

WAVELET ANALYSIS OF SOLAR MACRO-SPICULE RECURRENCES

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We study the temporal behavior of the intensity of spicules and macro-spicules at the solar limb as observed by TRACE (Transition Region and Corona Explorer) 1600 Å channel and obtain some evidence of spicule oscillations using the wavelet analysis techniques. The time-frequency analysis provided by the wavelet analysis shows a temporal behavior of spicules with recurrences at periods of about 200-260 seconds with a typical lifetime of 10 minutes. Finally, we discuss two scenarios regarding source of spicule oscillations.

HIGH FREQUENCY OSCILLATIONS IN THE SOLAR CHROMOSPHERE AND THEIR CONNECTION WITH HEATING

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High frequency acoustic waves are suggested as a source of mechanical heating in the quiet chromosphere. The frequency interval 70mHz to 1.6mHz is investigated using observations obtained with ground based telescopes - the VTT Tenerife and the Dunn Solar Telescope at the National Solar Observatory. We analyze several spectral lines, Fe I 543.45nm, Fe I 543.29nm and G-band; and observe that the majority of oscillations are connected with the magnetic fields, therefore not yielding enough mechanical flux for the heating of the chromosphere. This correlation also observable in the quiet Sun areas.

PARTICLE ENERGIZATION IN SOLAR FLARES: RECONNECTION AND COLLAPSING TRAPS

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We try to review the recent views and results concerning the processes of flare energization in reconnecting current layers and collapsing magnetic traps. As we believe, the findings from Yohkoh and RHESSI strongly supported the theory of magnetic reconnection and collapsing trap acceleration in application to solar flares. We confront these models with new observational results and discuss the possibilities to observe the collapsing traps in flares.

SMALL OSCILLATIONS COMBINING NONLINEARLY TO TRIGGER FLARES

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In the Callebaut-Fourier analysis the whole family of higher order terms associated with a several first order perturbation waves is considered. This family becomes divergent for certain phases if the sum of the amplitudes of the first order terms exceeds a critical limit. This convergence limit has been calculated analytically in some cases and numerically in many cases. Thus a combination of small oscillations may yield local divergences, leading to an explosive situation and instability. In a singular stripe the speeds become very large, even singular, creating runaway electrons explaining the high energetic particles in flares. This results in a fine filamentation of the magnetic field for which much shorter dissipation times apply even in ordinary MHD. This triggering mechanism may explain the flash and the further decay of flares. Of course the most appropriate regions for this triggering are those where present day reconnection models apply. Moreover, a cascade reaction may occur: sound waves at the solar surface may combine to trigger a bright point, several bright points may combine to trigger a prominence or a solar flare or a coronal mass ejection (CME), each time involving a much larger energy output.

SOLAR DYNAMO : EXACT SOLUTION IN IDEAL MHD FOR GIVEN RADIAL, POLOIDAL OR TOROIDAL FLOWS

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In a previous paper (Callebaut and Khater, IAUS 233, 'Solar Activity and its Magnetic Origin', Eds. V. Bothmer and A. A. Hady, Cambridge UP, 2006, p.9) we gave the exact solution in spherical coordinates of the ideal MHD evolution equation provided the velocity is purely toroidal. The toroidal flow generates a toroidal field from the poloidal components of the magnetic field as a result of the differential rotation. The relevance for the solar dynamo is obvious. However, several dynamo theories attempt (as a second step) to regenerate a poloidal field from the new field (or from its remains after losing energy in sunspots, etc.). Hence we consider here purely poloidal and purely radial flows and obtain the exact solution. Again the main feature is that the growth is linear in time and proportional to a Jacobian constructed from the velocity and the flux function of the components of the magnetic field perpendicular to the flow. The result may be applied to the meridional motion (first its surface latitudinal part and next its radial part, then its inner latitudinal part and again a radial part) or to (the inward part of) convective cells.

EXACT SOLUTIONS FOR TWO-DIMENSIONAL FORCE-FREE MAGNETIC FIELDS WITH MASS FLOW

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Force-free magnetic fields with variable field-to-current ratio and with mass flow in a given direction are investigated in two dimensional Cartesian geometry. Several exact solutions are obtained in the case of constant Mach number. Many can be classified into soliton-like, anti-soliton-like, kink-like and anti-kink-like configurations. The bunching and torsion-like aspects are discussed. Some possible examples in the solar atmosphere are considered.

EXACT ANALYTICAL SOLUTIONS FOR NONLINEAR DYNAMICS OF DIPOLE VORTEXES WITH SOLAR APPLICATIONS

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A localized as well as long-time static dipole vortex is one of the fundamental structures of two dimensional flows in magnetized plasmas. Relaxation in two dimensions leads to reduction of the nonlinear evolution equations. We obtain several classes of exact solutions for those equations. Initially unstable nonlinear dipoles may reorganize to stable ones. Some of them are adequate to represent magnetic fields at the solar surface and above it. They yield several kinds of structures.

