non-flaring active region do not show peculiar motion. In some cases, the particular spots also show the motion consistent with a rising emerging flux tube in which pair of spots move away from each other. It is likely that the peculiar motion of spots implies the rising motion of flux tube perturbed by unknown reason. From this study, we expect that SOLAR-B/SOT will be able to reveal the detailed relation between the sunspot motion, related magnetic activity and flare onset, making a short term prediction of flare occurrence possible.

P61 **The Relation between Soft X-ray Ejections and Hard X-ray Emission on 2000 November 24 Flare**

H. Takasaki (Kwasan Observatory, Kyoto University), A. Ayumi, J. Kiyohara, and K. Shibata

We present the relation between the hard X-ray emission and plasmoid ejections in a flare occurred at the active region NOAA 9236 on 2000 November 24. In this flare, many soft X-ray plasmoids are ejected one ofter another, and the time profile of hard X-ray emission has many spiky components. We discuss the temp relation and energetic relation betweeen each ejected plasmoid and hard X-ray emission.

P62 **Combining Hydrodynamics Modeling with Test Particle Tracking to Improve Flare Simulations**

H. (T.) Winter (Montana State University, Physics Dept.) and P.C.H. Martens

We are combining thermal plasma and non-thermal particle numerical models in order to improve flare simulations. Non-thermal particle collision models provide heating and momentum deposition for the thermal plasma. The thermal plasma models in turn provide an evolving temperature and density structure for the non-thermal particles target plasma. This allows us to simulate thermal and non-thermal flare emission under a variety of increasingly realistic solar conditions. The model flare emission is then folded through the response functions of solar observatories in order to provide simulated data that can be compared to observational results. This provides a means to verify the predictions of multiple flare models with observed flare behavior.

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13.11 CORONAL MASS EJECTIONS

P63 Multiwavelength study of a CME: linking an erupting filament to a rising coronal X-ray source

C. Goff (Mullard Space Science Laboratory, University College London, UK), L. van Driel-Gesztelyi, L.K. Harra, S.A. Matthews and C.H. Mandrini

A long-duration event (LDE) linked to a slow coronal mass ejection (CME) was observed in the vicinity of the NW solar limb on 16 April 2002. A comprehensive multiwavelength analysis involving TRACE (195 A), RHESSI, SOHO/EIT, CDS and LASCO observations as well as magnetic modelling (SOHO/MDI) provided several new pieces of evidence supporting the classical LDE/CME scenario: the event started with the eruption of a filament, which was found to have helical mass motions when crossing the CDS spectrograph slit situated 50" above the limb. Rising with the filament, about 20,000 km under it, a coronal X-ray source was imaged which we identified as a plasmoid originating from the interaction between upward reconnection outflow and the closed magnetic structure of the erupting filament. We also found downflows of plasma in hot, newly reconnected flare loops. Finally, connecting the height-time profile of the erupting filament in TRACE data to the one of the CME, we found evidence for an exponential acceleration phase, indicating MHD instability of the erupting structure.

P64 Observational evidence for the relationship between Halpha surges and large-scale coronal activities

Y. Liu (Kwasan and Hida Observatories, Kyoto University)

From the observations taken by ground-based Halpha telescopes and space SOHO/LASCO instruments, we found that some emerging flux activities could trigger large-scale reconstruction of coronal fields, i.e., coronal mass ejections (CMEs). This indicates that the small-scale magnetic flux emerged from below the photosphere could in fact drive out the preexisting coronal flux from below. In a preliminary statistical study based on 12 long-length surges, it was found that the morphology of surges should have close relationship to the shape of the CMEs associated. The spike (or, jet)-like surges correspond to the jetlike CMEs, the diffused surges usually occurred associated with halo CMEs, while the highly sheared surges were found to have no obvious CME association. We deduced that the different Halpha surge morphology should suggest different situation of the coronal fields before the coronal disturbance caused by EFRs.

