ILIA STATE UNIVERSITY

Welcome to

Our mysterious Sun: magnetic coupling between solar interior and atmosphere

September 25-29, 2017, Tbilisi, Georgia

Abstract Book

Our Mysterious Sun Tbilisi 2017

ABASTUMANI ASTROPHYSICAL OBSERVATORY
ILIA STATE UNIVERSITY

შოთა რუსთაველის საქართველოს ეროვნული სამეცნიერო ფონდი
SHOTA RUSTAVELI NATIONAL SCIENCE FOUNDATION OF GEORGIA

September 25

08:30-09:30 Registration
09:30-10:00 Welcome
19:30 Welcome reception

September 27

15:00-18:30 Excursion

September 28

15:00-18:30 Visit wine cellar
20:00 Conference diner
Scientific program

September 25

Session I: Future space missions and ground-based telescopes
Session II: Solar dynamo, activity and magnetic coupling of interior and atmosphere
Session III: Convection and Helioseismology

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Session IV: Photospheric magnetism
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Session VII: Solar corona

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Session VIII: Solar wind
Session: IX: Solar flares, CMEs and space weather

September 25

Session I: Future space missions and ground-based telescopes

10:00-10:25 Holly Gilbert: Solar Orbiter: Joint Mission to Study the Sun (Invited talk)

Author(s): Holly Gilbert

Abstract

This mission to explore the Sun-Heliosphere connection is the first medium-class mission of ESA's Cosmic Vision 2015-2025 program and is being jointly implemented with NASA. The dedicated payload of 10 remote-sensing and in-situ instruments will orbit the Sun as close as 0.3 A.U. and will provide measurements from the photosphere into the solar wind. The three-axis stabilized spacecraft will use Venus gravity assists to increase the orbitalinclination out of the ecliptic to solar latitudes as high as 34 degrees in the extended mission. Solar Orbiter's science team has been working closely with the Parker Solar Probe (PSP) scientists to coordinate observations between these two highly-complementary missions. In addition to providing a Solar Orbiter status update, I will present the exciting new science opportunities that the synergy between Solar Orbiter and PSP offer in the search to understand the origins of the heliosphere.

10:30-10:55 Manuel Collados: The European Solar Telescope: the future of European ground-based solar physics (Invited talk)

Author(s): M. Collados & the EST Team

Abstract

With first light expected in 2026, the European Solar Telescope (EST) represents the most im-portant technological joint effort made by the European ground-based Solar Physics commu-nity. EST will improve considerably the present observational capabilities thanks to its 4-metre diameter. Its optical design is especially designed to study magnetic phenomena taking place in the solar atmosphere, optimising two crucial aspects. On the one hand, its polarimetrically-compensated design is conceived to cancel out the instrumental polarisation induced by the individual elements of the optical train. This property is crucial to detect very small, both spatial and temporal, fluctuations of the magnetic field. Secondly, its design includes a power-ful multi-conjugate adaptive optics system (MCAO) to optimally correct the wave-front dis-tortions introduced by the Earth's atmosphere. With this MCAO system, EST is intended to measure the Sun at diffraction limit, with a spatial resolution of 20-30 km. The design is com-plemented with a suite of instruments that will operate simultaneously, to extract the maxi-mum information about the dynamics, thermodynamics and magnetism of the solar plasma at different layers. In this talk, the present status of the project will be presented, emphasising on the most recent technical developments and on the new operational models that will maximise the scientific impact of the data obtained with this facility.

11:00-11:45 Coffee break and poster view

Session II: Solar dynamo, activity and magnetic coupling of interior and atmosphere

11:45-12:15 Mausumi Dikpati: Global MHD tachocline instabilities (Invited review)

Author(s): Mausumi Dikpati

Abstract

Extensive studies of global instabilities in 2D and quasi-3D shallow-water and thin-shell mod-els of solar/stellar tachocline indicate that the tachocline differential rotation can be hydrody-namically and magnetohydrodynamically unstable to nonaxisymmetric modes with low longi-tudinal wave numbers, m=1 as well as m>1. During nonlinear evolution of these instabilities, m=1 modes produce clam-shell pattern of broad toroidal fields and tipping of toroidal bands, whereas m>1 modes produce deformation of toroidal bands. Magnetized shear modes nonli-nearly interact with high-frequency gravity waves. Radiative and overshoot tachoclines of the Sun and Sun-like stars are prone to this type of instabilities, due to which high latitude jet or polar spin-up occurs, and Reynolds, Maxwell and mixed stresses in the disturbances together with changing shell-thickness and meridional flow cause the evolution of differential rotation. After discussing the above results, we will present the importance of helical flow generated by shallow-water tachocline instabilities. We will demonstrate how the swelling and depression, created in the tachocline fluid due to such instability, can be responsible for producing "active-longitudes" on the solar/stellar surface. The interactions of oscillatory neutral modes and growing modes in a linear shallow-water system were demonstrated by Zaqarashvili et al. to explain the observed Rieger-type periodicity and quasi-biennial oscillations. During nonlinear evolution, an oscillatory exchange of energy occurs between the Rossby waves and differential rotation in the tachocline, and can explain the quasi-periodic, bursty "seasons" of solar activity. We will close by discussing the crucial role the tachocline dynamics play in influencing space-weather by shaping the spatio-temporal patterns of global magnetism manifested at the solar surface.

12:20-12:35 Kirill Kuzanyan: Tilt and Helicity of Solar Active Regions: theoretical mechanism and observational regularities

Author(s): K. Kuzanyan; N. Kleeorin, I. Rogachevskii, D. Sokoloff, A. Tlatov, K. Tlatova

Abstract

The series of data on tilt of bipolar regions in the solar photosphere may be extended to nearly one century using Mount Wilson sunspot data for 1917-2016. The other data on bipolar groups involving magnetograms from ground-base and space-born instruments can also be used for more recent periods. The advantage of these series is its systematic properties and simplicity, and the main regularity revealed is the Joy’s low indicating hemispheric bias in tilt angles.In our studies we developed a simplest idea on the mechanism of formation of tilt connected with buoyancy of unstable magnetic flux tubes formed with the dynamo generated mean magnetic fields in the solar convection zone. During its rising phase the bipolar formations achieve some additional twist due to Coriolis force which is comparable my magnitude but for the most phases of the solar cycle is statistically opposite in sign to the original dynamo generated magnetic helicity. The interplay between these two effects determines the observed twist and helicity in the solar photosphere. Furthemore, the balance is dynamic with constant loss of helicity towards the solar corona and heliosphere with the solar wind. The latter can be estimated as the residual of the observed and theoretically calculated produced magnetic helicity. We have found that for the most of slammer bipolar

groups there is no preferred bias in tilt and twist while for the larger bipolar formations it follows the hemispheric (Joy’s) law. Therefore, we conclude that for the scales of larger active regions may reflect the conditions of the operation of solar dynamo while the smaller groups refer to the background fluctuation component. The proposed mechanism explains well some peculiarities of the observed variability of tilt in hemispheres with solar cycle.

12:40-12:55 Tlatov: Formation of a polar magnetic field in a cycle 24

Author(s): A.G. Tlatov

Abstract

Analysis of synoptic data from the Synoptic Telescope for Operating Prognosis (STOP) at Kislovodsk mountain astronomical station and the Vector Spectromagnetograph SOLIS shows that the reversals of solar polar magnetic fields exhibit the asymmetry in activity between Northern and Southern hemispheres. The evolution of the polar magnetic field was considered, and it was shown that the polarity in cycle 24 was reversed December 2014–January 2015 in the Southern Hemisphere. In the northern hemisphere, there was a three-fold reversal in November 2012, in July 2013 and in October 2014. Three-fold polarity reversals were observed in cycles 12 and 14 in the Southern Hemisphere and in cycles 16, 19, and 20 in the Northern Hemisphere.

The annual variation of the amplitude of the polar magnetic field associated with the projection effect is much higher for the southern hemisphere than for the northern hemisphere. Perhaps this is due to the presence of an essential horizontal component of the magnetic field.

In a classical model of solar activity cycle, the magnetic regions of predominantly following polarity fields are transported polewards due to meridional flows and diffusion. This field gradually cancel out the polar magnetic field of the previous cycle, and rebuild the polar field of opposite polarity setting the stage for the next cycle. The preferential diffusion of the lower-latitude, leading-polarity flux across the equator leads to a net surplus of trailing-polarity flux in each hemisphere. In this model, the difference between the field of the leading and tail polarity is due to the difference in latitude of these spots (Joy's law). However, the polarity reversal begins much earlier than the flux of leading spots is compensated by the opposite hemisphere.

We consider the hypothesis that the difference between the drift of the magnetic fields of bipoles to the poles is due to the difference in the geometry of the base of the flux tube for the spots of the leading and following polarities anchored near the base of the convective zone. The surface meridional circulation promotes the emergence of following polarity fields, but not the leading polarity.

13:00-15:00 Lunch break

Session II: Solar dynamo, activity and magnetic coupling of interior and atmosphere

15:00-15:15 Laurent Gizon: Equatorial Rossby waves in the solar interior

Author(s): Laurent Gizon

Abstract

Using two independent techniques, we unambiguously detect and characterize large-scale vorticity waves in the shallow subsurface layers of the Sun with the dispersion relation of textbook Rossby waves. These Rossby waves may be important for understanding the nature of large-scale solar flows.

15:20-15:35 Eka Gurgenashvili: North-south Asymmetry in Rieger-type Periodicity during Solar Cycles 19-23

Author(s): Eka Gurgenashvili, Teimuraz Zaqarashvili, Vasil Kukhianidze, Ramon Oliver, Jose Ballester, Mausumi Dikpati, and Scott McIntosh

Abstract

Rieger-type periodicity has been detected in different activity indices over many solar cycles. It was recently shown that the periodicity correlates with solar activity having a shorter period during stronger cycles. Solar activity level is generally asymmetric between northern and southern hemispheres, which could suggest the presence of a similar behavior in the Rieger-type periodicity. We analyse the sunspot area/number and the total magnetic flux data for northern and southern hemispheres during solar cycles 19-23 which had remarkable north-south asymmetry. Using wavelet analysis of sunspot area and number during the north-dominated cycles (19-20) we obtained the periodicity of 160-165 days in the stronger northern hemisphere and 180-190 days in the weaker southern hemisphere. On the other hand, south-dominated cycles (21-23) display the periodicity of 155-160 days in the stronger southern he-misphere and 175-188 days in the weaker northern hemisphere. Therefore, the Rieger-type periodicity has the north-south asymmetry in sunspot area/number data during solar cycles with strong hemispheric asymmetry. We suggest that the periodicity is caused by magnetic Rossby waves in the internal dynamo layer. Using the dispersion relation of magnetic Rossby waves and observed Rieger periodicity we estimated the magnetic field strength in the layer as 45-50 kG in more active hemispheres (north during the cycles 19-20 and south during the cycles 21-23) and 33-40 kG in weaker hemispheres. The estimated difference in the hemis-pheric field strength is around 10 kG, which provides a challenge for dynamo models. Total magnetic flux data during the cycle 20-23 reveals no clear north-south asymmetry which needs to be explained in the future.

