The Impact of the Chromosphere on Numerical Models of the Convection Zone-to-Corona System

W. P. Abbett

UC Berkeley

Invited Talk

Abstract:

This review will provide an overview of recent progress toward simulating the magnetic and energetic connection between the convection zone and corona with a particular emphasis on the effect of the chromosphere on the coupled system. We will discuss the challenges inherent in modeling the dynamics and energetics of the chromosphere, then review what 3D MHD simulations of the atmosphere are able to tell us about about the transport of magnetic flux and energy from below the visible surface into the low atmosphere and corona. We will explore how the dynamic chromosphere affects the structure and non-potentiality of the overlying coronal field, and what implications this may have to force-free models based on photospheric magnetograms.

Connecting the photosphere to the corona : Reconstructing the Solar Coronal Magnetic Field

T. Amari (1), F. Delyon (1), F. Alauzet (2), A. Canou (3)-(1), Z. Mikic (4), J.J Aly (5), SOLIS/Team and Stanford SDO/HMI Team

(1)CNRS, Centre de Physique Th\'eorique de l'Ecole Polytechnique, F-91128 Palaiseau Cedex, France.amari@cpht.polytechnique.fr (2)INRIA - Projet Gamma.Domaine de Voluceau - Rocquencourt - B.P. 105.78153 Le Chesnay Cedex (France) (3) Institut d'Astrophysique Spatiale, Bâtiment 121, Universite Paris Sud, 91405 ORSAY Cedex, France. (4) Predictive Science Inc., San Diego, CA 92121, USA (5)AIM - Unite Mixte de Recherche CEA - CNRS - UniversiteParis VII - UMR 7158, Centre d'Etudes de Saclay, F-91191 Gif sur Yvette Cedex, France

Contributed Talk

Abstract:

The low solar corona is dominated by the magnetic field which is created inside the sun by a dynamo process and then emerges into the atmosphere. This magnetic field plays an important role in most structures and phenomena observed at various wavelengths such as prominences, small and large scale eruptive events, and continuous heating of the plasma, and therefore it is important to understand its three-dimensional properties in order to elaborate efficient theoretical models. Unfortunately, the magnetic field is difficult to measure locally in the hot and tenuous corona. But this can be done at the level of the cooler and denser photosphere, and several instruments with high resolution vector magnetographs are currently available (THEMIS, Imaging Vector Magnetograph

(IVM), the Advanced Stokes Polarimeter (ASP)), SOLIS, HINODE, Solar Dynamics Observatory (SDO), or will be shortly available and future programmed missions such as SOLAR-ORBITER. This has lead solar physicists to develop an approach which consists in reconstructing the coronal magnetic field from boundary data given on the photosphere. We will present our recent progress and results to solve this problem at the scale of active regions or larger ones such as full disk or synoptic scales, for which the large amount of data as well as their sparsity on the solar disk, require to develop particular strategies. We will also illustrate the interest of the reconstruction for characterizing the magnetic environments of prominences, emerging sub-photospheric structures and the pre-eruptive ones.

The Role of Topology in the Energetics of the Coupled Solar Atmosphere

Spiro K. Antiochos

NASA/GSFC

Invited Talk

Abstract:

The defining physical property of the solar atmosphere is that the magnetic field dominates the plasma. This property implies that magnetic topology plays the central role in determining the structure and energetics of the atmosphere. For example, the formation of observed coronal loops, the explosive energy release in flares and coronal mass ejections, and the creation of the solar wind are all controlled by the topological constraints imposed on the plasma by the magnetic field. In this presentation I discuss how magnetic topology leads to the formation of the structures and dynamics observed in the solar atmosphere including the wind. Not surprisingly, the most important process for driving the dynamics is magnetic reconnection, which acts to break many of the topological constraints. Reconnection, however, preserves some of the topology, in particular, helicity. This turns out to have major implications for the coupled atmosphere. In this presentation, I will also discuss the implications of the topological constraints on observations from SDO and Hinode. This work was supported, in part, by the NASA TR&T and SR&T Programs.

Forecast of the total and solar irradiance based on HMI/SDO magnetograms and solar surface magnetic flux transport models

Luis Eduardo A. Vieira, Thierry Dudok de Wit, Matthieu Kretzschmar, Mehmet Karaca

LPC2E/CNRS and University of Orleans

Poster

Abstract:

The evolution of the outer layers of the Sun drives the energy flux through the Heliosphere. Therefore, the ionized and neutral components of planetary environments are significantly affected by changes in the Sun. While the total solar irradiance is the main external source of heat to the Earth's couple atmospheric/oceanic system, the emission in different regions of the spectrum affects the composition and the thermal structure of different layers of the Earth's atmosphere. Consequently, near real-time monitoring and forecast of the solar irradiance is a key element of weather and space weather programs. Here we present a model to reconstruct and predict the solar irradiance based on HMI/SDO magnetograms and solar surface magnetic flux transport models. We find that we can obtain reliable reconstructions of the level of the total and spectral irradiance up to one month. The preliminary results, uncertainties and operational issues are discussed in details. This work is supported by the European Commission's Seventh Framework Programme (FP7/2007-2013) under the grant agreement n° 218816 (SOTERIA project) and 261948 (ATMOP Project). A prototype of the forecast model is available at: http://lpc2e.cnrs-orleans.fr/~soteria/.

Force-free Magnetic Fields and Electric Currents inferred from Coronal Loops and Stereoscopy

Markus J. Aschwanden, P. Boerner, C.J.Schrijver, and A. Malanushenko

Solar and Astrophysics Lab., LMSAL, ATC

ePoster

Abstract:

Force-free magnetic fields are considered to be a natural state of the low plasma-beta corona. There exist about a dozen of numerical nonlinear force-free field (NLFFF) computation codes that are able to caclulate a divergence-free and force-free solution of the magnetic field, by extrapolation from a lower boundary condition that is specified with 3D vector magnetograph data. However, significant differences in the solutions have been found among the different NLFFF codes, as well as in comparison with stereoscopically triangulated 3D coordinates of coronal loops, exhibiting field misalignment angles of 20-40 degrees. Each calculation of a NLFFF solution is computing-intensive and no code is fast enough to enable forward-fitting to observations. Here we derive an analytical approximation of NLFFF solutions that is accurate to

second order and can efficiently be used for forward-fitting to coronal loops. We demonstrate the accurcay of the NLFFF forward-fitting code by reproducing the Low and Lou (1990) analytical model withg an accuracy of <5 degres. Further, we show examples of fitted NLFFF solutions to STEREO observations of coronal loops. Future NLFFF fits are expected based on line-of-sight magnetograms and automated loop tracings only, without requiring vector field and STEREO data.

Inversion tools for chromospheric lines

A. Asensio Ramos

Instituto de Astrofisica de Canarias

Invited Talk

Abstract:

Chromospheric lines are usually formed in non-local thermodynamical equilibrium conditions. The radiation that we see with our telescopes in a point of the solar atmosphere strongly depends on what are the physical conditions in very distant regions. This highly complicates the extraction of thermodynamical and magnetic information from the observations. In this talk I discuss the complexity of the inversion of chromospheric spectral lines, how to deal with them and the main differences with the inversion of photospheric spectral lines: non-locality and the presence of magnetic structures. I present the tools we have to extract information from the relatively optical thin lines of He I and from the optically thick Ca II infrared lines. I will also discuss some extensions to these tools that I consider we need to develop in the future.

The Prominence/Coronal Cavity Connection: using Hinode, AIA, and IRIS to explore the source of quiet-Sun CMEs

Thomas Berger

LMSAL

Contributed Talk

Abstract:

The Hinode and SDO/AIA missions have revolutionized our view of prominences and coronal cavities. Hinode/SOT observations have established that quiescent prominences are extremely dynamic structures with constant filamentary downflows, rising magnetic "bubbles" that lead to Rayleigh-Taylor instability flows, and various MHD wave modes. SDO/AIA has shown that coronal cavities have helical magnetic topology and that quiescent prominences and coronal cavities should be viewed as elements of a single magnetic system: magnetic flux ropes in the corona, by far the largest coherent magnetic

structures on the Sun and the source of all quiet-Sun CMEs. In this talk we review the Hinode/SOT and SDO/AIA observations of prominences and coronal cavities to demonstrate the unification of these previously disparate topics. We conclude with a look at possible measurements using IRIS to further our understanding of this complex chromospheric/coronal magnetic system.

Synoptic measurements of chromospheric and prominence magnetic fields with the Chromosphere Magnetometer ChroMag

Bethge, C. (1), de Wijn, A.G. (2), McIntosh, S.W. (3), Tomczyk, S. (4), Casini, R. (5)

High Altitude Observatory

<u>Poster</u>

Abstract:

The Chromosphere Magnetometer is part of the Coronal Solar Magnetism Observatory (COSMO) proposed by the High Altitude Observatory (HAO) in collaboration with the University of Hawaii and the University of Michigan. Routine measurements of chromospheric and coronal magnetic fields are vital if we want to understand fundamental problems like the energy and mass balance of the corona, the onset and acceleration of the solar wind, the emergence of CMEs, and how these phenomena influence space weather. ChroMag is designed as a Lyot-type filtergraph polarimeter with an FOV of 2.5 solar radii, i.e., it will be capable of both on-disk and off-limb polarimetric measurements. The Lyot filter - currently being built at HAO - is tunable at a fast rate, which allows to determine line-of-sight velocities. This will be done in the spectral lines of H alpha at 656.3 nm, Fe I 617.3 nm, Ca II 854.2 nm, He I 587.6 nm, and He I 1083.0 nm at a high cadence of less than 1 minute, and at a moderate spatial resolution of 2 arcsec. ChroMag data will be freely accessible to the community, along with inversion tools for an easier interpretation of the data. A protoype instrument for ChroMag is currently being assembled at HAO and is expected to perform first measurements at the Boulder Mesa Lab in Summer 2012. We present an overview of the ChroMag instrument and the current status of the protoype.

Large scale MHD model of the solar corona above time dependent HMI/SDO magnetograms

Bingert S., Peter H.

Max Planck Institute for Solar System Research

Contributed Talk

Abstract:

The SDO spacecraft provides a unique tool to observe the solar atmosphere simultaneously in the photosphere and the corona. The magnetic field and the energy transport couples the whole system, which requires a model that describes the atmosphere all the way from the photosphere into the corona. We present the results of a large scale three dimensional magneto-hydrodynamic model of the solar corona, that is driven by the (time variable) magnetic field in the photosphere as observed by HMI/SDO. The results of the 3D MHD model are then used to synthesize the coronal emission and is directly compared to AIA/SDO observations. The domain of the numerical model spans over 100x100 Mm^2 in horizontal directions and reaches a height of 80 Mm, thus containing the full (small) active region. The spatial resolution is sufficient to resolve thin loops and fine structure in the transition region and corona. This large scale model includes all needed physics, such as anisotropic heat conduction and radiative loss to account for a proper coronal pressure. Based on the data we also derive basic parameters, e.g. the energy flux through the domain or the structure and energy content of the coronal magnetic field.

Observational/Modeling constraints of magneto-convective energy into atmosphere

Robert Cameron

Max Plack Institute for Solar System Research

Invited Talk

Abstract:

We will discuss the interaction of convection and magnetic fields in the solar photosphere. In particular we will concentrate on the broad range of time and spatial scales over which structures are generated and evolve. The importance of waves, vortices and braiding of the magnetic footpoints will be mentioned, as well as future problems which need to be tackled.

State-of-the-art of non-LTE diagnostics: observations and simulations

Mats Carlsson

Institute of Theoretical Astrophysics

Invited Talk

Abstract:

Advanced MHD simulations combined with non-LTE diagnostics are revolutionizing our view of chromospheric dynamics and heating. We will discuss how well synthetic observables compare with observations, how diagnostic codes can be used to derive physical information about the atmosphere, what is missing in current calculations and the consequences of current assumptions. Examples will focus on often used or to-be-used diagnostics of chromospheric lines, such as Ca II 8542, H-alpha and Mg II h/k.

Opportunities and challenges in determining the chromospheric magnetic field using He I 10830

Rebecca Centeno

High Altitude Observatory

Invited Talk

Abstract:

Determining the magnetic structure of the Solar Chromosphere entails all sorts of observational, theoretical and computational challenges. Within the observational approach, the first step in the inference of Chromospheric magnetic fields is to measure the imprints that these fields leave on the spectral line radiation. This already poses a problem due to the intrinsic weakness of the polarization signatures and the highly dynamic nature of the Chromosphere. The second hurdle is to interpret the spectral line radiation. This usually involves using a spectral line inversion code, i.e., a non-linear iterative algorithm that requires solving the radiative transfer equation coupled to the statistical equilibrium equations (a problem that has a non-linear iterative nature in itself!) at each iterative step. Due to its peculiar formation mechanism, the He I 10830 A multiplet offers a series of advantages that allow us to skip some of these obstacles. I will show some of the findings of the past decade that prove the enormous diagnostic potential of this triplet and I will argue why it should be considered as one of the Rosetta Stones for understanding Chromospheric magnetism.

Active region emergence sites observed with HMI

Rebecca Centeno

High Altitude Observatory

Contributed Talk

Abstract:

One of the advantages of SDO/HMI is the consistent quality and uninterrupted nature of the data that it provides. We take advantage of this to study the emergence of active regions from the moment that the magnetic fields show their first imprints on the solar surface. Flux emergence sites are characterized by moving dipolar features (MDFs) that appear in between the main footpoints of an AR. In longitudinal magnetograms, MDFs show an inverse polarity configuration with respect to that of the active region. The vector magnetic field and line-of-sight velocity measurements of HMI allow us to track the dynamic and magnetic properties of these features and understand their movements in terms of the bending and straightening of magnetic field lines.

Data-Driven Modeling of the Evolution of Active Regions and Coronal Holes

Cheung, M. C. M. (1), DeRosa, M. L. (1)

(1) Lockheed Martin Solar & Astrophysics Laboratory, Palo Alto, CA, USA

ePoster

Abstract:

We present results from numerical simulations of the evolution of solar Active Regions (ARs) and Coronal Holes (CHs). The simulations use the magnetofrictional method, which solves the induction equation to drive magnetic configurations toward force-free states in response to photospheric changes. The method is applied to modeling energy build-up in ARs and morphological changes in CHs. Comparisons with AIA data will be presented.

Observational signatures of simulated reconnection in solar photosphere

Danilovic,S.

MPS Germany

Contributed Talk

Abstract:

Recent IMaX/Sunrise observations reveal many short-lived high velocity flows that appear at very small scales everywhere in the quiet Sun. The flows usually appear close to the patches of opposite magnetic polarities. In some cases, the inversion result show localised temperature increase and strong downflows. Here, we confirm the hypothesis that some of the observed events are in fact produced by the reconnection of the emerging with the preexisting field. We concentrate on individual reconnection events in the realistic 3D MHD simulations and describe observational signatures that are likely to arise. The comparison of simulated with observed cases suggests that there might be currents sheets forming very low in the atmosphere. The retrieved temperatures and velocities imply that the observed events are much more energetic than the simulated cases.

White Light Coronal Velocity and Temperature Diagnostics

Joseph M. Davila, Nelson Reginald, and O. C. St. Cyr

NASA Goddard Space Flight Center

Poster

Abstract:

During the March 2006 total solar eclipse we conducted an imaging experiment using the Imaging Spectrograph of Coronal Electrons (ISCORE) to determine the coronal electron temperature and its radial flow speed in the low solar corona. This technique required taking images of the solar eclipse through four broadband filters centered at 385.0, 398.7, 410.0 and 423.3 nm. The K-coronal temperature is determined from intensity ratios from the 385.0 and 410.0 nm filters, and the K-coronal radial flow speed is determined from intensity ratios from the 398.7 and 423.3 nm filters. The theoretical model for this technique assumes a symmetric corona devoid of any features like streamers that might alter the coronal symmetry. The model also requires an isothermal temperature and a uniform outflow speed all along the line of sight. We will call this the Constant Parameter Thomson Scattering Model (CPTSM). The latter assumption may sound unreasonable but in the symmetric corona with rapid fall of the electron density with height in the solar corona, the major contributions to the K-coronal intensity along a given line of sight comes from the plasma properties in the vicinity of the plane of the sky. But the pressing question is how is the derived plasma properties by ISCORE compare with the nature of the true corona. For this we turn to the CORHEL model by Predictive Science Inc. which

used magnetogram data to create a realistic model of the solar corona that are made available through the Community Coordinated Modeling Center (CCMC) at GSFC. That team has consistently produced the expected coronal image days prior to many total eclipses where the major coronal features from their model matched actual coronal image on the day of the eclipse. Using the CORHEL model data we have calculated the K-coronal intensities at 385.0, 398.7, 410.0 and 423.3 nm using the electron density, plasma temperature (assumed to be electron temperature) and the flow speeds of the plasma along the line of sight in the CORHEL model and have calculated the temperature and radial flow speed sensitive intensity ratios. Next we identify the isothermal electron temperature and the radial flow speed in the CPTSM model that would match the temperature sensitive and radial flow speed sensitive intensity ratios from the CORHEL model and compare the CPTSM temperature and flow speed values with the corresponding values in the CORHEL model in the plane of the sky. These comparisons were made for Carrington Rotation 1977 with the CORHEL model of the solar corona rotated in intervals of 45 degrees with respect to the observer located at 1 AU. The average of the difference between the electron temperatures and the radial flow speed at 5 solar radii in the East-West direction were (underestimated by 0.02 MK or an error of 1.7%) and (overestimated by 22.km/sec or an error of 18%), respectively and in the South-North direction were (underestimated by 0.04 MK or an error of 3.2%) and (overestimated by 42 km/sec or an error of 21%), respectively.