SPATIAL DAMPING OF LINEAR NON-ADIABATIC MAGNETOACOUSTIC WAVES IN A PROMINENCE MEDIUM

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We study the spatial damping of linear non-adiabatic magnetoacoustic waves in a homogeneous, isothermal and unbounded medium permeated by a uniform magnetic field, with physical properties akin to those of solar prominences. We consider an energy equation with optically thin radiative losses, thermal conduction and heating, and linearize the MHD equations to obtain a sixth order polynomial in the wavenumber k which represents the dispersion relation for slow, fast and thermal MHD waves. Since we are interested in the spatial damping, we have taken ω as real and have solved numerically the dispersion relation to obtain complex solutions for the wavenumber k corresponding to fast, slow and thermal waves. The thermal wave shows the strongest spatial damping while the fast wave shows the weakest spatial damping. At periods greater than 1 s the spatial damping of magnetoacoustic waves is dominated by radiation, while at shorter periods the spatial damping is dominated by thermal conduction. For very short periods the isothermal regime is attained and the damping length becomes almost constant. Radiative effects on linear magnetoacoustic slow waves can be a viable mechanism for the spatial damping of short period prominence oscillations while thermal conduction does not play any role. In particular, short-period oscillations (5–15 min) observed in quiescent limb prominences, which seem to be due to internal fundamental slow modes, have damping lengths in the range $10^4 - 5 \times 10^4$ km, in good agreement with our results.

CORONAL SEISMOLOGY BASED ON EIT WAVE OBSERVATIONS

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The determination of coronal magnetic field has attracted a lot of efforts from both direct measurements and model inversions. For the model inversion researches, coronal loop and filament oscillations provided a method to infer the localized magnetic parameters, which can be called localized coronal seismology. Moreton waves, which are thought to be the footprint of a fast-mode shock wave in the corona, can be used to diagnose coronal magnetic parameters in a spatial range of up to 10^5 km. Recently, a globally propagating wave phenomenon, i.e., EIT waves, is thought to be the ideal proxy for the global seismology. However, such a model inversion strongly depends on our understanding of EIT waves. At present, several mechanisms are under debate, including fast-mode wave model, successive opening model, and so on. Based on our successive opening model, we discuss how the EIT wave observations can be applied to diagnose both the coronal magnetic field strength and the magnetic connectivity.

RADIATION HYDRODYNAMICS COLLAPSE OF LOGATROPIC PROTOSTARS

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We study the collapse of nonsingular logatropic spheres and the subsequent accretion phase with radiative transfer and appropriate dust opacity, starting with initial configurations close to hydrostatic and thermal equilibrium. A sequence of models with varying masses between one and hundred solar masses is considered. In all cases, a fiducial truncation pressure that is representative of star-forming cloud cores in an isolated environment is assumed. The dust thermal spectrum from infrared to radio wavelengths is derived and compared with the observed fluxes of several hot cores. We also discuss the implications of the accretion phase on the formation of massive stars.

IDENTIFICATION OF LINEAR SLOW SAUSAGE WAVES IN MAGNETIC PORES

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The analysis of an 11-hour series of high resolution white light observations of a large pore in the sunspot group NOAA 7519, observed on 5 June 1993 at the Swedish Vacuum Solar Telescope, La Palma, Canary Islands, has been recently described by Dorotovič et al. (2002). Special attention was paid to the evolution of a filamentary region attached to the pore, to horizontal motions around the pore, and to small-scale morphological changes. One of the results was the determination of temporal area evolution of the studied pore where the area itself showed a linear trend of decrease with time at an average rate of $-0.23 \text{ Mm}^2 \text{ h}^{-1}$ during the entire observing period. There is strong evidence that coupling between the solar interior and magnetic atmosphere can occur at various scales and that the referred decrease of the area may be connected with a decrease of the magnetic field strength according to the magnetic field-to-size relation. Periods of global acoustic, e.g. p -mode, driven waves are usually in the range of 5–10 minutes. However, by assuming that magneto-acoustic gravity waves may be the drivers, the observed periodicities (frequencies) are expected to be much longer (smaller), falling well into the mMHz domain. In this work we determine typical periods in the area evolution of the pore using wavelet analysis. The resulted periods are in the range of 20–70 minutes. Our findings suggest that periodic elements of the temporal evolution of the area of this studied pore could be considered as an observational evidence of linear low-frequency slow sausage (acoustic) waves in magnetic pores. This would give us further evidence on the coupling of global solar oscillations to the overlaying magnetic atmosphere.