15:40-15:55 Teimuraz Zaqarashvili: Magneto-Rossby waves in the solar tachocline

16:00-16:30 Coffee break and poster view

Session III: Convection and Helioseismology

16:30-17:00 Mark Miesch: The Convection Conundrum: Mystery and Intrigue Below the Solar Surface (Invited review)

Author(s): Mark S. Miesch

Abstract

Helioseismology has revolutionized the discipline of solar internal dynamics. For the first time in human history we can peer below the surface of a star. But interpreting helioseismic mea-surements is not easy. Some signals are more subtle than others. Though there is general agreement on helioseismic inversions of the internal rotation profile, a definitive characteriza-tion of the convective motions and meridional circulation remains elusive. In particular, some (not all) helioseismic investigations suggest that convective velocity amplitudes are much smaller than predicted by global convection models. The models themselves seem to be consis-tent with this assessment; they generally yield unrealistic differential rotation profiles if solar values are used for the luminosity and rotation rate. Furthermore, local-area models of solar surface convection also seem to over-estimate the power at the largest scales they can capture. But if large-scale convective motions are really so weak, then how can they carry the solar luminosity and how can they establish the mean flows that are observed? These questions de-fine the "convection conundrum". In this talk I will review the recent observational, theoreti-cal and numerical modeling results that are challenging our understanding of deep solar con-vection. I will also consider several possible ways to resolve the convective conundrum, in-volving physical processes that are not yet reliably captured in global convection simulations.

17:05-17:20 Chris Hanson: The state of the art: Inversions for flows in the solar interior

Author(s): Chris S. Hanson, Damien Fournier, Laurent Gizon

Abstract

Despite helioseismology being over 50 years old, a consensus on the actual structures of the meridional circulation and convective flows (supergranules) has yet to be reached. This has been in part due to the difficulties of observations and in part due to the lack of accurate and consistent solving of the forward and inverse problems. In this talk we will present a computa-tional approach to inverting for these large scale flows through the computation of travel-time and cross-covariance amplitude sensitivity kernels of the flow. Our study and inversion of synthetic data will demonstrate the capabilities of our method, as well as the observational demands of the inversion in order to be accurate. This work is a promising step towards un-derstanding the large scale flows in the solar interior.

17:25-17:40 Hannah Schunker: Statistical analysis of the evolution of active region tilt angles

Author(s): Hannah Schunker

Abstract

Active region tilt angles have been observed to `relax' towards a more east-west orientation as active regions evolve and this motion has been used to constrain models of flux rising to the surface of the Sun from the deep interior. We tracked the individual motions of the leading and following polarities in over 150 active region polarities (from the Solar Dynamics Observatory Helioseismic Emerging Active Region (SDO/HEAR) survey, Schunker et al. 2016) at the surface during emergence to constrain the dominant physics guiding the polarity motions and tilt-angle onset. We found that the mean north-south motion of the polarities is consistent with the expected displacement due to the Coriolis force acting on the east-west motion of the polarities after flux first appears at the surface. The change in tilt angle due to a purely east-west motion of the polarities plus the change in tilt angle from this north-south separation due to the Coriolis effect can account for the apparent tilt angle relaxation.

17:45-18:00 Sushanta Ttripathy: Magnetoseismic Study of Active Regions

Author(s): S.C. Tripathy, K. Jain, S. Kholikov, F. Hill and P. Cally

Abstract

The interpretation of acoustic waves surrounding active regions has been a difficult task since the influence of magnetic field on the incident waves is not fully understood. As a result, structure and dynamics of active regions beneath the surface show significant uncertainties. Recent numerical simulations confirm that the atmosphere above the photosphere modifies the seismic observables at the surface. Thus the key to improve helioseismic interpretation beneath the active regions requires a synergy between models and helioseismic inferences from observations. In this context, using data from Helioseismic Magnetic Imager and Atmospheric Imaging Assembly on board the Solar Dynamics Observatory, we characterize the spatio-temporal power distribution around active regions as a function of the height in the solar atmosphere. Specifically, we focus on the power enhancements seen around active regions as a function of wave frequencies, strength, inclination of magnetic field and observation height as well as the relative phases of the observables and their cross-coherence functions. We expect that these effects will help in comprehending the interaction of acoustic waves with magnetic field and provide better measurements of sub-surface flows.

September 26

Session IV: Photospheric magnetism

09:15-09:45 Sami Solanki: Photospheric Magnetism (Invited review)

Author(s): Sami K. Solanki

Abstract

The photosphere is the layer in which most measurements of solar magnetic fields have been and continue to be made due to the relatively strong fields and the availability of sufficiently Zeeman sensitive spectral lines formed in that layer. Hence it is also the layer in which our knowledge of the Sun's magnetic field is the largest. Consequently, observations of photospheric magnetism serve not only to study the magnetic field at the solar surface, providing insights into magnetoconvection, the often fine-scale structure and evolution of small and large magnetic features and the small-scale dynamo acting close to the solar surface. Such observations are also used to extrapolate the magnetic field into the upper solar atmosphere and to infer the structure and the production of the magnetic field in the solar interior from the field's global structuring. In this review the complex structure and dynamics of the photospheric magnetic field will be introduced, and some of the connections with other atmospheric layers will be pointed out.

09:50-10:05 Nataliia Shchukina: Spectropolarimetric diagnostics of photospheric magnetic fields from the Hanle and Zeeman effects

Author(s): Nataliia Shchukina, Javier Trujillo Bueno

Abstract

We present results of spectropolarimetric studies aimed at determining the magnetism of the photospheric regions that look “empty” in solar magnetograms, that is, the Sun's “hidden” magnetism. First, we analyze the Hanle effect in the Sr I 460.7 nm line, one of the Ti I multiplets and molecular lines. Then, we report on the quiet Sun magnetic fields seen by “Zeeman eyes”. We pay special attention to the spectral region around 1083.0 nm. It is a powerful diagnostic window which contains information coming simultaneously from the chromosphere (He I 1083.0 nm triplet) and from the photosphere (Si I at 1082.7 nm). We conclude that the strength of the hidden field fluctuates on the spatial scales of solar granulation, with rather weak fields above the granular regions, but with a distribution of stronger fields in the inter-granular regions. The ensuing magnetic energy density is so significant that the energy flux turns out to be substantially larger than that required to balance the chromospheric energy losses.

10:10-10:25 Robertus Erdelyi: MHD waves in asymmetric waveguides

Author(s): Robertus Erdelyi

Abstract

The recent suit of high spatial and temporal resolution of satellite and ground-based observa-tions have enabled to make a leap forward in studying MHD waves in solar magnetic waveguides present from the chromosphere to corona. The building block of solar atmospheric magnetism is often modelled in the form of a magnetic slab or magnetic flux tube.

The foundations of the theory of MHD waves applicable to solar waveguides, in the way we use them today, were laid down in the early 1980s. The basic concept was that MHD waveguides are embedded in a symmetric plasma environment. This theory was later further developed by adding a number of important subtleties, incl. variation in cross-section, stratification, various inhomogeneities along or across the waveguide, curvature, etc. However, one aspect was hardly considered: the waveguides may not actually be in a symmetric (non)magnetised plasma environment. Here, we demonstrate, how to overcome this important aspect and report on the development of theory of MHD waves and their applications to waveguides in asymmetric (non)magnetised plasma environment. We also present a number of solar magneto-seismologic applications to a range of waveguides present in the lower solar atmosphere (e.g. sunspot light bridge, light wall) or even in the chromosphere or low corona (e.g. prominences). We show how observed information of MHD waves and oscillations can be employed to obtain diagnostics about the asymmetric environment the waveguides are embedded in. We also show briefly how such waveguides support the development of local instabilities relevant for plasma heating.

10:30-11:40 Coffee break and poster view

Session IV: Photospheric magnetism

11:40-11:55 Arnold Hanslmeier: Tomography of the lower solar atmosphere

Author(s): Arnold Hanslmeier, Markus Roth

Abstract

The dynamical processes that take place in the photosphere and propagate through the lower chromosphere are extremely important in order to understand high energetic release in the chromosphere/corona. We give a short review on high resolution solar photospheric observa-tions and then present mainly one instrument, HeLLRIDE that enable quasi simultaneous ob-servation of different layers in the solar photosphere/chromosphere up to about 2500 km. At present, this instrument is installed at the German VTT but a migration to GEGOR is consi-dered. First results of coherent evolution of temperature and velocity fields are shown.Other instrument using spectro polarimetry are available at the SVST. Polarimetry will be also included in HeLLRIDE in the near future.

12:00-12:15 Peter Leitner: Tracking of photospheric shock waves in computational fluid dynamics data by means of post-processing detection algorithms based on edge detection and shock surface normals computation

Author(s): Leitner, P., Zaqarshvili, T., Hanslmeier, A., Veronig, A., Lemmerer, B., Muthsam, H.J.

Abstract

Simulations of the solar convection including radiation transport allow us to examine and track photospheric shock waves in detail unparalleled by direct observation. It is still not clear which processes trigger shocks and how significant a role they play for the energy transport to the upper layers of the atmosphere. Apart from traditional techniques of shock wave detection that rely on a search for the concentration of contour lines of pressure, density, and tempera-ture and for the localization of Mach number isosurfaces, we employ recent

post-processing methods specifically aimed at the analysis of computational fluid dynamics (CFD) data that allow us to more accurately locate and segment shock fronts as they propagate through the photospheric plasma. We present an application of different detection algorithms on radiation hydrodynamics (RHD) and radiation magnetohydrodynamics (RMHD) simulation data of the photosphere that are based on an edge detection technique as well as a method to locate shock surface normals based on the local pressure gradient. We will compare the emergence of shock patterns in these two qualitatively different simulations and discuss the correlation of the shock structures with the underlying flow field.

