7.1

Large Scale Eruptive Event Initiation Mechanisms and Flux ropes

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Several mechanisms have been proposed to explain the initiation of large scale eruptive events such as CME, among which are the Flux Cancellation Model, the Converging Flows Model, and the Break Out Model. Some major points on which those models differ depend on the presence or not of a twisted flux rope, either as an equilibrium structure that is destabilized or only as the product of reconnection during the dynamic phase of the CME, as well as their magnetic helicity budget. The site of reconnection and its nature as a necessary condition or a consequence of the CME, related to the topology of the configuration, is also an important characteristic of those models, and is still subject to debate. We will present some results we have obtained which address some of those issues.

7.2

Dependence of Solar Wind Velocity on Low Latitude Pc3 Magnetic Pulsations

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Pc3 Geomagnetic pulsations are quasi-sinusoidal variations in the Earth's magnetic field in the period range 10–45 seconds. The magnitude of these pulsations ranges from fraction of a nT(nano Tesla) to several nT. These pulsations can be observed in a number of ways. However the application of ground based magnetometer arrays has proven to be one of the most successful methods of studying the spatial structure of hydromagnetic waves in the earth's magnetosphere.

The solar wind provides the energy for the Earth's magnetospheric processes. Pc3–5 geomagnetic pulsations can be generated either externally or internally with respect to the magnetosphere. The Pc3 studies undertaken in the past have been confined to middle and high latitudes. The spatial and temporal variations observed in Pc3 occurrence are of vital importance because they provide evidence which can be directly related to wave generation mechanisms both inside and external to the magnetosphere. At low latitudes ($L < 3$) wave energy predominates in the Pc3 band and the spatial characteristics of these pulsations have received little attention in the past.

An array of four low latitude induction coil magnetometers was established in south-east Australia over a longitudinal range of 17 degrees at $L = 1.8$ to 2.7 for carrying out the study of the effect of the solar wind velocity on these pulsations. Digital dynamic spectra showing Pc3 pulsation activity over a period of about six months have been used to evaluate Pc3 pulsation occurrence. Pc3 occurrence probability at low latitudes has been found to be dominant for the solar wind velocity in the range 400–700 Km/sec. The results suggest that solar wind controls Pc3 occurrence through a mechanism in which Pc3 wave energy is convected through the magnetosheath and coupled to the standing oscillations of magnetospheric field lines.

In conclusion it has been demonstrated that he occurrence probability of Pc3 pulsations depends on solar wind velocity with a threshold at about 320 km/sec and ranging up to 700 km/sec. It is likely that an instability originating from the direct interaction between the solar wind and the magnetosphere is exciting Pc3 pulsations through bow-shock associated waves.

7.3

Modeling Non-Potential Fields in Solar Active Regions

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Many models aim to reproduce the non-linear force-free fields in the solar corona; in this particular study, the magnetofrictional relaxation method is tested. This method produces non-linear force-free fields from line-of-sight magnetograms and uses ground-based Hα images to define the location of a filament. Testing the model involves comparing the model's results to TRACE and Hinode XRT observations of highly sheared, non-potential magnetic field structures in several non-flaring active regions. Results from such tests are presented.

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7.4

Active regions: Evolution and Effect on Time-Distance Measurements

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We study the influence of active regions on travel time measurements in time-distance analysis. Preliminary results obtained with SOHO/MDI and GONG++ data are presented.

7.5

FLCT: A Fast, Efficient Method for Performing Local Correlation Tracking

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In this poster, we describe the computational techniques for the recently updated FLCT local correlation tracking method. The FLCT code is then evaluated using a series of simple 2D known flow patterns that test its accuracy and characterize its errors. Finally, flow patterns derived from observed magnetogram and white light data are compared, and the differences interpreted.

7.6

Magnetic Field Topology Originating in the Tachocline Zone.