MHD WAVES AT A SPHERICAL INTERFACE MODELLING CORONAL GLOBAL EIT WAVES

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Energetically eruptive events such as flares and coronal mass ejections (CMEs) are known to generate global waves (e.g. EIT waves, X-ray waves, Moreton waves), propagating over large distances, sometimes comparable to the solar radius. In this contribution EIT waves are modelled as waves propagating at a spherical density interface in the presence of a radially expanding magnetic field. The generation and propagation of EIT waves is studied numerically by solving the dispersion relation for coronal parameters. Simple equilibria lead to several results which can be identified in observational data (e.g. dimming)

P-MODE LEAKAGE AND LYMAN- α INTENSITY

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We present an observational test of the hypothesis that leaking p modes heat the solar chromosphere. The wave energy carried by leaking p modes in magneto-acoustic portals is measured using MOTH and MDI data. We simulate the propagation of these modes into the chromosphere to determine the height where the wave energy is dissipated by shock waves. A statistical approach is then used to check if this heating process could account for the observed solar cycle variability of the intensity in the Lyman- α emission.

ION-NEUTRAL COLLISIONS IN PROMINENCE PLASMAS

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Since prominence material seems to be partially ionised is hardly recommended to evaluate the effect of the collisions between electrons, ions and neutrals.

Using a one-fluid MHD set of equations derived taking into account various effects in a partially ionised plasma (collisions between different species and Joule dissipation) we have studied the temporal damping of the magnetoacoustic waves in different configurations.

From the results of this work one can conclude that the presence of neutrals in the plasma only affects the fast wave in a relevant way. This wave attenuation arises mostly from collisions between ions and neutrals and is stronger when takes place in a medium with strong magnetic field, low density and low ionisation fraction.

Given the poor knowledge about the values of the density and ionisation fraction in prominences, it is hard to judge the importance of the physics of a partial ionisation in the damping of fast waves in solar prominences.

GAUSSIAN PULSE PROPAGATION IN CORONAL LOOPS

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We study the hydrodynamical evolution of a Gaussian pulse along a magnetic flux tube by means of numerical simulation with VAC (the versatile advection code). In this model, we consider the effects of solar gravity, thermal conduction, viscosity, and radiation losses. We find that viscosity is the major source for damping of the pulse, while thermal conduction plays only a minor role. The implications of the pulse propagation on the generation of small-amplitude standing waves are discussed.

ANALYTICAL STUDIES OF SOHO HALLOWEEN STORMS DATA

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Energetic and eruptive activities have occurred during the period 19 October - 10 November, 2003 (so-called Halloween storms). Again these storms appeared one year later, during the period 3- October - 13 November, 2004. It is considered a second peak during the decline phase of cycle 23. There were two eruptive solar proton flares which were released on 26 and 28 October 2003, where the last one was the most eruptive flare recorded since 1976 with importance X17/4B. The aim of this study is to follow the morphological and magnetic changes of the active region before, during and after the high energetic flares were produced. Also, applying the cumulative summation curves method for the different indices of the active region and geomagnetic indices by using data measurements by SOHO. The results are promising and can be used for proton flares and Geomagnetic Storms prediction, few days before their occurrence. The reasons of release of these Eruptive Storms (so called Halloween storms), has been also discussed, and during the decline phase of cycle23.

WAVE PROPAGATION IN MULTIPLE FLUX TUBES AND HEATING OF THE CHROMOSPHERIC NETWORK

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We use 2-D MHD calculations to examine wave propagation in multiple flux tubes in the magnetic network. This is a continuation of our earlier work on the response of a *single* flux tube due to transverse motions of its footpoints. We now extend the analysis to consider a more realistic model of the network consisting of three vertical flux tubes which have a filling factor of about 10% in the network. The tubes expand with height and merge with neighboring tubes at a height of around 600 km. We apply a transverse velocity perturbation with period of 24 s uniformly along the lower boundary located at the base of the photosphere. This generates (a) vertically propagating fast and slow MHD waves within the flux tube; and (b) acoustic waves generated at the flux tube edge near the lower boundary that propagate spherically outwards. Our simulations enable us to study the complex wave pattern due to waves generated in the individual tubes as well as their interaction with those emanating from adjacent tubes. Our results show that dominant heating of the chromosphere occurs due to slow magnetoacoustic waves in a region that is close to the flux tube axis. We examine observational implications of these results.

INFERRING THE CHROMOSPHERIC MAGNETIC FIELD USING WAVES

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The aim of this work is to examine the hypothesis that the wave propagation time in the solar atmosphere can be used to infer the magnetic topography in the chromosphere as suggested recently by Finsterle et al. (2004). We do this by using an extension of our earlier 2-D MHD work on the interaction of acoustic waves with a flux tube. It is well known that these waves undergo mode transformation due to the presence of a magnetic field that is particularly effective at the surface of equipartition between magnetic and thermal energy density, the $\beta = 1$ surface. This transformation depends sensitively on the angle between the wave vector and the local field direction. At the $\beta = 1$ interface, the wave that enters the flux tube, (essentially the fast mode) has a higher phase speed than the incident acoustic wave. A time correlation between wave motions in the non-magnetic and magnetic regions could therefore provide a powerful diagnostic for mapping the magnetic field in the chromospheric network.