12:20-12:35 David Kuridze: Spectropolarimetric inversions of the Ca 8542 and Fe I 6173 Å lines in a M-class solar flare

Author(s): D. Kuridze, V. Henriques, M. Mathioudakis, J. de la Cruz Rodriguez, M. Carlsson

Abstract

We study the M1.9 class solar flare SOL2015-09-27T10:40 UT using high-resolution spectro-polarimetric observations in the Fe I 6173 and Ca II 8542 Å lines obtained with the CRISP im-aging spectropolarimeter on the Swedish 1-m Solar Telescope. Spectropolarimetric inversions of these lines using the non-LTE code NICOLE are used to construct semiempirical models of the lower flaring atmosphere to investigate the evolution of the temperature and velocity structure as well as that of the photospheric and chromospheric magnetic field of the flare. Due to the integrating nature of radiative transfer, the usage of two lines sampling distinct but slightly overlapping height regions provides a much better constraint on the atmospheric pa-rameters along with the increase in sampled range. A comparison of the temperature stratifi-cation in flaring and non-flaring areas reveals strong heating of the flare ribbon during the flare peak in the chromosphere. Analyses shows that the polarization signals of the ribbon in the chromosphere during the flare maximum become stronger when compared to its sur-roundings. The latter effect serendipitously allows measurements of the line-of-sight magnetic field in the flaring chromosphere. The magnetic field strength in the photosphere is unchanged during the flare.

12:40-12:55 Tamar Chaghiashvili: Photospheric responses during high-energy flares

Author(s): Tamar Chaghiashvili, Teimuraz Zaqarashvili, David Kuridze, Mihalis Mathioudakis

Abstract

Solar magnetic field interaction with plasma controls the most dynamical processes and topo-logical changes in various coronal structures. Even small variations in dense photospheric plasma and/or magnetic field may lead to the most catastrophic eruptions, such as solar flares and CMEs. Moreover, plasma and magnetic field interaction has its important effect on the photosphere itself. The good example of it is the White light flare. White light flares are rare phenomena. They were believed to occur only with high energy flares. But recent high-resolution detectors revealed that they are characteristic for all flares. It is crucial to study WLFs to understand the physical and morphological changes of the solar photosphere. We studied the evolution of the well-developed sunspot of NOAA Active Region 11429. The active region hosted two X 5.4 and X 1.3 flares on March 7, 2012. They occurred in one hour interval with starting times 00:02 and 01:05 respectively. The first flare lasted 40 minutes and the second - 17 minutes.

We studied flare related white light emission, calculated the movement of WLFs, and suggested the model which may explain the movement of the WL emission. Time-Distance diagram of HMI continuum shows that an average speed of WLFs in continuum is 12-18 km/s. The flaring region was observed by STEREO A as well. The average upward velocity of the flaring loops detected by STEREO A is 14 km/s. This speed can be correlated to the footpoint propagation speed.The movement of the WLFs can be explained withing standard flaring model; the observed WL motion in the photosphere is the effect and the consequence of both the particle propagation along the magnetic field lines and the upward motion of the X-point.

13:00-15:00 Lunch break

Session V: Chromospheric structure and dynamics

15:00-15:30 Jaime De la Cruz Rodriguez: The chromosphere: structure and dynamics (Invited review)

Author(s): J. de la Cruz Rodriguez

Abstract

The chromosphere is transparent to most of the radiation that is emitted in the photosphere and only a few spectral lines have sufficient opacity to sample this layer of the Sun: Ca II H&K, Ca II 8542, Mg II h&k, Hα, He I 10830. In the chromosphere magnetic pressure equals or surpasses gas pressure, giving rise to a complex force balance that is responsible for the very fine structuring of the chromosphere and that gives rise to very intrincate motions and jets. Most chromospheric lines form under non-LTE conditions which makes it very challenging to derive the physical state of the chromospheric plasma from the observed intensities. In this talk I will review spectral lines and techniques that can be used to derive meaningful physical parameters from chromospheric observations, with special focus in active regions.

15:35-15:50 Mats Carlsson: Recent developments in modelling of the chromosphere

Author(s): Mats Carlsson

Abstract

The chromosphere is arguably the most difficult and least understood domain of solar physics. All at once it represents the transition from optically thick to thin radiation escape, from gas-pressure domination to magnetic-pressure domination, from neutral to ionised state, from MHD to plasma physics, and from near-equilibrium ("LTE") to non-equilibrium conditions. The heating requirements of the solar chromosphere are not easily determined since the radia-tive cooling is dominated by optically thick spectral lines that form far from equilibrium. Energy estimates are therefore very model dependent. 1D semi-empirical model atmospheres indicate that to maintain the quiet, average solar chromosphere, the required energy input is in the range 2-12 kW/m2 but these models neglect many important aspects like the dynamics of the chromosphere, non-equilibrium ionization effects and spatial structuring.In this talk, we will present 3D "realistic" radiation-MHD simulations spanning the solar at-mosphere from the convection zone to the corona, and synthetic observations calculated from the simulations. We will present a variety of simulations showing the strong dependency of the heating and dynamics of the chromosphere on the magnetic field configuration.

15:55-16:15 Nabil Freij: QSEBs with co-spatial IRIS Bursts (Invited talk)

Author(s): C. J. Nelson, N. Freij, A. Reid, R. Oliver, M. Mathioudakis, R. Erdelyi

Abstract

Ellerman bombs have been widely studied over the past two decades; however, only recently have counterparts of these events been observed in the quiet-Sun. We combine Hα and Ca II 8542 line scans at the solar limb with spectral and imaging data sampled by the Interface Re-gion Imaging Spectrograph. Twenty one QSEBs were identified and three of these QSEBs dis-played clear repetitive flaring through their lifetimes, comparable to the behaviour of EBs in Active Regions. Two QSEBs in this sample occurred co-spatial with increased emission in SDO/AIA 1600 and IRIS slit-jaw imager 1400 data, however, these intensity increases were smaller compared to EBs. One QSEB was also sampled by the IRIS slit during its lifetime, dis-playing increases in intensity in the Si IV 1393 and Si IV 1403 cores as well as the C II and Mg II line wings, analogous to IRIS bursts. Using RADYN simulations, we are unable to reproduce the observed QSEB Hα and Ca II 8542 line profiles leaving the question of the temperature stratification of QSEBs open. Our results imply that some QSEBs could be heated to Transition Region temperatures, suggesting that IB profiles should be observed throughout the quiet-Sun.

16:20-16:35 Sara Esteban Pozuelo: Polarization in penumbral microjets

Author(s): Sara Esteban Pozuelo, Jaime de la Cruz Rodriguez, Ainar Drews, Luc Rouppe van der Voort, Goran Scharmer

Abstract

Penumbral microjets (PMJs) are short-lived, fine-structured and elongated brightenings in the chromosphere above sunspots penumbrae. They were firstly reported by Katsukawa et al. (2007) in wide-band Ca II H imaging from the Hinode satellite and were interpreted as signatures of reconnection in the interlaced penumbral magnetic field configuration. This scenario is supported by early observational studies and simulations. Thanks to studies at different heights between the chromosphere and the corona using high-resolution intensity filtergrams, we know that PMJs have a precursor phase (Reardon et al. 2013), heat to transition region temperatures (Vissers et al. 2015), and even some of them can be due to alternative reconnection scenarios (Tiwari et al. 2015, Samanta et al. 2017). Recently, Drews & Rouppe van der Voort (2017) characterized their main observational properties from a morphological and spectral point of view. However, there are important elements still unknown: we do not know if PMJs leave any hint on all Stokes profiles (or just in Stokes I) and how their fine structure is. This work is focused on these aspects and our main goal is to study in-depth for the first time the polarization on PMJs at chromospheric heights. We are using simultaneous observations in the Fe I 630 nm pair, Ca II 854.2 nm and Ca II K 393 nm acquired with the CRISP and CHROMIS spectropolarimeters at the SST. Our first results reveal that PMJs have noticeable polarization signals that suggest the existence of two atmospheric components. Specifically, their circular polarization is remarkably, which can be used as a proxy to identify PMJs. We find that polarization signals along PMJs show different spatial distribution, depending on the behavior of the emission peaks of Ca II 854.2 nm. Each distribution reveals how the mixture of these components change and is affected by surrounding transients.

16:40-17:10 Coffee break and poster view

Session V: Chromospheric structure and dynamics

17:10-17:30 Marco Stangalini: Polarized Kink Waves in Magnetic Elements: Evidence for Chromospheric Helical Waves (Invited talk)

Author(s): Marco Stangalini

Abstract

In recent years, new high spatial resolution observations of the Sun's atmosphere have revealed the presence of a plethora of small-scale magnetic elements down to the resolution limit of current solar telescopes (100120 km on the solar photosphere). These small magnetic field concentrations, due to the granular buffeting, can support and guide several magnetohy-drodynamic wave modes that would eventually contribute to the energy budget of the upper layers of the atmosphere. In this contribution I will show new results from the analysis of the horizontal velocity of magnetic elements in the solar chromosphere. By exploiting the high spatial and temporal resolution chromospheric data acquired with the Swedish 1 m Solar Tele-scope, and applying the empirical mode decomposition technique to the tracking of the solar magnetic features, a phase relation between the two components of the horizontal velocity vector itself is found, resulting in its helical motion.

17:35-17:50 Kris Murawski: Numerical model of a partially-ionized solar atmosphere

Author(s): K. Murawski

Abstract

Solar processes for energy release and transport are essentially evaluated within a framework of single-fluid MHD. As the lower layers of the solar atmosphere contain large amount of neu-trals, these processes need to be re-assessed by taking into account more realistic 2-fluid models of plasma. Two-fluid effects appear to be important for the quantification of the supply of energy, momentum and mass into the overlying chromosphere and corona, and therefore they are strictly associated with two major issue of heliophysics, mainly chromospheric and coronal heating and solar wind generation. With the use of JOANNA code (Wójcik 2017) we perform numerical simulations of 2-fluid wave phenomena. Particularly, we show that spicules and Alfvén waves are efficiently damped by ion-neutral collisions and therefore they are able to transfer significant amount of their energies into heat, contributing to the chromospheric heating and solar wind generation.

17:55-18:10 Rahul Sharma: Dynamical response of 3D spicular waveguides to the magnetohydrodynamical wave-mode(s)

Author(s): Rahul Sharma, Gary Verth, Robertus Erdelyi

Abstract

Spicules play an important role in the transfer of mass and mechanical energy through the In-terface Region. This transport of energy is in the form of magnetohydrodynamical (MHD) waves and is manifested in the dynamical behavior of spicular waveguides. The transverse, torsional and field-aligned motions of spicules have previously been observed in

imaging-spectroscopy and analyzed separately for wave-mode identification. Here, we have combined the line-of-sight (LOS) and plane-of-sky (POS) kinematic components, using the high spa-tial/temporal resolution Hα imaging-spectroscopy data from the CRisp Imaging SpectroPola-rimeter (CRISP) based at the Swedish Solar Telescope (SST) to achieve a better understanding of these motions as a whole. Coupled evolution of LOS and POS velocity components, along with intensity variations indicate presence of both compressible and incompressible wave-modes in spicular structures. The talk will emphasise the combined LOS and POS dynamics in fine temporal and spatial scale evolution of resultant 3D components, but also on more precise interpretation of wave-mode(s) embedded in the observed waveguides.