NLTE inversions from a 3D MHD Chromospheric simulation

J. de la Cruz Rodriguez (1), H. Socas-Navarro (2), M. Carlsson (3), J. Leenaarts (3)

(1) Department of Physics and Astronomy, Uppsala University, Sweden, (2) Instituto de Astrofisica de Canarias, Spain, (3) Institute of Theoretical Astrophysics, University of Oslo, Norway

<u>Invited Talk</u>

Abstract:

The structure of the solar chromosphere is believed to be governed by magnetic fields, even in quiet Sun regions with a relatively weak field. Measuring the magnetic field of the solar chromosphere is an outstanding challenge for observers. Inversion codes allow for detailed interpretation of full-Stokes data from spectral lines formed in the chromosphere. However, the applicability of non-LTE inversions to infer physical conditions in the dynamic 3D solar chromosphere, has not yet been studied in detail. In this study, we use a snapshot from a 3D MHD simulation of quiet-sun, extending from the photosphere to the corona, to asses the reliability of non-LTE inversions to infer chromospheric quantities, especially the magnetic field.

What we can and cannot learn from seismology of the solar atmosphere

I. De Moortel

University of St Andrews

Invited Talk

Abstract:

During the last decade or so, new instruments have revealed a surprisingly large number of observations of oscillatory behaviour in the solar atmosphere. Both standing and propagating waves have now been detected in a variety of different structures with a wide range of instruments. After the initial euphoria in coronal seismology applications, the subject now needs to go through a period of consolidating and verifying results. So, what can we actually learn from coronal seismology? This talk will invite the community to debate future directions for both theoretical modelling and observational campaigns. How robust are the basic MHD waves models? Do they apply in the highly dynamical and structured solar atmosphere? What can we learn from numerical modelling? And what exactly can we deduce from the observations?

Coupling, damping and dissipation of magnetic waves in the chromosphere and corona

I. De Moortel

University of St Andrews

Invited Talk

Abstract:

In this talk I will give an overview of current (numerical) modelling of MHD waves and oscillations, emphasising in particular the process of mode coupling. Can models predict the observed damping rates and energy flux? How reliable are the comparisons between theory and observations? As observations of waves and oscillations become increasingly more detailed, it has become clear that the role of wave heating of the solar atmosphere has to be reassessed. I will highlight some of the recent modelling results as well as try to outline where future efforts are needed.

The Chromosphere and Prominence Magnetometer

Alfred de Wijn, Christian Bethge, Scott McIntosh, Steven Tomczyk and Roberto Casini

High Altitude Observatory

ePoster

Abstract:

ChroMag is an imaging polarimeter designed to measure on-disk chromosphere and off-disk prominence magnetic fields using the spectral lines of He I (587.6 and 1083 nm). It is part of the planned CoSMO suite, which includes two more instruments: a large 1.5-m refracting coronagraph for coronal magnetic field measurements, and the K-Coronagraph for measurement of the coronal density. ChroMag will provide insights in the energetics of the solar atmosphere, how prominences are formed, and how energy is stored and released in the magnetic field structure of the atmosphere. An essential part of the ChroMag program is a commitment to develop and provide community access to the ”inversion” tools necessary to interpret the measurements and derive the magneto-hydrodynamic parameters of the plasma. A prototype instrument is currently under construction at the High Altitude Observatory. We will present an overview of the ChroMag instrument concept, target science, and prototype status.

PSF Correction for AIA Using Lunar Limb Data

Craig DeForest and Bala Poduval

Southwest Research Institute

ePoster

Abstract:

PSF correction is important for myriad inferences that can be made from EUV imagery, including heating distribution and impulsivity; DEM; and wave amplitude measurements. Using lunar limb and solar flare data, we have prepared model PSF functions to describe the scattering performance of the six EUV channels of AIA. We have not attempted to model the core of the PSF (focus), only its wings (stray light) of each channel. We find that, typically, about half of the scattered light is in the diffuse component of the PSF model, although there is significant variation across the channels. The diffraction component of the PSF was determined by direct inspection of the diffraction pattern from flaring images, with some a priori knowledge of the physics and nature of the diffraction grid (following the methods of Gburek on TRACE and more recently, Cheung on AIA); and the diffuse component was determined by iteratively fitting imaging performance around the lunar limb in eclipse images, with the assumption that the Moon is dark in the EUV. We present the PSFs and summary data, along with a preliminary comparision with the diffraction-only models developed at SAO, and describe where to get both the quantitative PSF models and their inverses (for direct deconvolution) in FITS format.

Topological tools for the analysis of active region filament stability

Edward E. DeLuca (1), A. Savcheva (1,2), A. van Ballegooijen (1), E. Pariat (3), G. Aulanier (3), Y. Su (1)

(1) CfA, (2) Boston University, (3) Observatoire de Paris

Contributed Talk

Abstract:

The combination of accurate NLFFF models and high resolution MHD simulations allows us to study the changes in stability of an active region filament before a CME. Our analysis strongly supports the following sequence of events leading up to the CME: first there is a build up of magnetic flux in the filament through flux cancellation beneath a developing flux rope; as the flux rope develops a hyperbolic flux tube (HFT) forms beneath the flux rope; reconnection across the HFT raises the flux rope while adding addition flux to it; the eruption is triggered when the flux rope becomes torus-unstable. The work applies topological analysis tools that have been developed over the past decade and points the way for future work on the critical problem of CME initiation in solar active regions. We will discuss the uses of this approach, current limitations and future prospects.

The impact of the chromosphere on magnetic fields: field extrapolations

DeRosa, Marc L.

Lochkeed Martin Solar and Astrophysics Laboratory, Palo Alto, CA USA

Invited Talk

Abstract:

Because knowledge of the coronal magnetic field is the key to gaining an understanding of the dynamics of the coronal plasma, efforts to measure or infer coronal magnetic fields have received much attention. In particular, many techniques for extrapolating the coronal magnetic field from photospheric boundary data have been developed, especially as magnetic field data at increasingly higher resolution in space and time as well as vector magnetogram inversions have become more readily available. However, it has become apparent that some extrapolation methods encounter difficulties, as the resulting extrapolations often do not provide reliable estimates of important coronal properties such as free energy and relative helicity. In this talk, we review some of the various difficulties associated with magnetic field extrapolations based on photospheric magnetograms, and discuss likely causes and solutions. We will particularly elucidate the impact of the chromospheric layer on such extrapolations, which is likely impacting the reliability of the extrapolation process as it lies between the region sampled by the boundary data [the photosphere] and the region of interest [the corona].

Electric Fields and Poynting Fluxes from Vector Magnetograms

G. H. Fisher, B. T. Welsch, W. P. Abbett

University of California, Berkeley

Invited Talk

Abstract:

The availability of vector-magnetogram sequences with sufficient accuracy and cadence to estimate the temporal derivative of the magnetic field allows us to use Faraday's law to find an approximate solution for the electric field in the photosphere, using a Poloidal–Toroidal Decomposition (PTD) of the magnetic field and its partial time derivative. Without additional information, however, the electric field found from this technique is under-determined – Faraday's law provides no information about the electric field that can be derived from the gradient of a scalar potential. Here, we show how additional information in the form of line-of-sight Doppler-flow measurements, and motions transverse to the line-of-sight determined with ad-hoc methods such as local correlation tracking, can be combined with the PTD solutions to provide much more accurate solutions for the solar electric field, and therefore the Poynting flux of electromagnetic energy in the solar photosphere. Reliable, accurate maps of the Poynting flux are essential for quantitative studies of the buildup of magnetic energy before flares and coronal mass ejections.

On the Magnetic-Field Diagnostics Potential of SDO/HMI

B.Fleck (1), K. Hayashi (2), R. Rezaei (3), N. Vitas (4), R. Centeno (5), M. Cheung (6), S. Couvidat (2), C. Fischer (1), O. Steiner (3), T. Straus (7), B. Viticchie (1)

(1) ESA, (2) Stanford Univ, (3) KIS, (4) SRON, (5) HAO, (6) LMSAL, (7) INAF/OAC

Poster

Abstract:

The Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO) is designed to study oscillations and the magnetic field in the solar photosphere. It observes the full solar disk in the Fe I absorption line at 6173 Å. We use the output of three high-resolution 3D, time-dependent, radiative magneto-hydrodynamics simulations (two based on the MURaM code, one on the CO5BOLD code) to calculate Stokes profiles Fi(λ,x,y; i=I, V, Q, U) for the Fe I 6173 Å line for snapshots of a sunspot, a plage area and an enhanced network region. Stokes filtergrams are constructed for the 6 nominal HMI wavelengths by multiplying the Stokes profiles with a representative set of HMI filter response functions. The magnetic field vector B(x,y) and line-of-sight Doppler velocities V(x,y) are determined from these filtergrams using a simplified version of the HMI magnetic field processing pipeline. Finally, the reconstructed magnetic field B(x,y)

and line-of-sight velocity V(x,y) are compared to the actual magnetic field B0(x,y,z) and vertical velocity V0(x,y,z) in the simulations.

State of the art single fluid MHD numerical modeling of the coupled solar atmosphere

Boris Gudiksen

Instute for theoretical astrophysics, University of Oslo

Invited Talk

Abstract:

Modeling the solar atmosphere has for a long time been known to be a very complex problem. The wealth of observational features identified in solar observations have multiplied with increasing spatial, temporal and spectral resolution. To explain the high quality of space and ground based observations, models must be very sophisticated and be able to treat a number of physical regimes, where the dominating terms in the equations change drastically. Numerical simulations are now able to explain some, but certainly not all of the observed features. The numerical complexity of solving the equations governing the physics of the solar atmosphere is very high, and a number of different numerical techniques must be used in order to create a coherent picture of the connected solar atmosphere. We are now at a level where simulations have to include a much larger range in vertical extend than has been previously done. The wealth of numerical problems arising when doing so has lead to a number of numerical codes that are specialized to deal with a specific problem, and which now are being augmented to handle a larger range of problems. Hopefully with time we will have a number of numerical codes that are sophisticated enough to deal reliably with the whole solar atmosphere. I will give a review of some the codes that have been able to produce results from a fully connected solar model.

Post-Flare Half-Loops: What are They?

Guidoni, Silvina E. (1), McKenzie, David E. (1), Longcope, Dana W. (1)

Montana State University - Bozeman

ePoster

Abstract:

The M1.4 flare of Jan 28, 2011 has a remarkable resemblance to the famous Tsuneta flare of 1992. It was observed with Hinode/XRT, SDO/AIA, and STEREO (A)/EUVI, giving us higher resolution, greater temperature coverage, and stereoscopic views of this iconic structure. The high temperature images reveal a brightening that grows in size to form a tower-like structure at the top of the post-flare arcade. They also show that loops that are successively connected to this tower develop a density increase in one of their legs that can reach 4 times the density value of the other leg, giving the appearance of “half loops”. These jumps in density last for an extended period of time. On the other hand, XRT filter ratios suggest that temperature is approximately uniform along the entire loop. XRT filter-ratio density maps corroborate that the brighter legs have higher density than the rest of the loop. The tower is a localized density increase at even higher densities than the brighter side of the loop. This may correspond to a shock at the top of the loops. We use STEREO images to show that the half loop brightening is not a line-of-sight projection effect of the type suggested by Forbes & Acton.

Overview of simulations and observations of the coupling between solar regions

Viggo Hansteen

Institute of Theoretical Astro., Univ. of Oslo

Invited Talk

Abstract:

We will discuss simulations and observations of the outer solar atmosphere, in particular the chromosphere, transition region and corona, as a coupled system. Focus will be on how the atmosphere is energized, how mass and energy is transferred between various regions, and what the mechanisms are that couple the various regions. Current simulations are described with an eye towards the physics included, and a discussion of what is missing, e.g. the topology of magnetic fields studied, large physical scales, non-equilibrium ionization and generalized Ohm's law. The impact of the physical assumptions is assessed. Specific synthetic observables from the IRIS instrument are presented and their diagnostic value is discussed.

Photosphere-Corona Connection in Active-Region Plage

H. Hara

National Astronomical Observatory of Japan

Poster

Abstract:

We discuss the relationships between the temperature of coronal loops and photospheric magnetic properties at their footpoints in an active-region plage from observations by Hinode. The motion of photospheric magnetic fields is tracked by the correlation tracking of SOT FG Stokes-V maps to estimate the photospheric horizontal velocity. We find that the horizontal velocity is anti-correlated with the filling factor of photospheric magnetic

fields estimated from the SOT SP data. It is confirmed from high-resolution observations by Hinode that the footpoints of hot (warm) coronal loops in X-ray (EUV) observations are rooted at low (high) magnetic filing factor regions within the plage. The distribution of energy flux to the corona in the plage is calculated from observations according to a model in Katsukawa & Tsuneta (2005). The distribution appears to explain the footpoint position of hot and warm loops.

Opportunities and challenges in determining the chromospheric magnetic field

J. Harvey

NSO

Invited Talk

Abstract:

While some progress has been made inferring the chromospheric magnetic field from intensity-only images and field extrapolations from the photosphere, this has to be followed by actual measurements. Great interest in measuring the magnetic field in the chromosphere is indicated by ~20 instruments currently operational and ~17 under development or planned. The instrumentation falls into two distinct and complementary classes with advocates for both approaches. A challenge is to find enough clever people to effectively use all of these chromospheric polarimetric facilities. A major impediment is converting the polarization signals into magnetic field patterns in the highly structured and dynamic chromospheric atmosphere. Several physical processes compete to produce spectral line polarization. Ranging from simple bisector and center-of-gravity to forward modeling and several inversion methods, the analysis of chromospheric polarization observations is a messy problem with many opportunities for vigorous discussions.

The synoptic maps of Br from HMI observations

Hayashi, Keiji (1), Hoeksema, J. Todd (1), Liu, Yang (1) Sun, Xudong (1), Centeno, Rebecca (2), Leka, K.D. (3), Barnes, Graham (3)

(1) Stanford University, (2) HAO, (3) NWRA/CoRA

Poster

Abstract:

The vector magnetic field measurement can, in principal, give the “true” radial component of the magnetic field. We prepare 4 types of synoptic maps of the radial photospheric magnetic field, from the vector magnetic field data disambiguated by means of the minimum energy method developed at NWRA/CoRA, the vector data determined under the potential-field acute assumption, and the vector data determined under the

radial-acute assumption, and the standard line-of-sight magnetogram. The models of the global corona, the MHD and the PFSS, are applied to different types of maps. Although the three-dimensional structures of the global coronal magnetic field with different maps are similar and overall agreeing well the AIA full-disk images, noticeable differences among the model outputs are found especially in the high latitude regions. We will show details of these test maps and discuss the issues in determining the radial component of the photospheric magnetic field near the poles and limb.

Formation of MgII lines in solar prominences

Petr Heinzel

Astronomical Institute, Academy of Sciences, Czech Republic

Contributed Talk

Abstract:

Solar prominences have been observed in MgII h and k lines, both from space (OSO-8) or from stratospheric balloons. Non-LTE modeling of these resonance lines was then performed and the results have been compared to available observations. We briefly review this past effort and present new transfer computations which take into account all details of the MgII line formation under realistic prominence conditions. We estimate the role of MgII lines in radiation cooling of prominence plasmas and show how they affect the radiative relaxation in these structures. Finally, we also demonstrate the diagnostic capabilities of these lines useful for thermodynamic and velocity measurements.

The nature of hydrogen and helium continua in SDO/EVE spectra of solar flares

P. Heinzel, E. H. Avrett

Astronomical Institute, Academy of Sciences, Czech Republic; Center for Astrophysics, Cambridge, USA

Poster

Abstract:

For selected flare events we present the SDO/EVE spectra of hydrogen and helium resonance continua and compare them with the results of the non-LTE transfer computations based on semi-empirical flare models. We discuss the formation of these continua and their diagnostic potential for determination of the temperature structure of the flaring atmosphere. Non-thermal processes are also considered. As a benchmark we present our comparison of the quiet-Sun EVE spectra with the flux synthesized from the model C6 of Avrett and Loeser (2008).