NUMERICAL SIMULATIONS OF SHOCK WAVE-DRIVEN CHROMOSPHERIC JETS

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We present the results of numerical simulations of shock wave-driven jets in the solar atmosphere. The dependence of observable quantities such as maximum velocity and deceleration on parameters such as the period and amplitude of initial disturbances and the inclination of the magnetic field is investigated. Our simulations show excellent agreement with observations of dynamic fibrils, and shed new light on the correlation between velocity and deceleration and on the regional differences found in observations.

DETERMINATION OF FLUTE OSCILLATIONS DRIVEN BY FUNDAMENTAL KINK OSCILLATIONS OF A MAGNETIC CYLINDER

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The leakage and nonlinear coupling of fundamental (kink) oscillations in a 3-dimensional uniform straight magnetic cylinder, representing coronal loops, is investigated by numerical simulations. Nonlinear kink waves are driven into the system at one of the two footpoints in the long wavelength approximation. The motivation of this study is to determine whether nonlinear coupling through leakage to higher harmonic oscillations (flute modes) could be accounted for the rapid decay of oscillations of coronal flux tubes observed by various high-resolution space-born EUV instruments (e.g. TRACE or STEREO).

TWISTING FLUX TUBES AS A CAUSE OF MICRO-FLARE ACTIVITY

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High-cadence optical observations of an H- α blue-wing bright point near solar active region NOAA 10794 are presented. The data were obtained with the Dunn Solar Telescope at the National Solar Observatory/Sacramento Peak using a newly developed camera system, the RAPID DUAL IMAGER. Wavelet analysis is undertaken to search for intensity-related oscillatory signatures, and periodicities ranging from 15 to 370 s are found with significance levels exceeding 95%. During two separate microflaring events, oscillation sites surrounding the bright point are observed to twist. We relate the twisting of the oscillation sites to the twisting of physical flux tubes, thus giving rise to reconnection phenomena. We derive an average twist velocity of 7.7 km/s and detect a peak in the emitted flux between twist angles of 180° and 230°.

FLUX TUBE EMERGENCE THROUGH A TURBULENT ROTATING CONVECTIVE SPHERICAL SHELL

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We present recent 3D MHD numerical simulations of the non-linear dynamical evolution of magnetic flux tubes in a turbulent rotating convection zone in spherical geometry, using the anelastic spherical harmonic (ASH) code. Mean flows such as differential rotation and meridional circulation are taken into account when computing the evolution of the tube-like structure. We seek to understand the mechanism of emergence of strong toroidal fields through a turbulent layer from the base of the solar convection zone to the surface as active regions. We confirm the results obtained in cartesian geometry that two parameters influence the tubes during their rise through the convection zone : the initial field strength and amount of twist. We also find that the tube rise almost radially independently of the initial latitude (either low or high) and that towards the end meridional flows seem to influence the tube evolution. However we do not see a clear influence of the differential rotation on the flux tube evolution. Finally we see that the tube rise at different speed as a function of longitude depending on whether or not it is locally embedded in an up or downflows.

THE SUNSPOT AS A LOCAL MAGNETIC STRUCTURE: STABILITY AND OSCILLATIONS

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The simple energetic model of typical sunspot as a well localized, compact magnetic structure is presented. The basic part of magnetic energy of the system is concentrated in the cool, compressed part of magnetic flux tube at the depths from Wilsons depression depth (300-500 km) to 2-3 Mm. The variational method is applied to describe the equilibrium and stability of the system in terms of values, averaged over the cross-section of sunspot. The sunspot equilibrium is shown to be stable only when its magnetic field strength B lies between 0.8-1.0 and 4-5 kG. The radial-vertical oscillations of sunspot as a whole near the equilibrium have been analyzed. The eigen frequency was found for basic global mode , when the umbral oscillations take place only. In case of global (umbra + penumbra) oscillations, the lower modes, with , can be revealed. The theoretical curves for , and fit very well the observational ones. The measured periods of eigen long-term oscillations of sunspots vary from 40 to 200 min. Unique observational data were obtained last years at Pulkovo observatory using the Zeeman and Doppler effects.

**LONG-TERM OSCILLATIONS OF SUNSPOTS
DETECTED BY DOPPLER SHIFTS AND ZEEMAN
BROADENING ON DIGITAL SPECTROHELIOGRAMS**

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Presented is developed in Central (Pulkovo) Astronomical Observatory the method of direct registration of Dopler shifts, as well as Zeeman broadening of spectral lines, on optical digital spectrograms of active regions on the Sun was used to study the oscillation of sunspots and magnetic elements in their vicinity. Besides the well known 3-5 minutes oscillations, the long-term oscillations with a period about 80 min were found in sunspots and magnetic elements of surroundings: the last effect reveals only on rather long (more than 4 hours) consequent series of observations. These oscillations are interpreted in the frame of Shallow sunspot model as vertical-radial periodical displacements of the entire sunspot (or magnetic element). They are eigen oscillations of the system and are excited by perturbations of surrounding turbulent medium (i.e. photosphere and convective zone).

