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Hemispheric Sunspot Numbers R_n and R_s from 1945–2004: Extended and improved catalogue

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Abstract

We present the extended and improved catalogue of hemispheric Sunspot Numbers R_n and R_s covering the time span 1945–2004. The data set is based on sunspot drawings from the Kanzelhöhe Solar Observatory (KSO) and the Skalnaté Pleso Observatory (SPO). The merged data set covers KSO data from 1952 until 2004 (sunspots could not be reconstructed from drawings for the time 1947–1951) and SPO data from 1945 to 2004. Results from a cross-validation with the international hemispheric sunspot numbers (Sunspot Index Data Center - SIDC) available for the time span 1992-2004 confirm the high quality of the merged data set compared to KSO data only (cf. Temmer et al., 2002). First investigations concerning the N-S asymmetry excess are presented applying the paired Students t-test for daily hemispheric Sunspot Numbers including solar cycles 18 to 20.

X-ray loop-top altitude decrease in an X-class flare

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Abstract

We studied RHESSI X-ray source motions in the 2003 November 3, X3.9 flare together with complementary data from SXI, EIT, and Kanzelhöhe Hα. Particular emphasis was laid on the apparent altitude decrease of the RHESSI X-ray loop-top (LT) source early in the flare before changing to the commonly observed upward growth of the flare loop system. Our main observational results agree with recent findings from Sui and Holman (2003) and Sui et al. (2004) in that at higher photon energies the LT source is located at higher altitudes and shows higher downward velocities than at lower energies. RHESSI spectra indicate that during the time of LT altitude decrease the emission of the LT source is thermal bremsstrahlung from a "superhot" plasma with temperatures up to 45 MK. Simulation results from a magnetic collapsing trap model (see the contribution by Karlický et al.) can reproduce the key observational findings in case that the emission in the LT is thermal bremsstrahlung.

Manifestations of a large-amplitude coronal wave caused by a CME/flare event

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Abstract

We present observations of a large-amplitude coronal wave caused by the CME/flare event that took place on 3 November 2003 around 10 UT. The disturbance is recorded in Hα (Moreton wave), EUV Fe XII 195 Å line (EIT-wave), soft X-rays (SXI-wave), and for the first time also in the Nancay radioheliograms, showing up as a weak broad-band metric-wavelength radio emission. The NRH-wave emission pattern was spanning between the Moreton/EIT/SXI wave and the metric type II burst source that was excited higher up in the corona. We present the kinematics of the disturbance and the morphology of its radio signature. The discovery of a broad-band radio emission excited by the wave offers a diagnostic tool providing an insight into physical conditions in the disturbance itself.

Electrodynamic processes in the solar magnetic loops and their relation to the low-frequency modulations of solar microwave emissions

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Abstract

Spectral and temporal evolutions of the low-frequency (LF) pulsations modulating solar microwave radiation (37 GHz) recorded at the Metsahovi Radio Observatory were studied by the data analysis algorithm based on a "sliding window" Fourier procedure and Wigner-Ville method.

Microwave radiation of solar flares is interpreted as an electron gyrosynchrotron radiation. In the case of a power-law distribution of electrons in energy the intensity of gyrosynchrotron radiation from the loop is proportional to a moderately high (1,56) power of the background magnetic field. Therefore, any slow variations of the magnetic field associated with disturbances of the electric current in a radiating source, will modulate the intensity of the microwave radiation.

Quite often the dynamic spectra of the LF pulsations contain several spectral tracks demonstrating a similar or slightly different temporal behaviour. The multi-track features of the LF spectra is considered as an indication that the radiation is produced within a system consisting of several closely located magnetic loops and involved in a common global dynamical process. Application of the equivalent electric circuit models of the loops with inclusion of the effects of their inductive interaction allows to explain and reproduce the main dynamical features of the observed LF modulation dynamic spectra.

Velocity field in the magnetic structures and in their surroundings

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Abstract

We demonstrate an effect in that the photospheric velocity fields are shifted in regions occupied by the magnetic field, if compared with velocity fields of non-magnetic regions surrounding them. We observe such an effect in data obtained by the Ondrejov photoelectric magnetograph. By the evaluating of velocity fields measured by the MDI instrument of the SoHO satellite observatory we have found that Doppler velocity fields are appreciably influenced by the solar magnetic and intensity field. The data were for our purpose inapplicable. The velocity fields of regions occupied by the magnetic field show a red-shift of the Doppler velocities, if compared with the velocity fields of regions without the magnetic field. The zero level of these Doppler velocities occurs mostly in between averaged velocity fields of both regions. Due to this zero level we then mostly observe a red-shift in regions with the magnetic fields, and on the contrary, a blue-shift in regions without the magnetic field, surrounding the previous regions.

Multi-wavelength observations of two limb flares-clues for CME models

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Abstract

Combining observations from GOES, TRACE, RHESSI, SOHO/EIT, MDI, CDS and LASCO, I will show two flares which occurred close to the western solar limb on 16 April 2002 and on 10 November 2004. Both flares started with the lift-off of a filament followed by flare loop arcade formation. The lower and higher coronal height-time plots of the CME indicated exponential rise, which suggest an acceleration due to instability. I will discuss the observed CME signatures in the context of various CME models.