HMI Magnetic Field Observations

J.T. Hoeksema & the HMI Magnetic Field Team

Stanford University

Poster

Abstract:

SDO/HMI produces a wide array of full-disk photospheric magnetic field observations on a regular cadence. The current status and procedures to access the line-of-sight, vector, synoptic, synchronic, space weather, and other magnetic images, movies, and data products are described.

What is there before a flare?

Hugh S. Hudson

SSL/UC Berkeley

Poster

Abstract:

The physical parameters in a region about to flare (or to make a micro-event of any sort) should be of interest to many people, and should be a suitable topic for (serendipitous) IRIS observations. Flaring is associated generally with magnetic fields, but apparently only infrequently with pre-existing coronal structures at high temperatures. This poster reviews what is known and aims at eliciting discussion of what could be observed with IRIS.

Update on the Heliophysics Events Knowledgebase

Neal Hurlburt
LMSAL
ePoster

The HEK team has been working to evolve the Heliophysics Events Knowledgebase originally developed for Hinode and SDO to suppport there evolving needs and to integrate new missions such as IRIS. Here we present the current status and updates that will be available for use in time for IRIS operations.

Observations and modeling of magnetic reconnection in the coupled solar atmosphere

Hiroaki Isobe

Kyoto University

Invited Talk

Abstract:

The plasma parameters in the solar atmosphere varies drastically with height. The corona is fully ionized and almost collisionless, the photosphere and chromosphere is partially ionized and fully collisional, and the transition region is a marginal region in terms of collisionality and ionization. These very different regions are dynamically coupled by magnetic fields and waves. It is also interesting that, similarly to terrestrial ionosphere, the ratio of ion-cyclotron frequency and ion-neutral collisional frequency varies with height, giving rise to differnt effects by neutrals such as ambipolar diffusion and Hall effect. Recent observations have shown that magnetic reconnection occurs throughout the solar atmosphere, not only in the fully ionized and collisionless corona but also in the partially ionized and fully collisinal lower atmosphere, in similar mophologies but different scales. Therefore the solar atmosphere can be considered as an unique laboratory for magnetic reconnection in various plasma parameters. In this talk I will review the recent observations and the advances in theoretical modelings of magnetic reconnection in different part of the solar atmosphere.

A preliminary study of the HOP-187 jet analysis

Jackson, B. (1), Yu, H.-S. (1), Buffington, A. (1), Clover, J. (1), Shimojo, M. (2), Sako, N. (3)

(1) University of California, San Diego, CA, USA, (2) Nobeyama Solar Radio Observatory, NAOJ, NINS, Japan, (3) Department of Astronomical Science, Sokendai, NAOJ, Japan

Contributed Talk/ePoster

Abstract:

The Hinode Observing Proposal (HOP)-187, “Tracking X-ray Jets from the Solar Surface to Interplanetary Space” (Jackson and Shimojo, 2011) was carried out successfully during the summer of 2011. On two occasions (00-06 UT 17 June, 2011, and 00-08 UT 22 August 2011) XRT observations were run at a higher cadence over the south polar region in conjunction with LASCO C2 observations that also provided an enhanced 5-minute cadence and 100-sec exposures from this instrument. This campaign effort was joined by the NASA SDO AIA, the Solar TErrestrial RElations Observatory (STEREO) Coronagraph (COR II) and Heliospheric Imagers (HI’s), ground-based interplanetary scintillation (IPS) observations from the Solar Terrestrial Environment Laboratory

(STELab) and Ootacamund (Ooty), India, and finally data from the Solar Mass Ejection Imager (SMEI). In this data analysis, as in previous campaign-mode operations of the Hinode XRT instrument, we find a positive correlation between the brightest of the polar jets and a high-speed response traced into the interplanetary medium. Here, we report on the preliminary measurements of the jet responses that were observed during this successful HOP-187 campaign.

Non-Stationary Deconvolution for the IRIS NUV Slit-Jaw Imager

Sarah A. Jaeggli, Charles C. Kankelborg, M. Carlsson, B. De Pontieu, & The IRIS Team

Montana State University

Poster

Abstract:

High spatial resolution context imaging is essential to linking spatial structures with spectral signatures in the chromosphere, a critical part of the science requirements for IRIS (Interface Region Imaging Spectrograph). Measurements of the optical figure of the Solc filter indicate that the NUV slit-jaw imager on IRIS will have a somewhat broader PSF than the other instrument channels. We have developed an advanced deconvolution technique which combines measured PSFs sampled over the image plane to achieve the best correction for each pixel. We have conducted an analysis of this technique on synthetic data, and we assess the quality of the resulting images containing a variety of simulated effects, including cosmic ray hits, photon counting noise, discrete energetic solar events (flares), and saturation and overflow artifacts.

Diffusivity of Isolated Internetwork Ca II H Bright Points Observed by SuFI/SUNRISE

Jafarzadeh, S. (1), Solanki, S. K. (1), Cameron, R. H. (1), Feller A. (1), Pietarila, A. (2), Lagg, A. (1), Barthol, P. (1), Berkefeld, T. (3), Gandorfer, A. (1), Knoelker, M. (4), Martinez Pillet, V. (5), Schmidt, W. (3), and Title, A. (6)

(1) Max-Planck-Institut fuer Sonnensystemforschung, Max-Planck-Str. 2, 37191 Katlenburg- Lindau, Germany, (2) National Solar Observatory, 950 N. Cherry Avenue, Tucson, Az 85719, USA, (3) Kiepenheuer-Institut fuer Sonnenphysik, Schoeneckstr. 6, 79104 Freiburg, Germany, (4) High Altitude Observatory, NCAR, 3080 Center Green, Boulder, CO 80301, USA, (5) Instituto de Astrofisica de Canarias, C/Via L tea, s/n 38205, La Laguna, E-38200 Tenerife, Spain, (6) Lockheed-Martin Solar and Astrophysics Lab., 3251 Hanover St., Palo Alto, CA 94304, USA

ePoster

Abstract:

We analyze trajectories of the proper motion of intrinsically magnetic, isolated internetwork Ca II H BPs (with mean lifetime of 461 sec) to obtain their diffusivity behaviors. We use high spatial and temporal resolution image sequences of quiet-Sun, disc-centre observations obtained in the Ca II H 397 nm passband of the Sunrise Filter Imager (SuFI) on board the SUNRISE balloon-borne solar observatory. In order to avoid misidentification, the BPs are semi-manually selected and then automatically tracked. The trajectory of each BP is then calculated and its diffusion index is described by a power law exponent, using which we classify the BPs' trajectories into sub-, normal and super- diffusive. In addition, the corresponding diffusion coefficients (D) based on the observed displacements are consequently computed. We find a strong super-diffusivity at a height sampled by the SuFI/SUNRISE Ca II H passband (i.e. a height corresponding roughly to the temperature minimum). We find that 74% of the identified tiny BPs are super-diffusive, 18% move randomly (i.e. their motion corresponds to normal diffusion) and only 8% belong to the sub-diffusion regime. In addition, we find that 53% of the super-diffusion regime (i.e. 39% of all BPs) have the diffusivity index of 2 which are termed as "Ballistic BPs". Finally, we explore the distribution of diffusion index with the help of a simple simulation. The results suggest that the BPs are random walkers superposed by a systematic (background) velocity in which the magnitude of each component (and hence their ratio) depends on the time and spatial scales. We further discuss a simple sketch to explain the diffusivity of observed BPs while they migrate within a supergranule (i.e. internetwork areas) or close to the network regions.

Key- or tomb- stones in the bridge from photosphere to corona?

Philip G Judge

HAO, NCAR

Invited Talk

Abstract:

The Sun's atmosphere must get from photospheric pressures of 10^5 dyn cm^{-2}, where gas pressures and Reynolds stresses dominate, to coronal pressures of 10^{-1} dyne cm^{-2}, where magnetic stresses become dominant, within a mere 2000km. Outside of sunspots, the photospheric boundary layer exhibits hydrodynamic turbulent structure. The low pressure chromosphere- corona transition, while poorly understood, is clearly ordered by magnetic fields. Across the intervening scale heights, the richness of coupled magneto-hydrodynamics in a partially ionized atmosphere out of LTE, within which ions become magnetized, somehow leads to what we observe as the "magnetic chromosphere". We understand only the overall *thermal* structure of the chromosphere, it behaves as a thermostat: in response to heating energy is stored in latent heat of ionization and lost to radiation. But in terms of the *magnetic* structure, we must deal with: interaction with the plasma including multi-fluid effects, especially ion-neutral damping; effects of stratification on coupling wave modes; the existence of weak, discontinuous solutions to the MHD equations (current sheets). To generate discussion, I will argue that we have

little idea what the chromosphere does to the incoming flux of EM energy from beneath, and that current generations of MHD models are far from providing this understanding. We must not let apparent "successes" of, e.g., potential field models on large scales seduce us into thinking we understand how the Sun makes the photosphere-corona transition.

Obtaining Line Intensities and Profiles From MOSES Sounding Rocket Data

Kankelborg, Charles C. (1), Atwood, Shane M. (1), Courrier, Hans T. (1), Plovanic, Jacob T. (1), Rust, Thomas L. (1)

Montana State University, Bozeman, MT

Poster

Abstract:

The Multi-Order Solar EUV Spectrograph (MOSES) obtains images dispersed at three spectral orders from an objective grating, with the goal of reconstructing EUV spectra of He II (30.38 nm) and Si XI (30.33 nm) simultaneously over a large 2D field of view. We present preliminary results from a new data inversion code, estimating the spectrum in every pixel. This capability opens a new window on the solar atmosphere.

The generation of shock waves traveling from the photosphere to the transition region within network magnetic elements

Kato, Y. (1), Hansteen, V. (2), Steiner, O. (3), Carlsson, M. (2)

(1) NAOJ, (2) ITA, Univ. of Oslo, (3) KIS

Contributed Talk

Abstract:

We investigate the generation of shock waves near the photosphere by convective downdrafts in the immediate surroundings of the magnetic flux concentration, using radiation magnetohydrodynamic (RMHD) 2D simulations of the solar atmosphere. The simulations comprise the layers from the upper convection zone to the lower corona. We call this the "magnetic pumping process". We find that the generated slow modes via magnetic pumping travel upward along the magnetic flux concentration, developing into a shock wave in chromospheric heights. The waves continue to propagate further up through the transition region and into the corona. In the course of propagation through the transition layer, a small fraction of the longitudinal slow mode is converted into a transverse wave mode. We report on how much energy is deposited by propagating shock waves through the transition region and we discuss the the dissipation process above the photosphere within the magnetic flux concentration..

Determining electric fields from vector magnetograms.

Kazachenko, M; Fisher, G. H; Welsch, B.T.

Space Sciences Lab, UC BERKELEY

ePoster

Abstract:

Existence of systematic measurements of vector magnetic fields allows us to estimate electric field in the photosphere, using Poloidal-Toroidal Decomposition of the magnetic field and its partial time derivative (Fisher et l. 2011). The PTD method is based on solving a set of Poisson equations which in the past has been done using Fast Fourier Transform techniques. We modify the existing PTD method by improving the poisson solver using a package of solvers for elliptic partial differential equations called Fishpack. We apply the PTD with a new Poisson equation solver to several test cases with a known electric field. We find that for the ANMHD simulation test case application of the new poisson solver yields a more accurate values of electric field than before. We further investigate the applicability of our method to other test cases using simulations of M. Cheung and Y. Fan.

Beyond single fluid MHD: multi-fluid modeling of the coupled solar atmosphere

Elena Khomenko

Instituto de Astrofisica de Canarias

Invited Talk

Abstract:

The particular temperature and density conditions in the magnetized photosphere and chromosphere of the Sun usually lead to a very small degree of atomic ionization. In addition, at particular heights, the magnetic field may be strong enough to give rise to a cyclotron frequency larger than the collisional frequency for some species, while for others the opposite may happen. These circumstances can influence the collective behaviour of the particles and some of the hypotheses of magnetohydrodynamics may be relaxed, giving rise to non-ideal MHD effects. These effects are potentially important for the dynamics and energy exchange in the solar photosphere and, especially, chromosphere. In particular, there are evidences that such phenomena as wave propagation and damping, magnetic reconnection, formation of stable magnetic field concentrations, magnetic flux emergence, etc. can be affected. In this contribution, I will discuss the current state-of-the-art of multi-fluid MHD modelling of the coupled solar atmosphere. I will revise the major issues, physical mechanisms and assumptions of the MHD approach, and discuss future simulations that would be required to address some unresolved topics. I will present the first results of numerical simulations using the

modified MHD equations, showing that the chromosphere can be effectively heated due to non-ideal MHD effects.

Effects of vortex tube dynamics in the chromosphere

Kitiashvili I.N. (1), Kosovichev A.G. (1), Lele S.K. (1), Mansour N.N. (2), Wray A.A. (2)

(1) Stanford University, California, USA, (2) NASA Ames Research Center, California, USA

Contributed Talk

Abstract:

Investigation of the solar atmosphere dynamics cannot be complete without understanding coupling, and mass and energy exchange between the strongly-turbulent subphotosphere and the chromosphere. Modern computational capabilities allow us to construct realistic dynamical models, which take into account dynamical, chemical and radiative properties of the solar plasma. Such simulations based on first physical principles and accurate modeling of effects of magnetic field and small-scale turbulence, coupled with spectro-polarimetric line formation calculations, provide synthetic multi-wavelength observables, and are very important for interpretation of observational data. The simulations allow us to study physical processes and phenomena that have not been resolved in observations. In this talk we will present our recent results of high-resolution 3D radiative MHD numerical simulations of top layers of the convective zone and the chromosphere. The simulations reveal ubiquitous distribution of small-scale swirling motions in quiet-Sun and magnetic regions, forming vortex tubes extending from the subphosphere into the chromosphere. Our results show that these small-scale vortex tubes that originally formed in subsurface layer and penetrate into the chromosphere provide an efficient coupling of the turbulent convective layers with the atmosphere. They play important role in various processes, such as shearing instabilities, wave excitation, formation of magnetic flux tubes and transport of energy, mass, momentum and also turbulent properties from the convection zone into the chromosphere. In the presentation, we will focus on the physical aspects of the vortex tube formation, penetration into the atmosphere, interaction with magnetic fields, their role in the energy exchange, and on observational diagnostics and comparison with observational data.

Spectropolarimetry of the photosphere and the chromosphere with IBIS

L. Kleint (1), A. Sainz Dalda (2)

(1) HAO/NCAR, Boulder CO 80301 (2) Stanford-Lockheed Institute for Space Research, Stanford, CA 94305

Contributed Talk

Abstract:

We have obtained quasi-simultaneous spectropolarimetric imaging observations of various chromospheric and photospheric features in the lines Fe I 6302 A, Ca II 8542 A, H-alpha 6563 A and Na I 5896 A with the IBIS instrument at Sac Peak. Our targets include the quiet Sun, pores, sunspots, and flaring regions and our goal is to analyze the 3D magnetic field structure of the solar atmosphere. We carry out NTLE inversions with the NICOLE code to investigate interpretation techniques for chromospheric spectropolarimetric observations. The very faint polarization signatures make chromospheric inversions of the quiet Sun challenging. On the other hand, they are quite pronounced during flares and show us that the chromospheric magnetic structure is seemingly unrelated to the photosphere during these events.

The Pros and Cons of 1D vs. 3D Modeling

James A. Klimchuk

NASA Goddard Space Flight Center

Invited Talk

Abstract:

Advances in computing capability have led to tremendous improvements in 3D modeling. Entire active regions are being simulated in what might be described as a first principles way, in which plasma heating is treated self consistently rather than through the specification of heating functions. There are limitations to this approach, however, as actual heating mechanisms on the Sun involve spatial scales orders of magnitude smaller than what these simulations can resolve. Other simulations begin to resolve these scales, but they only treat a tiny volume and do not include the all important coupling with larger scales or with other parts of the atmosphere, and so cannot be readily compared with observations. Finally, 1D hydrodynamic models capture the field-aligned evolution of the plasma extremely well and are ideally suited for data comparison, but they treat the heating in a totally ad hoc manner. All of these approaches have important contributions to make, but we must be aware of their limitations. I will highlight some of the strengths and weaknesses of each.