TWO MODES OF PROPAGATING WAVES IN SUNSPOT CHROMOSPHERE

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In this contribution we present the observations of sunspot chromosphere oscillations. We found that running penumbral waves and umbral running waves are different phenomena. Authors suggest the existence of two modes of propagating waves at the chromospheric level. Connection between these modes and magnetic field topology can be inferred from the analysis of mode propagation velocity and spatial localization.

OSCILLATORY CHARACTERISTICS OF POLAR FACULAE

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Polar faculae are solar formations located outside the main solar activity zone. One may assume that they are not connected directly with active regions, and the topology of their magnetic field differs from those for middle-latitude faculae. Till now there is no reliable information about parameters of oscillations and waves in photosphere and chromosphere of polar faculae. Simultaneous observations in several spectral lines allow us to investigate different atmosphere levels. Spatial distributions of line-of-site velocity fluctuation were compared with a brightness and magnetic field configuration. Connection of frequency modes with chromospheric network elements was researched. Besides, we tried to reveal propagating waves in regions under observation.

OBSERVATION OF PROPAGATING WAVE PROCESSES AT THE BASE OF CORONAL HOLES

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Coronal holes (CH) are involved into processes of energy exchange between lower solar atmosphere and corona. Waves can play an important role in these processes. We found propagating oscillations at the base of CH at the photosphere-chromosphere level. Phase speed is about 50-90 km/s at 3 mHz. It is shown, that low-frequency oscillations are localized near the boundaries of chromospheric network.

STEEP MAGNETIC STRUCTURES IN THE SOLAR ATMOSPHERE

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The sub-photospheric and the lower atmospheric layers of the Sun consist of weakly ionized gas composed largely of neutral hydrogen, protons and electrons with an admixture of heavy elements. Such a three-component plasma should be described within the framework of a non-ideal magneto-hydrodynamics which includes the effects of Hall and Ambipolar diffusion. An exact steady state solution is derived for the magnetic induction equation which incorporates the Hall and the Ambipolar terms along with the resistivity due to electron-ion and electron-neutral collisions. It is found that magnetic structures of steep gradient leading to current sheets and fast dissipation of magnetic energy at the reconnection sites are formed. Clearly, these effects are likely to play an important role in providing an efficient mechanism for heating the chromosphere.

TRANSVERSE OSCILLATIONS OF TWO CORONAL LOOPS

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Fast magnetohydrodynamic waves in a system of two coronal loops are studied. The system is modelled as smoothed, dense plasma cylinders in a uniform magnetic field. The collective properties of the complete system due to the interaction between the individual loops are analysed from two points of view. Firstly, the normal modes of the equilibrium configuration are numerically calculated and the dependence of frequency with the separation between tubes and spatial distribution of the eigenfunctions is investigated. Secondly, we analyse the time dependent problem of the excitation of a pair of tubes. We find that there are four trapped normal modes that produce transverse oscillations of the loops. There are two modes where the loops oscillate in phase, while in the other two they oscillate in antiphase. The excitation of these modes depends of the shape and location of the initial disturbance. We find that the loop pair oscillates in the normal modes after an initial disturbance. In some cases, the system shows beating and the phase lag between the loops is $\pi/2$.

DAMPING OF NON-ISOTHERMAL HOT CORONAL LOOPS OSCILLATIONS

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Recently, high resolution observations by the SOHO and TRACE spacecrafts have identified oscillating coronal loops and propagating waves along magnetic loops in the solar corona. These new discoveries established a new discipline that is known as coronal or magneto-seismology. The importance of this lays in the potential for the diagnostics of coronal structures and retrieving knowledge about the mechanism(s) of coronal heating. In our presentation we study the influence of gravitational stratification in non-isothermal coronal loops of semicircular shape, considering the effects of the sources of energy dissipation, namely thermal conduction, compressive viscosity, and radiative cooling and heating, on the dissipation of longitudinal standing waves. The nonlinear loop equations are solved numerically using a 1D, finite-difference code based on a temporally and spatially second order accurate, semi-implicit, Lagrangian solver. We analyse how the non-isothermal temperature profile affects and modifies the damping time of the loop oscillation.

EMISSION OF ALFVÉN WAVES BY TURBULENT CONVECTION. FIRST STAGE OF CORONAL HEATING THEORY

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Generation of Alfvén waves is considered in the framework of Langevin-Burgers approach applied to model the photospheric turbulent convection. Under this approach there is calculated the heating rate due to Alfvén waves dissipation. There is presented an explicit formula for the energy flux of the Alfvén waves along the magnetic field. The Alfvén waves are considered as intermediary between the turbulent energy and the heat. The derived results are related to a wave channel of heating of the solar corona. If we incorporate amplification of Alfvén waves by shear flow the suggested model of heating can be applied to analysis of the missing viscosity of accretion discs and to reveal why the quasars are the most powerful sources of light in the universe. It is supposed that the Langevin-Burgers approach to turbulence we have applied in the current work can be also helpful for other systems where we have intensive interaction between a stochastic turbulent system and waves and can be used in many multidisciplinary researches in hydrodynamics and MHD.