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The longitudinal structure of the photospheric magnetic field over the last three solar cycles has been studied. The dependence on the latitude, on the hemisphere, phase of cycle and on the cycle itself was analyzed. The reconstruction of the longitudinal structure in the heliographic system rotating like the photospheric field (latitude and time dependent) has been performed as well as in different rigidly rotating systems. A longitudinal structure, exceptionally regular and symmetric in both hemispheres, has been found without any assumption about the rotation of the Sun. This structure originates from the tachocline zone under the convective envelope. A comparison between the rotational rate of the large scale magnetic field and helioseismological findings of omega as a function of latitude and radius was performed.

7.7

Multi-Spectral Analysis of Acoustic Power Suppression in Active Regions

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We study the relative suppression in acoustic power in the regions of high magnetic fields at different heights in the solar atmosphere. The technique used here is the ring-diagram analysis, which has been proven a powerful tool in local helioseismic studies. The data sets include simultaneous Dopplergrams obtained with the Ni I 676.8 nm from Global Oscillation Network Group (GONG), K I 769.9 nm from Magneto-Optical Filters at Two Heights (MOTH), and Na I 589.0 nm from MOTH and Mount Wilson Observatory (MWO) during the declining phase of the solar cycle 23. It should be noted that the Ni and K lines are formed in the photosphere while the Na line is formed in lower chromosphere. The power spectra are fitted to a model with Lorentzian profile to extract the acoustic mode parameters. The difference in power suppression in active regions with increasing height can be explained in terms of the expanding magnetic flux tubes.

7.8

ATST Design and Status

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The ATST has passed its Preliminary Design Review and has nearly completed an Environmental Impact Study for locating the telescope on Maui. This paper gives a short summary of the current design and status of the project.

7.9

The Subsequent Decaying Regions of NOAA AR7978

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Sunspot NOAA AR7978 first emerged on July 6, 1996 during solar activity minimum at S09E15 with a moderate complexity. The region returned in the next rotation as sunspot group AR7981 with a decayed region and an alpha spot. The same region returned three more rotations subsequently as spotless regions. In this paper, using MDI full disk magnetograms we investigate the magnetic field evolution of this fascinating active region which also had some remarkable large scale effects on the solar corona. It is a rare opportunity to have such a region for studying the magnetic field evolution. The region was evolving for five rotations without interacting with any other regions. We are able to follow the region for several to a few days each rotation. Parameters represent the evolution of magnetic field have been obtained for the second to fourth rotations due to data suitability. Analyses and discussions of the implications of our results will be given in terms of the factors that play roles in active region evolutions.

7.10

Prospects for Control Diagnostics of Seismic Emission from the Quiet Sun

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We consider what fully compressible simulations of convection offer for our understanding of the origin of seismic waves on which p-mode diagnostics are based.

7.11

Long Exposure Point Spread Function Estimation from Adaptive Optics Loop Data: Results and Validation

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Current work in Solar Physics requires high resolution observations from ground based telescopes. However, the performance of any ground based telescope is ultimately limited by optical aberrations produced by atmospheric turbulence. Adaptive Optics (AO) is a powerful tool that corrects these aberrations in real time, considerably improving image quality.

We present a method to estimate the long exposure PSF of the AO corrected solar image using AO loop data. Wavefront sensor and mirror data produced by the AO system during normal operation contain information about uncorrected residual aberrations that define the shape of the long exposure point spread function (PSF). The estimated long exposure PSF is used to improve image quality through post-processing techniques. Post-processed images produce more reliable quantitative measurements of physical parameters.

Results obtained by applying the method to actual solar and star observations captured at the Dunn Solar Telescope will be shown. The accuracy of the estimated PSFs is tested with observations of the star Sirius which produce a direct measurement of the system's PSF.