18:15-18:30 Nana Shatashvili: Magneto-Fluid Coupling in Dynamic Finely Structured Solar Atmosphere – Theory and Simulation

Author(s): N.L. Shatashvili, S. M. Mahajan, R. Miklaszewski, S.V. Mikeladze, K.I. Nikol’skaya, K.I. Sigua and Z. Yoshida

Abstract

We suggest that the interaction of the fluid and the magnetic aspects of a plasma may be a crucial element in creating the enormous diversity in the solar atmosphere - the loop-structures comprising the solar corona can be created by plasma up-flows (source of both mass and energy) interacting with ambient magnetic fields — the primary heating of these struc-tures is caused by the viscous dissipation of the flow kinetic energy [1]. We show that for effi-cient loop formation, the primary up-flows of plasma in the chromosphere / transition region should be relatively cold and fast. During trapping and accumulation the locally supersonic up-flows thermalize (due to the dissipation of the short scale flow energy) leading to a bright and hot coronal structure. Calculations reveal that the sub-Alfvenic flows develop a substan-tial, spatially-varying short-scale component leading to “secondary heating”. The emerging scenario, then, is: the coronal loop does not “happen” by the filling of some hypothetical virtual loop with hot gas, its formation and heating are simultaneous and the ”loop” has no ontological priority to the flow - the dissipation of short–scale component of the velocity field may provide a primary (during very formation) and a secondary (supporting) heating for the coronal structure (closed, open). This picture pertains even for more violent events (flares, erupting prominences and CMEs).

Fast up-flows are generated when primary plasma flows (locally sub-Alfvénic) are accelerated while interacting with ambient arcade-like closed field structures. The relevant time scales, flow speeds (≥100 km/s), and amplification are dictated by the initial ion skin depth, and the local plasma β [2]. In the presence of dissipation, these up-flows play a fundamental role in the heating of the finely structured stellar atmospheres; their relevance to the solar wind is also obvious. The characteristics of a given structure of a finely structured solar atmosphere are de-termined by the initial and boundary conditions. ”New” up-flows could be trapped by other structures with strong/weak magnetic fields and participate in creating different dynamical scenarios leading to: formation/heating of a new structure [1]; explosive events/ prominences/CME eruption [3]; creation of a dynamic escape channel (providing im-portant clues toward the creation of the solar wind); and wave-generation could also be trig-gered.

2.5- dimensional two-fluid dynamical code (containing the Hall term, heat flux, and ion vis-cosity) was used to study the flow dynamics and the magneto-fluid coupling in Solar Atmos-phere. The numerical work is combined with simple analytical arguments to predict, and ex-plain the essential features of the up-flow acceleration, the hot loop-formation/heating processes, and energy redistribution phenomena associated with the interaction of a primary plasma flow with closed field-line magnetic structures.

September 27

Session VI: Magnetic coupling in the solar atmosphere

09:15-09:45 Bart De Pontieu: Interface Region Imaging Spectrograph views of how the solar atmosphere is energized (Invited review)

Author(s): Bart De Pontieu

Abstract

At the interface between the Sun's surface and million-degree outer atmosphere or corona lies the chromosphere. At 10,000K it is much cooler than the corona, but also many orders of magnitude denser. The chromosphere processes all magneto-convective energy that drives the heating of the million-degree outer atmosphere or corona, and requires a heating rate that is at least as large as that required for the corona. Yet many questions remain about what drives the chromospheric dynamics and energetics and how these are connected to the transition region and corona.
The Interface Region Imaging Spectrograph (IRIS) is a NASA small explorer satellite that was launched in 2013 to study how the Sun's magneto-convection powers the low solar atmosphere. I will review recent results from IRIS in which observations and models are compared to study the role of small-scale magnetic fields in the generation of violent jets and how these jets feed plasma into the transition region and hot corona, the heating of the chromosphere and its impact on the transition region, the onset of fast magnetic reconnection in the solar atmosphere.

09:50-09:10 Abhishek Srivastava: High-frequency Torsional Alfvén Waves as an Energy Source in the Solar Corona (Invited talk)

Author(s): A.K. Srivastava; J. Shetye; K. Murawski; J.G. Doyle; M. Stangalini; E. Scullion; T. Ray; D. P. Wójcik; B. N.Dwivedi

Abstract

Generation of radiation and supersonic wind from the Sun's corona requires a large input of energy ($\sim 10^2$-10^4 Wm^{-2}) to balance these losses. The role of magnetohydrodynamic (MHD) waves has been examined as one of the primary candidates to energize the solar atmosphere and transporting energy for the coronal heating and wind acceleration. Direct evidence of these waves and their dissipation are not yet fully established though. In this talk, we discuss the first direct observation of the high-frequency Torsional Alfvén waves in the fine structured magnetic flux tubes in the solar atmosphere. Using a stringent 3-D numerical model, we find that such high-frequency waves are capable of transferring $\sim 10^3$ Wm^{-2} energy into the overlying corona that is a sufficient Poynting flux not only to heat it but also to originate the supersonic solar wind. The future implications of these new findings are also discussed.

10:15-10:30 Roberto Soler: Propagation of Torsional Alfven Waves from the Photosphere to the Corona: Reflection, Transmission, and Heating in Expanding Flux Tubes

Author(s): R. Soler, J. Terradas, R. Oliver, J. L. Ballester

Abstract

It has been proposed that Alfven waves play an important role in the energy propagation through the solar atmospheric plasma and its heating. Here we theoretically investigate the propagation of torsional Alfven waves in magnetic flux tubes expanding from the photosphere up to the low corona and explore the reflection, transmission, and dissipation of wave energy. We use a realistic variation of the plasma properties and the magnetic field strength with height. Dissipation by ion-neutral collisions in the chromosphere is included using a multiflu-id partially ionized plasma model. Considering the stationary state, we assume that the waves are driven below the photosphere and propagate to the corona, while they are partially reflected and damped in the chromosphere and transition region. The results reveal the existence of three different propagation regimes depending on the wave frequency: low frequencies are reflected back to the photosphere, intermediate frequencies are transmitted to the corona, and high frequencies are completely damped in the chromosphere. The frequency of maximum transmissivity depends on the magnetic field expansion rate and the atmospheric model, but is typically in the range of 0.04-0.3 Hz. Magnetic field expansion favors the transmission of waves to the corona and lowers the reflectivity of the chromosphere and transition region compared to the case with a straight field. As a consequence, the chromospheric heating due to ion-neutral dissipation systematically decreases when the expansion rate of the magnetic flux tube increases.

10:35-10:50 Teimuraz Kvernadze: Detection of the Hanle and Zeeman Effects in Hα and He I D3 of the Solar Spicules using Polarization-holographic Imaging Stokes Polarimeter

Author(s): Kvernadze T., Kurkhuli G., Kakauridze G., Kilosanidze B., Kulijanishvili V., Khut-sishvili E.

Abstract

We report the results of Spectropolarimetric observations of Spicules in Hα and He I D3 ob-tained in the Abastumani Astrophysical Observatory using an innovative polarization-holographic Stokes imaging polarimeter. The observations were made on the 53 cm non-eclipsing coronagraph and its spectrograph with spectral dispersion of 0.96 Å/mm in the second order of grating.

The great attention were paid to the polarimetric calibration of the instrumental setup and further data reduction of observational material.

The observational Stokes profiles show clear evidence of magnetic field induced Hanle and Zeeman effects. We estimate the magnetic field strength to have about 40G in the observed solar spicules.

Our results show that the Polarization-holographic Imaging Stokes Polarimeter has excellent potential for the solar spectropolarimetric observations and its sensitivity and accuracy could be substantially increased in case of improvement of seeing of the coronagraph and the use of the fast readout rate CCDs.

10:55-11:25 Coffee break and poster view

Session VI: Magnetic coupling in the solar atmosphere

11:25-11:55 Javier Trujillo Bueno: Prospects to Explore the Outer Solar Atmosphere with the Polarization of Ultraviolet Lines (Invited review)

Author(s):

Abstract

12:00-12:15 Isabell Piantschitsch: Numerical Simulation of Large Scale Amplitude Coronal Waves interacting with Corona Holes

Author(s): Isabell Piantschitsch, Bojan Vrsnak, Arnold Hanslmeier, Birgit Lemmerer, Astrid Veronig, Tomislav Zic

Abstract
We developed a new numerical code that is capable of performing 2.5D simulations of magne-tohydrodynamic (MHD) wave propagation in the corona and its interaction with a low density region like a coronal hole (CH). We observe that the impact of the wave on the CH leads to effects like reflection and transmission of the incoming wave, stationary features at the CH boundary, reflections inside the CH or formation of a density depletion. The formation of sta-tionary bright fronts was one of the primary reasons for the development of pseudo-wave theories. Here we show that stationary features at the CH boundary can be the result of the interaction of an MHD wave with a CH. We compare cases of varying densities inside the CH and different initial density amplitudes of the incoming wave. Morever, we analyze morphol-ogy and kinematics of primary and secondary waves, i.e. we describe the temporal evolution of density, magnetic field, plasma flow velocity, phase speed and position of the wave amplitude.

12:20-12:35 Błażej Kuzma: 2-Fluid Numerical Simulations of Solar Spicules

Author(s): Błażej Kuźma, Krzysztof Murawski, Pradeep Kumar Kayshap, Dariusz Wójcik

Abstract
With the use of newly developed JOANNA code, we numerically solve 2-fluid (for ions + electrons and neutrals) equations in 2D Cartesian geometry. We follow the evolution of a spicule triggered by an initial pulse in vertical components of ion and neutral velocity launched from the upper chromosphere. Our numerical results reveal that this pulse steepens into a shock that propagates upward into the corona. The chromospheric cold and dense plasma lags behind this shock and rises into the corona with the mean speed of 20-25 km/s. The formed spicule exhibits the upflow/downfall of plasma during its total life-time of around 3-4 minutes, and it follows the typical characteristics of a classical spicule which is modeled by magnetohydrodynamics. The simulated spicule consists of a dense and cold core that is dominated by neutrals. The general dynamics of ion and neutral spicules are essentially similar to each other; some differences are seen in structures of both spicules, Rayleigh-Taylor instabilities seen in neutral plasma, and growing in time rarefaction of the ion spicule. We show that the spicule contributes to solar wind generation.

13:00-15:00 Lunch break

Excursion

September 28

Session VII: Solar corona

09:15-09:45 Therese Kucera: Solar Prominences - Structure and Origins (Invited review)

Author(s): T.A. Kucera

Abstract

Solar prominences (also known as filaments) are relatively high density, low temperature structures suspended in the much hotter, more rarefied corona. They form over extended, sheared magnetic neutral lines and are known to erupt as parts of coronal mass ejections (CMEs). Although a long-observed feature of the corona, they are still incompletely unders-tood. I will review observations and models regarding the structure and origins of prominenc-es. This will include discussions of the prominence magnetic field and its relation to the larger scale prominence channel and cavity, the nature of prominence barbs, and the origins of prominence plasma.