THERMALLY DAMPED LINEAR COMPRESSIONAL WAVES IN A 2D SOLAR CORONAL MODEL

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The high resolution observations (TRACE and SOHO) of waves in coronal structures have revealed a rapid damping of modes, sometimes their dumping length being of the same order as their wavelength. The rapid damping of modes in coronal loops permits us to derive values for magnetic field (intensity, structure) and transport coefficients (used in the study of heating mechanism). In this contribution we study the dumping of linear compressional waves considering a two-dimensional propagation in gravitationally stratified plasma in the presence of thermal conduction. By considering this 2D model, we show that the presence of an additional transversal motion has an important effect on the damping of the waves. For this theoretical model allows we conclude that the main effects influencing the damping of the waves are the degree of the transversal structuring and temperature.

COMBINED OBSERVATION AND SIMULATION OF P-MODE PROPAGATION INTO THE SOLAR CORONA

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Observations have shown the connection between oscillations within the sunspot photosphere and photospheric p-modes. In the strong, vertical, magnetic field regions of sunspot umbrae, it is thought that these acoustic p-modes undergo mode conversion to slow-magnetoacoustic waves, and that these slow-magnetoacoustic p-modes may be waveguided from the photosphere into the solar corona along the magnetic field. Observations are presented of the propagation of these waves and their channelling into the coronal parts of magnetic loops, originally emerging from a sunspot region. These observations are combined with 2-D MHD numerical simulations of wave leakage and direct propagation within the model sunspot atmosphere. The simulations are driven at the photospheric level by the Doppler velocity field of p-modes observed within the sunspot, and the response of forward modelling of the atmosphere is compared to observations. In the future, this combined approach of observation and theoretical modelling may be exploited to allow magneto-seismology of the solar atmosphere above sunspots or active regions.

PHOTOSPHERIC FLARE FOOTPRINTS

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We analyse the 6 mHz egression power signatures of some X-class acoustically active solar flares. During the impulsive phase these flares produced conspicuous seismic signatures which have kernel-like structures, mostly aligned with the neutral line of the host active region. The kernel-like structures show the effect of constructive interference of the acoustic waves emanating from the complex source, suggesting motion of the acoustic sources. The co-alignment between the seismic signatures and the hard X-ray emission observed by RHESSI from the footpoints of the coronal loops suggests a direct link between relativistic particles accelerated during the flare and the hydrodynamic response of the photosphere during flares.

GRADIENT DRIFT ION-CYCLOTRON INSTABILITIES IN THE SOLAR CORONA

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Recent observations revealed that the solar atmosphere is highly structured in density, temperature and magnetic field. The presence of these gradient in the plasma leads to the appearance of currents which in the weakly collisional corona constitute a free energy for driving microinstabilities. These instabilities are very important since they constitute an important source of ion-cyclotron waves which have been observed to play an important role in coronal heating but whose coronal origin remains unclear. Considering a density stratification transverse to the magnetic field, we aim to study the possible occurrence of these gradient-induced microinstabilities under typical coronal funnel conditions. Assuming the WKB approximation, we perform a Fourier plane waves analysis using the collisionless multi-fluid model. While neglecting the electron inertia this model allows to take into account ion-cyclotron wave effects that are absent from the one-fluid MHD model.

ON THE ORIGIN OF SOLAR WIND. ALFVEN WAVES INDUCED JUMP OF CORONAL TEMPERATURE

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Absorption of Alfvén waves is considered as the main mechanism of heating in the solar corona. It is concluded that the sharp increase of the plasma temperature by two orders of magnitude is related to a self-induced opacity with respect to Alfvén waves. This temperature jump is due to absorption of high frequency Alfvén waves in a narrow layer above the solar surface. There is calculated the dissipated in this layer power per unit area due to damping of Alfvén waves, which blows up the plasma and gives birth to the solar wind. A model short wave-length (WKB) evaluation takes into account the $1/f^2$ frequency dependance of the transversal magnetic field and velocity spectral densities. Such spectral densities agree with an old magnetometer's data taken by Voyager 1 and recent theoretical calculations in the framework of Langevin-Burgers MHD. The present theory predicts existence of intensive high frequency MHD Alfvén waves in the cold layer beneath the corona. It is shortly discussed how this statement can be checked experimentally. It is demonstrated that the magnitude of the Alfvén waves generating random noise and the solar wind velocity can be expressed only in terms of satellite experimental data. It is advocated that investigation of properties of solar surface as random driver by optical methods is an important task for future solar physics.

REPETITION OF SOLAR EXPLOSIVE EVENTS

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We explore the spatial structure and temporal evolution of explosive events using spectral observations of the Si_{IV} 1393 Å line obtained with the SUMER/SOHO. We found 21 sites where explosive events re-occur. Based on our observations, the maximum number of re-occurrence is eight during half an hour. Otherwise, some events display only two times of re-occurrence during the same time interval. The explosive events are in some cases separated by 3-5 minutes, suggesting a oscillation behavior as well as the chromospheric pattern.

