Generation of magnetic field

Title: Ulysses observation of the poloidal and toroidal solar magnetic fields

Author: A Dickson Benjamin

Abstract: There are many evidences that magnetically closed structures propagate through interplanetary space and they mainly evolve from the sunspot regions. They are easily understood in terms of subsurface tororidal magnetic field. The tororidal field is a field whose lines of force are circles around the solar axis. The roots of the field are concentrated somewhere inside the sun and driven by convective force coupled with magnetic buoyancy to form solar sunspot pairs. Estimating the mean sunspot field (toroidal field) which occupy only a small fraction of convective zone is practiclly not possible. In addition to mean toroidal field there is a mean poloidal field. The poloidal having its lines of force in meridional planes containing solar axis. The mean polodidal field, which by definition is axis symmetric, or an average over longitude over more rotations may provide a reasonably good value of both toroidal and polodidal magnetic fields. The solar dipole field (poloidal field) has been measured and studied extensively using solar magnetograms. Although the global solar magnetic field has been observed and extensively analyzed, the toroidal and meridional field lines have never before been detected and measured. Ulysses vector helium magnetometer/fluxgate instruments provide the direct in situ measurement of the polodial, torodial, and meridional solar magnetic field components in the interplanetary space. In fact, the magnetic field components are entangled mutually and may lose their actual features as they travel through the inhomogeneous interplanetary medium. Still, the magnetic field components hold the intense features far from the surface of the Sun in the interplanetary medium. Just like the magnetogram which provides data averaged over longitudes, the satellite data averaged over longitudes may provide various components of global solar magnetic field. For the present study, the average data (over longitude and time) of interplanetary magnetic field (IMF) parameters are derived from Ulysses fluxgate/vector helium magnetometer data for the period 1991-2004. The running average of IMF for each Carrington rotation is considered for the entire two Ulysses orbits around the Sun. Ulyssesâ€TMs two orbits around the Sun nearly coincided with the two phases of the solar cycle, the first orbit during the minimum phase of the solar cycle 22 and the second orbit, the maximum phase of the solar cycle 23. These observations also provide an insight in to the solar poloidal field reversal during the epoch of the solar maximum activity. Observations also show the formation as well as the oscillations of sunspots in both the phases of solar activity.

Title: Mean Field surface Dynamo in partially ionized plasmas

Author: Kunwar Alkendra Pratap Singh

Abstract: A dynamo operating in the partially ionized, surface and

atmospheric layers of stars can produce a variety of magnetic structures on their surfaces. In a partially ionized plasma like in the solar photosphere and the overlying layers, the magnetic induction equation is subjected to the Hall drift and ambipolar diffusion along with the Ohmic dissipation. It turns out that in the presence of a surface shear, Hall & ambipolar diffusion, magnetic field components can grow rapidly to form small spatial horizontal structures. Thus, these non-ideal effects along with a surface shear can play an important role in driving the dynamo action in the partially ionized surface layers of cool stars.

Title: Can Flux Transport Solar Dynamo Models Function with a Shallow Meridional Flow?

Author: Soumitra Hazra

Abstract: Kinematic dynamo models of the solar cycle that rely on magnetic flux transport processes have traditionally relied on a deep meridional flow pervading the full solar convection zone. The current understanding of the solar cycle, based not only on such dynamo models but also on flux tube dynamics simulations, is that strong toroidal flux tubes are stored and amplified in a stable layer beneath the base of the convection zone, from where they buoyantly rise to produce sunspots. However, some recent interpretations of solar meridional flow observations are along the lines that the meridional flow is shallow and remains confined to the top 10% of the Sun. Here, we explore whether flux transport dynamos could function with such a shallow meridional flow and discuss the consequences that this scenario would have on our traditional understanding of magnetic field dynamics in the solar interior.

Title: Effect of large scale shear on a dynamo in spherical shell

Author: Aditi Sood

Abstract: A kinematic dynamo action is studied in a spherical shell with a small scale prescribed velocity field. Velocity field is considered to be axisymmetric and nature of flow is steady and strongly helical. Flow is chosen in such a way so that we have dipole/quaderupole decoupling for magnetic field B. The effects of large scale shear on dynamo is studied for different modes for large Reynolds number R_{m}. Specifically, we have studied the the flow in the presence of radial and latitudinal shears and observe the behaviour of growth rate and structures of magnetic field B. Growth rate is found to decrease with increasing R_{m} and we find that dynamo becomes slow in the presence of radial/latitudinal shear.

Sub surface structure of flows convection

Title: Properties of p- and f modes in hydromagnetic turbulence

Author: Nishant Singh

Abstract: With the ultimate aim of using the fundamental or f-mode to study helioseismic aspects of turbulence-generated magnetic flux concentrations, we use randomly forced hydromagnetic simulations of a piece wise isothermal layer in two dimensions with reflecting boundaries at top and bottom. We compute numerically diagnostic wave number frequency diagrams of the vertical velocity at the interface between the denser gas below and the less dense gas above. We study the effects of uniform (both horizontal and vertical) as well as non-uniform magnetic field on especially the f-mode and discuss some novel features that we find. Specifically we find that the f-mode fans out in the diagnostic k-omega diagram, in the presence of harmonically varying magnetic field. Based on our new findings, we argue that the f-mode could be used as a sensitive tool to determining subsurface magnetic fields.

Title: Quenching and anisotropy of hydromagnetic turbulent transport

Author: Bidya Binay Karak

Abstract: Hydromagnetic turbulence affects the evolution of large-scale magnetic fields through mean-field effects like turbulent diffusion and the alpha-effect. For stronger fields, these effects are usually suppressed or quenched, and additional anisotropies are introduced. Using different variants of the test-field method, we determine the quenching of the turbulent transport coefficients for the forced Roberts flow, isotropically forced non-helical turbulence, and rotating thermal convection. We see significant quenching only when the mean magnetic field is larger than the equipartition value of the turbulence. Expressing the magnetic field in terms of the equipartition value of the quenched flows, we obtain for the quenching exponents of the turbulent magnetic diffusivity about 1.3, 1.1, and 1.3 for Roberts flow, forced turbulence, and convection, respectively. However, when the magnetic field is expressed in terms of the equipartition value of the unquenched turbulence, these quenching exponents become about 4, 1.5, and 2.3, respectively. For the alpha-effect, the exponent is about 1.3 for the Roberts flow and 2 for convection in the first case, but 4 and 3, respectively, in the second. In convection, the quenching of turbulent pumping follows the same power law as turbulent diffusion, while for the coefficient describing the Omega*J effect nearly the same quenching exponent is obtained as for alpha. For forced turbulence, turbulent diffusion proportional to the second derivative along the mean magnetic field is

quenched much less, especially for larger values of the magnetic Reynolds number.

Title: Sun: from dynamo to spots

Author: Dhrubaditya Mitra

Abstract: We perform direct numerical simulations of the equations of magnetohydrodynamics with external random forcing and in the presence of gravity. The domain is a divided in two parts, in the bottom layer the forcing is helical whereas in the top layer the helicity of the forcing is zero with a smooth transition in the middle. At early times, a large-scale helical dynamo develops in the bottom layer. At late times the dynamo saturates, but the vertical magnetic flux continues to develop and rises to form dynamic bipolar structures at the top, which later disappear and reappear again. Their field strength can exceed three times the equipartition value of the turbulence. This is the first example of self-consistent generation of bipolar magnetic structures from a dynamo simulation.

MAGNETO CONVECTION AND TRANSPORT

Title: Properties of Umbral Dots

Author: Rahul Yadav

Abstract: Umbral dots (UDs) are tiny bright features observed in the umbra of a sunspot or pore; they are the manifestation of magneto- convection, and have a wide range of size (0.2 -- 0.5 arcsec) and lifetime (5 – 40 sec). They are believed to be responsible for the energy transfer in the sunspotâ€TMs umbrae or pores. Due to their small size and time variation their studies require a high spatial and temporal resolution observation. We aim to understand the physical properties of UDs using high resolution observations obtained from the Solar Optical Telescope (SOT) onboard Hinode. An automatic identification and tracking algorithm will be applied to the UDs. The location and size of UDs derived from the identification algorithm while the tracking algorithm used to find the lifetime and velocity. In addition, the spectropolarimetric data from the SOT/SP onboard Hinode used to find the magnetic field strength and inclinations, line-of- sight velocity in and around the UDs. The analysed result will be compared with the existing models that describe the UDs.

Title: Fine structure of pores

Author: Lokesh bharti

Abstract: We present high resolution observations of pores obtained from onboard Hinode. The pores in G-band show filamentary structure with dark core similar to penumbral filaments. They evolve in granules at the edge of pore and migrates inside the pore. In some cases more than one such filamentary structure found in a one granule. The width of these filamentary structure is comparable to thin penumbral filaments and length is lesser than penumbral filaments. Their life time is several minutes. Origin of such structure may be due to fluting instability at the granule edge in the presence of more inclined field at the pore boundary.