Links between photospheric and chromospheric oscillations

A.G. Kosovichev (1), I.N. Kitiashvili (1), U. Mitra-Kraev (2), T. Sekii (3)

(1) Stanford University, Stanford, CA, USA; University of Cambridge, Cambridge, UK;National Astronimcal Observatory, Mitaka, Japan

ePoster

Abstract:

Oscillations excited by turbulent convection play important in the dynamics and energetics of the solar atmosphere. Oscillations below the acoustic cut-off frequency form photospheric resonant modes trapped in the interior but also penetrating into the chromosphere. Above the frequency cut-off, the oscillations represent traveling waves in the chromosphere that form pseudo-modes due to interference with waves coming from the interior. The physics of the chromospheric oscillations, their coupling to the photospheric oscillations, and their role in the chromospheric dynamics and energetics are not fully understood. The observed oscillation properties strongly depend on the excitation mechanism, interaction with turbulence and radiation, and local structure and dynamics of the chromosphere. Significant advances can be made through multi-wavelength observations of atmospheric oscillations and realistic numerical radiative hydrodynamics simulations. Using Hinode/SOT data we investigate the basic properties of solar oscillations observed at two levels in the solar atmosphere, in the G-band (formed in the photosphere) and in the CaII H line (chromospheric emission). We analyzed the data by calculating the individual power spectra as well as the cross-spectral properties, i.e., coherence and phase shift. The observational properties are compared with theoretical models and numerical simulations. The results reveal significant frequency shifts between the CaII H and G-band spectra, in particular above the acoustic cutoff frequency for pseudo-modes. The cross-spectrum phase shows peaks associated with the acoustic oscillation (p-mode) lines, and begins to increase with frequency around the acoustic cut-off. However, we find no phase shift for the (surface gravity wave) f-mode. The observed properties for the p-modes are qualitatively reproduced in a model that includes a correlated background due to radiative effects. Our results show that multi-wavelength observations of solar oscillations, in combination with radiative hydrodynamics modeling, help to understand the coupling between photospheric and chromospheric oscillations.

Using Kepler Data to Characterize the Flare Properties of GK Stars

Kowalski, Adam F. (1), Deitrick, Russell J. (1), Brown, Alex (2), Davenport, Jim R. A. (1), Hawley, Suzanne L. (1), Hilton, Eric J. (3), Ayres, Thomas R. (2), Berdyugina, Svetlana V. (4), Harper, Graham M. (5), Korhonen, Heidi (6), Walkowicz, Lucianne M. (7)

(1) University of Washington, (2) University of Colorado, (3) Institute for Astronomy, University of Hawaii, (4) Kiepenheuer Instut feur Sonnenphysik, Germany, (5) Trinity College, Dublin, Ireland, (6) Niels-Bohr Institute, University of Copenhagen, (7) Princeton University

Poster

Abstract:

Due to their high occurrence rate and large contrast against the background stellar emission, white-light flares on a handful of very active low-mass M stars have been the

primary source for our understanding of optical flare emission. Kepler's high-precision, long baseline light curves have opened up the characterization of white-light emission to new domains of stars, including active G dwarfs. We present the properties of white-light flares on GALEX-selected solar-type stars from GO data in Q1-Q7. The flares are discussed in relation to intrinsic stellar properties, which are constrained by a vast amount of follow-up characterization of the sample. We compare the flare properties to large white-light flares observed on the Sun. These high-precision state-of-the-art observations will provide important constraints for models of internal magnetic dynamos and NLTE radiative-hydrodynamic simulations of energy deposition in the lower atmospheric layers.

Doppler velocities studied simultaneously in the chromosphere and photosphere of an active region filament

Kuckein, C. (1,2), Martinez Pillet, V. (1), Centeno, R. (3)

(1) Instituto de Astrofisica de Canarias, (2) Departamento de Astrofisica, Universidad de La Laguna, (3) High Altitude Observatory

Contributed Talk

Abstract:

We present line-of-sight velocities retrieved simultaneously at two different heights (chromosphere and photosphere) on two days in an active region (AR) filament. The velocities, as well as the magnetic field parameters, were inferred from full Stokes inversions of the photospheric Si I 10827A line and the chromospheric He I 10830A triplet. Various inversion methods with different number of components and different weights of the Stokes parameters were used. Moreover, the velocities were calibrated on an absolute scale. We found a ubiquitous chromospheric downflow in the faculae surrounding the AR filament with an average velocity of 1.6 km/s. However, in the filament region, upflows in the photosphere were detected, when the Stokes signals from the transverse fields are given more weight in the inversions. In the chromosphere, the filament is also moving upward as a whole with a mean speed of -0.24 km/s as deduced from the He I inversions. However, on the second day the chromospheric portion above an orphan penumbra shows localized upflow patches while the rest of the filament is dominated by the same downflows observed elsewhere in the plage region. Photospheric supersonic downflows are detected below the filament, close to the PIL, that last for tens of minutes. The observed velocities in this AR filament strongly suggest a scenario where the transverse fields are mostly dominated by upflows. The filament flux rope is seen to be emerging at all heights with a few exceptions in the chromosphere. No large scale downflow of transverse field lines is observed in the photosphere.

Hall Reconnection in Partially Ionized Plasmas in the Magnetic Reconnection Experiment

Eric E. Lawrence, Hantao Ji, Masaaki Yamada, and Jongsoo Yoo

Princeton Plasma Physics Laboratory

Poster

Abstract:

In many space and astrophysical plasmas, such as the solar chromosphere and protoplanetary disks, the degree of ionization can be quite low; often 1\% or less. In addition, magnetic reconnection is thought to be a fundamental process in these plasmas. The presence of a large neutral atom population has at least two effects relevant to magnetic reconnection. First, electron-neutral collisions enhance resistive dissipation. Second, strong ion-neutral collisions increase effective ion inertia. This may increase the length scales on which fast Hall reconnection is predicted to occur. By using high gas fill pressures in the Magnetic Reconnection Experiment (MRX), we can study reconnection in partially or weakly ionized plasmas ($n_n/n_e = 1--200$). A newly constructed magnetic probe array allows us to make magnetic measurements of the reconnection region with high spatial resolution and large spatial extent. This will allow us to diagnose, for example, the structure of the Hall quadrupole field in these conditions. Langmuir and spectroscopic diagnostics will also provide insight into how neutrals affect ion outflows and therefore the overall reconnection process. These results will also be discussed in the context of ongoing theoretical work.

The formation of the Halpha line in the solar chromosphere

Leenaarts, J. (1,2), Carlsson, M. (1,3), Rouppe van der Voort, L. (1)

(1) Institute for theoretical astrophysics, University of Oslo, Norway (2) Utrecht University, The Netherlands, (3) Center of mathematics for applications, University of Oslo, Norway

Contributed Talk

Abstract:

We use state-of-the-art radiation-MHD simulations and 3D non-LTE radiative transfer computations to investigate Halpha line formation in the solar chromosphere. We find that 3D radiative transfer is essential in modeling hydrogen lines due to the low photon destruction probability in Halpha. The Halpha opacity in the upper chromosphere is mainly sensitive to the mass density and only weakly sensitive to temperature. We find that the Halpha line-core intensity is correlated with the average formation height: the lower the intensity, the larger the average formation height. The line-core width is a measure of the gas temperature in the line-forming region. The fibril-like dark structures seen in Halpha line-core images computed from our model atmosphere are tracing

magnetic field lines. These structures are caused by field-aligned ridges of enhanced chromospheric mass density that raise their average formation height, and therefore makes them appear dark against their deeper-formed surroundings.

Using non-LTE diagnostic tools: Multi3d

Leenaarts, J. (1,2)

(1) Institute for theoretical astrophysics, University of Oslo, Norway (2) Utrecht University, The Netherlands, (3) Center of mathematics for applications, University of Oslo, Norway

Invited Talk

Abstract:

I will give a tutorial session on the use of the 3D NLTE radiative transfer code Multi3d. The code uses MPI-parallelization and can handle large 3D input atmospheres such as those provided by radiation-MHD models. I'll show how to set up a run and discuss some of the commonly used input options and show how to analyze the results with IDL. I'll provide a web location where the code can be downloaded together with a manual, the IDL analysis package and a test problem. I'll show some results obtained by combining radiation-MHD models with radiative transfer computations done with Multi3d.

Spectropolarimetry in the Sodium 589.6nm D1 line: Evaluating the Resulting Chromospheric (?) Vector Field Maps.

KD Leka, G. Barnes, R.G. Stockwell, E.L. Wagner, H. Uitenbroek, M. Derouich

NWRA, NSO

Poster

Abstract:

Pioneering work by T. R. Metcalf almost two decades ago pointed to the Na 589.6nm D1 line as a contender for providing chromospheric vector magnetic field measurements (using the Zeeman effect). We report here on a systematic examination of what can be expected from Sodium 589.6nm spectropolarimetry, with respects to polarization-signal amplitudes and retrieval, and the implementation of the inversion for this line based on the Jeffries, Lites & Skumanich Weak-Field Approximation algorithm. The analysis is performed using both synthetic data and observations from the Imaging Vector Magnetograph, for which a large dataset of Sodium 589.6nm vector spectropolarimetry exists. The synthetic data are based on a 3-D field extrapolated from photospheric vector magnetograms of two active regions, four distinct model atmospheres coupled with NLTE synthesis of the emergent NaI D1 Stokes polarization spectra, computed for a variety of viewing angles. In this manner, a broad representation of active-region features, field strengths and observing angles are tested using ``hare & hound'' approaches, including evaluating algorithm performance in the presence of noise and instrumental effects. We compare retrieval algorithms for the very weak (as expected) polarization signals, and evaluate the retrieved vector magnetic field at a range of inferred heights. Finally, we provide an example from the IVM and discuss the prospects for obtaining and interpreting chromospheric vector magnetic field maps. Support for this work comes from NASA NAG5-12466, NASA NNH09CE60C, AFOSR F49620-03-C-0019, NSF/NSWP ATM-0519107, NSF/SHINE ATM-0454610, and NSF CRG ATM-0551055.

Magnetic Helicity in Emerging Active Regions: A Statistical Study

Yang Liu, and HMI Team

Stanford University

Poster

Abstract:

Magnetic helicity in emerging active regions in early phase of solar cycle 24 is studied using HMI vector magnetic field data. Magnetic helicity in the active-region corona is computed from the helicity flux across the photosphere, which is derived using the measured vector magnetic field on the photosphere and the velocity field derived from time-series vector magnetic field data using the algorithm DAVE4VM (Schuck 2008). The so-called ``hemisphere rule'' of magnetic helicity is examined. Relationship between solar transient and magnetic helicity in active regions is also explored here.

SDO/AIA Observations of Various Coronal EUV Waves Associated with Flares/CMEs and Their Coronal Seismology Implications

Wei Liu, Leon Ofman, Markus J. Aschwanden, Nariaki Nitta, Junwei Zhao, Alan M. Title

(1) Stanford-Lockheed Institute for Space Research; (2) Catholic University of America and NASA Goddard Space Flight Center; (3),(4),(6) Lockheed Martin Solar and Astrophysics Laboratory; (5) W. W. Hansen Experimental Physics Laboratory, Stanford University.

ePoster

Abstract:

MHD waves can be used as diagnostic tools of coronal seismology to decipher otherwise elusive critical physical parameters of the solar corona, such as the magnetic field strength and plasma density. They are analogous to acoustic waves used in helioseismology, but with complexities arising from the magnetic field and nonlinearity.

Recent high cadence, high resolution, full-disk imaging observations from SDO/AIA have opened a new chapter in understanding these waves. Various types of EUV waves associated with flares/CMEs have been discovered or observed in unprecedented detail. In this presentation, we will review such new AIA observations, focusing on the following topics and their interrelationships: (1) quasi-periodic fast waves traveling along coronal funnels within CME bubbles at speeds up to 2000 km/s, associated with flare pulsations at similar frequencies; (2) quasi-periodic wave trains within broad, diffuse pulses of global EUV waves (so-called EIT waves) running ahead of CME fronts; (3) interactions of global EUV waves with local coronal structures on their paths, such as flux-rope coronal cavities and their embedded filaments (kink oscillations) and coronal holes/active regions (deflections). We will discuss the implications of these observations on coronal seismology, on their roles in transporting energy through different parts of the solar atmosphere, and on understanding their associated eruptive flares/CMEs.

SDO/AIA Observations of Sustained Coronal Condensation and Mass Drainage in Prominences as Return Flows of the Chromosphere-Corona Mass Cycle

Wei Liu, Thomas Berger, B. C. Low

(1) Stanford-Lockheed Institute for Space Research; (2) Lockheed Martin Solar and Astrophysics Laboratory; (3) High Altitude Observatory

Contributed Talk

Abstract:

It has recently been proposed that prominences are manifestations of a magneto-thermal convection process that involves ever-present dynamic descents of cool material threads and upflows of hot bubbles (Berger et al. 2011 Nature). On global scales, prominences may play an important role as the return flows of the chromosphere-corona mass cycle, in which hot mass is originally transported upward through spicules. A critical step in this cycle is the condensation of million-degree coronal plasma into T<10,000 K prominence material by radiative cooling instability. However, direct observation of coronal condensation has been difficult in the past, a situation recently changed with the launch of the Hinode/SOT and SDO/AIA. We present here the first example observed with SDO/AIA, in which hours of gradual cooling through multiple EUV channels (from 2 MK to 80,000 K) in large-scale loops leads to eventual condensation at magnetic dips, forming a moderate-size prominence of 10^14 gram. The prominence mass is not static but maintained by a continual supply through condensation at a high rate of 10^10 gram/s against a comparable drainage through numerous vertical threads at less than free-fall speeds. Most of the total condensation of 10^15 gram, comparable to a CME mass and an order of magnitude more than the instantaneous mass of the prominence itself, is drained in merely one day. These new observations show that a macroscopically quiescent prominence is microscopically dynamic, involving the passage of a significant mass that bears important implications for the chromosphere-corona mass cycle. This interpretation

is further supported by the recent theoretical development on spontaneous formation of current sheets and cool condensations (Low, Berger, Casini, & Liu, this meeting).

The Hydromagnetic Nature of Quiescent Prominences

B.C. Low (1), T. Berger (2), R. Casini (1), W. Liu (2,3)

1 HAO/NCAR; 2 LMSAL; 3 Stanford University

ePoster

Abstract:

High-resolution observations of quiescent prominences with Hinode and SDO have revealed within their interiors the ever-¬present descent at less than free-fall speeds of cool, vertical dense filaments interspersed among upward, narrow streams at comparable speeds of heated, low-density plasma. We address the physical nature of this dynamical state. Despite the high magnetic Reynolds numbers characterizing this hydromagnetic environment, magnetic reconnection takes place via spontaneous formation and dissipation of current sheets by the coupled effects of highly-anisotropic thermal conduction, gravity, optically-thin radiation, heating, and high electrical conductivity. In this interesting new version of the theory of Parker (1994, Spontaneous current sheets in magnetic fields, Cambridge U Press), pervasive reconnections produce a perennial local descent of dense condensations under gravity along newly reconnected magnetic field lines and a concurrent turbulent rise of buoyant pockets of heated magnetized plasma through the large-scale magnetic structure. This mechanism may explain the massive downward drainage through a quiescent prominence observed recently (Liu et al. 2012 ApJ 745, L21) and, in the broader context, relate the quiescent prominence to the surrounding chromosphere/corona as a novel, large-scale, magneto-thermal convective phenomenon (Berger et al. 2011, Nature 472, 197)

Braided Solar Magnetic Field Structures Observed with SDO

Lundstedt, H. (1), Persson, T. (2)

Swedish Institute of Space Physics, Lund, Sweden (1), Center for Mathematical Sciences, Lund University, Lund, Sweden (2)

Poster

Abstract:

Stretching, twisting and folding of the magnetic field due to chaotic plasma motions below solar surface can not only drive a large-scale dynamo but also produce braided structures as seen on and above solar surface. Multifractal studies of the photospheric magnetic field, measured with HMI, suggest braided structures of many different sizes.

Braided magnetic structures contain magnetic energy. In this presentation we discuss whether or not the release of it, can explain Ellerman bombs and nano-flares. A series of AIA images of a filament in wavelengths 304 , 211 and 171 were analyzed. In an earlier helioseismic study of the AR 486 in 2003, we showed a good correlation between strong vorticity below solar surface, strong magnetic fields on surface and strong X-ray flares in the corona. Current study is therefore also considered to be extended to more intense solar flares.

Coronal hole boundaries and the slow solar wind from Hinode/EIS/XRT/SOT and SUMER/SoHO

M. S. Madjarska, Zh. Huang, J. G. Doyle and S. Subramanian

Armagh Observatory

ePoster

Abstract:

We present a statistical study on outflows at coronal hole boundaries and inside coronal holes and discuss their role in the slow solar wind formation in the low solar corona. The outflows are studied in XRT/Hinode image data taken with the Al_poly filter using an automatic identification method. A spectroscopic analysis is made using EIS and SUMER data of spectral lines with formation temperatures in the range from 10 000 K to 12 MK. The derived plasma parameters of about 60 phenomena will be reported. The longitudinal magnetic field data for each feature falling in the SOT/Hinode field-of-view (more than 25) are studied using a magnetic feature tracking procedure and a visual inspection. The mechanism of the outflow formation and acceleration will be discussed.