USING THE NEAR INFRARED TO PROBE UMBRAL DYNAMICS

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We use the McMath Pierce Solar Telescope in conjunction with the NSO Aladdin Camera (NAC) with adaptive optics to search for a dependence of magneto-hydrodynamic (MHD) wave speeds on the average field strengths in four sunspot umbrae. We measure velocity signals with the Fe I 15648, Fe I 15652 and the molecular OH line at 15650.5. We identify the linear and non-linear characteristics of oscillatory signals and any associated propagation speeds. Since the dominant umbral oscillations are the slow MHD wave, acting similar to a pure acoustic wave, they should not show a dependence on umbral field strength. We test this hypothesis. We obtain high cadence observations to build up a time series of spectropolarimetric data for 4 sunspot umbrae. The near-infrared data is especially interesting because so few sunspot studies have been conducted at this wavelength and it is not adversely affected by scattered light.

ROSSBY WAVES IN "SHALLOW WATER" MAGNETOHYDRODYNAMICS

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The influence of a toroidal magnetic field on the dynamics of Rossby waves in a thin layer of ideal conductive fluid on a rotating sphere is studied in the "shallow water" magnetohydrodynamic approximation for the first time. Dispersion relations for magnetic Rossby waves are derived analytically in Cartesian and spherical coordinates. It is shown that the magnetic field causes the splitting of low order (long wavelength) Rossby waves into two different modes, here denoted fast and slow *magnetic Rossby waves*. The high frequency mode (the fast magnetic Rossby mode) corresponds to an ordinary hydrodynamic Rossby wave slightly modified by the magnetic field, while the low frequency mode (the slow magnetic Rossby mode) has new and interesting properties since its frequency is significantly smaller than that of the same harmonics of pure Rossby and Alfvén waves.

SPIKES TAXONOMY NEEDED. MULTI-SPECTRAL CHARACTERIZATION OF SOLAR SHORT DURATION RADIOBURSTS

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We pay attention to the characteristics of millisecond spikes in relation to the general activity in which they are included, processes with very different time scales. To analyze this aspect we selected the Bastille Day Flare radio emission observations provided by the Trieste Astronomical Observatory (OAT) radio polarimeters at 237, 327, 408, 610, 1420 and 2695 MHz, with 100 Hz temporal resolution. Some complementary data were obtained from open sources in Internet (Goes X-R, SOHO images, etc.) The waiting time distribution between individual maxima (flux ≥ 10 sfu) was calculated searching for self-organized criticality. Left and right polarization components were analyzed separately. The analyzed temporal interval presents two activity periods. The first related to HXR and gamma emission with both polarized components millisecond events, and the following activity period is dominated by the right polarized component events. This behavior is considered evidence of two different dominant generation mechanisms for millisecond events. Without solving this problem will be difficult to obtain a homogeneous data to compare with observations and accept or reject generation hypothesis. An analysis of the millisecond events profile could help to discriminate between different generation hypotheses

HIGH BETA PLASMA DISRUPTIONS IN SPACE AND LABORATORY PLASMAS

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Explosive magnetohydrodynamic (MHD) instabilities in laboratory plasmas, the solar corona and the Earth's magnetosphere play a major role in disrupting configurations associated with magnetic confinement and plasma energy storage. Central to our approach to this problem is the fact that the presence of resonances in Hamiltonian systems can have a destabilizing effect on the system as a whole. In Tokamaks, toroidally localized, high- n (toroidal) ballooning modes are driven to instability due to toroidally localized changes in the pressure gradient caused by low frequency, low- n modes. As an example of generic high beta disruptions we shall examine the nonlinear stability of the magnetic field topology and possible nonlinear plasma instabilities that might occur in the near Earth magnetotail (8-10 RE) during the substorm growth phase. These nonlinear instabilities lead to the initiation of the substorm intensification at the Earthward edge of the plasma sheet. Central to our model are ultralow frequency (1-4 mHz), normal modes (shear Alfvén waves). The work we present is based, in part, on a Lagrangian-Hamiltonian approach, with possible further refinements on measures of nonlinear instability in MHD systems.

PROPERTIES OF OSCILLATING CORONAL LOOPS AS VIEWED BY HINODE X-RAY TELESCOPE

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We use high-cadence observations collected by the X-Ray Telescope on Hinode at the end of 2006 and beginning of 2007 to study some physical properties of coronal loop oscillations. We will show the results for transverse velocity of the flowing gas, as well as lifetime and frequency of the oscillations. We will compare the results of these observations with simple field configuration models and estimates of the goodness of the model choice will be made.

ON THE HIGH FREQUENCY ALFVÉN WAVE IN POLAR CORONAL HOLES

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We study the propagation and dissipation of high-frequency Alfvén wave with period 0.001 s in the solar wind source region. We find decrement of damping length scale and energy flux density in the x-z space of the solar wind source region, which shows an efficient dissipation. This dissipation of Alfvén wave energises the solar wind particles and causes an enhanced outflow speed near the boundaries of the source region. We underline the importance of the dissipation of Alfvén wave with a period 0.001 s as one of the primary energy sources, for both inside and boundaries of the solar wind source region. The theoretical results are supported with observationally derived non-thermal velocities from the O v 629 transition region line.