P65 **Origin of the Sheared Magnetic Fields that Erupt in Flares and Coronal Mass Ejections**

R. Moore (NASA/MSFC/NSSTC) and Alphonse Sterling

From a search of the Yohkoh/SXT whole-Sun movie in the years 2000 and 2001, we found 37 flare-arcade events for which there were full-disk magnetograms from SOHO/MDI, coronagraph movies from SOHO/LASCO, and full-disk chromospheric images from SOHO/EIT and/or from ground-based observatories. Each of these events was apparently produced by the ejective eruption of sheared core magnetic field (as a flux rope) from along the neutral line inside a mature bipolar magnetic arcade. Two thirds (25) of these bipoles had the normal leading-trailing magnetic polarity arrangement of active regions in the hemisphere of the bipole, but the other third (12) had reversed polarity, their leading flux being the trailing-polarity remnant of one or more old active regions and their trailing flux being the leading-polarity remnant of one or more other old active regions. From these observations, we conclude: (1) The sheared core field in a reversed-polarity bipole must be formed by processes in and above the photosphere, not by the emergence of a flux rope bodily from below the photosphere. (2) The sheared core fields in the normal-polarity bipoles were essentially the same as those in the reversed-polarity bipoles. (3) Hence, the sheared core fields in normal-polarity mature bipoles are likely formed mainly by the same processes as in reversed-polarity bipoles. (4) A prime objective of Solar-B should be to discover and elucidate these processes.

P66 **Studying the magnetic origin of solar eruptions with SOLAR-B data**

A. Nindos (University of Ioannina)

Recent studies (Nindos & Andrews 2004; Nindos 2005) have provided direct observational support for the paradigm that the magnetic helicity accumulation in the corona is a necessary condition for CME initiation. Under this paradigm, flares without CMEs are regarded as simple reconnection events while CMEs are the valves through which the Sun gets rid of its excess helicity. However, several aspects of the paradigm need clarification and possibly modification. The instruments on board the SOLAR-B mission will provide a unique opportunity for such work. In this talk, I propose a roadmap for the exploitation of the SOLAR-B data in order to shed more light on the processes leading to eruptive events. I assume that they result from the interplay between magnetic reconnection and approximate helicity conservation in the corona and propose observing programs that will allow us to study these processes in detail.

P67 **Observing Filament Eruptions with Solar-B**

A. C. Sterling (NASA/MSFC/NSSTC) and R. L. Moore

In recent years we have been observing the initiation of solar eruptions that involve solar filaments. The filaments act as tracers for the evolution of the coronal magnetic field just prior to and just after the start of fast eruption. We have primarily used data from SOHO/EIT, Yohkoh/SXT, and TRACE, along with hard X-ray data from various instruments and line-of-sight magnetograms from SOHO/MDI or Kitt Peak. This work has allowed us to better understand the dynamics of magnetic fields leading up to eruption, including a "slow-rise" phase of filament movement and activation, and the transition from the slow-rise phase to the violent eruption. Here we will explain how we will utilize high-time-cadence and high-spatial-resolution images, EUV spectroscopic data, and vector magnetograms of Solar-B to improve upon our understanding of the earliest stages of solar eruptions, and we will discuss prospects for using the new data to isolate the mechanism (or mechanisms) responsible for triggering the onset of fast eruption.

P68 **Three Dimensional Motion of Plasmas Associated with Coronal Mass Ejections Observed with NOrikura Green-line Imaging System (NOGIS)**

I. Suzuki (Graduate University for Advanced Studies (Sokendai)), T. Sakurai, and K. Ichimoto

In order to investigate the structure and the driving mechanism of Coronal Mass Ejections (CMEs), it is important to examine in detail the magnetic field structure in the low corona. NOrikura Green-line Imaging System (NOGIS), with its unique capability of Doppler imaging, was used to study CMEs and its source regions observed on 1999 May 7 and 2005 July 28. In 1999 May 7 event, the source region consisted of two loop systems, a small loop system and a neighboring larger loop system. The small loop moved toward the large loop and destabilized it, resulting in the CME with a red shift. In 2005 July 28 event, ejection of a small loop system with a red shift started from among neighboring larger loop systems. We suggest that the direction of mass ejection depends on the configuration of magnetic fields around the source region and the location of the initial energy release in the magnetic field configuration.