PCC I – Photospheric Magnetic Field

Title: Unravelling the Sun climate link

Author: Abhinna Behera

Abstract: The varying magnetic field of the Sun and the sunspot cycle modulate the Sun's energy output and the heliospheric open flux. The former is the primary energy input into the global climate system and the later may be relevant for climate due to its modulation effect on cosmic rays. It is the sole reason behind the formation of the cloud, winds and water currents in ocean, sea, etc. Hence, it will be prudent to discern the Sun-Climate link by focusing on changes occurs in solar activity and global climate. This accentuated connection is the main theme of our work and to find out this connection, we deploy Fourier and wavelet transform. The periodic behavior of the solar activity has been studied to a great extent; the multi-scale characterization of the sunspot cycle and the global temperature anomalies reveals clear signature of self-similarity, complex scaling behavior and periodicity. Using generalized Hurst exponent, we have quantified the self similar nature and to capture the transient behavior present in the solar activity, as well as in global temperature by using the scale dependent varying window. Using Morlet wavelet function, the optimal time-frequency localization has been shown to focus on the cyclic behavior of solar activity that is the best observed as the formation of the sunspot numbers every day. The sunspot numbers, spanning over 400 years, is a direct proxy for varying solar magnetic field. We use the contemporary northern hemisphere anomalies along with this. To focus on long-term climate relevant trends, the well-known 11 year periodicity has been eliminated by taking the decadal average of both sunspot numbers and temperature anomalies. This work explores the phase relationship between temperature anomalies and the sunspot numbers with the changes in the correlation coefficients between them, calculated on decadal basis.

Title: Quasi-Static 3d Magnetic Field Evolution in Solar Active Region NOAA 11166 Associated

Author: Vemareddy Panditi

Abstract: We study the quasi-static evolution of coronal magnetic fields constructed from the non-linear force-free field (NLFFF) approximation aiming to understand the relation between the magnetic field topology and ribbon emission during an X1.5 flare in active region (AR) NOAA 11166. The flare with a quasi-elliptical and two remote ribbons occurred on 2011 March 9 at 23:13 UT over a positive flux region surrounded by negative flux at the center of the bipolar AR. Our analysis of the coronal magnetic structure with potential and NLFFF solutions unveiled the existence of a single magnetic null point associated with a fanâ€“spine topology and is co-spatial with the hard X-ray source. The footpoints of the fan separatrix surface agree with the inner edge of the quasielliptical ribbon and the outer spine is linked to one of the remote ribbons. During the evolution, the slow footpoint motions stressed the field lines along the polarity inversion line and caused electric current layers in the corona around the fan separatrix surface. These current layers trigger magnetic reconnection as a consequence of dissipating currents, which are visible as cusp-shaped structures at lower heights. The reconnection process reorganized the magnetic field topology whose signatures are observed at the separatrices/quasi-separatrix layer structure in both the photosphere and the corona during the pre-to-post flare evolution. In agreement with previous numerical studies, our results suggest that the line-tied footpoint motions perturb the fan-spine system and cause null point reconnection, which eventually causes the flare emission at the footpoints of the field lines.

Title: Topological properties of coronal fields derived from Non-linear extrapolations of Force free solutions.

Authors: A. Mangalam

Abstract: A systematic study of the linear and nonlinear force-free (NLFF) magnetic field equation for simple axisymmetric configurations is applied to simulate photospheric vector magnetograms. Based on these simulations, we built three-dimensional axisymmetric field configurations and calculated the energy and relative helicity for active regions (ARs). We extend this framework to extapolate the linear non-axisymmetric force-free fields and estimate the variation of twist angle as a function of height. We also calculate useful topological quantities relevant to the plasma entropy.

Title: Solar filaments and their footpoints relative to photospheric magnetograms

Author: Aparna Venkataramanasastry

Abstract: Injection of mass via the ends of the filaments as a mechanism by which a filament acquires mass is studied. Images obtained on Oct 30, 2010, in H-alpha centreline and at discrete steps in the wings of H-alpha using the Dutch Open Telescope (DOT) are used. The set of DOT H-alpha images are used in combination with magnetogram images obtained from the Helioseismic Magnetic Imager (HMI) instrument aboard the Solar Dynamics Observatory (SDO) satellite. The images of each wavelength in the wings of H-alpha are first aligned and made into animations to study the properties of mass motions. Three filaments at different stages in their life are present in the region of interest (Carrington location W28N37). One of the filaments is stable throughout the period of observation (six hours). The second filament is an erupting filament and the third filament is in the process of formation. Definite ends on both sides of a filament are observed only in the first filament. The other filaments show definite or clear end points mostly near the positive magnetic fields. The filaments commonly show multiple ends and on occasions are visible as threads. Definite evidence of mass motions is seen occurring into and out of the visible ends of all filaments. These motions also appear similar to the mass motions occurring in the chromospheric fibrils as also suggested by Lin et al. (2008). The chromospheric fibrils are also present in the field of view and the mass motions in these fibrils are visible in the animations. Magnetic properties of the footpoints are studied by overlaying the DOT images with the magnetograms using full disk H-alpha images as a reference. The ends of the filaments in the far blue and red wing H- alpha images are used for accurately locating their position with respect to the magnetogram. A statistical analysis of the positions of the footpoints of the filaments taken from all the images with respect to the magnetic field of the photosphere is made. While the positions of the footpoints are consistent with previous observations (Martin 1998; Wang 2001; Lin et al. 2008; Joshi et al. 2013), they appear to be tending to lie on the majority polarities rather than in between the majority and minority polarities as was evident in previous observations. This may be indicating the presence of weaker magnetic fields that are difficult to detect either due to low spatial resolution of the images or sensitivity of the instruments. The variation in the magnetic field in the region of interest with respect to time is also measured to understand the effect of the change in the field on the injection and draining of the mass via the footpoints. This is further analysed to see its effects on the erupting filament.

Title: Analysis of phase relationship between sunspot activity and 10.7-cm flux

Author: Satish Kumar Kasde

Abstract: We have studied the phase relationship between sunspot activity and solar radio flux (F10.7 cm) during January cm Radio Flux 1964 to December 2013 including the solar cycles 20 to 23 with the rising phase of

solar cycle 24. Wavelet based techniques such as cross wavelet transform (XWT), wavelet coherence (WTC) and cross recurrence plots (CRPs) are used in this work. Analysis shows that the Schwabe cycle is connected with quasi-periodicity changes of solar activity. The XWT and WTC show area with high common power, located at the Schwabe cycle belt, where the sunspot activity and solar F10.7 are asynchronous.

Title: Are we headed towards a Maunder like minimum - solar, solar wind and ionospheric signatures

Author: Janardhan Padmanabhan

Abstract: We show from a study of solar magnetic fields and solar wind micro-turbulence in the inner-heliosphere that we are probably headed towards a long period of little/no sunspot activity similar to the most well-known Maunder minimum from 1645\,--\,1715. Our observations of a steady decline of solar high latitude magnetic fields combined with the fact that cycle 24 is already past its peak, implies that high-latitude magnetic fields will continue to decline until $\sim$2020. In addition, interplanetary scintillation observations of solar wind micro-turbulence levels have also shown a steady decline in sync with the declining solar photospheric fields. An assessment of the possible impact of such a decline in solar photospheric fields on terrestrial ionospheric current systems based on the one-to-one correlation of sunspot number and night time F-region maximum electron density reveals that there will be no significant effect on such systems. Our results indicate that the period post 2020 will be very useful for undertaking systematic ground based low- frequency radio astronomy to study the high red-shift universe, as the night time ionospheric cutoff could be well below 10 MHz for a prolonged period of time.

Title: Estimation of Magnetic Gradients using Photospheric and Chromospheric Magnetic Measurement

Author: Mohana Krishna

Abstract: Magnetic field measurements at two different heights is an area of current interest in order to understand the magnetic gradients of active regions. Such measurements provide a valuable information on the nature of the magnetic field (potential vs non-potential) and constrain the existing extrapolation models. Such measurements techniques are feasible currently with the new instrumentation and analysis techniques. We present one such measurement carried out with the IBIS and FIRS instruments at the Dunn Solar Telescope, National Solar Observatory, Sunspot. A sunspot was observed using these two instruments in polarimetry mode. While FIRS was used with the Photospheric FeI 630.2nm line, IBIS was observing the Chromospheric 854.2nm line. The LOS magnetic field estimates from these two instruments were combined to arrive at the magnetic field gradients of this active region. The results for this active region will be presented along with the potential use of this method for solar atmospheric magnetic diagnostics.

Title: Measurement of chromospheric magnetic fields using forward modelling -- an overview

Author: Smitha Narayanamurthy

Abstract: The chromosphere is an important atmospheric layer that connects the photosphere, transition region and corona. The nature of the chromospheric magnetic fields has remained elusive, the measurement of which is difficult due to the Non Local Thermodynamic Equilibrium effects that dominate in the chromospheric layers. One of the well known methods to measure magnetic fields is by forward modelling the observed Stokes profiles of magnetically sensitive lines in the Second Solar Spectrum. In this work, we present an overview of some of the challenges faced in forward modelling the chromospheric lines, through several examples.