09:50-10:05 José Luis Ballester: The temporal behaviour of MHD waves in a partially ionized prominence-like plasma: Effect of heating and cooling

Author(s): Ballester J. L., Carbonell M. , Soler R., Terradas J.

Abstract

Small amplitude oscillations in prominences are known from long time ago, and from a theo-retical point of view, these oscillations have been interpreted in terms of standing or propagat-ing linear magnetohydrodynamic (MHD) waves. In general, these oscillations have been stu-died by producing small perturbations in a background equilibrium with stationary physical properties. Taking into account that prominences are highly dynamic plasma structures, the assumption of an stationary equilibrium is not realistic, and any imbalance between promi-nence heating and cooling processes produces a temporal variation of prominence temperature.

On the other hand, prominence plasma is partially ionized, thus, when prominence plasma is heated the degree of ionization increases. On the contrary, when the prominence plasma cools down, recombination takes place decreasing the ionization degree. As a consequence, the temporal variation of the temperature and ionization degree modifies plasma parameters such as the mean atomic weight, resistivities, viscosity, thermal conduction coefficients, etc. In our calculations, and during the heating process, the plasma goes from almost fully neutral to al-most fully ionized, while during the cooling process, the plasma goes from almost fully ionized to almost neutral, therefore, the full expression for the specific internal energy able to describe the behaviour of the plasma in those different situations must be considered.

In summary, our main aim here is to study how the temporal variation of temperature and plasma parameters modifies the temporal behaviour of MHD waves in a partially ionized prominence-like plasma. Furthermore, apart from considering a background whose tempera-ture changes with time, perturbed optically thin radiation and thermal conduction as damping mechanisms for MHD waves are also considered, and we have sought for numerical solutions to the linear MHD wave equations when all the above mentioned physical processes are taken into account. This approach is new since earlier studies of MHD waves in a partially ionized prominence plasma have always assumed an stationary background with constant temperature and ionization degree.

10:10-10:25 Aaron Hernandez-Perez: On the generation mechanisms of ribbons in a confined flare

Author(s): Aaron Hernandez-Perez, Julia K. Thalmann, Astrid M. Veronig, Yang Su, and Peter Gömöry

Abstract

We analyze a confined multiple-ribbon M2.1 are (SOL2015-01-29T11:42) that originated from a fan-spine coronal magnetic field configuration within active region NOAA 12268. The rib-bons form in two steps. First, two primary ribbons form at the main flare site, followed by the formation of secondary ribbons at remote locations. We observe a number of plasma flows at extreme-ultraviolet temperatures during the early phase of the flare (as early as 15 min before the onset) propagating towards the formation site of the secondary ribbons. The secondary ribbon formation is co-temporal with the arrival of the pre-flare generated plasma flows. The primary ribbons are co-spatial with RHESSI hard X-ray sources, whereas no enhanced X-ray emission is detected at the secondary ribbons sites. The (E)UV emission associated to the sec-ondary ribbons peaks approximately 1 min after the last RHESSI hard X-ray peak. A nonlinear force-free model of the coronal magnetic field reveals that the secondary flare ribbons are not directly connected to the primary ribbons, but to regions nearby. Detailed analysis suggests that the secondary brightenings are most likely produced due to dissipation of kinetic energy of the plasma flows (heating due to compression), and not due to non-thermal particles accele-rated by magnetic reconnection, as is the case for the primary ribbons.

10:30-10:45 Pavel Kotrc: On the Measurement of Spectral Continua Flux in Solar Flares

Author(s): P. Kotrc, P. HEINZEL and M . Zapior

Abstract

We developed a new method of measurement of optical continua flux in solar flares. We report on the recent progress in the project and the consequences to solar flares models

10:50-11:35 Coffee break and poster view

Session VII: Solar corona

11:35-11:55 Konstantinos Karampelas - Heating by transverse waves in 3D simulations of turbulent coronal loops (Invited talk)

Author(s): K. Karampelas, T. Van Doorsselaere, P. Antolin

Abstract

In the recent years, a number of numerical studies has been focusing on the significance of Kelvin-Helmholtz instability in the dynamics of oscillating coronal loops. This process, which enhances the transfer of energy into smaller scales, has also been connected with heating of coronal loops, by introducing dissipation mechanisms, like resistivity. The effects of wave heating appear at the turbulent layer, which is expected to be found near the outer regions of loops, leaving their denser inner parts without a sufficient heating mechanism. In the current work we study the effects of wave heating from transverse waves in a coronal loop. Using the

MPI-AMRVAC code, we perform ideal, three dimensional magnetohydrodynamic (MHD) si-mulations of both (a) footpoint driven and (b) impulsively excited standing kink waves in a straight density enhanced coronal flux tube. Models of both spatially uniform and spatially changing initial temperature profiles are considered. The temporal and spatial evolution of our systems are studied, in the presence of numerical resistivity. We identify Ohmic heating as the reason for the observed temperature increase, as indicated by the higher values of current densities and average temperatures near the footpoints for the cases of uni-form initial temperature. Transverse Wave Induced Kelvin-Helmholtz (TWIKH) rolls are gen-erated near the velocity antinodes of our models, leading to an expanded turbulent layer. At later simulation times, the initial density profile at the apex is completely deformed, leading to a lack of clear distinction between the various parts of the loop. Thus the loop becomes fully turbulent, spreading the effects of wave heating throughout the loop cross section.

12:00-12:15 Charalambos Kanella - Radiative Cooling of Joule Heating Events in MHD Simulations of the Solar Corona

Author(s): Charalambos Kanella and Boris V. Gudiksen

Abstract

Context Statistical studies shows that nanoflares (Glencross1975,Parker1983a) alone

are not enough to heat the solar corona. Nanoflares in cooperation with slow-burning current-sheets could be another mechanism able to heat the corona, since both are manifestations of different degree of magnetic field distortion. Both mechanisms unable to be observed with the current instrumentation, are however apparent in MHD simulations in Bifrost code.

Aim: Our goal is twofold: First, to observe the manifestation of each mechanism in SDO/AIA intensity maps, Emission Measure (EM) analysis, and time-lag maps in cross correlation analy-sis, even when assuming better resolution than that of the AIA instruments. Second, to set li-mitations on what can be deduced from the specific instruments and methods in observations.

Methods: We identify 3-D heating events in the simulated solar corona in several timesteps, and we synthesize the 6 EUV/AIA filters, calculate cross-correlation maps between pairs of filters, and compute Emission Measure (EM).

Results: We find that cooling at the sites of heating events responds immediately, proceeds quickly from hotter to cooler AIA filters, and it is significantly lower than in diffuse regions. Diffuse regions are regions that combine slow-burning current-sheets, and a group of small-scale unresolved heating events unable to be detected. The signal at each pixel in synthesized 2-D images consists of a group of multiple 3-D heating events (strands). In EM analysis, we also find multi-thermal structures, which when embedded within diffuse regions form small loops. We also identify traces of compressible waves initiated at the location of heating events that travel along strands; this observation strengthens our belief that waves distort the mag-netic field generating current sheets or enhancing already-existing ones. In the time-lag maps of AIA filters cross-correlation analysis, we place a 600 sec upper limit; time-lags in QS above that limit are biased by lateral flows.

12:20-12:35 Chris Nelson - The role of cancellation in driving small-scale transients and filling coronal loops

Author(s): C. J. Nelson, R. Erdelyi, M. Mathioudakis

Abstract

Photospheric magnetic cancellation has been shown to occur at the foot-points of a range of transient phenomena (Nelson et al., 2016; Reid et al., 2016), supporting the hypothesis that such events are the observational signatures of magnetic reconnection. Recent results (Chitta et al., 2017), however, have also highlighted the role that cancellation (and, therefore, potentially magnetic reconnection) could play in the filling and heating of coronal loops. In this talk, we will discuss the cancellation of the photospheric magnetic field co-spatial to a range of features in the solar atmosphere, both small-scale and large-scale. We will investigate whether cancellation co-spatial to small-scale transients (e.g. Ellerman bombs) is differentiable from cancellation apparently responsible for the filling and heating of coronal loops. This talk out-lines our initial attempts at understanding the fundamental process of photospheric magnetic cancellation and, specifically, how this cancellation impacts on the corona.

12:40-12:55 Leon Ofman: The role of waves and turbulence in the solar wind plasma

Author(s): Ofman, Leon

Abstract

The solar wind is the background state of the heliosphere consisting of fast and slow compo-nents originating in various parts of the solar corona. However, the processes that lead to the solar wind heating and acceleration are not fully understood, and their study is one of the main goals of the near-future Parker's Solar Probe and Solar Orbiter missions. The main challenge in understanding the solar wind is connecting the large scale fluid-like to small scale kinetic processes. The ion composition of the solar wind is an important property that provides signatures of the solar wind formation, sources in the corona, and acceleration. In particular, the alpha particle can carry significant fraction of the solar wind momentum and energy flux. I will review briefly the current understanding of the solar wind acceleration and heating physical mechanism (focusing on the fast wind), and will present the observational evidence for waves, turbulence, and kinetic dissipation. I will discuss the results of numerical models of the multi-ion solar wind plasma, using 2.5D and 3D hybrid models, demonstrating the effects of kinetic dissipation of turbulent wave spectra and instabilities, and will discuss the role of alphas on the instabilities, and on the solar wind heating. The models provide the anticipated waves spectra, dispersion relation, and velocity distribution functions (VDFs) of protons and ions, that can be used as signatures of the kinetic heating processes in the solar wind in future observations in the inner heliosphere.

13:00-15:00 Lunch break

Visit wine cellar

Conference dinner

September 29

Session VIII: Solar wind

10:00-10:30 Rui Pinto: The solar wind: challenges for theory, modelling and observations (Invited review)

Author(s): Rui F. Pinto

Abstract

The solar wind is an uninterrupted flow of highly ionised plasma that is accelerated in the low solar corona and expands into the interplanetary space. Fast and slow wind streams develop at different places in the solar atmosphere, following closely the large-scale distribution of the coronal magnetic field at all moments of the solar cycle. Beyond their terminal speed, slow and fast wind flows also tipically show different acceleration length-scales, density and temperature radial profiles, heavy ion composition, types of waves and turbulent spectra. The solar wind background flow is furthermore a key component of space weather, being the source of corotating density structures that perturb planetary atmospheres and affecting the evolution and propagation of more energetic perturbations (such as CME). An unprecedented ensemble of space missions will be launched in the next years, and will provide the community with many new insights on long-standing open questions. I will review recent research on the topic over the last years, the major challenges faced, and direction of future research in terms of solar wind observations, theory and modelling.