Non-Linear Force-Free Modeling of Solar Corona With The Aid of Coronal Loops

A. Malanushenko, M. DeRosa, C. Schrijver, M. S. Wheatland, S. Gilchrist

MSU/LMSAL, LMSAL, Univ. of Sydney

Poster

Abstract:

Accurate models of the coronal magnetic field are vital for understanding and predicting solar activity and are therefore of the greatest interest for solar physics. As no reliable measurements of the coronal magnetic field exists at present, the problem of constructing field models is typically viewed as a boundary value problem. The construction of realistic field models requires knowledge of the full vector of magnetic field at the boundaries of the model domain; vector magnetograms are, however, measured in the non force-free photosphere and their horizontal components are subject to large

uncertainties. Even if an uncertainty-free vector magnetogram at the top layer of the chromosphere was known, the problem remains an extremely challenging non-linear problem. There are various methods for pre-processing vector magnetograms and using them to construct models of the coronal field. The success of these models is often judged based on how close its field lines correspond to the observed coronal loops, which are believed to follow lines of the coronal magnetic field. At present, the correspondence between coronal loops and magnetic field lines of many models based on the vector magnetograms is far from perfect (DeRosa et. al., 2009). The estimates of free energy in the field as well as distribution of the magnetic currents through the volume could be dramatically different for different models used (Schrijver et. al., 2008). This testifies to the need of a completely new approach to this problem. We present such an approach and demonstrate its results based on AIA and HMI data. We have developed a way to use coronal loops as a constraint for magnetic modelling; the field is therefore constructed to match coronal loops. We found that when tested on known magnetic fields the new method is able to reproduce overall shape of the field lines, large-scale spatial distribution of the electric currents and measure up to 60% of the free energy stored in the field. This was achieved with as little as line-of-sight magnetogram and less than hundred of synthetic "loops", that is, lines of magnetic fields projected onto a plane of the sky. We found that line-of-sight HMI magnetograms and spatial resolution of the AIA instrument combined with the amount of filters available are more than sufficient for obtaining such data. We briefly describe this new method and demonstrate reconstructions of the coronal magnetic field obtained using AIA and HMI data. We evaluate how well it reproduces coronal features and how much energy and helicity estimates fluctuate with time for a stable non-flaring active region, thus establishing the reliability of the new method.

Importance of the partial ionization in the chromosphere using 2D radiative-MHD simulations

Juan Martinez-Sykora, Bart De Pontieu, Viggo H. Hansteen

Lockheed Martin Solar and Astrophysics Lab.

ePoster

Abstract:

The bulk of the solar chromosphere is weakly ionized and interactions between ionized particles and neutral particles will have significant consequences for the thermodynamics of the chromospheric plasma. We investigate the importance of introducing neutral particles into the MHD equations using numerical 2.5D radiative MHD simulations obtained with the Bifrost code. The models span the solar atmosphere from upper layers of the convection zone to the low corona, and solve the full MHD equations with non-grey and non-LTE radiative transfer and thermal conduction along the magnetic field. The effects of partial ionization are implemented using the generalized Ohm's law, i.e., we consider the effects of the Hall and ambipolar diffusion in the induction equation. The ohmic, Hall, and ambipolar diffusivities show variations of several orders of magnitude in the chromosphere. These strong variations of the various magnetic diffusivities are absent and significantly underestimated when using the semi-empirical VAL-C model as a basis for estimates. We find that in the chromosphere, the ambipolar diffusion is of the same order of magnitude or even larger than the numerical diffusion used to stabilize our code. As result of this, we can study the effects of it in the simulations. The ambipolar diffusion produces strong impact on the chromosphere changing the thermal properties, dynamics and magnetic field evolution.

Spectroscopic Diagnostics with IRIS

H.E. Mason and G. Del Zanna

University of Cambridge

Contributed Talk

Abstract:

This talk will review the spectroscopic diagnostics available in the IRIS wavelength bands, built on the previous heritage of observations in the 1330-1410A wavelength band. Consideration will be given to the accuracy of available atomic data in CHIANTI and the relevant atomic processes. Ways in which the IRIS data could be used to complement observations from other observatories (SDO and Hinode) will be explored with a view to probing the energy transport and dissipation in the solar atmosphere.

Observational Evidence of Magnetic Waves in the Solar Atmosphere

Scott W. McIntosh

HAO/NCAR

Invited Talk

Abstract:

The observational evidence in supporting the presence of magnetic waves in the outer solar atmosphere is growing rapidly - we will discuss recent observations and place them in context with salient observations made in the past. While the clear delineation of these magnetic wave "modes" is unclear, much can be learned about the environment in which they originated and possibly how they are removed from the system from the observations. Their diagnostic power is, as yet, untapped and their energy content (both as a mechanical source for the heating of coronal material and acceleration of the solar wind) remains in question, but can be probed observationally - raising challenges for modeling efforts. We look forward to the IRIS mission by proposing some sample observing sequences to help resolve some of the zoological issues present in the literature.

Estimating the (Dark) Energy Content of the Solar Corona

Scott W. McIntosh & Bart De Pontieu

HAO/NCAR & LMSAL

Poster

Abstract:

Exploiting the recent discovery of ubiquitous low-frequency (3-5mHz) Alfvénic waves in the solar chromosphere (with Hinode/SOT), and corona (with the ground-based CoMP and SDO/AIA) we report on the Alfvénic wave energy content of the corona using a blend of observational data and a simple forward model of Alfvénic wave propagation. We explore the apparent discrepancy in the resolved coronal Alfvénic wave amplitude (~0.5km/s) measure by CoMP compared to those of the Hinode and SDO near the limb (~20km/s).We see that the temporal invariance of the CoMP coronal non-thermal line widths ably capture the presence of the hidden, or dark, energy content in the corona. Exploiting the fact that the magnetic field permeating the corona is ubiquitously carrying Alfvénic motions of non-negligible amplitude we construct a simple model of wave propagation using the SOT and AIA measurements as strong constraints. This model reproduces the key spectroscopic measurements of the CoMP observations and allows us to place preliminary constraints on the impact of the coronal magnetic filling factor, the input wave spectrum, the dissipation on the wave motions observed, in addition to their energy content.

Global MHD Models of the Corona and Solar Wind

Z. Mikic, J. A. Linker, R. Lionello, P. Riley, V. S. Titov, and T. Torok

Predictive Science, Inc.

Invited Talk

Abstract:

Magnetohydrodynamic (MHD) models are useful in understanding the properties of the global solar corona. They typically use measured photospheric magnetic fields and an empirical specification of coronal heating. Comparisons of simulated EUV and X-ray emission from such models with observations (such as SOHO/EIT, Hinode/XRT, STEREO/EUVI, and SDO/AIA) can provide a tight constraint on coronal heating models. We will describe how these models can be used to improve our understanding of the process that heats the corona.

Magnetic flux emergence into the atmosphere: 3D numerical models.

Fernando Moreno-Insertis

Instituto de Astrofisica de Canarias

Invited Talk

Abstract:

The emergence of magnetic flux from the solar interior is one of the fundamental processes that shape the solar photosphere, chromosphere and corona. Taking place on a bewildering range of space- and timescales, it has defied detailed understanding for a long time, among other things due to insufficient observational and computing/modeling power. With the current golden age of solar space missions and with the advent of Petaflop massively parallel computing, the situation is quickly improving. Recent 3D numerical experiments are able to follow the emergence of small to intermediate bipolar regions from the topmost thousands of km below the surface into the low atmosphere and the corona. Some of those models include the simultaneous solution of the MHD and radiation transfer problems, with the divergence of the radiation flux then being used as entropy source in the plasma physics problem. In all cases, post-facto spectral synthesis based on the computed data permits comparison with observational data in the visible/IR, EUV and X-ray ranges. The interaction between theory and observation is thus reaching an excellent level and it must be strengthened for the benefit of future solar physics research. In this lecture, a review of recent modeling efforts of flux emergence processes will be provided. Although with a theoretical bias, the lecture will also provide results concerning the comparison with observations. A number of shortcomings of the current modeling capabilities will be discussed.

Observations from the HRTS-9 Rocket in the NUV Passband of the IRIS Mission

Jeff Morrill (1) , Clarence Kornedyke (1) , Donald McMullin (2), Linton Floyd (3)

(1) Naval Research Laboratory, Washington DC 20375, (2) Space Systems Research Corp., Alexandra VA 22314, (3) Interferometrics, Chantilly, VA 20151

Poster

Abstract:

The HRTS-9 rocket flew in April 1995 and observed several solar surface features on the western solar disk. The HRTS-9 spectrograph was modified to observe a 180 A wide portion of the solar spectrum near MgII at 2800 A. Also, a slit-jaw camera observed a 400 x 900" region around the 960" long x 1" wide spectrograph slit in five passbands, specifically,1540A (Si I), 1550A (C IV), 1560A (C I), 1600A, and images of H-alpha. During the flight, the slit was pointed at various features including the quiet sun near disk center and the limb, active regions, and a sunspot. At the end of the flight, the pointing was fixed and a slit scanning mechanism was used to collect a series of spectra that span

about 45". From this data set spectral images at specific wavelengths in the 2765 to 2885A range can be generated and compared to the broadband images at shorter wavelengths. For example, preliminary spectral images in the MgII k line show evidence of loop structures similar to those seen in C IV. Our previous efforts with this data set has focused on the impact these radiance observations near MgII have on solar spectral irradiance studies. These topics include examining the sources of solar irradiance variability, the center-to-limb variability of the quiet sun, and the relationship between the MgII intensity and the photospheric magnetic field. In light of the upcoming IRIS Explorer mission, we are turning our attention to those science goals in order to anticipate and support potential observations by the IRIS NUV spectrograph channel. In this presentation we present an overview of the available observations, previous results as well as discuss our ongoing analysis and preliminary spectral images of features in the region near MgII. Work sponsored by NASA.

Modeling magnetic reconnection in partially ionized chromospheric plasmas

Murphy, Nicholas A. (1), Raymond, John C. (1), and Zweibel, Ellen G. (2)

(1) Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA, (2) University of Wisconsin, Madison, WI, USA

Poster

Abstract:

Simulations of magnetic reconnection generally assume that the plasma is fully ionized. However, the ionization fraction in the solar chromosphere ranges from 0.005 to 0.5 so we must consider partial ionization effects such as ambipolar diffusion. In this poster we report on the initial stages of development for a new plasma simulation code to model partially ionized chromospheric reconnection. We will model ions and neutrals separately and include time-dependent ionization. By including elements with both high and low first ionization potentials, we will determine the amount of elemental fractionation that should be expected during chromospheric reconnection. These simulations will provide insight into observations of Type II spicules and chromospheric reconnection events by IRIS, SDO/AIA, and Hinode/SOT.

Equilibrium and Stability of Solar-Relevant Magnetized Arc Discharges

C. E. Myers, M. Yamada, E. E. Lawrence, H. Ji, R. M. Kulsrud, J. Yoo, and T. D. Tharp

Princeton Plasma Physics Laboratory

Poster

Abstract:

The equilibrium and stability properties of solar-relevant partial-toroidal arc discharges are studied in the laboratory. These discharges, which have an arched magnetic flux rope topology, are formed between two electrodes in the Magnetic Reconnection Experiment (MRX). Using internal magnetic probes and a fast framing camera, the discharge equilibria are found to expand and contract in response to radially-directed JxB forces. This behavior is similar to that of arched structures found in the solar corona. With regard to stability, the ideal external kink mode is studied in detail. It is found that the flux rope boundary conditions at each electrode play an important role in the kink stability of the discharges. In particular, changing the boundary conditions at the anode changes both the observed mode structure and the measured stabilization criteria.

Modeling waves, flows, and instabilities produced by impulsive events in coronal active regions

Ofman, L. (1,2), Liu, W. (3), Wang, T.J. (1), Davila, J.M. (2), Thompson, B.J. (2)

(1) Catholic University of America, Washington, DC, (2) NASA GSFC, Greenbelt, MD, (3) Lockheed Martin Solar and Astrophysics Laboratory, Palo Alto, CA

Contributed Talk

Abstract:

Recent high-resolution observations by SDO/AIA combined with spectral data from Hinode provide insights into the properties of MHD waves, flows, and instabilities in coronal active region plasma and their connection with impulsive energy release. Shear flow driven instabilities, such as the Kelvin-Helmholtz (KH) instability were only recently detected in detail in the corona. I will present recent results of 3D MHD models of slow and fast magnetosonic waves in active regions excited by jets and quasi-periodic flows driven by micro-flares at loops' footpoints. I will discuss models of super-fast magnetosonic waves detected recently by SDO/AIA.

Propagating waves along spicules

(1) Okamoto, Joten (2) De Pontieu, Bart

(1) NAOJ, (2) LMSAL

Poster

Abstract:

We investigated the detailed and statistical properties of Alfvenic waves along spicules in the polar coronal hole using very high cadence observations of the Solar Optical Telescope onboard Hinode. We developed a technique for the automated detection of spicules and high-frequency waves in a time series of images. We detected 89 spicules, and obtained several observational results (i.e., we found a mix of upward propagating (59%), downward propagating (21%), as well as standing waves (20%)). We speculate that upward propagating waves are produced near the solar surface (below the spicule) and downward propagating waves are caused by reflection of (initially) upward propagating waves off the transition region at the spicule top. The mix of upward and downward propagating waves implies that exploiting these waves to perform seismology of the spicular environment requires careful analysis and may be problematic.

Non-equilibrium ionization in 3D numerical models

Kosovare Olluri, Boris Gudiksen, Viggo H. Hansteen

Institute of theoretical Astrophysics, University of Oslo

ePoster

Abstract:

The dynamic timescales in the chromosphere and transition region have been observed to be much smaller then the ionization equilibration timescales of many ions found in the region. Due to the fast changes in the properties of the atmosphere, long ionization- and recombination times may lead to ions being found far from their equilibrium temperatures. Spectroscopic investigations therefore needs to be interpreted with the help of numerical modeling in order to produce reliable results. By solving the rate equations within a realistic MHD simulation of the solar atmosphere, we are able to follow the ionization balance, and study the non equilibrium effects of the emitting gas. Due top lack of computation power, this has previously been done in simple 1D, but because of the many free parameters in these models, their conclusions are not free of uncertainties. The resent development in computing technology and atmospheric modeling makes it possible to study the full 3D effect of non equilibrium ionization. With the solar atmosphere model Bifrost, we have a 3D platform for calculating and following the ionization degree of important atoms of high abundances in the solar atmosphere. We will present our implementation, and a study of the C IV 1549 Å , Fe XII 195 Å, O IV 1399 Å and 1401 Å lines in 2D.

What can we learn from propagating Alfvenic waves?

D. J. Pascoe, I. De Moortel, A. W. Hood, and A. N. Wright

University of St Andrews

ePoster

Abstract:

Observations have revealed ubiquitous transverse velocity perturbation waves propagating in the solar corona. We perform 3D numerical simulations of footpoint-driven transverse waves propagating in a low beta plasma. When density structuring is present, mode coupling in inhomogeneous regions leads to the coupling of the kink mode to the Alfvén mode. The frequency-dependent decay of the propagating kink wave is observed as energy is transferred to the local Alfvén mode. Modest changes in density are capable of efficiently converting energy from the driving footpoint motion to localised Alfvén modes. Thus, realistic transverse footpoint motions will deposit energy to (azimuthal) Alfvén modes in the corona. Mode coupling is investigated in detail for propagating kink modes as an explanation for the observed wave damping and as a possible seismological tool. The observed strong damping of the Doppler shift oscillations indicates the presence of wide inhomogeneous layers at the edges of the loops. Our simulations (backed up by analytical calculations) show that in this regime, the traditional exp(-z/L) damping rate no longer applies. Hence, care has to be taken when seismologically inferring damping lengths from the observed oscillations. In addition, taking into account line-of-sight integration of multiple loops supporting transverse oscillations, we show that the energy budget present in the 3D coronal volume could be substantially higher than the energy budget derived from the observed Doppler shift oscillations.

Potential for diagnostics with IRIS and Mg II lines

Tiago M. D. Pereira, Mats Carlsson, Jorrit Leenaarts, Han Uitenbroek, Bart De Pontieu, Juan Martinez-Sykora,

NASA/ARC, University of Oslo, National Solar Observatory, LMSAL

ePoster

Abstract:

The IRIS mission will open up a new window into the solar chromosphere and transition region. An important diagnostic that IRIS will bring is the Mg II H and K lines. Radiation from these lines is believed to be come from a wide range of formation depths, from the higher photosphere to the onset of the transition region. With a complex formation mechanism, Mg II H and K suffer from departures from LTE and partial redistribution (PRD). In this preliminary analysis we will look into the potential for diagnostics of Mg II H and K. Using a new parallel version of the RH code we synthesised Mg II H and K spectra from 3D rMHD simulations of the solar atmosphere. We will discuss the relevance of several approximations on the final observables, and will compare the Mg II H and K filtergrams with those of Ca II H, a robust chromospheric diagnostic line widely used with Hinode/SOT/BFI.