Title: Evaluation of standoff distance method to determine the coronal magnetic field using CME driven shock

Author: Suresh K

Abstract: We have analyzed the propagation characteristics of five limb CMEs/shocks observed in solar cycle 24. These CMEs, with well-structured flux rope, could be observed in 17 frames up to 15Ro using LASCO/C2/C3 and STEREO/COR2 data. Gopalswamy and Yashiro (2011) introduced “standoff distance method” to find the magnetic field in the corona using CME-driven shocks. In this paper, we used this technique to compute the magnetic field and studied the propagation and shock formation condition of these CMEs at 17 different locations for two adiabatic indices (gamma = 4/3 and 5/3). The magnetic field values derived in this paper agree with the literature values and they follow the general trend.

Coupling in the solar atmosphere

Title: Two-fluid MHD code for simulations of small-scale magnetic fields in the lower solar atmosphere

Author : Isabell Piantschitsch

Abstract: Our aim is to investigate magnetic reconnection in the chromosphere due to the evolution of magnetic flux tubes. We developed a new numerical two-fluid magnetohydrodynamic (MHD) code which will perform a 2.5D simulation of the dynamics from the upper convection zone up to the transition region. Our code is based on the Total Variation Diminishing Lax-Friedrichs method and includes the effects of ionneutral collisions, ionisation/recombination, thermal/resistive diffusivity as well as collisional/resisitve heating. The initial conditions include analytically constructed vertically open magnetic flux tubes within a realistic stratified

atmosphere. Initial MHD tests have already shown good agreement with known results of numerical MHD test problems.

Title: DEM analysis of a Prominence eruption

Author: Chandan Joshi

Abstract: We present here DEM analysis of the prominence eruption associated with an X-Class flare. The data analysed in this report were observed by AIA on board SDO on 25 Feb 2014. The prominence eruption was multi-structured as seen in different channels of AIA. The DEM analysis was used to draw the emission measure maps at different temperature scales as a function of time.

Title: Modeling Solar Prominences and analyzing their dynamics

Author: Swati Routh

Abstract: Solar Prominences are intriguing, but poorly understood, magnetic structures of the solar corona. Convective motions in the photosphere and sub-photosphere may be responsible for generating the magnetic fields that support long-lived quiescent solar prominences. The dynamics of solar prominences has been the subject of a large number of studies, and of particular interest is the study of prominence oscillations. Ground- and space-based observations have confirmed the presence of oscillatory motions in prominences and they have been interpreted in terms of magnetohydrodynamic (MHD) waves. This interpretation opens the door to perform prominence seismology, whose main aim is to determine physical parameters in magnetic and plasma structures (prominences) that are difficult to measure by direct means. We developed a theoretical model to analyze the nature of the dynamics of these quiescent solar prominences. Here we model the prominences as a thin vertical sheet of cool plasma. K-S model has been used as the basis to develop this new model and henceforth derive at a relationship for the variation of the prominence velocity and the frequency of the solar prominence oscillations. We derived the variation of the prominence speed with time considering an averaged mean lifetime of the prominence oscillations and the plot of prominence speed with time shows that the velocity is increasing parabolically with time. Our results can help to predict the eject speed of prominence eruption. Thus it can help to understand also the dynamics behind coronal mass ejections.

Title: Constraining amplitude of density turbulence in the solar corona and solar wind

Author: Madhusudan Ingale

Abstract: We aim to study the constraints imposed on the amplitude of density turbulence (C_N^2) in solar corona and solar wind by observations of angular broadening of radio sources. The amplitude of density turbulence in the solar corona is important, for instance, in determining the scattering of radio waves due to density irregularities. We explore three different

prescriptions of C_N^2. In case of spherical wave propagation we elucidate the connection between scattering measure and the phase structure function to determine the role of C_N^2 in the predictions of the angular broadening. We compare these predicted source sizes with observations of radio noise-storm sources at 327 MHz. We find that the analytical models of C_N^2 are consistent with the obseravtions of the compact sources in the solar corona. For the distant celestial sources seen through the solar wind we compare the observations of the phase structure function with the one obtained by the models of C_N^2 for the baseline of 10 km and wavelength of 12.6 cm and at a solar elongation of 5$R_{\odot}$. We find that the models underpredicts the values of the phase structure function.

Title: Evidence of Dissipation of Slow Magneto-acoustic Waves in a Polar Coronal Hole

Author: Girjesh R. Gupta

Abstract: We focus on a polar coronal hole region to find any evidence of dissipation of propagating slow magneto-acoustic waves. We obtained time-distance and frequency-distance maps along the plume structure in a polar coronal hole. We also obtained Fourier power maps of the polar coronal hole in different frequency ranges in 171~\AA\ and 193~\AA\ passbands. We performed intensity distribution statistics in time domain at several locations in the polar coronal hole. We find the presence of propagating slow magneto-acoustic waves having temperature dependent propagation speeds. The wavelet analysis and Fourier power maps of the polar coronal hole show that low-frequency waves are travelling longer distances (longer detection length) as compared to high-frequency waves. We found two distinct dissipation length scales of wave amplitude decay at two different height ranges (between 0--10 Mm and 10--70 Mm) along the observed plume structure. The dissipation lengths obtained at higher height range show some frequency dependence. Individual Fourier power spectrum at several locations show a power-law distribution with frequency whereas probability density function (PDF) of intensity fluctuations in time show nearly Gaussian distributions. Propagating slow magneto-acoustic waves are getting heavily damped (small dissipation lengths) within the first 10~Mm distance. Beyond that waves are getting damped slowly with height. Frequency dependent dissipation lengths of wave propagation at higher heights may indicate the possibility of wave dissipation due to thermal conduction, however, the contribution from other dissipative parameters cannot be ruled out. Power-law distributed power spectra were also found at lower heights in the solar corona, which may provide viable information on the generation of longer period waves in the solar atmosphere.

Title: Standing Slow MHD Waves in Radiatively Cooling Coronal Loops

Author: Khalil AlGhafri

Abstract: The standing slow magneto-acoustic oscillations in cooling coronal loops are investigated. There are two damping mechanisms which are considered to generate the standing acoustic modes in coronal magnetic loops namely thermal conduction and radiation. The background temperature is assumed to change temporally due to optically thin radiation. In particular, the background plasma is assumed to be radiatively cooling. The effects of cooling on longitudinal slow MHD modes is analytically evaluated by choosing a simple form of radiative function that ensures the temperature evolution of the background plasma due to radiation coincides with the observed cooling profile of coronal loops. The assumption of low-beta plasma leads to neglect the magnetic field perturbation and eventually reduces the MHD equations to a 1D system modelling longitudinal MHD oscillations in a cooling coronal loop. The cooling is assumed to occur on a characteristic time scale much larger than the oscillation period that subsequently enables using the WKB theory to study the properties of standing wave. The governing equation describing the time-dependent amplitude of waves is obtained and solved analytically. The analytically derived solutions are numerically evaluated to give further insight into the evolution of the standing acoustic waves. We find that the plasma cooling amplifies the amplitude of oscillations. In spite of the weak damping caused by radiative cooling in relatively cool coronal loops, the emergence of thermal conduction enhances the damping rate of slow standing MHD waves strongly in hot coronal loops.

Title: Nonlinear Evolution of 3D Dispersive Alfven waves in solar Plasmas

Author: Ram Pal Sharma

Abstract: Nonlinear dispersive Alfven waves(DAW), play key role in the heating of solar corona and explaining the different scaling laws in accelerated corona (so called solar wind). In the present work dynamical equations governing the nonlinear dynamics of the DAW will be presented by taking into account the ponderomotive force associated with the 3D DAW. Numerical and semianalytic results will be presented for different solar plasma regions having low and high plasma beta. Cavitation in solar corona and its relevance to observations will be discussed. In high plasma beta case the turbulence generation mechanism will be studied and its relevance to observed scaling laws will be presented. Acceleration of plasma particles in turbulent structures will also be presented by using the velocity space diffusion coefficient in the Fokker Planck equation.

Title: Standing longitudinal oscillations in hot loops of the solar corona

Author: Sanjay Kumar

Abstract: Standing long-period (with the periods longer than several minutes) oscillations in large hot (with the temperature higher than 3 MK)

coronal loops are observed as the quasi periodic modulation of the EUV and microwave intensity emission and the Doppler shift of coronal emission lines. Theoretical modelling of this phenomenon shows that the observed oscillations are readily excited as standing slow magnetoacoustic waves by impulsive energy releases. Damping of these oscillations was shown to be associated with the effect of thermal conduction. We generalized the theoretical model of standing slow magnetoacoustic oscillations in a hot plasma, including the effects of the radiative losses and accounting for plasma heating. The heating mechanism is not specified and taken empirically. It is shown that the evolution of the oscillations is described by a generalized Burgers equation. Numerical solution of an initial value problem for the evolutionary equation demonstrates that different dependences of the radiative cooling and plasma heating on the temperature lead to different regimes of the oscillations, including growing, quasi stationary and rapidly decaying. Our findings provide a theoretical foundation for probing the coronal heating function, and explain the observations of decayless long-period quasi periodic pulsations in flares.