7.12

Pre-College Solar Science Education using the Filament/SXT Online Correlation Catalog

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Solar science in grades 5–12 will be fused with real data by internet access to the soon-to-be-released online Filament/SXT Correlation Catalog. This database was created by Ivy Merriot, a high school astronomy teacher at Abaetern Science Institute (an online science school), under the guidance of Dr. Petrus Martens of Montana State University and Dr. Alexei Pevtsov of the National Solar Observatory at Sunspot, NM. The data in this online catalog comes from a SOHO image analysis of SXT sigmoids by Zach Blehm and Dr. Richard Canfield of MSU-Bozeman that was later correlated with Hα images digitized by Ivy Merriot from film archives of the Flare Patrol Solar Telescope at Sunspot, NM. This is a catalog that will be useful to researchers at all levels as well as pre-college students. The user can enter data on SXT, EIT, Hα, and CMEs to find correlations between these and SXT sigmoids. The original purpose of the catalog was to correlate filaments with sigmoids, but much info is added to also relate these to Yashiro's database of CMEs. Ivy Merriot has also built an area on the catalog's webpage to show students how to use the data in this catalog for science fair projects and on-going solar research at a level a pre-college student can enjoy.

7.13

The Tilted Solar Dipole at Solar Minimum

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We investigate the tilt of the solar dipole away from the rotational axis at solar minimum. We use the coronal streamer geometry as observed by LASCO C2 East and West limb data to identify the tilt of the solar dipole in the equatorial plane. We also analyze the center-of-gravity of the polar caps as defined by coronal hole boundaries and the high-latitude unipolar regions observed in magnetogram data. We suggest that the tilted dipole observed at solar minimum is a result of an MHD instability acting upon the toroidal magnetic bands in the solar interior (Cally et al. 2003) causing the toroidal bands to tip with respect to the equatorial plane. This allows for the asymmetric eruption of sunspots at high-latitudes early in the sunspot cycle mapping out an $m = 1$ pattern in longitude as found by Norton & Gilman (2005). The decay of the follower spots and migration of this flux poleward creates a polar cap in the next sunspot cycle that is slightly misaligned with the N-S rotational axis.

References

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7.14

Magnetohydrostatic Solar Prominences in Near-Potential Coronal Magnetic fields

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We present numerical magnetohydrostatic solutions describing the gravitationally stratified, bulk equilibrium of cool, dense prominence plasma embedded in a near-potential coronal field. These solutions are calculated using the FINESSE magnetohydrodynamics equilibrium solver and describe the morphologies of magnetic field distributions in and around prominences and the cool prominence plasma that these fields support. The equilibrium condition for this class of problem is usually different in distinct subdomains, separated by free boundaries, across which solutions are matched by suitable continuity or jump conditions describing force balance. We employ our precise finite element elliptic solver to calculate solutions not accessible by previous analytical techniques with temperature or entropy prescribed as free functions of the magnetic flux function, including a range of values of the polytropic index, temperature variations mainly across magnetic field lines and photospheric field profiles sheared close to the polarity inversion line. Out of the many examples computed here, perhaps the most noteworthy is one which reproduces precisely the three-part structure often encountered in observations: a cool dense prominence surrounded by a cavity, within a flux rope embedded in a hot corona.

7.15

On the Relationship between CME Associated Waves: CMEs-Driven Shock Waves vs. EIT Waves

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We study the relationship between CME-driven shock waves and EIT waves. For this purpose, we analyze observations of a CME eruption on 05 March 2000 recorded by different instruments on board the Solar and Heliospheric Observatory (SOHO). To the best of our knowledge, the present study is the first of its kind. The Extreme-ultraviolet Imaging Telescope (EIT) images show propagation of an "EIT wave" predominantly in the North-East direction from the source region. The Large Angle Spectrometric Coronagraph (LASCO) C2 images show a clear deflection (kink) in a remote streamer propagating outwards along with the associated CME. No CME material was present between the CME flank and the remote streamer to cause such a deflection. Spectra from the Ultraviolet Coronagraph Spectrometer (UVCS) show excessive spectral line broadenings, Doppler shifts and intensity variations (enhancement followed by dimming) in the O VI lines along with emissions of Si XIII and Mg X hot lines at 520 Å and 525 Å, respectively. Interestingly, the three features — the EIT wave, streamer deflection and CME-driven shock wave — are seen to propagate in the same direction, i.e., North-East, showing the spatial correlation between them. Spatial and time correlations show that the deflection and the propagation of the kink in the streamer and plasma heating and spectral line broadening are basically due to CME-driven shock wave. The EIT wave is seen with a slower speed than the CME-driven shock wave. This could be due to wave propagation in different media with different physical properties such as densities, temperatures, and magnetic fields causing fast leakage of energy in the lower corona. Based on the above physical background we interpret this EIT wave as the signature of a CME-driven shock wave in the lower corona.