P69 **Evolution of the photospheric magnetic field in the source regions of coronal mass ejections**

D. Tripathi (Department of Applied Mathematics and Theoretical Physics)

EIT (Extreme-ultraviolet Imaging Telescope), LASCO (Large Angle Spectrometric Coro-

nagraph) and MDI (Michelson Doppler Imager) on board SoHO (Solar and Heliospheric Observatory) provide and unprecedented opportunity to study the source regions of coronal mass ejections (CMEs) in the low corona as well as in the Photosphere. Here we present a study of association of post-eruptive arcades (PEAs) observed on the solar disk by EIT at 195 with CMEs. We found that each and every PEAs observed by EIT have an associated CME. Therefore EUV PEAs can be considered as the reliable tracers of CME source regions on the solar disk. Further, we selected 7 PEA events associated with filaments in order to study the magnetic field in the source region based on the MDI magnetograms. Based on these observations, for two events evidence for magnetic flux cancellation was detected. For other two events one of the foot-points of the filament was rooted close to a near by evolving active region. However in three cases emergence of new flux was seen. Therefore, we conclude that different varieties of evolutions in the Photospheric magnetic field can lead to CME eruptions. The upcoming missions like SOLAR-B will help us understand the evolution of Photospheric magnetic field in terms of CME eruptions.

P70 **Eruption of a Kink-unstable Filament in Region NOAA 10696**

D. Williams (Mullard Space Science Laboratory, University College London), T. Toeroek, P. Demoulin, L. van Driel-Gesztelyi, B. Kliem

On 2005 November 10, TRACE observed an X2.5 flare in NOAA Active Region 10696. The observations were taken at very short cadence (3.7s) in the ultraviolet 1600channel. The flare was accompanied by a filament eruption, whose initiation we investigate using both TRACE and SOHO images. We find signatures of tether weakening by both flux emergence and a lateral variation of "break-out". However, the evolution of the erupting filament is consistent with that of a flux rope undergoing the MHD kink instability. This suggests that the kink instability is the main driver of the eruption.

13.12 SOLAR WIND

P71 **The energetics of the slow solar wind**
L. Ofman (Catholic University of America)

Observations and numerical models show that the slow solar wind is associated with coronal streamers. However, the exact heating and acceleration mechanism of the slow wind is unknown. Moreover, the energization mechanism is likely to be different for electrons, protons, and heavy ions. Some of the main objectives of Solar B is to understand the opening of magnetic field and heating of the coronal plasma that forms the solar wind. I will present recent results of three-fluid numerical models of the slow solar wind heating and acceleration in coronal streamers. I will discuss the possible heating mechanisms of electrons, protons, and heavy ions in the slow wind, and the formation of open flux in streamers. I will show the relation of the numerical results to past observations by SOHO, and Ulysses spacecraft, and future observations with Solar B.

P72 **Filamentary Structures in the Solar Corona**
R. Woo

An important development with radio occultation measurements has been the discovery of extensive spatial structuring in the outer corona with the finest filamentary structures of kilometer scale size. In this paper, we will describe these observations and present the latest results. The latter include evidence for continual reconnection all over the Sun at the base of the corona, which unifies observations of small- and large scale structure of the outer corona, and provides insight into the connection between coronal and photospheric fields. The filamentary structures in the outer corona, which presumably trace the open magnetic field lines, are found to be predominantly radial, reinforcing similar earlier conclusions based on measurements of large-scale structure.

P73 **Role of small-scale dynamics in coronal holes and quiet regions for coronal heating and solar wind acceleration**
Y. Yamauchi (CSTR/NJIT), H. Wang, and R. L. Moore

Small-scale dynamics such as macrospicules, microflares, and mini-filament eruptions are of interest because they are believed to play an important role in coronal heating and solar wind acceleration in coronal holes and quiet regions through the magnetic network activity. We made high-spatial and temp resolution TRACE UV/EUV observations of coronal holes and quiet regions in September 2004 jointly with BBSO H-alpha and mag-

netogram observations. From the observations, we study the dynamics, structure, and magnetic setting of small-scale explosive events in coronal holes and in quiet regions. Most macrospicules showed brightening at their base in CIV images. This is compatible with these macrospicules being driven by explosive reconnection between short magnetic loops and high-reaching field lines rooted in the network. We also investigate where the differences of physical properties in coronal holes and quiet regions come from, even though the fine-scale magnetic activity of the network is expected to be essentially important in both regions. We report whether any differences between the events in coronal holes and quiet regions are seen. We discuss what we expect of the Solar-B mission for the study of small-scale dynamics on the basis on our observations.