Title: Kinetic Alfven Wave localization and Turbulent Spectrum

Author: Anju Kumari

Abstract: The localization of Kinetic Alfven wave (KAW) caused by finite amplitude background density fluctuations has been studied in intermediate beta plasma. KAW breaks up into localized large amplitude structures when perturbed by MHD fluctuations of the medium which are in the form of magnetosonic waves. Numerical simulation has been performed to analyse the localized structures and resulting turbulent spectrum of KAW applicable to magnetopause. Simulation results reveal that power spectrum deviates from Kolmogorov scaling at the transverse size of KAW, equal to ion gyroradius. Steepening of power spectrum at shorter wavelengths may be accountable for heating and acceleration of the plasma particles. The obtained results are compared with observations collected from the THEMIS spacecraft in magnetopause.

Title: Circularly Polarized Dispersive Alfven Wave and Its Role in Solar Wind Turbulence at 1 A.U

Author: Swati Sharma

Abstract: We intend to study the nonlinear temporal evolution of the parallel propagating finite frequency Alfven wave (also called Dispersive Alfven wave/Hall MHD wave) propagating in the solar wind regime of the solar region when a perpendicularly propagating magnetosonic wave is present in the background. The finite frequency Alfven wave behaves differently from the usual non-dispersive behavior of the Alfven wave. To study the nonlinear processes (such as filamentation) taking place in the solar regions such as solar wind, the dynamical equation of both the waves are derived. Numerical simulation involving finite difference method for the

time domain and pseudo spectral method for the spatial domain is then performed to analyze the transient evolution of these waves. The power spectra of the Dispersive Alfven wave is also investigated. The power spectra shows the energy distribution of the Dispersive Alfven wave over different wavenumbers. For DAW the spectra shows a steepening for scales larger than the proton inertial length. This means that the wave energy gets transferred to the solar wind particles as the wave reaches higher wavenumbers. This steepening of the power spectra can be explained on account of the finite frequency of the Alfven wave. The obtained results are consistent with the observations made by CLUSTER spacecraft and the recent results obtained by Meyrand and Galtier, Phys. Rev. Lett., 109, (2012).

Title: Dynamics of braided active region moss as seen from Hi-C

Author: V. Pant

Abstract: Primary goal of High resolution Coronal (Hi-C) imager was to observe and characterize the coronal structures. High resolution (0.1''/pixel) and high cadence (5.5 sec) of Hi-C makes it apt for the study of high frequency oscillations. In the present work we focussed on braided active moss region to search for high frequency dynamics. We find short period, large amplitude transverse oscillations with large velocity amplitude. We also find longitudinal flows along the loops with large velocities, which may be related to nano- flares/sub-flares in these regions. In this poster these results with its consequences on coronal heating is presented.

Title: Reflecting Magnetoacoustic wave in hot coronal loops

Author: Pankaj Kumar

Abstract: Slow magnetoacoustic waves have been discovered earlier in hot coronal loops (intensity and Doppler shift oscillations) with SOHO/SUMER, at temperatures T >6 MK. Using high resolution observations from SDO/AIA, we report intensity oscillations in a hot coronal loops (T~8-10 MK). The AIA images show a large coronal loop that was rapidly heated following plasma ejection from one of the loop's footpoints. A wave-like intensity enhancement, seen very clearly only in the 131 and 94 Ã... channel images, propagated ahead of the ejecta along the loop, and was reflected at the opposite footpoint. The wave reflected four times before fading. The characteristic period and the decay time of the oscillation were ~630 and ~440 s, respectively. The phase speed was about 460-510 km/s which roughly matches the sound speed of the loop (430-480 km/s). The observed properties of the oscillation are consistent with the observations of Dopper-shift oscillations discovered by SUMER and with their interpretation as slow magnetoacoustic waves.

Title: Oscillations in active region fan loops

Author: Tanmoy Samanta

Abstract: Propagating intensity disturbances are often observed in active region fan loops. They were thought to be slow mode MHD waves based on some of the observed properties. But the recent studies involving spectroscopy indicate that they could be due to high speed quasi-periodic upflows and it is difficult to distinguish them from propagating slow waves. In this context we have studied a clean fan loop structure in the active region AR 11465 using simultaneous spectroscopic and imaging observations from Extreme-ultraviolet Imaging Spectrometer (EIS) on board Hinode and Atmospheric Imaging Assembly (AIA) on board SDO. Analysis of the data shows significant oscillations at different locations. We explore the nature of these oscillations to determine if the waves or flows could cause these oscillations while looking at different line parameters to improve the current understanding on the nature of these disturbances.

Title: Kink Oscillations in Twisted and Annular Magnetic Flux Tubes with Flows

Author: Satya Narayanan

Abstract: MHD waves play an important role in the transfer of energy from the different layers of the Sun. They also play a crucial role in heating of the solar corona. There are many types of MHD waves, namely, the Alfven modes, the Fast and Slow Magnetoacoustic modes for a uniform plasma which is compressible. However, in nature, the plasma is not homogeneous. For example, in the case of the solar corona, there are loop structures (called the coronal loops) which are manifestations of inhomogeneous plasma, caused by gradients in the magnetic fields. Magnetic structures present in the plasma, give rise to additional modes such as kink, sausage and flute modes, in addition to the surface and body waves. In this study, we consider the basic equations of an ideal MHD plasma, with uniform flows, which is compressible, without dissipation. Two types of geometries are considered. The effect of uniform flows on kink oscillations are studied for (1) uniformly twisted magnetic tubes and (2) magnetic annuli. Assuming wavelike solutions, the linearized equations of motion are simplified to yield a single wave equation for the displacement. The boundary conditions, namely, the continuity of the displacement and total pressure (gas pressure + magnetic pressure) across the interfaces of the twisted tube and the annuli are imposed to derive the dispersion relation governing the kink oscillations. The dispersion relation for the fully compressible case is rather complicated. To begin with, we resort to the study on the effect of uniform flows in twisted tubes and the annulus for an incompressibe fluid. The fully compressible case will be taken up later.

Title: Nonlinear Interaction of Proton Whistler with Kinetic Alfven Wave to Study Solar Wind Turbulence

Author: Ravinder Goyal

Abstract: This paper presents the nonlinear interaction between small but finite amplitude kinetic Alfven wave (KAW) and proton whistler wave using two-fluid model in intermediate beta plasma, applicable to solar wind. The non-linearity is introduced by modification in the background density. This change in density is attributed to the nonlinear ponderomotive force due to KAW. The solutions of the model equations, governing the nonlinear interaction (and its effect on the formation of localized structures), have been obtained using semi-analytical method in solar wind at 1AU. It is concluded that the KAW properties significantly affect the threshold field required for the filament formation and their critical size (for proton whistler). The magnetic and electric field power spectra have been obtained and their relevance with the recent observations of solar wind turbulence by Cluster spacecraft has been pointed out.

Title: The study of sidereal rotation of the Sun at two different radio frequency flux

Author: Hitaishi Bhatt

Abstract: The sidereal coronal differential rotation of the sun is studied for a decade. Here this phenomenon is investigated by flux modulation method, from different frequency fluxes. We have used 1.415 GHz & 2.695 GHz frequency fluxes observed at Learmonth station, Australia for the period of 1988 to 2009 (almost two solar cycles). For the accurate measurement of rotation period, the Gaussian fit has been taken. From the result of the fits the synodic rotation period is found which is converted into the sidereal rotation by subtracting the additional rotational due to observations is taken on earth. Comparison of sidereal coronal differential rotation period of two different frequency fluxes has been studied. The result shows the co-ordination up to some extent in both the trend. The detailed comparison of these show close resemblances in several years where as there are differences in the estimated sidereal rotation periods as much as half a day.

Magnetic structures in solar atmosphere

Title: Wave phenomena in sunspots

Author: Johannes Loehner-Boettcher

Abstract: The highly dynamic solar atmosphere exhibits a wealth of MHD modes channelled by magnetic fields. These waves play an important role in the transport of energy up to the chromosphere and corona. We investigate the oscillatory phenomena present in sunspots by analyzing a (1h) time series of multiwavelength observations of NOAA11823 taken at high spatial and temporal resolution with ROSA and IBIS at the DST. By means of wavelet analysis, we study the occurrence and characteristic periodicity of umbral oscillations as well as running penumbral waves at photospheric and

chromospheric levels. We find that, close to temperature minimum heights, umbral flashes and horizontally diverging waves occur continuously with a periodicity of 2-3 minutes and actually correspond to the same propagating event. We will address further questions like, e.g., are these phenomena of chromospheric nature? How deep down in the atmosphere can one find their signatures? Are they triggered by the global p-modes?

Title: Halpha formation is simple after all

Author: Rob Rutten

Abstract: Halpha is the quintessential diagnostic of the dynamically structured solar chromosphere. I will show that its source function is usually dominated by simple two-level scattering, not by "photoelectric control" as claimed in the literature since Thomas and Jefferies work in the 1950s. Yet more astounding, I will demonstrate that LTE is a good assumption for the line opacity under appropriate considerations, and that this property can make dynamic structures be more opaque in Halpha than in any other chromospheric line (even MgII h+k). These insights lead to suggestions for the physical nature of all types of Halpha fibri.