Are there really two types of spicules?

Tiago M. D. Pereira, Bart De Pontieu, Mats Carlsson

NASA/ARC, LMSAL, University of Oslo

ePoster

Abstract:

Observations with the high-resolution Solar Optical Telescope onboard Hinode have revealed that there are at least two types of spicules with markedly different properties. Type I spicules show velocities of order 20-30 km/s, lifetimes of order 3 to 10 minutes with up-and downward motions. Type II spicules show larger velocities (50-100 km/s), shorter lifetimes (30-180s) and mostly upward motions. Type I spicules seem to dominate in active regions, with type II spicules prevalent in quiet Sun and coronal holes (De Pontieu et al., 2007, Pereira et al., 2012). Recently, some work has questioned whether type II spicules exist (Zhang et al., 2012), suggesting that a majority of spicules in coronal holes show up and downward motion. We show observational evidence that contradicts these recent claims, and confirms the existence of two distinct types of spicules with properties similar to what was described by De Pontieu et al. (2007).

Coronal loops with constant cross-section reproduced in 3D MHD models

Peter, Hardi (1) and Bingert, Sven (1)

(1) Max-Planck-Institut fuer Sonnenphysik, Katlenburg-Lindau, Germany

Contributed Talk

Abstract:

EUV and X-ray images of the solar corona show loops with a more or less constant cross-section. Because the magnetic field is expanding with height, one would expect the coronal loops to expand with height. Suggestions on special magnetic structures have been made to understand the constant cross section of the loops, e.g. introducing helicity. However no convincing picture could be presented yet. We present results from a 3D MHD box model of a solar active region, which is heated through braiding of magnetic field lines and subsequent Ohmic dissipation. From the MHD model we synthesize emission as it would be observed with AIA/SDO. These synthetic images clearly show EUV loops with constant cross-section and thus can reproduce the observed structures.

The analysis of the densities and temperatures in relation to the magnetic structure in the 3D model box shows that the constant cross section is a result of the temperature and density variation in the loop structure perpendicular to the magnetic field. These results underline that one has to account for the three-dimensional nature of the corona even when investigating a seemingly one-dimensional structure such as a coronal loop.

Circumfacular regions and magnetic canopies as seen in Ca II 8542 Å

Anna Pietarila, Jack Harvey

National Solar Observatory

ePoster

Abstract:

Active regions appear bright in Ca II 8542 Å line core intensity while the surrounding areas are darker than the active region or the quiet Sun. These areas are referred to as circumfacular regions. We use SOLIS VSM Ca II 8542 Å data (photospheric and chromospheric full disk magnetograms as well as high spectral resolution Stokes I and V profiles) to study the relationship between photospheric and chromospheric LOS magnetic fields and detailed properties (e.g., line bisectors, Stokes V asymmetries) of the spectral profiles. There is a connection between magnetic canopies, circumfacular regions and Ca II 8542 Å bisector spans which may explain the observed solar cycle variation of the Sun-as-a-star Ca II 8542 Å bisectors.

Fast DEMs for EIS and AIA

Joseph Plowman(1), Charles Kankelborg(1), Petrus Martens(1), Miriam Ritchie(2), Jason Scott(1), Rahul Sharma(3)

(1) Montana State University, Bozeman, MT, USA, (2) University of St Andrews, Scotland, UK, (3) Mohanlal Sukhadia University, Rajasthan, India

ePoster

Abstract:

We present a method for constructing Differential Emission Measures (DEMs) using data from solar imagers such as EIS and AIA. In its basic form, the method is very fast (approximately one minute per full disk AIA image), although the DEMs obtained can contain regions of moderately negative emission measure (EM). We demonstrate an extension of the method which removes regions of negative EM while closely matching the data. The fidelity of the method is analyzed, its results are compared to those of the PINTofALE MCMC DEM algorithm, and it is applied to a coronal loop observed on April 19, 2011.

Forward modeling of coronal polarization

Rachmeler, Laurel (1), Gibson, Sarah E. (1), Casini, Roberto (1), Dove, James (2), Tomczyk Steve (1)

(1) HAO/NCAR, (2) Metro. State College, Denver

Contributed Talk

Abstract:

Coronal polarization measurements from the Coronal Multichannel Polarimeter (CoMP) instrument provide quantitative information about the magnetic field above the solar limb. Inversion of these measurements is difficult due to the optically thin nature of the plasma. Our forward technique can be used with both local and global models to obtain quantitative comparisons between models and observations of the coronal magnetic field. We have used the forward technique to study the magnetic nature of quiescent coronal cavities. We present results from the cavity analysis as well as ways to interpret the coronal polarization data without calculating inversions.

New insight on the coupling of the solar atmosphere from imaging spectroscopy

K. Reardon, G. Cauzzi

INAF/Arcetri Astrophysical Observatory

Contributed Talk

Abstract:

We present spectrally resolved, high-resolution observations of chromospheric diagnostics obtained with IBIS covering a full active region. In particular, the data includes the first high-resolution observations of the He I D3 line (587.6 nm), a subordinate of the more famous HeI 1083.0 nm line, showing loops and other structures on the solar disk at the 150 km diffraction limit. The large FOV of our data allows a meaningfully comparison with the SDO full disk observations to investigate the coupling between different portions of the solar atmosphere and the topology of the chromospheric magnetic field. The relationship between the chromospheric signatures and the SDO 304 Å and 171 Å emission provides intriguing hints to the existence of low-lying loops at TR temperatures effectively disconnected from the corona.

Explaining observed red and blue-shifts using multi-stranded coronal loops

S. Regnier, R. W. Walsh, J. Pearson

Jeremiah Horrocks Institute, University of Cental Lancashire

ePoster

Abstract:

Magnetic plasma loops have been termed the building blocks of the solar atmosphere. However, it must be recognised that if the range of loop structures we can observe do consist of many "sub-resolution" elements, then current one-dimensional hydrodynamic models are really only applicable to an individual plasma element or strand. Thus a loop should be viewed is an amalgamation of these strands. They could operate in thermal isolation from one another with a wide range of temperatures occurring across the structural elements. This scenario could occur when the energy release mechanism consists of localised, discrete bursts of energy that are due to small scale reconnection sites within the coronal magnetic field- the nanoflare coronal heating mechanism. These energy bursts occur in a time-dependent manner, distributed along the loop/strand length, giving a heating function that depends on space and time. An important observational discovery with the Hinode/EIS spectrometer is the existence of red and blue-shifts in coronal loops depending on the location of the footpoints (inner or outer parts of the active region), and the temperature of the emission line in which the Doppler shifts are measured. Based on the multi-stranded model developed by Sarkar and Walsh (2008, ApJ, 683, 516), we show that red and blue-shifts exist in different simulated Hinode/EIS passbands: cooler lines (OV-SiVII) being dominated by red-shifts, whilst hotter lines (FeXV-CaXVII) are a combination of both. The distribution of blue-shifts depends on the energy input and not so much on the heating location. Characteristic Doppler shifts generated fit well with observed values. We also simulate the Hinode/EIS rasters to closely compare our simulation with the observations. Even if not statistically significant, loops can have footpoints with opposite Doppler shifts.

Internal vs external reconnection observed by SDO in a newly emerged active region

S. Regnier

Jeremiah Horrocks Institute, University of Central Lancashire

Contributed Talk

Abstract:

The emergence of magnetic fields through the photosphere and the interaction with the coronal environment is an important process allowing the magnetic energy and magnetic helicity to be transported from the convection zone to the solar wind. SDO instruments such as AIA and HMI allow us to study in details the first steps of the emerging process and the thermal structure of the new-born active region. For this study, we combine the SDO/AIA observations at high-cadence in different temperature ranges (from photosphere to the hot corona) with potential field extrapolation of SDO/HMI line-of-sight magnetic field. In particular, we study (i) the interaction of the emerging flux with the coronal environment leading to magnetic reconnection and magnetic pressure enhancement owed to the complex topology of the magnetic field, (ii) the evidence of internal magnetic reconnection within the emerging flux tube whilst crossing the photosphere and expanding into the corona. The later is evidenced by the observation of Ellerman bombs at the chromospheric level and the structuring of the photospheric magnetic field. We thus provide a timeline of the events in the eight hours after the beginning of flux emergence.

High-resolution observations of type II spicules

Rouppe van der Voort, Luc

Institute of Theoretical Astrophysics, University of Oslo, Norway

Contributed Talk

Abstract:

Type II spicules are a class of spicules that is connected with mass-loading and heating of the solar corona. Type II spicules are characterized by short lifetimes and high apparent velocities. Combined with their narrow spatial widths, type II spicules are challenging to observe. We use the CRISP imaging spectropolarimeter at the Swedish 1-m Solar Telescope on La Palma to observe type II spicules at the limb and their counterparts on the solar disk, the so-called "Rapid Blue-shifted Excursions" (RBEs). The combination of adaptive optics and image post-processing allows CRISP to attain high resolution simultaneously in the spatial, temporal and spectral domains. Here we present results from the analysis of several high-quality data sets which allow to constrain the physical properties of type II spicules.

Graphical introduction to chromospheric line formation

Rob Rutten

Lingezicht Astrophysics and ITA, Oslo

Invited Talk

Abstract:

The basics of chromospheric line formation theory were laid out in the 1960s and 1970s by e.g., Thomas, Avrett, Hummer, Jefferies, Mihalas, Shine, Milkey. Since then there has been a long silence, without much progress in understanding the chromosphere or its

diagnostics. At present, the situation changes thanks to better ground-based observing, space-based monitoring, and increasingly realistic numerical simulations. There is a now a strong need to revamp classical one-dimensional static modeling as basis for chromospheric line interpretation into 3D dynamic understanding of the major diagnostics, including IRIS's Mg II h&k. In this introduction I aim to explain the old wisdom in tutorial fashion, using cartoons and graphs as means towards an intuitive grasp of fads and fallacies of chromospheric line formation.

Observation, inversion and numerical simulation of single-lobed Stokes V profiles in the quiet sun.

A. Sainz Dalda, J. Martínez-Sykora, L. Bellot Rubio, A. Title

(1) Stanford-Lockheed Institute for Space Research, (2) Lockheed-Martin Solar and Astrophysics Laboratory, (3) Instituto de Astrofísica de Andalucía, (3) Lockheed-Martin Solar and Astrophysics Laboratory

<u>Contributed Talk</u>

Abstract:

We have studied characteristics and statistics of strong asymmetric profiles in Stokes V, i.e., single-lobed profiles, in quiet sun using Hinode/SOT. These profiles require the existence of a velocity gradient along the line-of-sight, possibly associated with gradients of magnetic field strength, inclination and/or azimuth. For a better understanding, observations, inversions and numerical simulations are compared. We focus our analysis of the observations on the statistical properties of the single-lobed Stokes V profiles and the results provided by the inversions using SIRJUMP, which is an LTE inversion code that can reproduce sharp discontinuities or jump in the magnetic field and line-of-sight velocity of the atmosphere model. In the quiet sun, magnetic field is continuously appearing and disappearing at small scales due to the convective motions and the input of new flux from deeper layers. From radiative MHD 3D simulations, using Bifrost code, we note that most of these small scale processes have stratifications with gradients of magnetic field strength, inclination and velocities. As result, those stratifications showing jumps in the magnetic field configuration are associated with the existence of single-lobe Stokes V profiles in the solar photosphere, as we previously assumed for the inversions. We show that most of these profiles come from emerging and disappearance magnetic flux in small scales in the simulations. Finally, we emphasize importance of the comparison between the synthetic profiles from the simulations with the observed ones and the atmospheres that produce them. This comparison will ultimately improve the realism of the simulations and quantify the emerging and disappearance flux in the quiet sun.

The IRIS Education and Public Outreach Program, an Overview

Deborah Scherrer

Stanford University

Poster

Abstract:

The original IRIS Education and Public Outreach program has been recrafted to better mesh with NASA's EPO guidelines and the skill sets of our team. We will present an overview of the new plan, which includes programs in higher education, K-12, informal education (science museums, etc.), and social media support. IRIS partners are putting together such programs as an Undergraduate Student Competition, a summer research experience for undergraduates, a NASA Quest challenge geared to middle school students, addition of spectroscopy into a Challenger Center module, the distribution of punch-out spectroscopes and accompanying curricula to classrooms, and a social medium program coordinated with, and based upon, the successful SDO social media model. Partnerships abound and enthusiasm is high for our new program -- come see what we have in mind! If you are an IRIS scientist, talk with us about how you can help.

Diagnosing the Prominence-Cavity Connection

Donald Schmit, Sarah Gibson

University of Colorado; High Altitude Observatory

ePoster

Abstract:

Prominences are regions of cool, dense plasma which are suspended above the solar limb within the much hotter and more rarefied solar corona. The coronal environment surrounding the prominence is often observed as an elliptical region of reduced density (compared to the ambient corona) known as a cavity. The fundamental problems in prominence physics are the magnetic support of condensed plasma and the mass-source of those condensations. We use the SDO/AIA dataset to probe the correlated dynamics in between the cool prominence and the coronal cavity. These dynamics are explained through the 1D modeling of the radiative instability. The magnetic field inferred from these dynamics is also compared to the 3D MHD models of prominence support. Through this joint approach, the dynamic nature of the prominence system is brought into sharp focus for the first time.

Type-II spicules: Heating and magnetic field properties from aligned CRISP/SST and SDO observations

Scullion, E. (1), Rouppe van der Voort, L. (1), De la Cruz Rodriguez, J. (2)

(1) Institute of Theoretical Astrophysics, University of Oslo, Norway (2) Department of Physics and Astronomy, University of Uppsala, Sweden

<u>Poster</u>

Abstract:

Over the past decade there has been a resurgence in the study of small-scale chromospheric jets known, classically, as spicules. Recent observations have lead us to conclude that there are two distinct varieties of spicule, namely, slower type-I (i.e. mottles, dynamic fibrils, H-alpha spicules etc.) and faster type-II (RBEs: Rapid Blue-shift Excursions on-disk). Such events dominate the dynamics of the chromosphere. Joint SDO (Solar Dynamics Observatory) and Hinode observations have revealed that fast spicules are the source of hot plasma channelling into the corona. Here we report on the properties of this widespread heating with observations from the high resolution CRISP (CRisp Imaging SpectroPolarimeter) instrument at the SST (1-m Swedish Solar Telescope, La Palma) and co-aligned SDO data. Furthermore, we reveal new insight into the formation of type-II spicules through considering the distribution of RBEs with respect to the photospheric magnetic field (via CRISP).

Millimeter/sub-millimeter wave observations for chromospheric science

Masumi Shimojo and ALMA project

ALMA Project Office, National Astronomical Observatory of Japan

<u>Poster</u>

Abstract:

Except flares, the mm/sub-mm waves come from the lower chromosphere, and the emission mechanism of the waves is thermal emission from optically thick layer. The fact has been known from 1970’s. However, the spatial resolved observation in the wavelength range is very rare, because most telescopes for mm/sub-mm wave observation do not have the capability of solar observations and solar interferometric observations require many antennas for resolving phenomena with short lifetime. The Atacama Large Millimeter/sub-millimeter Array (ALMA) is the largest interferometer in the world for astronomical observations in mm/sub-mm wavelength. ALMA is constructed by 66 antennas and the highest spatial resolution reaches 0.04 arcsec@100GHz / 0.005 arcsec@900GHz, when ALMA starts the full operation phase (~ 2013). Although the ALMA project is the huge international astronomical project, it is not known well that ALMA has the capability to observe the Sun. At the end of 2010, ALMA project started the scientific verification activity for solar observation by ALMA and we performed two observing campaigns for verifying solar observations in May and December 2011. In the paper, we present the progress of verification activities for ALMA solar observations and discuss the chromospheric science using ultra-high spatial resolution data obtained by ALMA.

Photospheric Magnetic Fields from Magneto-Convection Simulations

Robert F. Stein (1), Aake Nordlund (2), Dali Georgobiani (1)

(1) Michigan State University, (2) Niels Bohr Institute

Contributed Talk

Abstract:

We present the properties of photospheric magnetic fields from magneto-convection simulations and as they would be observed by Hinode, for both quiet Sun and plage regions. This will include statistical properties, morphology, Stokes spectra, energy fluxes and correlations with convection dynamics. The rate of flux emergence will be discussed as a constraint on model parameters.