10:35-10:50 Roberto Bruno: Magnetic Field Background Spectrum, from Fluid to Kinetic Scales, as Observed in the Solar Wind

Author(s): Roberto Bruno, Daniele Telloni, Danilo Delure and Ermanno Pietropaolo

Abstract

Power spectra of interplanetary magnetic field fluctuations show an unpredicted behavior at kinetic scales. Irrespective of what happens at fluid scales, the power spectral density level of kinetic scales remains largely unchanged when analysing either fast or slow wind belonging to corotating streams. These conclusions apply to canonical/pristine solar wind neither repro-cessed by dynamical interactions, which develop during the expansion nor affected by transient solar phenomena.

Because of this and because of the roughly fixed location of the break point separating fluid from kinetic scales, at a given heliocentric distance, we can establish, for the slow wind, a sort of background spectrum extending from fluid to proton scales. The power spectral level of this spectrum remains frozen when we look at the slow wind region of different corotating streams even if they are largely separated in time, i.e. coming from different solar source regions.

This background spectrum would be common to both fast and slow wind but, any time the observer would cross the inner part of a fluxtube channeling the fast wind into the interplan e-tary space, a turbulent and large amplitude Alfvénic spectrum would be overimposed to it.

10:35-10:50 Roberto Bruno: Magnetic Field Background Spectrum, from Fluid to Kinetic Scales, as Observed in the Solar Wind

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This background spectrum would be common to both fast and slow wind but, any time the observer would cross the inner part of a fluxtube channeling the fast wind into the interplane-tary space, a turbulent and large amplitude Alfvénic spectrum would be overimposed to it.

10:55-11:10 Grigol Gogoberidze: Very high frequency temperature spectrum in the solar wind

Author(s): G. Gogoberidze, Y. Voitenko & G. Machabeli

Abstract

We present study of the spectral properties of plasma turbulence both at magnetohydrodynamic and kinetic scales and compare theoretical results with recent high frequency observations of the solar wind perturbations performed using measurements of the Bright Monitor of the Solar Wind on board the Spektr-R spacecraft. We show that observed features of the thermal velocity power spectrum significantly differs from the theoretical expectation and present explanation of this inconsistency. We show that if the method of derivation of the plasma parameters from the Faraday cup measurements assumes isotropy of the temperature, then the thermal speed perturbations are dominated by perturbations of the magnetic field. As a result, features of the spectrum of the thermal speed are similar to the incompressible Alfvenic component. Based on this finding we present novel conclusions about perturbation dynamics in the solar wind.

11:15-11:45 Coffee break and poster view

Session VIII: Solar wind

11:45-12:05 Zoltan Vörös: In situ observations of magnetic reconnection in plasma turbulence (Invited talk)

Author(s): Z. Vörös

Abstract

We present, for the first time, both fluid-scale and kinetic-scale in-situ signatures of an ongo-ing reconnection in turbulent plasma. The spacecraft are crossing the reconnection inflow and outflow regions and the ion diffusion region (IDR). Inside the reconnection outflows D-shape ion distributions are observed. Inside the IDR mixing of ion populations, crescent-like velocity distributions and ion accelerations are observed. One of the spacecraft skims the outer region of the electron diffusion region (EDR), where parallel electric fields, energy dissipa-tion/conversion, electron pressure tensor agyrotropy, electron temperature anisotropy and electron accelerations are observed. Some of the difficulties of the observations of magnetic reconnection in turbulent plasma are also outlined.

12:10-12:25 Tina Kahniashvili: Magnetohydrodynamic Turbulence and Its Application

Author(s): Tina Kahniashvili, Axel Brandenburg, Alexander Tevzadze

Abstract

We perform high resolution numerical simulations of compressible magnetohydrodynamic turbulence and study helical and non-helical free decay in cosmic plasma. We identify the classes of turbulence and corresponding general scaling laws. In the presence of magnetic he-licity, inverse transfer from small to large scales is well known in magnetohydrodynamic tur-bulence and has applications in astrophysics, cosmology, and fusion plasmas. We report a simi-lar inverse transfer even in the absence of magnetic helicity. We compute for the first time spectral energy transfer rates to show that this inverse transfer is about half as strong as with helicity, but in both cases the magnetic gain at large scales results from velocity at similar scales interacting with smaller-scale magnetic fields. This suggests that both inverse transfers are a consequence of universal mechanisms for magnetically dominated turbulence

12:30-12:45 Bidzina Shergelashvili: The model of solar wind polytropic flow patterns

Author(s): B.M. Shergelashvili, V.N. Melnik, G. Dididze, H. Fichtner, T.V. Zaqarashvili, M. Khodachenko, S.Poedts

Abstract

We have developed a model of the polytropic radial solar wind flow patterns. The main novelty of the model is that it admits non-isothermal flow pattern solutions. Corresponding, analytic solutions have been obtained which allow precise parametrisation of the flow sub and su-personic regimes and temperature and density radial profiles for different values of the poly-tropic index (including cases of partially ionised plasmas). In analogy with the standard Park-er's solar wind, the presence of the flows before and after the sonic point is mathematically treated as a conjunction of the two flow states of the solar atmosphere. The physical content of the flow around the critical point is analysed rigorously. The results of the studies enable drawing of the wide class of the possible solutions for the solar wind, their subsequent poten-tial to be used for the either for the numerical modelling of the solar wind and solar radio burst studies is explored.

13:00-15:00 Lunch break

Session: IX: Solar flares, CMEs and space weather

15:00-15:30 Francesca Zuccarello: Eruptive phenomena on the Sun (Invited review)

Author(s): Francesca Zuccarello

Abstract

The emergence and evolution of solar active regions is often accompanied by eruptive events that can release energy in the solar atmosphere and in some cases can be responsible for the ejection of magnetized plasma from the Sun. In this scenario, solar flares may involve several mechanisms, from the destabilization of filaments, to the reconfiguration of the magnetic field through the process of magnetic reconnection, and to the acceleration of particles that can heat the plasma at different atmospheric heights. On the other hand, solar flares and filament eruptions are sometimes correlated to coronal mass ejections that, traveling through the inter-planetary space, might reach the Earth magnetosphere and give rise to phenomena studied in the framework of Space Weather.
We will review some recent improvements in our understanding of these phenomena and de-scribe how new observations could help us in providing the answers to some questions that are still open.

15:35-15:50 Marianna Korsos: Novel flare forecasting in 3D solar active regions

Author(s): Marianna Korsos

Abstract

In this presentation, we address newly discovered pre-flare behavioural patterns in typical sunspot groups by focusing on their evolution as a function of height above the solar surface in a 3-dimensional solar AR. Here, we further probe and apply the concept of the pre-flare beha-vioural patterns using a magneto-hydrodynamic (MHD) simulation generating solar-like flares.
We introduce and discuss the relevant properties and the capability of pre-flare tracking of ARs to improve Space Weather forecasting by focusing on the evolution from the photosphere towards the chromosphere, Transition Region and low corona. The basis of a proxy measure of our approach is the so-called weighted horizontal gradient of magnetic field (W_GM) defined between spots of opposite polarities closer to the polarity inversion line(s) of an AR. The value and the temporal variation of W_GM is found to possess novel and potentially important di-agnostic information about (i) the intensity of expected flares and (ii) the accuracy of onset time prediction.
Next, we will demonstrate how, by tracking the temporal evolution of W_GM, distance be-tween opposite polarity spots and the associated net flux at various heights in the lower solar atmosphere evolves as function of height. We show that this latter temporal behaviour across the chromosphere-low corona has fundamentally new forecast capabilities. We found, that at a certain height the converging of opposite polarities begins much earlier than at the photos-phere or at other heights. Therefore, we present a tool to identify the optimum height in the solar atmosphere for flare forecasting that may considerably increase the capability of the time prediction.

15:55-16:10 Aabha Monga: Fast CME associated with giant prominence eruption

Author(s): Aabha Monga, Wahab Uddin, Ramesh Chandra

Abstract

We have carried out the analysis of dynamic prominence eruption observed on 2014 September 26 on the south-east limb of the Sun from ARIES, Nainital in H-alpha. It was very energetic giant prominence eruption and the twisted bundle of flux ropes erupts beyond the LASCO C3 field-of-view. It is associated with a fast Coronal Mass Ejection (CME) with the speed of 1469 kms-1. Most of the prominence material erupted but partially falls over the surface of Sun. The height obtained by the CME in LASCO is ~ 30 Rsun. and the average speed in H-alpha ~ 550 kms-1. The event was well observed in H-alpha from ARIES and space-based missions like SDO, STEREO, LASCO, Nobeyama etc. We discuss this prominence eruption in the light of existing theories and it fulfills the criteria of kink instability and tether-cutting model.

16:15-16:30 Irakli Mghebrishvili: Statistical relation of tornadoes to instability of hosting prominences

Author(s): Mghebrishvili, I., Zaqarashvili, T., Kukhianidze, V

Abstract

We analyzed observational data obtained by the SDO/AIA 171 and 304 Å from 2011 January 01 to 2011 December 31. We studied the dynamics of all prominence tornadoes detected above the solar disk for the whole year. We identified totally about 361 events, which consist in separate tornadoes, group of tornadoes and hedgerow tornadoes. We studied statistical relation of tornadoes to the instability of hosting prominences and consequently to CMEs. We concluded that tornadoes generally cause instabilities of prominences and thus could be used as precursors for CMEs and consequently for space weather predictions.

16:35-17:05 Coffee break and poster view

Session IX: Solar flares, CMEs and space weather

17:05-17:25 David Tsiklauri: Particle-In-Cell, fully kinetic scale modelling of solar radio bursts based on non-gyrotropic and plasma emission mechanisms (Invited talk)

Author(s): D. Tsiklauri

Abstract

Basic physics of the radio emission mechanisms of solar type III bursts will be reviewed. A case will be made for alternatives to plasma emission, such as non-gyrotropic electron beam [1-3]. Further self-consistent particle-in-cell simulations of fundamental and harmonic radio plasma emission mechanisms will be presented [4]. Also, particle-in-cell simulations of the relaxation of electron beams in inhomogeneous solar wind plasmas [5] will presented, alleviating the problem of the beams travelling large interplanetary distances without experiencing quasi-linear relaxation.

[1] D. Tsiklauri, Phys. Plasmas 18, 052903 (2011)

[2] H. Schmitz, D. Tsiklauri, Phys. Plasmas, 20, 062903 (2013)

[3] M. Skender, D. Tsiklauri, Phys. Plasmas 21, 042904 (2014)

[4] J.O. Thurgood, D. Tsiklauri, Astron. Astrophys. 584, A83 (2015)

[5] J.O. Thurgood, D. Tsiklauri, J. Plasma Phys. vol. 82, 905820604 (2016)

17:30-17:45 Jordi Tuneu: Microwave and sub-mm radiation from energetic ion secondary par-ticles

17:50-18:05 Jaša Calogovic: Drag-Based Ensemble Model (DBEM): probabilistic model for he-liospheric propagation of ICMEs

Posters

Bagashvili Salome: Statistical properties of coronal hole rotation rates and their link to the solar interior?