7.16

Time Evolution of the Evershed Flow

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We show spectropolarimetric evidence that moving magnetic features (MMFs) around sunspots are the continuation of Evershed flow beyond the visible limits of the penumbra. Two Evershed clouds are seen to move radially outward across the same penumbral filament. At a given moment, the clouds cross the penumbral boundary and continue as MMFs of opposite polarity. This effect, in turn suggests a magnetic connection between the MMFs and the sunspot magnetic field. Some other relevant evolutionary effects related to the Evershed flow are also discussed.

7.17

Temporal Variations in a Sunspot Umbra and Penumbra

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We analyze the temporal variations in a sunspot umbra and penumbra as observed in the photosphere and the chromosphere with focus on the variability of the visible Evershed effect and its inverse counterpart. We challenge a potential connection between the two flow systems and scrutinize the relation between umbral oscillations and running penumbral waves. The investigation is based on a 2h sequence of line scans in the Zeeman insensitive FeI 709.04 nm line and one of the Ca II triplet lines at 854.2 nm obtained with the Interferometric BIdimensional Spectrometer (IBIS) operated at the Dunn Solar Tower under excellent seeing conditions.

7.18

Electric Fields and Currents Linking the Solar Interior and Atmosphere

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Energy, momentum and mass transports between the solar interior and atmosphere are regulated by many physical mechanisms. They lead to mechanical, thermodynamic and electro-dynamic in-equilibrium manifested ultimately as solar activity phenomena. They are described by different theoretical approaches using dissipative MHD equations with radiation, plasma kinetic formulations and Maxwell equations. Many details of these mechanisms are known, but not all important questions about their physics can be clearly answered, primarily because of insufficient experimental knowledge of needed physical parameters. One of the poorly investigated or even missing blocks in this regard belongs to electric charges and currents. The usual assumption about quasi-neutrality does not exclude the necessity of analysis of inductive and potential electric fields. Their relative importance is given by the dimensionless Faraday number, which is still not evaluated in many instances for eruptive prominences, flares and CMEs. We will attempt to do this in a preliminary way based on available limited physical information and data of indirect observations. The principal difficulty is that electric fields and currents are not measured directly on the Sun and can be only inferred. This procedure is not free from model assumptions, which are still far from being unique, in spite of opposite statements of many researchers biased by reconnection paradigms and their false evidences. We will bring arguments favoring high physical openness degree of solar activity manifestations and non-local couplings to their subphotospheric free energy drivers and not just local instabilities. Biggest flares and CMEs never happen without new magnetic flux emergence in the photosphere. This proves without any doubts the direct driving chain from interior to atmosphere. The openness degree should be evaluated using dimensionless Trieste numbers for internal, linking, and external energy, momentum and mass flows in structures and events under consideration. Electric fields and currents will be considered as important ingredients of these links.

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7.19

On the Origin of Strong Gradients in Photospheric Magnetic Fields

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Several studies correlated observations of impulsive solar activity — flares and coronal mass ejections — with the amount of magnetic flux near strong angular gradients in active regions' radial magnetic field, as measured in photospheric magnetograms. Practically, this empirical correlation holds promise as a space weather forecasting tool. Scientifically, however, the mechanisms that generate such gradients remain unknown. Hypotheses include the emergence of highly twisted or kinked flux ropes, and flux cancellation driven by photospheric flows acting fields that have already emerged. If such concentrations of flux near strong gradients are formed by emergence, then increases in unsigned flux near strong gradients should be correlated with increases in total unsigned magnetic flux — a signature of emergence. Here, we analyze time series of MDI line-of-sight magnetograms from several dozen active regions, and conclude that increases in unsigned flux near strong gradients tend to occur during emergence, though strong gradients can arise without flux emergence.