Scaling laws for quiet-sun magnetic fields

Jan Stenflo

ETH Zurich

Contributed Talk

Abstract:

The structuring of solar magnetic fields continues down to scales that are several orders of magnitude smaller than the scales that can currently be resolved. While the kG type flux tubes that can be explained in terms of the convective collapse mechanism have typical sizes in the range 10-70 km, the "hidden" flux of tangled fields that is revealed by the Hanle effect resides at still smaller scales. We have used a Hinode SOT/SP data set for the disk center of the quiet Sun to derive the kinetic and magnetic energy spectra in the resolved domain, and have used Hinode line-ratio data in combination with constraints from the Hanle effect to derive how the magnetic energy spectrum needs to be continued all the way down to the magnetic dissipation limit such that the combined constraints become satisfied. Special attention is paid to the effects of polarimetric noise and the modulation transfer function of the telescope. We find an approximate equipartition between kinetic and magnetic energy with power-law behavior in the range 200 - 1000 km. Below this scale the character of the energy spectrum changes, because it becomes dominated by the contribution from the kG flux tubes in the range 10 - 200 km. The spectrum then needs to be continued downwards to the dissipation limit (between 10

and 100 m) in a way that can explain the Hanle effect observations. We describe how the energy spectrum relates to the probability density functions for the flux densities and field strengths and to the cancellation function that describes the scaling of the average unsigned flux density.

Recurrent Eruptions in a Quadrupolar Magnetic Configuration Observed by SDO

Sun, Xudong; Hoeksema, Todd; Liu, Yang; Hayashi, Keiji

HEPL, Stanford University

ePoster

Abstract:

The active region AR11158 generated the first X-class flare of the current solar cycle as well as over a dozen CMEs over the course of a few days. Interestingly, most of these CMEs originated from a complex quadrupolar magnetic configuration on the eastern side rather than the center of the region where a major filament situated. A couple of pores emerged relatively late during the AR development but rapidly altered the magnetic connectivities, accumulating a large amount of electric current and free energy at the eruption site. HMI vector magnetograms and a non-linear force-free field extrapolation are used to explore the coronal field structures that favor the subsequent eruptions. AIA observation of the brightening flare loops and footpoint pairs provides further evidence for the interpretation.

Observation of Dynamic Features of Current Sheet Associated with 2010 August 18 Solar Flare

Takasao, S. (1), Asai, A. (2) Isobe, H. (2), and Shibata, K. (1)

(1) Kwasan and Hida Obserbatories, Kyoto University, (2) Unit of Synergetic Studies for Space, Kyoto University

ePoster

Abstract:

We report the simultaneous extreme-ultraviolet observation of magnetic reconnection inflow and outflow in a flare on 2010 August 18 observed by SDO/AIA. We found that during the rise phase of the flare, some plasma blobs appeared in a sheet structure above hot loops. The plasma blobs were ejected bidirectionally along the sheet structure (i.e. reconnection outflow). Simultaneously, bright threads visible in the extreme-ultraviolet images moved toward the sheet structure (i.e. reconnection inflow). Using the velocities of the inflow and outflow, we estimated the non-dimensional reconnection rate and found it varies during this period from 0.20 to 0.055. We also found that the plasma blobs in the sheet structure collided and possibly merged with each other before they were ejected from the sheet structure. From these observational results, we hypothesize that the sheet structure is the current sheet and that these plasma blobs are plasmoids or magnetic islands. This observational report could be important for understanding the dynamics of the reconnection region.

How to exploit current and future instrumentation to understand the coupled solar atmosphere

Tarbell, T.D.

LMSAL

Invited Talk

Abstract:

Using 3D MHD realistic simulations of the solar corona to test plasma diagnostics

Testa, P (1), De Pontieu, B. (2), Martinez-Sykora, J. (2,3), Hansteen, V. (3), Carlsson, M. (3)

(1) Harvard-Smithsonian Center for Astrophysics; (2) LMSAL; (3) Univ. of Oslo

Contributed Talk

Abstract:

We synthesize coronal images and spectra from advanced 3D MHD simulations obtained from the state-of-the art Bifrost code, and explore how well they reproduce coronal observations with SDO/AIA and Hinode/EIS. We apply standard diagnostic techniques (e.g., density, and temperature diagnostics) to the synthetic observations and investigate how accurately the derived physical information matches the plasma parameters of the model. We discuss the limitations of the diagnostics and their implications.

The mass cycle between the chromosphere and the corona/solar wind

Hui Tian

High Altitude Observatory, National Center for Atmospheric Research

Invited Talk

Abstract:

The plasma is not static but flows almost everywhere above the chromosphere. EUV and FUV spectroscopy reveals a lot of information of these mass flows, and thus enhances our understanding of coronal heating and solar wind origin. Through a single Gaussian fit to line profiles, emission lines formed in the transition region (TR) are usually found to exhibit ubiquitous redshifts. While coronal lines show predominant blueshifts in coronal holes (CHs), quiet-Sun (QS) network boundaries and active region (AR) edges. However, careful scrutiny of the line profiles indicates that they are obviously enhanced in the blue wings, suggesting the presence of a secondary high-speed upflow component besides the primary component. Meanwhile, imaging observations of HINODE/SOT and SDO/AIA clearly reveal ubiquitous episodic high-speed outflows in the form of type-II chromospheric spicules and propagating coronal disturbances (PDs). It has been suggested that the secondary component is associated with the type-II spicules and PDs, although further detailed investigations are needed to reach a solid conclusion. Moreover, recent AIA observations reveal slow downflows in cool passbands, which may represent the cooling of the previously heated plasma and should be embedded in TR line profiles. These heating upflows and cooling downflows are natural results of the mass cycling between the chromosphere and corona/solar wind, and their different relative intensities at different temperatures are likely to be responsible for the well-known temperature dependence of TR Doppler shift. So far various double Gaussian fit algorithms and red-blue asymmetry analysis techniques have been applied to coronal line profiles to derive parameters of the upflow component. However, an unambiguous decomposition of different components are still not possible by using data acquired by current spectrographs. The IRIS instrument, with a very small instrumental width and high spectral, temporal and spatial resolutions, might be able to unambiguously decompose different emission components in this continuous mass cycling process.

Spectroscopic observations of coronal mass ejections, coronal dimming and EUV jets

Hui Tian, Scott W. McIntosh

High Altitude Observatory, National Center for Atmospheric Research

Poster

Abstract:

Solar eruptions, particularly coronal mass ejections (CMEs) and extreme-ultraviolet (EUV) jets, have rarely been investigated with spectroscopic observations. We analyze several data sets obtained by the EUV Imaging Spectrometer onboard Hinode and find various types of flows during CMEs and jet eruptions. CME-induced dimming regions are found to be characterized by significant blueshift and enhanced line width by using a single Gaussian fit. While a red-blue (RB) asymmetry analysis and a RB-guided double Gaussian fit of the coronal line profiles indicate that these are likely caused by the superposition of a strong background emission component and a relatively weak (~10%) high-speed (~100 km s−1) upflow component. This finding suggests that the outflow velocity in the dimming region is probably of the order of 100 km s−1, not ~20 km s−1 as reported previously. Density and temperature diagnostics of the dimming region suggest that dimming is primarily an effect of density decrease rather than temperature change. The mass losses in dimming regions as estimated from different methods are roughly consistent with each other and they are 20%-60% of the masses of the associated CMEs. With the guide of RB asymmetry analysis, we also find several temperature-dependent outflows (speed increases with temperature) immediately outside the (deepest) dimming region. These outflows may be evaporation flows which are caused by the enhanced thermal conduction or nonthermal electron beams along reconnecting field lines, or induced by the interaction between the opened field lines in the dimming region and the closed loops in the surrounding plage region. In an erupted CME loop and an EUV jet, profiles of emission lines formed at coronal and transition region temperatures are found to exhibit two well-separated components, an almost stationary component accounting for the background emission and a highly blueshifted (~200 km s−1) component representing emission from the erupting material. The two components can easily be decomposed through a double Gaussian fit and we can diagnose the electron density, temperature and mass of the ejecta. Combining the speed of the blueshifted component and the projected speed of the erupting material derived from simultaneous imaging observations, we can calculate the real speed of the ejecta.

On the importance of Global Events in Destabilizations of the Solar Atmosphere

Alan Title

Lockheed Martin Advanced Technology Center

Contributed Talk

Abstract:

A large segment of solar research has focused on structures that give rise to violent events- flares and coronal mass ejections (CME's). This has placed emphasis on the development of active regions and filament channels with foci on energy build up and triggering. At the same time there have existed controversies about sympathetic flares, stealth CME's, and whether there can be CME's without flares. The operation of the Solar Dynamic Observatory, which collects full Sun line-of-sight and vector magnetograms field maps as well as full-Sun images in a range of wavelengths in the UV and EUV on a 12 second cadence 24/7, is now demonstrating that many violent solar events are connected. Recent simulations have suggested how the remote destabilizations occur. Maps of the Sun's magnetic topology show both the paths and the bounds of some of the instabilities. It is clear that we are in early stages of understanding of some of probably many mechanisms for destabilization. It is also clear that an understanding of the consequences of magnetic topologies are now, and will in the future be, a rich research topic. Movies of solar events and corresponding simulations will be shown.

Constraints on coronal magnetic fields from observations of visible and IR emission lines

Steven Tomczyk

HAO/NCAR

Invited Talk

Abstract:

Information on the strength and direction of coronal magnetic fields can be obtained from the observation of the polarization of visible and IR emission lines. These observations are confined to the corona above the solar limb and integrated along the line-of-sight. A wealth of information is also available through the analysis of the waves that permeate the corona as observed in line-of-sight velocity measurements. I will present an overview of the strengths and weaknesses of techniques for extracting information on coronal magnetism from these sources, and present an assessment for future progress in this area.

Spectroscopic Diagnostics and Heating of Active Region Cores

Tripathi, D.(1); Mason, H.E.(2); Klimchuk, J.A.(3)

1) Inter-University Centre for Astronomy and Astrophysics, Post Bag 4, Ganeshkhind, Pune 411007, India; 2) DAMTP, University of Cambridge, Cambridge CB3 0WA, England; 3) NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

<u>ePoster</u>

Abstract:

It is widely believed that we are still far from spatially resolving the fundamental plasma structures in solar corona. Therefore, we must use spectroscopic diagnostic techniques such as emission measure distribution (EM(T)) and Doppler shifts that are not affected by spatial averaging. Using observations recorded by the Extreme ultraviolet Imaging Spectrometer we have studies emission measure (EM) distribution and Doppler shift in the moss and inter-moss regions. The EM distributions obtained for moss regions cab be reproduced by considering strong coronal condensation scenario suggesting bulk downflow of the plasma. Doppler shift measurements for the moss regions show that almost all the moss regions are red-shifted with velocities up to 15km/s with mean velocity of ~5 km/s. However, the uncertainty on the Doppler shift was large. The EM distributions obtained for inter-moss regions have power law slopes of approximately 2.4 coolward of the peak. We compare the EM for inter-moss region with that obtained from nanoflare model using EBTEL (Enthalpy-Based Thermal Evolution of Loops). Our results suggest that the EM distribution for both the moss as well as inter-moss regions and Doppler shift in the moss regions can be explained by nanoflare heating. IRIS will provide a better account of the Doppler shift in the moss regions, which will dramatically enhance our understanding of the heating of active region core.

Observables for Measuring the Outer-Atmospheric Magnetic Field from Chromosphere to Corona

Trujillo Bueno et al.

IAC

<u>Contributed Talk</u>

Abstract:

The basic idea of optical pumping, for which Alfred Kastler received the 1966 Nobel Prize in physics, is that the absorption and scattering of light that is near-resonant with an optical transition can produce large population imbalances among the magnetic sublevels of atomic ground states as well as in excited states. The degree of this radiatively-induced atomic level polarization, which is very sensitive to the presence of magnetic fields, can be determined by observing the intensity and polarization of the scattered or transmitted spectral line radiation. Probably, the most important point for solar physics is that the outer solar atmosphere is indeed an optically pumped vapor and that the polarization of the emergent spectral line radiation can be exploited for detecting magnetic fields that are too weak and/or too tangled so as to produce measurable Zeeman polarization signals. Here we present several radiative transfer simulations of the linear polarization produced by optical pumping in selected FUV and EUV lines of the solar atmosphere, showing that their sensitivity to the Hanle effect is very suitable for magnetic field measurements in the upper chromosphere and transition region of the Sun. These results suggest that solar magnetometry using the spectral lines of optically pumped atoms in the chromosphere, transition region and corona should be a high-priority goal for large aperture solar telescopes, such as ATST, EST and SOLAR-C.

The RH suite of radiative transfer programs: a tutorial

Han Uitenbroek

National Solar Observatory/Sacramento Pek

Invited Talk

Abstract:

The RH suite of radiative transfer programs derives its name from the Rybicky-Hummer multi-level accelerated lambda iteration (MALI) formalism it employs for the general solution on Non-LTE problems in a given atmospheric model. The suite provides separate programs for Non-LTE solutions in 1-D, 2-D, and 3-D Cartesian, and spherical geometry, including the effects of partial frequency redistribution (PRD) and Zeeman-induced polarization. The code is flexible through the use of structured input files, and allows for the calculation of both atomic and molecular diagnostics. I will give a short tutorial on the structure of the code, the principles on which it is build, how to set up simple problems, and how to use the IDL-based graphical user interface to look at output results. The code is available for download for those interested in using it.

The role of magnetic braiding and MHD wave dynamics in the heating of the Sun's outer atmosphere

A. A. van Ballegooijen

SAO

Invited Talk

Abstract:

The solar corona is thought to be heated by dissipation of magnetic disturbances that propagate up from the Sun's convection zone. Two types of disturbance have often been considered: (1) twisting and braiding of coronal field lines as a result of random footpoint motions in the photosphere, and (2) MHD waves launched by such motions. One difficulty with the former is that coronal observations with Hinode/XRT and other imaging instruments show little evidence for braided fields. Furthermore, quasi-static braiding models predict that in active regions the misalignment angles of the braided field lines relative to the potential field should be large (~20 degrees), which is not consistent with coronal loop observations. We suggest that the braiding occurs on small transverse length scales in the corona (a few Mm or less), and must involve small misalignment angles (at most a few degrees). We argue that the braiding is dominated by small-scale footpoint motions occurring inside the kilogauss flux tubes in the photosphere (size < 100 km). Results from 3D MHD simulations of braided fields in coronal loops are presented. According to these models the footpoint motions cause Alfven waves to be launched into the system. The waves strongly reflect at the transition region, which leads to counter-propagating Alfven waves and turbulence in the chromospheric parts of the flux tube. Such turbulence has a major effect on the properties of the Alfven waves injected into the corona: the wave periods and transverse scales of the waves are much smaller than those of the photospheric footpoint motions. As a result, the turbulence in the corona proceeds very rapidly and is able to dissipate the injected energy very quickly, leading to small misalignment angles consistent with coronal observations. We find that most of the wave energy is dissipated in the lower atmosphere, consistent with observations of chromospheric and coronal heating rates in active regions. Therefore, this new dynamic braiding model appears to be consistent with a variety of observational constraints. We conclude there is a close relationship between the braiding of coronal field lines and wave heating processes.

What we can and cannot learn from seismology of the solar atmosphere

Tom Van Doorsselaere

KULeuven

Invited Talk

Abstract:

In this presentation, I aim to provide elements for the subsequent discussion. I will give an overview of the strengths and achievements of atmospheric seismology. I will also focus on the inherent limitations that are connected with this technique. Finally, I will highlight a few areas that have not been studied yet, but have a large potential for gaining additional information via atmospheric seismology.

2D Inversions

Michiel van Noort

Max Planck Institute for Solar System Research

ePoster

Abstract:

A new approach to inversion of high-resolution spectro-polarimetric solar image data is presented that explicitly takes the effects of telescope diffraction and other optical abberations in the observed data into account. The 2-dimensional solution can reliably reproduce the atmospheres from simulated data cubes and significantly improves the accuracy of profiles fitted to Hinode-SP data, compared to an equivalent 1-dimensional solution, without needing a more complex atmospheric model.

Think Scientifically: The Solar Dynamics Observatory's Elementary Science Literacy Program

Van Norden, Wendy, Wawro, Martha

ADNET Systems Inc.

Poster

Abstract:

The pressure to focus on math and reading at the elementary level has increased in recent years. As a result, science education has taken a back seat in elementary classrooms. The Think Scientifically book series provides a way for science to easily integrate with existing math and reading curriculum. This story-based science literature program integrates a classic storybook format with solid solar science, to make an educational product that meets state literacy standards. Each story is accompanied by hands-on labs and activities that teachers can easily conduct in their classrooms with minimal training and materials, as well as math and language arts extensions and assessment questions. These books are being distributed through teacher workshops and conferences.