All Participants

Family name	Given name	Institute	Country	E-mail:
Akita	Kyo	Osaka Gakuin University	Japan	kyo@utc.osaka-gu.ac.jp
ANTOLIN	PATRICK	Kyoto University, Department of Astronomy	Japan	patrick@kusastro.kyoto-u.ac.jp
Asai	Ayumi	Nobeyama Solar Radio Observatory	Japan	asai@nro.nao.ac.jp
Berger	Thomas	Lockheed Martin Solar and Astrophysics Lab	USA	berger@lmsal.com
Bobra	Monica	Smithsonian Astrophysical Observatory	USA	mbobra@mit.edu
BUECHNER	JOERG	MAX-PLANCK-INSTITUT FUER SONNENSYSTEMFORSCHUNG	GERMANY	BUECHNER@MPS.MPG.DE
Carlsson	Mats	Institute of Theoretical Astrophysics, University of Oslo	Norway	mats.carlsson@astro.uio.no
Chou	Dean-Yi	National Tsing Hua University, Taiwan	Taiwan	chou@phys.nthu.edu.tw
Cirtain	Jonathan	Smithsonian Astrophysical Observatory	USA	jcirtain@cfa.harvard.edu
CRANMER	STEVEN R.	Harvard-Smithsonian Center for Astrophysics	USA	scranmer@cfa.harvard.edu
Culhane	Len	Mullard Space Science Lab.	UK	jlc@mssl.ucl.ac.uk
Davis	John	NASA/Marshall Space Flight Center	USA	John.M.Davis@nasa.gov
de Pontieu	Bart	Lockheed Martin Solar & Astrophysics Lab	USA	bdp@lmsal.com
DeLuca	Edward	Smithsonian Astrophysical Observatory	USA	edeluca@cfa.harvard.edu
Dere	Kenneth	George Mason University	USA	kdere@gmu.edu
Doschek	George Alexander	Naval Research Laboratory	United States	gdoschek@ssd5.nrl.navy.mil
EKWUEME	LOUIS	AFRICAN INFORMATION TECHNOLOGY HOLDINGS	Gambia	aithinfo@fastermail.com
FARNIK	Frantisek	Astronomical Institute Academy of Sciences	Czech Republic	ffarnik@asu.cas.cz
GOLUB	LEON	Harvard-Smithsonian Center for Astrophysics	USA	golub@cfa.harvard.edu
Gudiksen	Boris	Institute of theoretical astrophysics, University of Oslo	Norway	boris@astro.uio.no
Hagino	Masaoki	Korea Astronomy and Space Science Institute	Rep. of Korea	hagino@kasi.re.kr
Hanaoka	Yoichiro	National Astronomical Observatory of Japan	Japan	hanaoka@solar.mtk.nao.ac.jp
Hansteen	Viggo	Institute of theoretical astrophysics, University of Oslo	Norway	viggoh@astro.uio.no
Hara	Hirohisa	NAOJ	Japan	hirohisa.hara@nao.ac.jp
Harra	Louise	UCL-MSSL	UK	lkh@mssl.ucl.ac.uk
Heggland	Lars	Institute of Theoretical Astrophysics, University of Oslo	Norway	lars.heggland@astro.uio.no
HEINZEL	Petr	Astronomical Institute Academy of Sciences	Czech Republic	pheinzel@asu.cas.cz
Hill	Lawrence (Larry)	NASA/Marshall Space Flight Center	USA	larry.hill@nasa.gov
Hirayama	Tadashi	NAOJ	Japan	t-h-hira@parkcity.ne.jp
Hori	kuniko	Solar Observatory, National Astronomical Observatory of Japan	Japan	hori@solar.mtk.nao.ac.jp
Hudson	Hugh	UC Berkeley	USA	hhudson@ssl.berkeley.edu
Ichimoro	Kiyoshi	NAOJ	Japan	ichimoto@solar.mtk.nao.ac.jp
Innes	Davina	Max-Planck-Institut fuer Sonnensystemforschung	Germany	innes@mps.mpg.de
Inoue	Satoshi	Hiroshima University	Japan	inosato@hiroshima-u.ac.jp
Isobe	Hiroaki	Department of Earth and Planetary Science, University of Tokyo	Japan	isobe@kwasan.kyoto-u.ac.jp
JANG	MIN HWAN	Dept. of Astronomy & Space Science, Kyung Hee University	Rep. of Korea	mjang@khu.ac.kr
Jeong	Hyewon	Seoul National University	Rep. of Korea	hwjung@astro.snu.ac.kr
Jongchul	Chae	Seoul National University, Astronomy Program/SEES	Rep. of Korea	chae@astro.snu.ac.kr