Title: First 3D imaging spectroscopy reconstructions of spicule velocity fields

Author: Rahul Sharma

Abstract: Spicules are thin, long, jet-like magnetic features which dominate the interface region between solar chromosphere and corona. Crucially, these enigmatic structures may be the key to understanding mass and energy Contributed transfer from the Sun lower atmosphere into its corona. For the first time, perpendicular velocity components of spicular plasma motion obtained from both spectroscopic information and high resolution imagery are combined to construct the actual 3D velocity field. The highest spatial/temporal resolution HÎ± imaging spectroscopy data is obtained with the CRisp Imaging SpectroPolarimeter (CRISP) based at the Swedish Solar Telescope (SST). The proposed technique provides much sought after insight into the fine-scale time/space plasma evolution of coupled transverse and rotational Alfvenic motions in spicules and their ultimate contribution to energy flux transfer between the lower and upper atmosphere.

Title: Density Structure of an Active Region Observed with EIS on HINODE

Author: Pradeep Kumar

Abstract: The EUV Imaging Spectrometer (EIS) on Hinode observe solar corona and upper transition region emission lines in the wavelength ranges 170 - 210 Ã... and 250 - 290 Ã.... EIS produces high resolution spectra that can be combined via rasters into monochromatic images of solar structures, such as active regions. We have adopted set of object oriented IDL routines that enable us to search, download and analyse solar data from the EUV imaging spectrometer (EIS) on-board Hinode. Using spectral observations performed over an active region on October, 14, 2011 with the EIS spectrometer on Hinode, we study the density structure at different temperatures. To analyze the density structure we compare density ratios of a series of iron lines observed by the Hinode/EUV Imaging Spectrometer (EIS). We found that the electron density in the observed active region (AR 11314) varies from 10^8.5 -10^12 cm^-3. The highest densities are found in bright, compact areas. Maps of intensities, velocities, and electron densities derived from these observations are presented and discussed. The density distribution and plasma temperature within solar active region, illustrate the power of EIS and Solarsoft IDL for solar plasma diagnostics. These powerful spectroscopic diagnostics will allow identification and characterization of magnetic reconnection and wave propagation processes in the upper solar atmosphere.

Title: Characteristics of coronal emission line profiles from HINODE/EIS

Author: K P Raju

Abstract: Spectral studies of solar coronal emission lines give information on the physical conditions of the corona which may provide insights to the coronal heating and the acceleration of the solar wind. There have been reports of asymmetries and excess blueshifts in coronal line profiles from both ground-based and space observations. These are interpreted in terms of nanoflare heating, type II spicules and nascent solar wind flow. Owing to its high spectral and spatial resolutions, EUV Imaging Spectrometer (EIS) on board HINODE observations will be particularly useful in the studies of solar corona. The emission line spectra from HINODE/EIS observations have been analysed using the Solar SoftWare (SSW). Emission lines from highly ionized states of Fe are used in the study. The characteristics of emission line profiles from different coronal regions obtained from the study are reported.

Title: On heating of solar active region loops cooling through conduction – driven evaporation

Author: Kumud Pandey

Abstract: It is well established that active regions contain magnetic loops, which are brighter than their surroundings. Although the individual loops are

still not well – resolved but, to a first approximation, one may consider them as separate loops . In view of continuously improving techniques and observations the study of single loop systems may be justified. We study heating in such active region loops following Narain (1981) and latest observations obtained through recent solar missions, such as solar B etc. We hope to obtain some significant results related to solar coronal heating.

Reference (s): Narain. U., 1981, Bull. Astron. Soc. India 9, 278

Title: Estimation of Sensitivities for Coronal Observations using Coronagraph on Aditya-L1

Author: Tejaswita Sharma

Abstract: A detailed study of the sensitivities for coronal emission line observations using lines at 5303Å, 7892Å, 10747Å is carried out for different coronal plasma parameters like - Temperature, Density and Velocity. These three emission lines are chosen for the proposed spectrographic channels for the Visible Emission Line Coronagraph (VELC), on-board Aditya mission. The sensitivities for the physical parameters are calculated taking into account the optical design of VELC and its expected throughput. These coronal parameters are important to decipher information about the solar corona dynamics, heating and density structures, and thus play a key role in modeling the three-dimensional structures of the solar corona.

Title: On the Drivers of Polar Coronal Jets

Authors: Pradeep K. Kayshap, A.K. Srivastava, and B.N. Dwivedi

Abstract: Polar jets are the confined plasma ejecta that propagate in the solar corona and transport mass and energy locally. Physical properties of the drivers of these jets and their role are not yet well established. Magnetic reconnection and MHD waves may be the major candidates that play crucial role in driving coronal jets. We present such a jet event from Hinode/EIS spectroscopic observations. In this event, we find that reconnection takes place at coronal heights. This only drives the hot plasma along the jet's magnetic spine lines. In yet another example, the small-scale reconnection in a small-kinked flux tube in the lower part of the solar atmosphere, produces reconnection generated velocity pulse. This further evolves in slow-shock and surface waves to drive the cool jet as observed in SDO/AIA 304 Å filter. Therefore, we conjecture that the reconnection height within the jet's basic magnetic field pre-configuration is crucial in its formation. The coronal reconnection constitutes the hot jets predominantly, while chromospheric reconnections drive the indirect consequences (e.g., MHD pulse, slow shocks) to further power such jets.

Chromospheric and coronal heating

Title: Diagnostics of electron distribution for a coronal loop observed by Hinode/EIS and SDO/AIA

Author: Elena Dzifcakova

Abstract: A bright coronal loop observed by SDO/AIA and Hinode/EIS during HOP 226 is analyzed. AIA data show that the loop within the AR core forms about an hour after the disappearance of a flare arcade formed during a B-class compact flare. The loop is multi-thermal, and observed in AIA 131A, 171A, 193A and 211A filters. Excellent Fe XI - XIII spectra obtained by Hinode/EIS allow for comprehensive diagnostics of the plasma. Using the latest atomic data available and a careful background subtraction, we determine that the electron density is log(Ne) = 9.1 - 9.5 and that the plasma is not Maxwellian, but exhibits significant departures towards kappa-distributions characterized by a high energy tail. The effects of multi-thermality on the non-Maxwellian diagnostics are discussed.

Title: Electron acceleration in the quiescent solar corona

Author: Tomin K James

Abstract: The power involved in elemental electron acceleration events in the solar corona is of considerable interest in the context of coronal heating. We focus on electron acceleration events that occur during relatively quiet periods, excluding large transients such as flares or coronal mass ejections. We build a database of such events observed by near-Earth spacecraft such as ACE, WIND and STEREO and shortlist only those which can plausibly be linked to acceleration episodes in the solar corona. The electrons detected at the Earth during such episodes presumably represent a fraction of the population that was accelerated in the corona. By calculating the power carried by the energetic electron population observed at the Earth, we hope to obtain an estimate of the power involved in the coronal acceleration episode. Such an estimate directly yields the energy contained in the accelerated electrons, without an appeal to the radiation generated by them.

MHD instabilities and Eruption

Title: Exploring the relationship between kink instability and solar flares

Author: Mayukh Panja

Abstract: Several observational studies have been performed to explore the relationship between solar flares and the photospheric magnetic field and all of these studies found that the non-potentiality of magnetic field is closely linked with solar flares. One important parameter used to quantify magnetic-nonptentiality is magnetic helicity (which contains both twist and writhe for an isolated flux tube). To measure the twist of solar active regions, researchers have used the force free parameter calculated from the force-free field equation. However the photosphere is a forced layer where the ratio of gas to magnetic pressure is nearly equal, and the validity of the force free layer is questionable. In this scenario, a new method was developed for

calculating best-fit twist, named flux tube fitting technique method, which is not derived from the force free field equation. Using this method two parameters Q-fit (which quantifies the twist) and Q-kink (which quantifies the critical twist threshold) have been calculated for the umbral part of several active regions. It seems that there is indeed a relation between the twist and the probability of the active region flaring. It has been observed that in the occasions in which the twist (Q-fit) exceeded a certain threshold (Q-kink), the active regions always had flares associated with them.

Title: Initiation and Eruption Process of Magnetic Flux Rope to Earth Directed-CME by Kink Instability

Author: Vemareddy Panditi

Abstract: An eruption event launched from solar active region (AR) NOAA 11719 is investigated based on coronal EUV observations and photospheric magnetic field measurements obtained from Solar Dynamic Observatory. The AR consists of a filament channel originating from major sunspot and its south section is associated with inverse-S sigmoidal system as observed in AIA passbands. We regard the sigmoid as the main body of the flux rope (FR). There also exists a twisted flux bundle crossing over this FR. The overlying flux bundle exhibits a kinkwrithe- rise evolution that has correspondence with rise motion of the FR. The emission measure and temperature along the FR exhibits increasing trend with its rising motion, indicating reconnection in the thinning current sheet underneath the FR. Net magnetic flux of the AR evaluated at north and south polarities showed decreasing behaviour whereas the net current in these fluxes exhibits increasing trend. As the positive (negative) flux is having negative (positive) current, the chirality of AR flux system is negatively (left handed) twisted which is consistent with the chirality of inverse S-sigmoidal FR. This analysis of magnetic fields of source AR suggest that the cancelling fluxes are prime factors to the monotonous twisting of the FR system reaching to a critical state to trigger kink instability and the rise motion. This rise motion is likely led to onset of torus instability resulting to Earth-directed CME and the progressive reconnection in thinning current sheet underneath the rising FR leads to M6.5 flare.