Author(s): S. R. Bagashvili, B.M. Shergelashvili, D. R. Japaridze, B.B. Chargeishvili, A. G. Ko-sovichev, V. Kukhianidze, G. Ramishvili, T.V. Zaqarashvili , S. Poedts, M. L. Khodachenko, P. De Causmaecker

Abstract

The present work discusses results of a statistical study of the characteristics of coronal hole (CH) rotation. We investigated CH rotation rates and studied their distribution over latitude and their area sizes. In addition, the CH rotation rates are compared with the solar photospheric and inner layer rotational profiles. We studied coronal holes observed within ±60º latitude and longitude from the solar disc centre during the time span from the 1 January 2013 to 20 April 2015, which includes the extended peak of solar cycle 24. We used data created by the Spatial Possibilistic Clustering Algorithm (SPoCA), which provides the exact location and characterisation of solar coronal holes using SDO/AIA 193 Å channel images. The average sidereal rotation rate for 540 examined CHs is 13.86 (±0.05) º/d. The latitudinal characteristics of CH rotation do not match any known photospheric rotation profile. The CH angular velocities exceed the photospheric angular velocities at latitudes higher than 35-40 degrees. According to our results, the CH rotation profile perfectly coincides with tachocline and the lower layers of convection zone at around 0.71 R; this indicates that CHs may be linked to the solar global magnetic field, which originates in the tachocline region.

Chargeishvili bidzina: The Differential Rotation of Various Solar Features

Author(s): Japaridze D. R., Chargeishvili B. B.

Abstract

The parameters of solar differential rotation of compact magnetic features and hydrogen filaments were calculated for solar activity cycles 20 and 21. Rotation rates of compact magnetic features are higher than rotation rates of hydrogen filaments at all heliographic latitudes. For higher latitudes, the difference between rotation rates of compact magnetic features and hydrogen filaments grows. Hydrogen filaments rotate more differentially than compact magnetic features.

Dididze Grigol: Comparative analysis of type III and fiber solar radio bursts before and during CME propagation

Author(s): G.Dididze, B.M. Shergelashvili,V.N. Melnik,V.V. Dorovskyy, A.I. Brazhenko, S. Poedts, T.V. Zaqarashvili, M.Khodachenko

Abstract

The general context of the present paper is to develop radio diagnostic tools for CMEs, which can work in combination with standard optical observations. Aims. The main goal is to analyze radio observational signatures of the dynamical processes in solar corona. In particular, to perform a dependence analysis of decameter radio emission data on local plasma parameters before and during CME propagation. In order to achieve this goal, we focus on the analysis of (in total 429) type III and (in total 129) fiber radio bursts. We study their main characteristic parameters such as their drift rate, the duration and instantaneous frequency bandwidth of these radio events using standard statistical methods. Furthermore, we infer local plasma parameters (e.g. density scale height, emission source radial sizes, emission spectrum width, etc.) using definitions of duration and instantaneous frequency bandwidth. The analysis reveals that the physical parameters of coronal plasma before (quiet period) considerably differ from those during the CMEs propagation (the periods of type IV radio bursts). Local density radial profiles and the characteristic spatial scales of radio emission sources vary more drastically during the CME propagation compared to quiet periods. The latter result may indicate the presence of coronal dimming, which is associated with CMEs and other eruptive events.The results of the work enable to distinguish different regimes of plasma state in the solar corona during the two considered periods. Our results create a solid perspective for the development of novel tools for coronal plasma studies using CME radio dynamic spectra.

Dumbadze Gulsun: Eigenspectra of active region long period oscillations

Author(s): G. Dumbadze, B.M. Shergelashvili, V. Kukhianidze, G. Ramishvili, T.V. Zaqarashvili, M. Khodachenko, E. Gurgenashvili, S. Poedts and P. De Causmaecker

Abstract

We studied the oscillatory dynamics of two ARs: NOAA 11327 and NOAA 11726 using two different methods of pattern recognition. After processing the data, we found that the axes and the inclination angle of the ARs oscillate in time. These oscillations are interpreted as the second harmonic of the standing long-period kink oscillations (with the node at the apex) of the magnetic flux tube connecting the two main sunspots of the ARs. In addition, we discovered that the lengths of the pattern axes in the ARs oscillate with similar characteristic periods and these oscillations might be ascribed to standing global flute modes. In both Ars we have estimated the distribution of the phase speed magnitude along the magnetic tubes (along the two main spots) by interpreting the obtained oscillation of the inclination angle as the standing second harmonic kink mode. After comparison of the obtained results for fast and slow kink modes, we conclude that both of these modes are good candidates to explain the observed oscillations of the AR inclination angles, as in the high plasma β regime the phase speeds of these modes are comparable and on the order of the Alfvén speed. Based on the properties of the observed oscillations, we detected the appropriate depth of the sunspot patterns, which coincides with estimations made by helioseismic methods. We also studied the oscillatory dynamics of some active regions. We found the spectra of the long-period oscillations of the ARs. There are not only the fundamental harmonics but also the set of higher harmonics in these ARs.

Gachechiladze Tamar: Long-term variation in the Sun's activity caused by magnetic Rossby waves in the tachocline

Author(s): Zaqarashvili, Teimuraz V.; Oliver, Ramon; Hanslmeier, Arnold; Carbonell, Marc; Ballester, Jose Luis; Gachechiladze, Tamar; Usoskin, Ilya G

Abstract
Long-term records of sunspot number and concentrations of cosmogenic radionuclides (10Be and 14C) on the Earth reveal the variation of the Sun's magnetic activity over hundreds and thousands of years. We identify several clear periods in sunspot, 10Be, and 14C data as 1000, 500, 350, 200, and 100 years. We found that the periods of the first five spherical harmonics

of the slow magnetic Rossby mode in the presence of a steady toroidal magnetic field of 1200-1300 G in the lower tachocline are in perfect agreement with the timescales of observed variations. The steady toroidal magnetic field can be generated in the lower tachocline either due to the steady dynamo magnetic field for low magnetic diffusivity or due to the action of the latitudinal differential rotation on the weak poloidal primordial magnetic field, which penetrates from the radiative interior. The slow magnetic Rossby waves lead to variations of the steady toroidal magnetic field in the lower tachocline, which modulate the dynamo magnetic field and consequently the solar cycle strength. This result constitutes a key point for long-term prediction of the cycle strength. According to our model, the next deep minimum in solar activity is expected during the first half of this century.

Japaridze Darejan: The Differential Rotation of Various Solar Features

Author(s): Japaridze D. R., Chargeishvili B. B.

Abstract

The parameters of solar differential rotation of compact magnetic features and hydrogen filaments were calculated for solar activity cycles 20 and 21. Rotation rates of compact magnetic features are higher than rotation rates of hydrogen filaments at all heliographic latitudes. For higher latitudes, the difference between rotation rates of compact magnetic features and hydrogen filaments grows. Hydrogen filaments rotate more differentially than compact magnetic features.

Khutsishvili Davit: Anti-phase oscillations of Ha line Doppler velocity and width in chromospheric limb spicules

D. Khutsishvili, T.V. Zaqarashvili, E. Khutsishvili, T. Kvernadze, V. Kulidzanishvili, V. Kakhiani, M. Sikharulidze

Abstract

Spectroscopic observations of limb spicules were carried out during September 25 and October 17-19, 2012 in Ha line using large 53-cm non-eclipsing coronagraph of Abastumani Astrophysical Observatory (Georgia). The spectrograph slit was located at the height of about 7500 km above the solar limb. Spectrograms in Ha line were obtained in a second order of the spectrograph, where reversed dispersion equal to 0.96 A/mm. Doppler velocities and FWHM of 35 spicules were measured with the average cadence of 4.5 s and standard error equal to +- 0.3 km/s and 0.03 A, respectively. Lifetimes of almost all measured spicules were 12-16 min, therefore they resemble type I spicules. We studied the temporal variations of Doppler shift and width of Ha line using the Lomb periodogram algorithm for unevenly distributed time series. We found the oscillations in both, velocity and width, with periods of 4-9 min (240-540 s) at confidence levels of 95% and clear anti-phase relations (stronger Doppler velocity - weaker Doppler width and vice versa) between Doppler velocity and FWHM in all 35 spicules. The observed anti-phase oscillation can be explained by helical motion of spicule axis formed after superposition of two linearly polarised magnetohydrodynamic kink waves in spicules.

Kuzanyan Kirill: Studies of Helicity Properties of Solar Vector Magnetic Field by Building Mosaic Maps

Author(s): K. Kuzanyan; K. Otsuji, T. Sakurai, and N. Yokoi

Abstract

The advantage of high resolution in solar optical instrumentation is unfortunately diminished by their limited fields of view. Large active regions in the solar photosphere or even groups and clusters of smaller activity formations surrounded by plages and bright points cannot be covered by typical field of view of not only such highly precise instruments like Hinode SOT and BBSO NST but many other lower resolution telescopes. For achievement of high quality vector magnetic field data with such instruments, one may need to build a series of overlapped mosaic maps of the solar photosphere. Here we propose a method of construction such mosaics for Hinode SOT/SP large field of view raster magnetic field observations, with account of the time of data scanning and pointing procedures, as well as intrinsic variability of the solar turbulence pattern and the structure of the photospheric magnetic field. We have obtained very precise mosaic maps of longitudinal magnetic field as well as less precise (with some degrading of resolution) for transversal fields and electric currents. We compare our data with snapshots from lower resolution SDO HMI instrument. Furthermore, we study the distribution of electric current helicity in such large cumulative field of view, having resolved its spatial spectra and find some evidence of cascade of turbulent energy and helicity over it, such as known as the bottle-neck effect. The further implications of these results are yet to be investigated further. The method of building large-scale mosaic magnetograms can be used in the future at the newest high resolution instrumentation such as NST, DKIST and EST.

Lomineishvili Sergo: Kink oscillations in Coronal loops and Prominence threads

Author(s): Sergo Lomineishvili, Teimuraz Zaqarashvili

Abstract

We study the magnetohydrodynamic oscillations of longitudinally inhomogeneous magnetic tubes to shed light on the problem of the frequency ratio for coronal loops and prominence threads.

After using specific density profiles (main request here is that density should have peak (maximum) at the center of the tube) and some boundary conditions, we get a transcendental dis-persion equations with Bessel functions. Then we solve these equations as analytically (in some approximations) as numerically and get following main result: The frequency ratio of second and first harmonics approximately is 3, conversely from homogeneous case where such ratio equal 2.