Jurcak	Jan	Astronomical Institute, Academy of Sciences	Czech Republic	jurcak@asu.cas.cz
Kamio	Suguru	Kwasan Observatory, Kyoto University	Japan	kamio@kwasan.kyoto-u.ac.jp
Kano	Ryouhei	National Astronomical Observatory of Japan	Japan	ryouhei.kano@nao.ac.jp
Karpen	Judith	Naval Research Laboratory	USA	judy.karpen@nrl.navy.mil
Katsukawa	Yukio	National Astronomical Observatory of Japan	Japan	yukio.katsukawa@nao.ac.jp
KEIL	STEPHEN L.	National Solar Observatory	U.S.A.	skeil@nso.edu
Khan	Josef	University of Glasgow	United Kingdom	joe@astro.gla.ac.uk
Kitai	Reizaburo	Kwasan & Hida Observatories	Japan	kitai@kwasan.kyoto-u.ac.jp
Kitakoshi	Yasunori	Department of Astronomy, University of Tokyo	Japan	yasunori.kitakoshi@nao.ac.jp
Kiyohara	Junko	Kwasan Observatory, Kyoto University	Japan	kiyohara@kwasan.kyoto-u.ac.jp
Kojima	Masayoshi	STE Lab. Nagoya University	Japan	kojima@stelab.Nagoya-u.ac.jp
Kosovichev	Alexander	Stanford University	USA	AKosovichev@solar.stanford.edu
Kosugi	Takeo	ISAS/JAXA	Japan	kosugi@solar.isas.ac.jp
Kubo	Masahito	University of Tokyo	Japan	masahito.kubo@nao.ac.jp
Kurokawa	Hiroki	Kwasan & Hida Observatories ,Graduate School of Science, Kyoto University	Japan	kurokawa@kwasan.kyoto-u.ac.jp
Kusano	Kanya	The Earth Simulator Center, JAMSTEC	Japan	kusano@jamstec.go.jp
Kwon	Ryun Young	Astronomy Program, School of Earth and Environmental Science, Seoul National University	Rep. of Korea	luxmundi@astro.snu.ac.kr
LARTEY	SORPHIA ASHORKOR	AFRICAN INFORMATION TECHNOLOGY HOLDINGS	Gambia	aithinfo@fastermail.com
Lim	Eun Kyung	Seoul National University	Rep. of Korea	uklim@astro.snu.ac.kr
Linton	Mark George	Naval Research Laboratory	USA	linton@nrl.navy.mil
Lites	Bruce	HAO/NCAR	USA	lites@hao.ucar.edu
Liu	Yu	Kwasan and Hida Observatories, Kyoto University	Japan	lyu@kwasan.kyoto-u.ac.jp
Longcope	Dana	Montana State University	USA	dana@solar.physics.montana.edu
Magara	Tetsuya	UCB/NRL (Univ. of California Berkeley/Naval Research Lab.)	USA	magara@ssl.berkeley.edu
Masembe	Samuel	Bamugolode Technological Institute	Uganda East Africa	sseminter001@yahoo.co.uk
Mason	Helen	University of Cambridge	UK	hm11@damtp.cam.ac.uk
Masuda	Satoshi	Solar-Terrestrial Environment Laboratory, Nagoya University	Japan	masuda@stelab.nagoya-u.ac.jp
McKenzie	David	Montana State University-Bozeman	USA	mckenzie@mithra.physics.montana.edu
MINOSHIMA	Takashi	University of Tokyo	Japan	takashim@eps.s.u-tokyo.ac.jp
Miyagoshi	Takehiro	Kwasan Observatory, Kyoto University	Japan	miyagosi@kwasan.kyoto-u.ac.jp
Moon	Yong-Jae	Korea Astronomy and Space Science Institute	Rep. of Korea	yjmoon@kasi.re.kr
Moore	Ron	NASA/MSFC/NSSTC	USA	ron.moore@nasa.gov
Moreno-Insertis	Fernando	Instituto de Astrofisica de Canarias	Spain	fmi@ll.iac.es
Musisi	Alfred	Bamugolode Technological Institute	Uganda East Africa	sseminter001@yahoo.co.uk
Nagashima	Kaori	Kyoto University	Japan	kaorin@kwasan.kyoto-u.ac.jp
Nagata	SHIN'ICHI	Hida Observatory, Kyoto Univeristy	JAPAN	nagata@kwasan.kyoto-u.ac.jp
Nakariakov	Valery	University of Warwick	UK	V.Nakariakov@warwick.ac.uk
Narukage	Noriyuki	Kwasan and Hida Observatories, Kyoto University	JAPAN	naru@kwasan.kyoto-u.ac.jp
Nindos	Alexander	University of Ioannina	Greece	anindos@cc.uoi.gr
Nishida	Keisuke	Kyoto University	Japan	nishida@kwasan.kyoto-u.ac.jp
Nitta	Shin-ya	The Graduate University for Advanced Studies	Japan	nittasn@yahoo.co.jp
Noglik	Jane	University of Central Lancashire	UK	jbnoglik@uclan.ac.uk
Notoya	Shun	University of Tokyo	Japan	notoya@eps.s.u-tokyo.ac.jp
Nozawa	Satoshi	Ibaraki Univ.	Japan	snozawa@env.sci.ibaraki.ac.jp
Ofman	Leon	Catholic University of America	USA	leon.ofman@gsfc.nasa.gov