Title: On the flare associated changes seen in the active region NOAA 11719 during an M-class flare

Author: Brajesh Kumar

Abstract: The solar active region NOAA 11719 produced an M6.5 class flare on 11 April 2013 around 06:55 UT, when it was located near the diskcenter (N10E08). This flare was accompanied by a type II radio burst, an EIT wave, a full halo CME, and a proton rich event. The flare was well observed by ground- and space-based observatories in various wavelengths and energies, viz., GONG, SOHO/LASCO, SDO, and GOES. The H-alpha images obtained by the GONG instrument located at the Udaipur Solar Observatory show filament activity in this active region before and during the flare. These

images also show the evolution of this flare as a two-ribbon structure and the flare ribbons covered the umbra of the sunspot as the flare progressed. The He II 304 Angstrom images obtained from AIA instrument on board SDO spacecraft show successive expansion and contraction of the flare ribbons during the flare. We have also examined the flare associated changes in velocity flows and magnetic field properties in the active region using the measurements obtained from HMI instrument on board SDO spacecraft. We observe changes in the velocity flows and magnetic fields in some localized regions of the active region during the flare. The vector magnetic field map of the active region obtained from HMI instrument at 06:48 UT on 11 April 2013 show twist in converging horizontal vector magnetic fields in the south polarity region before the beginning of the flare. The time evolution of total line of sight magnetic flux shows continuous decrease in both the magnetic polarities in the active region during 03:00-10:00 UT while the flare started at 06:55 UT. The net vertical current starts increasing in both the polarity regions before the onset of the flare and maintains higher values than earlier during the flare. This increase of the net current is generally considered to be precursor of the occurrence of eruptive events like flares and CMEs as has been reported earlier by several researchers. As it is observed that the north (south) polarity region is having dominant negative (positive) net current, the chirality of the active region flux system is likely to be twisted in left handed sense, whose signatures are reflecting in the form of inverse-S filament.

Title: Multi-Wavelength study of a prominence eruption associated with X class flare

Author: Sunitha Rakesh

Abstract: We report here multi-wavelength investigations of X-Class solar flare occurred on 25-Feb-2014 with its maximum at 00:47 UT. We use the data recorded by Solar Dynamics Observatory for this purpose. The high temporal and spatial resolution SDO/AIA data is analyzed to study the dynamics of flare evolution and CME propagation. The flare was the result of prominent eruption. Here we examine how the prominence expanded horizontally and variation in its height with time in different wavelengths of AIA/SDO. It is also observed that whole solar disk was brightened at 01:13:00 UT. The chronographic images from LASCO C3 are also studied to investigate the CME.

Title: Study of an M6.5/3B flare and associated EIT waves

Author: Aarti Fulara

Abstract: We analyze here the multi-wavelength study of an M6.5/3B class two ribbon flare on 11 April, 2013 from active region NOAA 1719. The multi-wavelength data includes the images from SDO, STEREO, LASCO and HiRAS instruments. The flare was associated with the EIT wave, Coronal Mass

Ejection (CME), type II radio burst and Solar Energetic Particle event (SEP). The flare was a long duration event showing two reverse J shaped ribbons in H-alpha and SDO 1600 A, which indicates negative helicity. The SDO observations indicate reverse sigmoid structure, which again indicates negative helicity. Therefore, the event was a good example of helicity conservation in chromosphere and Corona. We have computed the speeds of EIT wave, CME and associated type II radio burst and these are 300, 872 and 800 km/s respectively. Using the STEREO B EUVI and type II radio burst data, we have estimated the height of shock formation, which is around 1.43 solar radius. In order to understand the magnetic causes of flare and associated EIT wave, we have also analyzed the HMI magnetic field data of the active region. We interpret our results in the light of existing theories.

Title: Multi-wavelength diagnostics of energy build-up and trigger of X1.2 class flare on May 15, 2013

Author: Aabha Monga

Abstract: We study multi-wavelength evolution of a flare occurred on May 15, 2013 in NOAA 11748 having magnetic complexity \beta\gamma\delta. This flare was observed by both ground based and space borne instruments. We estimate flare plasma parameters using the spectroscopic observation from RHESSI mission employing Object Spectral Executive (OSPEX) package provided with Solar Soft. Moreover, we estimate the temporal evolution of thermal and non-thermal energetics for this flare. Preliminary investigation using H-alpha observations from ARIES 15-cm coude type solar telescope revealed this flare consisting two ribbons. Further, the study of spatial evolution of the flare ribbons shows a propagating brightening along the southern ribbon. Moreover, several H-alpha kernels were noticed. However, we do not find filament associated with this event. Therefore, to explore the driver of instability leading to this highly energetic flare, we study the morphological evolution of the active region using SDO and STEREO data. We also study the evolution of Photospheric magnetic field parameters from SDO/HMI magnetograms in conjunction to the EUV emission. From AIA/EUV images, we note various sets of coronal loops over the active region, which move upward in the corona as the flaring active region evolves. We explicitly note mass ejection and disruption of coronal loops. We make a height-time study of the loop eruption in order to understand the acceleration mechanism. We infer that this flare occurred in the lower corona as the coronal loops moved upward which suggest a possible signature of magnetic reconnection beneath the uprising loops.

Title: Study of mechanisms of energy build-up and release in solar flares

Author: Manisha Pithadia

Abstract: We investigate the mechanisms for the buildup and release of energy in solar flares. We consider the free magnetic field energy in the active region as the major source of energy build-up in the corona, while gradient and rotation angle of the active region as the cause of the flares. Therefore we undertake the measurement of magnetic field complexity employing HMI/SDO magnetograms to constrain the possible mechanisms providing the energy on one hand and causing trigger of flares on the other hand. We have analyzed 14 super active regions during year 2010-2014 considering that each has produced minimum 50 flares of â‰¥C1.0 class during its passage on the disk. We measure the magnetic flux [Î¦] to quantifying the energy made available from photosphere to the corona, while gradient (dH/dz) and rotation angle (Î¨) of the active region are measured to quantify the energy release process in the corona. The estimated magnetic flux, gradient and rotation are found to vary between 0.9X1025 -2.8X1026 Mx, 0.015 â€“ 1.25 X 10-2 gauss/cm and , -87 â€“ +90 degrees respectively. Moreover, we study the coronal GOES X-ray intensity variation to quantify the changes in simultaneous to the magnetic field variations in the photosphere. We compare the variation of the photospheric magnetic complexity (cause) parameter and X-ray flare energy loss rate (consequence) as a function of time and find common periodicities in the cause and consequence parameters. Comparison also enables us to establish an empirical relationship among cause and consequence parameters which may lead to predict the eruption.

Title: Prediction of the degree of spectral hardness of SEP event employing flare- CME-SEP relationship

Author: Nipa Bhatt

Abstract: Major solar eruptions (flares, coronal mass ejections (CMEs) and solar energetic particles (SEPs)) strongly influence geospace and space weather. Currently, the mechanism of their influence on space weather is not well understood, and requires a detailed study of the energetic relationship among these eruptive phenomena. Also, there is a strong need to improve our ability to predict the SEP events and their strength. From this perspective, we investigate 30 flares (observed by RHESSI), followed by weak to strong geomagnetic storms. Spectral analysis of these flares suggests a new power-law relationship ($r \sim 0.79$) between the hard X- ray (HXR) spectral index (before flare-peak) and linear speed of the associated CME observed by LASCO/SOHO. For 12 flares which were followed by SEP enhancement near Earth, HXR and SEP spectral analysis reveals a new scaling law ($r \sim 0.9$) between the hardest X- ray flare spectrum and the hardest SEP spectrum. Furthermore, a strong correlation is obtained between the linear speed of the CME and the hardest spectrum of the corresponding SEP event ($r \sim 0.96$). These newly discovered scaling laws have an important implication in the context of space weather research that (i) the hardest spectral parameter from the flare (non- thermal) and (ii) the linear speed of the associated CME, both play a key role in deciding the degree of spectral

hardness/strength of an SEP event near Earth. Thus, both may be employed to predict the degree of spectral hardness/strength of SEPs, which arrive near Earth in <10 h and affect the geospace environment in a variety of ways. We also propose that quantitative study of this nature may lead to developing a prediction tool for the degree of spectral hardness/strength of the SEP events.