Multi-instrument study of chromospheric jets

Kamalam Vanninathan, Maria Madjarska, Gerry Doyle

Armagh Observatory

Poster

Abstract:

The contribution to coronal heating by jets of various kinds like spicules, mottles, surges etc. originating in the solar chromosphere is an issue which is being currently largely explored. We analyse multi-instrument data taken in the plage area of active regions during dedicated observing runs with ROSA, IBIS at Sac Peak, USA, SOT, EIS/XRT/Hinode and AIA/SDO. The high-resolution and high-cadence data allow us to track chromospheric jets through the solar atmosphere and thus helps us to understand the dynamics and plasma properties of these features. The study is a forward step towards the exploration of the forthcoming state-of-art IRIS observations.

Determining the Typical Nanoflare Cadence in Active Regions: Comparing SDO/AIA Observations with Modeled Active Region Light Curves

Viall, Nicholeen M. (1), and Klimchuk, James A. (1)

1. NASA Goddard Space Flight Center, Greenbelt, MD

ePoster

Abstract:

Coronal plasma in active regions is typically measured to be at temperatures near ~1-3 MK. Is the majority of the coronal plasma in hydrostatic equilibrium, maintained at these temperatures through a form of quasi-steady heating, or is this simply a measure of the average temperature of widely varying, impulsively heated coronal plasma which is continually undergoing heating and cooling cycles? Addressing this question is complicated by the fact that the corona is optically thin: many thousands of strands which are heated completely independently are contributing to the total emission along a given line of sight. There is a large body of work focused on the heating of coronal loops, which are impulsively heated, however it is the diffuse emission between loops which often comprises the majority of active region emission. Therefore, a different and necessary approach to analyzing active region heating is to analyze all of the emission in an active region, and account for emission along the line of sight from all of the contributing strands. We investigate light curves systematically in an entire active region using SDO/AIA observations. We also model the active region corona as a line-of-sight integration of many thousands of completely independently heated strands. The emission from these flux tubes may be time dependent, quasi-steady, or a mix of both, depending on the cadence of heat release on each strand. We examine a full range of heat cadences from effectively steady (heat pulse repeat time << plasma cooling time) to fully

impulsive (heat pulse repeat time >> plasma cooling time) and model the resulting emission when superposing strands undergoing these differing heat cycles. We demonstrate that despite the superposition of randomly heated strands, different distributions of heat cadences produce distinct signatures in light curves observed with multi-wavelength and high time cadence data, such as those from the AIA telescopes on SDO. Using these model predictions in conjunction with SDO/AIA observations, we evaluate the typical cadence of heat release in different active regions and patterns therein, which is a crucial constraint on coronal heating mechanisms.

Growing and coupled transverse oscillations of a multistranded loop observed by SDO/AIA

Wang, Tongjiang (1), Ofman, Leon (1), Davila, Joseph M. (2), and Su, Yang (3)

(1) IACS/Physics Dept, Catholic Univ of America / NASA GSFC, USA, (2) NASA GSFC, USA, (3) IGAM/Institute of Physics, Univ of Graz, Austria

ePoster

Abstract:

We report the first evidence of transverse oscillations of a multistranded loop with growing amplitudes and internal coupling observed by SDO/AIA. The loop oscillations were triggered by a flare-CME event occurring in an active region visible at the limb. The multiwavelength analysis reveals the temperature dependence of multiple strands, which show differences in their oscillation amplitudes, phases and emission evolution. The physical parameters of growing transverse oscillations in 171A band are measured and the 3-D loop geometry is determined using STEREO/EUVI-A data. The strands have very similar oscillation frequencies and appear to oscillate in-phase or in a quarter-period phase delay. The observed oscillation properties of the loop strands agree with theoretically expected coupling between neighboring strands of a loop that undergoes a global kink mode oscillation. The transverse loop oscillations are also associated with intensity and loop width variations. We discuss the possible mechanisms that can excite the kink oscillations with growing amplitudes, and their associations with intensity and loop width variations.

Response of the Photospheric Magnetic Field to Flares

Haimin Wang

NJIT

Contributed Talk

Abstract:

In this study, we present a near disk-center, GOES-class X2.2 flare, which occurred in NOAA AR 11158 on 2011 February 15. Using the magnetic field measurements made by SDO/HMI, we obtained the first solid evidence of a rapid (in about 30 minutes) and irreversible enhancement in the horizontal magnetic field at the flaring magnetic polarity inversion line (PIL) by a magnitude of 30%. It is also shown that the photospheric field becomes more sheared and more inclined. This field evolution is unequivocally associated with the flare occurrence in this sigmoidal active region, with the enhancement area located in between the two chromospheric flare ribbons and the initial conjugate hard X-ray footpoints. These results strongly corroborate our previous conjecture that the photospheric magnetic field near the PIL must become more horizontal after eruptions, which could be related to the newly formed low-lying fields resulting from the tether-cutting reconnection. The M6.6 flare on February 13 in the same active region shows similar pattern.

Temperature dependence of EUV line parameters in network and internetwork regions for quiet Sun and coronal hole

Xin Wang, Scott W. McIntosh, Hui Tian

High Altitude Observatory

Poster

Abstract:

By using SUMER observations, we study the temperature dependence of the intensity contrast, Doppler shift, non-thermal width and profile asymmetry in network and internetwork regions for both the quiet Sun (QS) and coronal holes (CHs). In network regions, most of the transition region (TR) line profiles are more red shifted (by 0-5km/s) and narrower (by 1-6km/s) in QS than in CH. In the network, the RB asymmetries of all the selected TR and coronal line profiles are smaller (more blueward) in CH than in QS. While in the interwork region the difference disappears. In addition, we also systematically investigate differential emission measures (DEM) and electron densities and found different behavior in network and internetwork regions by using joint observations of SUMER and EIS. Our results suggest that the mass cycle between the chromosphere and corona mainly occurs in the network and one needs to separate

network and internetwork when discussing thermal and dynamic properties of the solar atmosphere.

SDO Education and Public Outreach

Wawro, M., Scherrer, D., McKenzie, D., Kellagher, E., Van Norden, W., Durscher, R., Winter, H., Myers, D.

ADNET, Stanford University, Montana State University, CIRES, Havard Smithsonian Center for Astrophysics

<u>Poster</u>

Abstract:

With the huge inflow of SDO data, the SDO E/PO team has focused its efforts on finding solutions that put SDO data into the hands of the public including classrooms and informal education programs. After summarizing the highlights of our post-launch activities, we will reintroduce the SDO E/PO team, describe current efforts aimed at increasing the number of people exposed to SDO data, and and the quality of programs using data, as well as start a dialog around how we as a community would like to move forward.

SDO citizen scientists; The Camilla Space Weather Project

Wawro, Martha (1), Durscher, Romeo (2), Van Norden, Wendy (1)

1) ADNET Systems INC 2) Stanford University

<u>Poster</u>

Abstract:

After the launch of the Solar Dynamics Observatory (SDO) in February of 2010 and the subsequent release of huge amounts of data to public venues there arose a need to educate the public not just about the existence of this data, but also how to utilize this data in a meaningful way. With a large formal citizen science project in the works but at least a year in prior to completion, the SDO education and public outreach (E/PO) team developed an interactive interface for the public and classrooms to use and analyze SDO data to make space weather predictions and to submit this data analysis. The Camilla Space Weather Project asks members of the public and classrooms to interact with SDO and other solar mission data in manner similar to solar scientists to make their own space weather predictions, with the goal of not only making the public more aware of SDO and SDO data, but to also make them more aware of how the data is used to monitor space weather events and the impact that space weather events can have on life on earth. The interaction of the general public with real data also creates a feeling of inclusion on the

SDO team and ownership in the project, which will help any future citizen science project by creating a ready pool of participants.

The Transit of Venus; Where the public meets science

Wawro, Martha (1), Durscher, Romeo (2), Van Norden, Wendy (1), Myers, Dawn (1)

1) ADNET Systems INC 2) Stanford University

Poster

Abstract:

This poster will highlight the planned activities for the 2012 Transit of Venus, including SDO sponsored event, the Transit of Venus website and will also include ways for the SDO science community to get involved with the event. This poster will also briefly describe the science that will be done around this event both by the public and scientists using SDO data. The poster will discuss the collaboration with the Sun Earth Day team as well as others around this last time in our life time event.

Morphology of a Hot Prominence Cavity Observed with XRT and AIA

Weber, Mark (1), Reeves, Katherine K. (1), Gibson, Sarah E. (2), and Kucera, Therese A. (3)

(1) Harvard-Smithsonian Center for Astrophysics, 60 Garden St. MS 58, Cambridge, MA 02138, USA, (2) HAO/NCAR, P.O. Box 3000, Boulder, CO 80307, USA, and (3) NASA Goddard Space Flight Center, Code 671, Greenbelt, MD 20771, USA

Poster

Abstract:

Prominence cavities appear as circularly shaped voids in coronal emission over polarity inversion lines where a prominence channel is straddling the solar limb. The presence of chromospheric material suspended at coronal altitudes is a common but not necessary feature within these cavities. These voids are observed to change shape as a prominence feature rotates around the limb. We use a morphological model projected in cross-sections to fit the cavity emission in XRT passbands, and then apply temperature diagnostics to XRT and AIA data to investigate the thermal structure. We find significant evidence that the prominence cavity is hotter than the corona immediately outside the cavity boundary. This investigation follows upon ``Thermal Properties of A Solar Coronal Cavity Observed with the X-ray Telescope on Hinode" by Reeves et al., 2012, ApJ, in press. M. Weber and K.K. Reeves are supported under contract NNM07AB07C from NASA to SAO. T. Kucera is supported by an award from the NASA SHP Program.

Small-scale rotating magnetic flux structures as alternative energy channels into the low corona

Wedemeyer-Böhm, Sven (1), Scullion, Eamon (1), Steiner, Oskar (2), Rouppe van der Voort, Luc (1), de la Cruz Rodriguez, Jaime (3), Erdelyi, Robertus (4), Fedun, Viktor (4)

(1) University of Oslo, Norway, (2) Kiepenheuer Institute for Solar Physics, Germany, (3) University of Uppsala, Sweden, (4) University of Sheffield, UK

Contributed Talk

Abstract:

Vortex flows are frequently observed in the downflow areas in the lanes between granules. The magnetic field is advected and trapped by these flows in the low photosphere. Consequently, the rotation of a vortex flow is transferred to the atmospheric layers above by means of the magnetic flux structure. This effect results in so-called swirls, which are observed in the chromosphere. New simultaneous observations with the Swedish Solar Telescope and the Solar Dynamics Observatory reveal that chromospheric swirls can have a coronal counterpart. This finding implies that the rotating flux structure couples the layers of the solar atmosphere from the photosphere to the (low) corona. Three-dimensional numerical simulations confirm this picture and reproduce the swirl signature. A combined analysis of the simulations and observations implies that such small-scale rotating flux structures could provide an alternative mechanism for channeling substantial energy from the photosphere into the upper solar atmosphere.

Transverse coronal loop oscillations seen in unprecedented detail by AIA/SDO

White, Rebecca.(1), Verwichte, Erwin.(1), Soler, Roberto.(2), Goossens, Marcel.(2), Van Doorsselaere, Tom.(2), Arregui, Inigo.(3)

(1) University of Warwick, UK, (2) Katholieke Universiteit Leuven, Belgium, (3) Universitat de les Illes Balears, Spain

ePoster

Abstract:

We present an observational study of transverse oscillations of eleven coronal loops observed in three separate events using data from the Solar Dynamics Observatory (SDO) which provides unprecedented temporal and spatial resolution of the solar corona. We study oscillatory events using the Atmospheric Imaging Assembly (AIA) instrument on board SDO, primarily in the 171 Angstrom bandpass to obtain information on loop lengths, periods and damping times. Where possible, data from SDO/AIA has been complimented with data from STEREO in order to obtain an estimation of the 3D loop geometry. Local coronal plasma properties are often difficult to measure using direct methods, however they can be probed using the diagnostic power of MHD waves. In particular, coronal loop oscillations interpreted as the fast MHD kink mode provide an

excellent tool for investigating such properties using the technique of coronal seismology. By probing the local coronal plasma, important information on the physical conditions in the vicinity of events such as solar flares and CMEs can be determined. Further to the observational study, analytic and Bayesian seismology inversion techniques are applied to the transverse loop oscillations under the thin tube, thin boundary approximations and under the assumption that they are damped via the mechanism of resonant absorption. This technique allows a 3D parameter space to be constructed that relates the density contrast, the loop inhomogeneity length scale and the Alfven travel time.

Recent results from MRX relevant to reconnection phenomena in solar atmosphere

M. Yamada, H. Ji, C. Myers, E. Lawrence, and T. Tharp

Center of Magnetic Self-Organization, PPPL, Princeton University, Princeton NJ 08543

Contributed Talk

Abstract:

This talk highlights results from the recent three major experimental campaigns carried out on MRX [Magnetic Reconnection Experiment]. (1) The equilibrium and stability properties of solar-relevant partial-toroidal arc discharges have been studied in the laboratory. The discharges, which have an arched magnetic flux rope topology, are formed between two electrodes in MRX. In the arched structures similar to those found in the solar corona, the flux rope boundary conditions at each electrode are found to play an important role in the kink stability of the discharges. (2) Magnetic reconnection in partially ionized plasmas has been studied. The presence of a large neutral atom population has two major effects on magnetic reconnection. The electron-neutral collisions enhance resistive dissipation and the strong ion-neutral collisions increase effective ion inertia. By using high gas fill pressures, we have studied reconnection in partially or weakly ionized plasmas. It is found that the reconnection rate does not change notably while the size of reconnection region stays the same as the neural density is increase to 20 times of the plasma density. (3) The effects of guide field on reconnection have been studied by systematically varying the applied guide field to values much greater than the reconnecting field. The out-of-plane quadrupole field, a signature of two-fluid reconnection, is readily identifiable in zero guide field plasmas, and a morphing of this field structure is observed as the applied guide field is varied. We observe that guide field significantly decreases the reconnection rate.

UV spectroscopy with IRIS - experience learned from Hinode/EIS

Peter Young

George Mason University

Poster

Abstract:

IRIS will be the fourth in a sequence of solar ultraviolet spectrometers, following on from CDS and SUMER on SOHO and Hinode/EIS. The experience gained from these missions will be valuable for ensuring that high quality science results emerge from IRIS right from the beginning of the mission. This presentation will summarize the experience gained from over five years of Hinode/EIS operations and science, and identify where that experience may benefit the IRIS team.

The 3D Analysis of Polar Jets Using Thomson-Scattering Observations from LASCO C3 Images and the Solar Mass Ejection Imager (SMEI)

H.S. Yu and B.V. Jackson

Center for Astrophysics and Space Sciences, University of California, San Diego, La Jolla, CA 92093, U.S.A.

ePoster

Abstract:

The X-Ray Telescope (XRT) onboard Hinode provides an opportunity to observe solar jetting activity above the solar poles. LASCO C3 images allow measurements of the coronal response to some of these jets, giving a determination of their speeds and energies that we compare with Hinode observations (Sako et al. 2010, 38th COSPAR). By using the full SMEI (Solar Mass Ejection Imager) image data set, we are able to study these same solar jet responses in the inner heliosphere. Preliminary results from 3D-reconstructed SMEI pseudo C3 coronagraph images have shown a good agreement at the correct position angles and time with the jet responses observed in LASCO (Jackson, 2012, Adv. in Geosciences). Using the SMEI volumetric data we carry this analysis farther, attempting to determine the extent to which these 3D jet responses maintain their identity into the inner heliosphere.

Ejection of cool plasma into the corona - comparison of results from a 3D MHD model with results from AIA/SDO, EIS/Hinode and a 1D loop model

Pia Zacharias, Sven Bingert, Hardi Peter

International Space Science Institute, Bern, Switzerland; Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany; Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany

ePoster

Abstract:

The formation and subsequent ejection of cool plasma into the corona will be discussed, as observed in our three-dimensional magnetohydrodynamic (3D MHD) model of the solar atmosphere extending from the photosphere into the corona. The model accounts properly for the energy balance, especially for heat conduction and radiative losses, allowing us to reliably synthesize the profiles of optically thin extreme ultraviolet emission lines and compare them to existing observations. A detailed description of the nature of this particular phenomenon will be provided. The analysis of the various forces acting upon the plasma in the 3D model shows that the pressure gradient which is driving the ejection is due to Ohmic dissipation of currents resulting from the braiding of the magnetic field lines by photospheric plasma motions. Preliminary results of a parameter study on the reproduction of the phenomenon in a one-dimensional loop model support the scenario of a heating event that leads to the ejection of cool plasma into the corona in both, the 1D loop model and the 3D model. In addition, results of the numerical model will be compared to observations from the Extreme Ultraviolet Imaging Spectrometer (EIS) onboard Hinode and the Atmospheric Imaging Assembly (AIA) onboard SDO, where we have also found evidence of cool plasma ejecta that are moving along magnetic field lines.