Oka	Mitsuo	Kwasan Observatory, Kyoto University	Japan	moka@kwasan.kyoto-u.ac.jp
Okamoto	Takenori	Kwasan Observatory, Kyoto University	Japan	okamoto@kwasan.kyoto-u.ac.jp
Opgenoorth	Hermann	ESA/ESTEC	Netherlands	hopgenoo@rssd.esa.int
Parenti	Susanna	Institut d'Astrophysique Spatiale, Fr	France	Susanna.Parenti@ias.u-psud.fr
Park	Young-Deuk	Korea Astronomy and Space Science Institute	Rep. of Korea	ydpark@kasi.re.kr
Park	Soyoung	Department of Astronomy, Seoul National University	Rep. of Korea	syongii@astro.snu.ac.kr
Pevtsov	Alexei	National Solar Observatory	USA	apevtsov@nso.edu
Potts	Hugh	University Of Glasgow	UK	hugh@astro.gla.ac.uk
Sakao	Taro	ISAS/JAXA	Japan	sakao@solar.isas.ac.jp
Sakurai	Takashi	National Astronomical Observatory of Japan	Japan	sakurai@solar.mtk.nao.ac.jp
Scharmar	Goran	The Institute for Solar Physics	Sweden	scharmer@telia.com
SCHMIEDER	Brigitte	Observatoire de Paris-Meudon	France	brigitte.schmieder@obspm.fr
SEKII	Takashi	NAOJ	Japan	sekii@solar.mtk.nao.ac.jp
Shibasaki	Kiyoto	Nobeyama Solar Radio Observatory	Japan	shibasaki@nro.nao.ac.jp
Shibata	Kazunari	Kwasan & Hida Observatories	Japan	shibata@kwasan.kyoto-u.ac.jp
Shimizu	Masaki	Kwasan Observatory, Kyoto University	Japan	shimizu@kwasan.kyoto-u.ac.jp
SHIMIZU	TOSHIFUMI	ISAS/JAXA	Japan	shimizu@solar.isas.jaxa.jp
SHIMOJO	Masumi	Nobeyama Solar Radio Observatory/NAOJ	Japan	shimojo@nro.nao.ac.jp
Shiota	Daikou	Kwasan and Hida Observatories, Kyoto University	Japan	shiota@kwasan.kyoto-u.ac.jp
Stein	Bob	Michigan State University	USA	stein@pa.msu.edu
Sterling	Alphonse	NASA/MSFC/NSSTC	USA	alphonse.sterling@nasa.gov
Suematsu	Yoshinori	National Astronomical Observatory of Japan	Japan	suematsu@solar.mtk.nao.ac.jp
Suzuki	Takeru	Department of Physics, Kyoto University	Japan	stakeru@scphys.kyoto-u.ac.jp
Suzuki	Isao	The Graduate University for Advanced Studies/National Astronomical Observatory	Japan	isuzuki@solar.mtk.nao.ac.jp
Takasaki	Hiroyuki	Kwasan Observatory, Kyoto University, Japan	Japan	takasaki@kwasan.kyoto-u.ac.jp