Title: Probing the thermal and non-thermal energetics of precursor and main phase of solar flares

Author: Arun Kumar Awasthi

Abstract: We study the spectral and temporal evolution of X-ray emission from fifty flare events which occurred during year 2003-2012 and shown unambiguous spatially linked precursor emissions. We aim to investigate preflare multi-wavelength emission in order to characterize flare plasma parameters associated with this phase of emission and their association with impending main phase of the flare. We forward-fit the X-ray spectral observation in 4-100 keV energy band with isothermal and power-law functions simultaneously, to estimate the flare plasma parameters viz. temperature (T), emission measure (EM) and non-thermal spectral index. A comparative study between the flare plasma parameters deduced during the precursor and main phases revealed that although EM during the precursor phase (0.01-0.1 x 10^49 cm^-3) have been ~2 orders lesser that that of the main phase (0.08-0.7 x 10^49 cm^-3), T reached ~80% (5-12 MK) of that estimated during the main phase (9-14 MK). In order to understand the cause for the immense heating during the precursor phase, we carried out an investigation of the temporal, spatial and spectral evolution of the M1.8 flare, which occurred in the active region 11195 (S17E31) on 2011 April 22. The study of the source morphology using the composite images in 131 Ã... wavelength and 6-14 keV revealed a multiloop system that destabilized systematically during the precursor and main phases. In contrast, hard X-ray emission (20- 50 keV) was absent during the precursor phase, appearing only from the onset of the impulsive phase in the form of foot-points of emitting loops. This study also revealed the heated loop-top prior to the loop emission, although no accompanying foot-point sources were observed during the precursor phase. The estimated energy, released in the precursor phase, was thermal and constituted â‰ˆ1 percent of the total energy released during the flare. The study of morphological evolution of the filament in conjunction with synthesized T and EM maps was carried out, which reveals (a) partial filament eruption prior to the onset of the precursor emission and (b) heated dense plasma over the polarity inversion line and in the vicinity of the slowly rising filament during the precursor phase. Based on the implications from multiwavelength observations, we propose a scheme to unify the energy release during the precursor and main phase emissions in which the precursor phase emission was originated via conduction front that resulted due to the partial filament eruption. Next, the heated leftover S-shaped filament underwent slowrise and heating due to magnetic

reconnection and finally erupted to produce emission during the impulsive and gradual phases.

Title: Investigation on CME and X-class Flares associated with and without DH type II bursts

Author: M. Bendict Lawrance

Abstract: We have performed an analysis of the Coronal Mass Ejection and X â€“ class x-ray flares associated with and without DH type II radio bursts. The events were observed during 23rd solar cycle and rising phase of 24th cycle. We have studied the relationship between the properties of flares, CMEs and DH type IIs. Some of the results obtained in the present study are the following: We found that most of the DH associated x-class events were Halo CMEs. The average CME speed of the X-class flares associated with DH-type-IIs is 1555 km/s which is more than two times greater than the CME speed of the x-class flares without DH with a speed of 705 km/s. In the case of X-class flares with DH type IIs, more than 70% of the events have starting frequencies greater than 10 MHz and ending frequencies below 1 MHz. We found that if the flare duration is below 30 minutes, then there is a less chance for producing DH-type- IIs, whereas, if the duration is above 30 minutes then there is more probability for producing DH-type-IIs. The DH associated X- class flares have high flare strength (3.44) which is 33% greater than the X-class flares without DH type II bursts (2.32).

Title: CME propagation: Where does aerodynamic drag take over?

Author: Nishtha Sachdeva

Abstract: Coronal Mass Ejections are subject to a variety of forces that determine their trajectories. These are Lorentz self-forces, solar wind drag, gravity etc. that become dominant at different heights during the propagation of a CME. We use a microphysical description for drag forces as described in Subramanian, Lara & Borgazzi (2012) to describe the solar wind coupling with the CMEs. This model uses a dynamical drag coefficient, thus rendering a more physical approach. Using this model we find that the aerodynamic drag due to momentum coupling with the solar wind dominates the trajectory of a CME above the heliocentric distance of 50 R_sun. This is contrary to the general assumption that the drag takes over early on during a CME propagation.

Title: Analysis of Solar Eruptive Events during the 24th Solar Cycle

Author: M.Syed Ibrahim

Abstract: The energetic solar explosions like flares and coronal mass ejections (CMEs) are called the solar eruptive events. In this paper, we investigated the disc-centered events observed during the period 2007-2013 in 24th solar cycle. Recent reports revealed that this cycle is different from that of previous cycle. Most of the disc-centered CMEs travel towards the earth. These CMEs are observed by SOHO/LASCO instruments and the X-ray flare data are obtained from GOES/HINODE catalog. We use two selection criteria, (i) disc centered origination (longitude and latitude range is Â±30o) and (ii) speed range (120 to 2400 km/s). Among the total number of CMEs (10436) ejected from the sun during the period, the speed range of 9972 events lies between 120 to 2400 km/s. Under the first selection criteria, only 713 events are selected for our study from these 9972 CMEs. The aim of the present work is to study the physical relationship between these two energetic phenomena (CME and flare). We have investigated the physical properties of CMEs (such as speed, width, acceleration, mass and energy) and flares (such as strength, duration, rise time and location). Their relationship is analyzed by correlation methods. The results of this analysis will be presented in this paper.

Title: How are Forbush decreases related with IP magnetic field enhancements?

Author: Arun Babu

Abstract: Cosmic ray Forbush decreases (FDs) are usually thought to be due to Earth-directed coronal mass ejections (CMEs) from the Sun and their associated shocks. When CMEs and their shocks reach the Earth, they cause magnetic field compressions. We seek to understand the relation between these magnetic field compressions and FDs at rigidities between 12 and 42 GV using data from the GRAPES-3 instrument at Ooty. We select those FD events that have a reasonably clean profile, and magnitude > 0.25%. We use the 1 minute averages IP magnetic field data from ACE/WIND space crafts and chekced the shock and magnetic clouds associated with them and we calculated the turbulence level, If of these magnetic fields. We look for the correlation of the Forbush decrease profile (cosmic ray flux) with the one hour average IP magnetic field. We incorporate the diffusion of the high energy protons into the large scale magnetic field as the cause of the lag observed in the correlation of FD profile with IP magnetic field. We used different perpendicular diffusion coeffiecents to study this relation. The enhancement of magnetic field compression associated with the FDs occures mainly in the shock-sheath region, and the turbulence level in the magnetic field also get enhanced in this region. We found that the FD profile observed in the GRAPES-3 muon telescope is in good correlation with the IP magnetic field enhancements. The observed lag between the cosmic ray flux and IP

magnetic field corresponds to the time taken by the high energy protons to diffuse into the magnetic field enhancement. Our study leads to the fact that the enhancement of magnetic field compression and the magnetic field turbulence level occures in the shock sheath region. The number of diffusions account for the observed lag between the FD profile and IP magnetic field ranges from few tens to hundreds of diffusions.

Title: Characteristics of Homologous Flares and the Initiation of Their Associated CMEs

Author: Induja M S

Abstract: In this study, we report and analyze the occurrence of a pair of homologous flares on 25th October 2013 in the active region AR1882 situated near the solar east limb. These X1.7 and X2.1 class flares (flare I & flare II respctively) which occurred in a time interval of ~7 hours, along with their associated CMEs show many similarities. The comparison between the soft X-ray, hard X-ray and microwave flux/count-rate profiles and the soft x-ray flux derivative plots show that both the flares obey Neupert effect and hence follow the standard flare model. SDO running difference movies, clearly show for both events, an internal reconnection occurring below a loop structure open the field lines and initiates the eruption. Both events were associated with a bunch of type III bursts followed by a type II burst. This similar morphology and identical characteristics of initiation, energy release and propagation of associated events show that energy has been provided to the surface from the underlying layers continuously and even after the first eruption, the active region maintains its magnetic configuration almost unchanged which caused the second flare to be identical. The flare profiles also showed some dissimilarities which were also studied. The decay phase of the second flare was broader than the first and also for the second flare, the hard X-ray flux peaked after the onset of soft X-ray rising phase. A thorough observation of the SDO images and the double peak of soft X-ray profile confirms that the second flare was proceeded by a small flare which caused the soft X-ray flux to rise before the Hard X-ray and the second one of this double flare (Flare II) is homologous to flare I. Also it was observed that the CME associated with flare II was almost two times faster than that of flare I. This along with the observation of an M-class flare without any CME from the same location shows that, the first CME has taken away the material which increased the Alfven velocity and this favoured the velocity of the second CME to be high.

Title: IRIS observations of magnetic reconnection and chromospheric evaporation in a solar flare

Author: Hui Tian

Abstract: IRIS has observed signatures of the Fe XXI 1354 line in tens of solar flares. In most of these events the Fe XXI line shows large blue shift or small Doppler shift. We report the first detection of large red shift (~200

km/s in line of sight) of the Fe XXI line with IRIS. Combined imaging and spectroscopic observations of IRIS, together with SDO/AIA and RHESSI observations, reveal that the redshfited Fe XXI feature is located around the loop-top hard X-Ray source and above the retracting loops. This large redshift is explained as signature of the downward moving reconnection outflow/retracting loops. Possible flux rope eruption and reconnection inflows are observed with the imagers. We have also found that the entire Fe XXI line is blueshifted by ~250 km/s at the loop footpoints. Cool lines of Si IV, O IV, C II and Mg II all show obvious redshift at the same locations, consistent with the scenario of chromospheric evaporation. Through a comparison with the reconstructed map of electron temperature we find that locations of ~10MK temperature generally coincide with the observed Fe XXI feature very well.