THE PIXELISED WAVELET FILTERING METHOD: THE STUDY OF THE MULTI-MODE SPATIAL STRUCTURE OF SUNSPOT AND CORONAL OSCILLATIONS

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A novel method, the pixelised wavelet filtering (PWF), for the determination of the spatial, temporal and phase structure of wave and oscillatory phenomena in imaging data, based upon the continuous wavelet transform, is developed. The PWF method allows us to obtain information about the presence of propagating and non-propagating (in the plane perpendicular to the LOS) waves in the data, and localise them precisely in time as well in space. The method is tested on the datasets obtained in microwave with the Nobeyama Radioheliograph and in EUV with TRACE. The method confirms previously reported fine spatial structuring of the sources of 3, 5 and 15 min periodicities in the microwave and EUV emission generated in sunspot atmosphere. In addition, the PWF method provides us with the unique information about the time and phase variability of the narrowband maps of the observed oscillations and waves. The applicability of the method to the analysis of coronal wave phenomena is discussed.

GLOBAL ACOUSTIC RESONANCE IN A STRATIFIED ATMOSPHERE

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The upward propagation of linear acoustic waves in an unbounded stratified atmosphere is studied. The wave motion is governed by the Klein-Gordon equation which contains a cut-off frequency introduced by stratification. The acoustic cut-off may act as a potential barrier when the temperature decreases with height. It is shown that waves trapped below the barrier could be subject to a resonance which extends into the upper part of the open atmosphere with constant lower temperature. The resonance occurs when the distance over which the temperature decreases exceeds the pressure scale height in the upper atmosphere. The parameter space characterizing the resonance is explored.

ENHANCED PHASE MIXING OF ALFVEN WAVES IN STRATIFIED AND DIVERGENT CORONAL STRUCTURES

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We explore the solar coronal heating enigma by an analytical and numerical study of the enhanced phase mixing of harmonic Alfvén waves propagating in gravitationally stratified coronal structures of varying magnetic field divergence. We derived corrected analytical solutions describing the enhanced phase mixing of Alfvén waves in weakly divergent stratified coronal structures. These new analytical solutions show that the enhanced phase mixing mechanism can dissipate Alfvén waves at heights less than half that predicted by the previous analytical solutions of Ruderman, Nakariakov and Roberts (1998). Improved analytical solutions that accurately describe the enhanced phase mixing of Alfvén waves in strongly divergent stratified coronal structures are also presented. In divergent and stratified coronal structures, enhanced phase mixing occurs only when the ratio of the magnetic and density scale heights, $H_b/H_\rho < 2$. The enhanced phase mixing of 0.1 Hz harmonic Alfvén waves propagating in strongly divergent, $H_b = 5$ Mm, stratified coronal structures, $H_\rho = 50$ Mm, can generate viscous heating rates of $10^{-4} \text{ J m}^{-3} \text{ s}^{-1}$ or 100 % of an active regions heating requirement, compared to ≈ 10 % in an uniform magnetic field. They are also fully dissipated within 20 Mm or six times lower than would occur as a result of standard phase mixing in uniform magnetic fields and is less than half the density scale height. This study shows that the importance of enhanced phase mixing as a mechanism for dissipating Alfvén waves in the solar corona, a stratified and divergent medium, has been seriously underestimated.

ELECTRON HEATING AND SURFING ACCELERATION BY ELECTROSTATIC WAVES IN CURRENT SHEET

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The electrostatic waves moving with phase velocity v_p may be excited through the magnetic reconnection in the solar flares. In the presence of an uniform transverse magnetic field B_z , the electrons trapped in the potential wall of electrostatic waves are accelerated in the outflow x direction of the current sheet plane (x, z) by surfing acceleration mechanism. It is found from test particle simulation that this acceleration process will discontinue, when the electrons de-trap from wave potential. However, the electrons heating by electrostatic waves in the current sheet are still generated, even if these electrons de-trap from wave potential.

SUNSPOT CHROMOSPHERIC HEATING BY KINETIC ALFVÉN WAVES

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Sunspot atmospheric models show that sunspots have a higher temperature than the surrounding quiet Sun in the upper chromosphere although they are dark in the photosphere. This letter presents a comparison between acoustic wave heating and kinetic Alfvén wave (KAW) heating in sunspots from the photosphere through the chromosphere based on a semi-empirical model calculated by non-LTE procedure. The result suggests that the acoustic wave heating still is a possible dominating mechanism in the photosphere and in the lower chromosphere below 850 km similar to previous works. But in the upper chromosphere above 850 km the KAW heating is a more promising candidate that dominates the sunspot chromospheric heating. We speculate that this probably relates to the ionization exceeding one in a thousand in the upper chromosphere, so that the plasma processes such as the kinetic Alfvén wave dissipation play an important role in the atmospheric dynamics.