Tanuma	Syuniti	Kwasan Observatory, Kyoto University	Japan	tanuma@kwasan.kyoto-u.ac.jp
Tarbell	Ted	Lockheed Martin Solar & Astrophysics Lab	USA	tarbell@lmsal.com
Title	Alan	Stanford Lockheed Institute for Space Research	USA	ATitle@solar.stanford.edu
Tripathi	Durgesh	Department of Applied Mathematics and Theoretical Physics	UK	dktripathi@gmail.com
Tsuneta	Saku	NAOJ	Japan	saku.tsuneta@nao.ac.jp
UeNo	Satoru	Kwasan & Hida Observatories	Japan	ueno@kwasan.kyoto-u.ac.jp
van Driel-Gesztelyi	Lidia	MSSL/UCL, UK and Konkoly Observatory, Hungary	UK	lvdg@mssl.ucl.ac.uk
Walsh	Robert	University of Central Lancashir	UK	rwwalsh@uclan.ac.uk
Wang	Haimin	Big Bear Solar Observatory	USA	haimin@flare.njit.edu
Watanabe	Tetsuya	National Astronomical Observatory	Japan	watanabe@uvlab.mtk.nao.ac.jp
Watanabe	Kyoko	Solar-Terrestrial Environment Laboratory, Nagoya University	Japan	kwatana@stelab.nagoya-u.ac.jp
Weber	Mark	Smithsonian Astrophysical Observatory	USA	mweber@cfa.harvard.edu
Wikstol	Oivind	Institute of theoretical astrophysics, University of Oslo	Norway	oivindw@astro.uio.no
WILLIAMS	David	Mullard Space Science Laboratory, University College London	United Kingdom	drw@mssl.ucl.ac.uk
Winter	Henry	Montana State University, Physics Dept.	USA	winter@solar.physics.montana.edu
Woo	Richard	Jet Propulsion Laboratory	USA	Richard.woo@jpl.nasa.gov
Yamada	Masaaki	PPPL、Princeton　Univ.	USA	myamada@pppl.gov

Yamamoto	Tetsuya	Department of Astronomy, Graduate School of Science, The University of Tokyo	Japan	yamamoto@solar.mtk.nao.ac.jp
Yamauchi	Yohei	Hida Observatory, Kyoto Univeristy	Japan	yamauchi@kwasan.kyoto-u.ac.jp
YOKOYAMA	Takaaki	University of Tokyo	Japan	yokoyama.t@eps.s.u-tokyo.ac.jp
YOSHIMURA	KEIJI	Montana State University	USA	yosimura@mithra.physics.montana.edu
YOUNG	PETER	CCLRC RUTHERFORD APPLETON LABORATORY	UNITED KINGDOM	p.r.young@rl.ac.uk
Yu	Dai	Department of Astronomy, Nanjing Univ.	China	ydai@nju.edu.cn
Zhang	Hongqi	National Astronomical Observatories, Chinese Academy of Sciences	China	hzhang@baoa.c.cn