Then comes its explanations with dependence on parameters (with appropriate graphs). In general, we can say that stronger inhomogeneity (inhomogeneity parameter) means stronger 'trap' for waves and this is like holding by potential energy.

McIntosh Scott: The End of the Road: Signatures of Solar Cycle Death and Potential Impacts on Dynamo Modeling

Author(s): Scott W. McIntosh

Abstract

We use an array of synoptic observations to identify the "death" of activity bands that belong to the 22-year magnetic activity cycle of the Sun. The termination point is extremely abrupt - a matter of days - and signals to the remaining activity bands at mid-latitude that it is time to grow in activity and produce the next sunspot cycle. We demonstrate that the timescales in-volved and discuss the implications of those times on the amount of flux in the convection zone that would be required to deliver the message in such a short time. The numbers obtained appear to put the current paradigm of dynamo modeling under extreme duress. Interestingly, these signatures of death and birth also leave an imprint on the terrestrial atmosphere - we will provide a few examples that appear to be correlated.

Oghrapishvili Natela: Differential Character of the Rotation of the Solar Coronal Holes

Author(s): Oghrapishvili N., Bagashvili S., Maghradze D., Gachechiladze T., Japaridze D., Shergelashvili B., Mdzinarishvili T., Chargeishvili B

Abstract

Solar differential rotation is one of the key issues in solar physics. The study of its characteris-tics is of particular importance in determining the mechanism of solar activity cycle.Two basic methods are used to study the problem. One is spectroscopic and is based on the Doppler effect of determining the radius of the light source. This method allows evaluating angular velocities of the emitting plasma layer.

Our interest in ongoing work is to study the coronal holes without compromising limitation on the above-mentioned material. We refused to filter the data and developed a unified approach for the whole range of latitudes. We do not study the rotation rate of each coronal hole, but the array of observations of all coronal holes is considered as the characteristics of the given latitude..

For the study, we used the data from the coronal hole catalog (http://www.solspanet.eu) compiled within the framework of the project SOLSPLANET (”Solar and Space Weather Network of Excellence”). The catalog was compiled on the basis of SDO/AIA data that was observed on 193 Å wavelength. We obtained and analyzed 9933 records for 529 coronal holes from 2014 and 2309 records for 131 coronal holes from 2015.

According to the results of the work, the differential nature of rotation of the coronal holes can be regarded as the established fact. The raised rotation rates in polar regions can be caused by the mixed velocity of coronal holes of different generations in the regions and its study is subject to future research.The study has clearly demonstrated north-south asymmetry of latitudinal distribution of rota-tion rates.

Philishvili Elena: Dynamics of flaring loop system in ascending phase of the M2.1 class flare

Author(s): E. Philishvili, B. M. Shergelashvili, T. V. Zaqarashvili, V. Kukhianidze, G. Ramish-vili, M. Khodachenko, S. Poedts, and P. De Causmaecker

Abstract

The dynamics of the flaring loops in active region (AR) 11429 are studied. The observed dynamics consist of several evolution stages of the flaring loop system during the ascending phase of the registered M-class flare. The dynamical properties can also be classified by different types of magnetic reconnection, related plasma ejection and aperiodic flows, quasi-periodic oscillatory motions, and rapid temperature and density changes, among others.
We have studied the characteristic location, motion, and periodicity properties of the flaring loops by examining space-time diagrams and intensity variation analysis along the coronal magnetic loops using AIA intensity and HMI magnetogram images (from the Solar Dynamics Observatory).
We detected bright plasma blobs along the coronal loop during, the intensity variations of which clearly show quasi-periodic behavior. We also determined the periods of these oscillations. Two different interpretations are presented for the observed dynamics. Firstly, the oscillations are interpreted as the manifestation of non-fundamental harmonics of longitudinal standing acoustic oscillations driven by the thermodynamically nonequilibrium background (with time variable density and temperature). The second possible interpretation we provide is that the observed bright blobs could be a signature of a strongly twisted coronal loop that is kink unstable.
We also detected set of transient flows with the average velocity of 90 km/sec. According to our findings, we interpret these events as the results of thermally and hydrodynamically unst-able sources.

Tevzadze Alexander: Anisotropic firehose instability in shear flows with heat fluxes

Author(s): E. S. Uchava, A. G. Tevzadze, B. M. Shergelashvili, N. S. Dzhalilov, S. Poedts

Abstract

We study the effects of heat flows and velocity shear on the parallel firehose instability in the collisionless of weakly collisional plasma flow. For this purpose we use anisotropic 16-momentum MHD fluid closure model that takes into account the pressure and temperature anisotropy, as well as the effect of anisotropic heat fluxes. The linear stability analysis of the firehose modes is carried out in the incompressible limit, where the flow is parallel to the background magnetic field, while the velocity is sheared in the transverse to the flow direction.
We analyze the effects of the velocity inhomogeneity in the low shear rate limit. It seems that normally parallel firehose perturbations acquire transverse components proportional to the velocity shear parameter. On the other hand, velocity shear introduces asymmetry of the growing firehose modes: perturbations propagating streamwise and in the opposite directions exhibit growth rate asymmetry.
The effect of heat fluxes is most profound for modes with oblique wave-numbers k_{\perp}/k_{\parallel} < 1$. We have derived the effective heat flux parameter that shows the importance of the anisotropic heat effects. It seems that effects due to the heat fluxes grow with the parameter of the pressure asymmetry and plasma beta parameter. We discuss the im-plications of the presented study on the observational features of the solar wind and possible measurement of the wind shear based on the theoretical predictions.

Tlatova Kseniya: Properties Of Filaments In Solar Activity Cycles N 15-24

Author(s): Kseniia Tlatova, Valeriya Vasil'eva, Andrey Tlatov

Abstract

The series of solar filaments characteristics is represented. This series is obtained by processing of daily observations in the H-alpha line according to the Kodaikanal observatory in Kodai-kanal (India, 1912-2002). The series is complemented by database of filaments properties ac-cording to Kislovodsk for the period 1959-2016, Sacramento Peak (USA, 1962-2002) and Meu-don (France, 1982-2015). These data are unique because they trace the polarity inversion line which helps to identify the large-scale organization of the solar magnetic field. To select solar filaments boundaries, we have developed methods based on automatic allocation procedures of low-contrast objects on the solar disk, and methods of editing the selected structures in semi-automatic mode. More than 24 thousand photographic plates were processed in total for Ko-daikanal with more than 326 thousand filaments being allocated.
Comparative analysis of solar filaments characteristics in 15-24 cycles of activity was carried out. The connection of solar filaments indices and long-term parameters of space weather is considered.

Tsinamdzghvrishvili Tamar: Proper Motions of Coronal Bright Point

Tsinamdzghvrishvili T., Shergelashvili B. M., Chargeishvili B., Mghebrishvili I., Mdzinarishvili T., Japaridze D.,Kukhianidze V

Abstract

Bright points are most common magnetic formations in the Solar Corona. The purpose of our work is to study the movements of Coronal Bright Points. In this paper, we use SDO data. We take visually long period bright points and prepare relevant fits file series for processing. Our software algorithm automatically follows the selected bright point and captures the helio-graphic coordinates of its centroid in the fits file series. At the same time, the program outlines the pixel area of a coronal bright point and derives orientation and other characteristics of a fitted ellipse. For the statistical analysis of coordinates, we eliminate the solar rotational com-ponent from the longitudinal motion. The final result shows that in all processed data of bright points (100 bright points) longitudinal and latitudinal movements show sharply expressed oscillations. We estimated oscillation periods and the correlation between longitudinal and latitudinal oscillations. We also studied period of orientation changes of bright points. The research reveals long period oscillations and short period oscillations. We studied latitudinal dependence of bright point proper motion features.

Uchava Elene: Anisotropic firehose instability in shear flows with heat fluxes

Author(s): E. S. Uchava, A. G. Tevzadze, B. M. Shergelashvili, N. S. Dzhalilov, S. Poedts

Abstract

We study the effects of heat flows and velocity shear on the parallel firehose instability in the collisionless of weakly collisional plasma flow. For this purpose we use anisotropic 16-momentum MHD fluid closure model that takes into account the pressure and temperature anisotropy, as well as the effect of anisotropic heat fluxes. The linear stability analysis of the firehose modes is carried out in the incompressible limit, where the flow is parallel to the background magnetic field, while the velocity is sheared in the transverse to the flow direction.
We analyze the effects of the velocity inhomogeneity in the low shear rate limit. It seems that normally parallel firehose perturbations acquire transverse components proportional to the velocity shear parameter. On the other hand, velocity shear introduces asymmetry of the growing firehose modes: perturbations propagating streamwise and in the opposite directions exhibit growth rate asymmetry.
The effect of heat fluxes is most profound for modes with oblique wave-numbers k_{\perp}/k_{\parallel} < 1$. We have derived the effective heat flux parameter that shows the importance of the anisotropic heat effects. It seems that effects due to the heat fluxes grow with the parameter of the pressure asymmetry and plasma beta parameter. We discuss the im-plications of the presented study on the observational features of the solar wind and possible measurement of the wind shear based on the theoretical predictions.

Vashalomidze Zurab: Spectral Inversion of the Halpha and Ca II 8542 A lines by Modified Cloud Model

Author(s): Július Koza, Zurab Vashalomidze, Teimuraz Zaqarashvili, Ján Rybák, Arnold Hanslmeier

The poster presents results of analysis of the chromospheric jet observed simultaneously in the Hα and Ca II 8542 Å spectral lines by the SST/CRISP instrument. The new version of the modified cloud model is applied to interpret the data in terms of the source functions, the line center optical thicknesses, the Doppler widths, and the line-of-sight velocities in both lines. Spectral inversion is performed by the Levenberg–Marquardt least-squares minimization method. We show that the model works well in those parts of a line profile showing some asymmetry (line flanks) but fails in the line center and far wings with small or zero asymmetry. The Hα source function increases from the jet core towards its outer limits from 0.2 to the values ≥ 0.3. The Hα line center optical thickness decreases from the jet core towards its outer limits from ≈ 0.8 to 0.5. The jet is optically thicker in Ca II 8542 Å (0.84) than in Hα (0.74). The Doppler width has a single-peak distribution for Hα but double-peak distribution for Ca II 8542 Å. The peak at 0.2 Å suggests very cold jet plasma and/or very small non-thermal broadening. The line-of-sight velocit"Spectral Inversion of the Halpha and Ca II 8542 A lines by Modified Cloud Model"y in Hα is much larger (≈ −24 kms−1) than in Ca II 8542 Å (≈ −10 kms−1) contradicting to a simple picture of a cylindrical axially symmetric jet.