Title: Some results on flare induced global oscillations in the Sun

Author: Hemant Kumar Saini

Abstract: It was speculated by Wolff (1972) that solar flares could excite free global oscillations in the Sun. In the recent times, there have been some reports on the observation of flare-induced global waves in the Sun. Here, we present the analysis of the diskintegrated velocity observations of the Sun obtained from the GOLF instrument on board SOHO spacecraft covering several flare events. The GOLF data used here are for the period from 11 February, 2011 to 17 February, 2011. These observations span over several successive flares which occurred during the period 12-17 February, 2011. On the other hand, 11 February, 2011 remained a completely quiet day. Application of Fourier Transform to the disk-integrated velocity signals from the solar surface obtained from GOLF indicates that there is enhanced power of pmodes as well as high-frequency oscillations in the Sun during the flares as compared to the quiet condition. We also plan to apply this analysis to the disk-integrated intensity observations of the solar surface obtained from the VIRGO instrument on board SOHO mission for the same time period in order to compare the results obtained by the analysis of aforementioned GOLF observations.

Title: On the role of photospheric velocity and magnetic field in the filament eruption as observed by SDO

Author: Sajal Kumar Dhara

Abstract: Solar filaments are large chromospheric structures which contain dense and cool plasma relative to their surroundings. The filaments form above the neutral line of the photospheric magnetic field and survive for days to weeks. Most of them eventually disappear with eruptions associated with flares and coronal mass ejections (CME) which affects the space weather. Understanding the trigger mechanisms for filament eruptions is important. On many occasions the magnetic flux cancellations at the polarity inversion line

is observed as a triggering agent for the filament eruption. We investigated the photospheric velocity and magnetic fields during the initial phase of the filament eruptions using HMI and AIA/SDO data. These filaments are associated with four different active regions which are observed at different time of the solar cycle 24. Two filament eruptions are associated with M - class flare and the remaining two events are associated with C and X - class flares. In this poster, we will present the detailed observational study about the evolution of the photospheric velocity and magnetic fields during the initial stage of the filament eruption.

Title: Dependence of transit time on the properties of ICMEs associated with MC and Ejecta

Author: Shanmugaraju A

Abstract: We considered a set of Interplanetary Coronal Mass Ejections (ICMEs) which contains Magnetic Clouds (MC) and Ejecta (EJ). We have analyzed the relations between the properties of these ICMEs with the CME transit time from the Sun to the Earth to study: (a) dependence of transit time on the properties of CMEs and ICMEs, and (b) differences between MC and EJ. We found that CME initial speed and the interplanetary acceleration (IP) decide the CME transit time. There are differences noted in the linear regressions of transit time with speed and IP acceleration between all ICMEs and two separate regressions of MC and EJ.

Title: A study on the kinematics of a CME-CME interaction event associated with flares and type II bursts

Author: S. Prasanna Subramanian

Abstract: The subject of interaction between the Corona Mass Ejections (CMEs) is important in the concept of space-weather studies. In this paper, we study a CME-CME interaction event on 22 May 2013 observed in coronagraphs in SOHO and STEREO. At first, a C-class X-ray flare was ejected at 8:02 UT from the location N21W89. At 8:48 UT, a slow pre-CME moving with a speed of 687 km/s was observed by C2 coronagraph. At 13:08 UT, a M-class X- ray flare was detected by GOES spacecraft from the location N13W80. It was associated with a fast and wide CME. It travelled with a speed of 1466 km/s. Since both the CMEs are from same active region, there is a chance of interaction between the CMEs around 14:18 UT. Due to this interaction, some features are observed in radio spectrum between 1-3 MHz frequency. The primary-CME was also associated with a DH type II radio burst. The kinematic profiles of pre and primary CMEs are also studied in this paper.

Title: A weak solar flare associated with a CME and a type II burst

Author: G.Selva rani

Abstract: We report on the analysis of a Coronal Mass Ejections (CMEs) and a type II radio burst associated with B7.0 X-ray flare occurred on 18 March 2010. For this, we analyze multiwavelength observations like, radio observations from the Culgoora and Wind/WAVES in combination with SOHO/LASCO data to retrieve the association of solar activities such as CME, type II burst and flare. The results from the preliminary analysis are, (i) the onsets of flare and CME coincide with each other around 23:00UT, (ii) a EUV event is reported in SECCHI around 23:03UT, (iii) the type II burst occurred during (23:11 - 23:18UT) the decay phase of solar flare in the frequency range 120 â€“ 30 MHz with a drift rate of ~0.15 MHz/s, (iv) the estimated type II speed (550km/s) is nearly similar to the CME speed (713km/s), and (v) there is a temporal sequence in the occurrence of events in the order: onsets of flare/CME, EUV wave event and type II burst.

Title: Hydrodynamic Evolution of an M-class Flaring Loop System from Multiple Impulsive Heating

Author: Soumyaranjan Dash

Abstract: We model the physical phenomena taking place in an M-class flaring-loop system in the solar corona invoking multi-phase heating of plasma. Each heating pulse in the loop system is a single-peaked in time, i.e., Gaussian type. Using basic energy balance equation and hydrodynamic model of Aschwanden and Tsiklauri (2009), we model a process of multiple impulsive heating in a flaring loop system. We invoke the multiple heating pulses generated by flare energy release in the loop system in our model. In temporal evolution of the loop system, an average loop-length and multiple heating pulses are defined. The model evolves with temperature and density in accordance with the imposed multiple heating pulses. Heating phenomena are recorded in the solar corona. After heating, the loop system takes time to cool, which gives rise to plasma condensation. During the multiple heating and subsequent cooling phases, the evolution of temperature and density is modeled. The trend of density variation qualitatively matches with that of GOES soft X-ray emissions during the flare. This confirms the multi-phase heating due to multiple magnetic reconnection, and consequently the density (therefore emissions) and temperature evolution in the flaring loop system.

Title: Tolerance Analysis of Solar Ultraviolet Imaging Telescope Optics

Title: Subhamoy Chatterjee

Abstract: Imaging sun in different wavelengths is invaluable for understanding its dynamic aspects and relevant impacts on space weather. The atmosphere of the Sun presents a number of puzzling physical

phenomena of great importance. Imaging in particular wavelength band demands efficient imaging telescope with optimized parameters. A proposal was submitted for a Solar Ultraviolet Imaging Telescope (SUIT) to ISRO to study the Sun in Near Ultraviolet Wavelengths (NUV, 200 – 400 nm). SUIT provides a new opportunity for imaging the Sun in NUV with appreciable image quality. This study addressed optimization of SUIT optics using suitable merit function and variables. It also includes simulation of image quality degradation due to geometry and alignment errors in optical surfaces. Appropriate compensator and its movement was found out for nullifying different errors in imaging optics both theoretically and through simulation revealing error bounds of individual parameters based on limit of merit function and restriction in compensator movements. Furthermore, Monte Carlo simulation has been performed to find worst fabrication and alignment error combination to confirm whether image degradation is acceptable. Thermal variation in space being an important factor to affect the image quality, temperature tolerance of the telescope system has also been explored. Hence this study performs error budgeting of crucial parameters in solar NUV imaging telescope.

Title: Solar Ultraviolet Imaging Telescope (SUIT) for Aditya-L1

Authors: Avyarthana Ghosh with the SUIT Team

Abstract: The Solar Ultraviolet Imaging Telescope is an imaging telescope on-board the Adtiya which will be placed in the halo-orbit around the first Lagrangian point (L1) of the Sun-Earth system. The SUIT has been designed to make full-disk observations of the Sun between 200 nm and 400 nm (near UV domain) wavelength range. The SUIT is aimed at studying the dynamics and coupling of lower solar atmosphere and the centers of eruptive events. Because it is a space-based telescope, there is no attenuation by the earth's atmosphere. Moreover, SUIT provides continuous observations with sufficiently high spatial and temporal resolution that can address issues like motion of the shock-fronts, heating of chormosphere by current sheets, MHD waves, magnetic reconnection, acoustic heating etc. Hence, it has the potential to provide the best opportunity to study the dynamics and coupling of the chromosphere and the transition region.

Title: Performance Modelling of the Solar Ultraviolet Imaging Telescope on-board Aditya-L1

Authors: Avyarthana Ghosh

Abstract: The Solar Ultraviolet Imaging Telsecope (SUIT) is one of the payloads on-board the Aditya (a satellite placed in the halo-orbit around the first Lagrangian point (L1) of the Sun-Earth system). It is an imaging telescope making full-disk observations of the Sun within the wavelength band 200 nm to 400 nm. The telescope has a set of 8 filters out of which 5 are narrowband and 3 are wideband. The narrowband filters are at 214 nm,

388 nm, 300 nm, 279/280 nm (Mg II h and k lines) and 397.8 nm (Ca II line) whereas the wideband filters are at 200-240 nm, 240-300 nm and 320-360 nm. The incoming photon counts, the filter responses, the quantum efficiency of the CCDs used as well as the reflectivity of the aluminium mirrors used are different at these wavelength bands. Hence the throughput calculation for each of these filters have been done. The imaging performance of the telescope has also been carried out to have a prototype image of the Sun as will be seen by SUIT.

Title: Modulator Design for Coronal Polarimetry

Authors: K. Sankarasubramanian

Abstract: Direct measurement of coronal magnetic field is a challenging task as the Stokes – V signal even above active regions are very week (~ 0.1%). In order to measure such a week polarization signals, it is important to minimize any systematic errors introduced in the measurement process. In this task, we list out the major systematic in such measurement process and the possible ways of minimizing the systematic. We would also discuss the design aspects of the modulator unit for a possible coronal polarimetry in the upcoming Indian mission Aditya.