On line profile asymmetries in solar flares

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Abstract

Spectral lines in solar flares may indicate profile asymmetries. This phenomenon can contain information about velocity fields as present in different optical depths and geometric heights of solar atmosphere affected by thermal heating or different non-thermal flare processes. Spectral lines of various chemical elements originate in different heights of solar atmosphere so they can keep information about the special distribution and time evolution of velocity field in the flaring atmosphere. To detect vertical velocity field from observed H? profiles we analyse spectral line profile asymmetries. In addition to a classical bisector method we use a method of comparison of the observed and non-LTE calculated profiles. Possibilities and results of these two methods are compared ad discussed.

Spectra and models of prominence mass motion

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Abstract

Optical spectroscopy of the eruptive prominences often reflects very intricate motions of the structures projected to the spectrograph slit. Spectra analysis provides direct information about the structure kinematics and considering the force fields (magnetic, gravitational) it also reveals the dynamical aspects of the structures. Simpler phenomena can be simulated and compared with archive spectra which often show various peculiarities. This paper shows four elementary structure models - cylinder, cone, ellipsoid and spiral. These models can be

rotated arbitrarily to the observer and their geometric and motional parameters can be changed. Typical features are compared with spectra.

Solar radio bursts of very short durations

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Abstract

Characteristics of super-short time structures (SSSs) occurring in the metric solar type IV radio bursts are described. We focus on the frequency range 200-450 MHz, providing a one-to-one identification of individual SSSs in the single frequency records of the Trieste Astronomical Observatory and spectral records of Artemis-IV (Greece) and AIP (Germany). The most important, surprising characteristic of SSSs is their duration at half power, which ranges from 4 to 50 ms and is much shorter than generally expected in the metric range. The analysis of the spectral and single-frequency data reveals a number of very different morphological categories: 1a) broad-band SSS pulses, 1b) broad-band drifting SSSs, 2a) narrow-band spike-like SSSs, 2b) narrow-band drifting SSSs, 3) structured SSSs, consisting of a narrow-band emission feature and a broad-band absorption part. Class 2 is divided into SSSs appearing in diffuse or compact clouds and those constituting ordered spectral features, e.g., zebra patterns. As a special example we present SSSs (duration 4-10 ms) that form zebra pattern. Here we include the analysis of the evolution of radio source positions from the Nancay Radioheliograph, compared with MDI (Michelson Doppler Imager) magnetograms and potential field extrapolations.

Some statistical properties of coronal bright points

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Abstract

Full-disc solar images obtained with the Extreme Ultraviolet Imaging Telescope (EIT) on board the Solar and Heliospheric Observatory (SOHO) are used to analyse solar differential rotation and related phenomena by tracing coronal bright points. Two different procedures of data reduction were developed: an interactive and an automatic method (Brajša et al., 2001, A&A 374, 309). A small north-south rotational asymmetry and subtle differences between several tracer subtypes (point-like structures, small loops, and small active regions) were determined using the data obtained in 1998 and 1999 (Brajša et al., 2002, A&A 392, 329). The same data set was reduced to analyse the properties of the solar velocity field indicated by motions of coronal bright points (Vršnak et al., 2003, A&A 404, 1117) and for the simultaneous determination of the true solar synodic rotation velocity and the height of tracers (Brajša et al., 2004, A&A 414, 707). We now extend the analysis to study some statistical properties of coronal bright points, such as spatial distribution and north-south asymmetry, lifetime and velocity distributions. In particular, a possible correlation between the average velocity of proper motion and lifetime of coronal bright points will be analysed.

On the 3D kinetic approach to solar streamer modeling

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Abstract

Coronal streamers which form the streamer belt around the Sun are basic 3D structures of the solar corona. They exhibit the solar corona radial expansion over magneto active regions. Among the constructing elements of the streamers are current sheets, magnetic islands and magnetic ropes which represent

their diverse 3D morphology. On one hand, streamers are formed as 3D diamagnetic structures during electromagnetic instability in the current carrying plasma with double flows. But on the other hand, they appear as dissipative 3D structures formed during the inductive interaction between the expanding radial flow of the solar wind plasma and the magnetic field of an active region. We study the second approach in terms of Vlasov plasma kinetic theory considering the solar corona as a hot, slowly expanding maxwellian collisionless plasma. The magnetic active region is represented as a superposition of the dipole and toroid components. The nature of the effective conductivity and the resulting dissipation is related to the effect of a small population of "resonant" particles in the velocity phase space influenced by the inductive magnetic field. Resulting 3D structure is elongated in radial direction and can be separated on two components in terms of cylindrical harmonics. The first component appears in the form of a "two-line-current system" with the opposite currents in the radial direction. These currents are additionally modulated and form ray elements in the streamer. The second component forms a "theta current configuration" which is a combination of two solenoids with opposite currents, separated by a neutral sheet. Additional modulation here causes a fine structure current sheet elements in the streamer. The scale of fine structure elements is defined via the new spatial plasma dispersion parameter.

Numerical simulations and observations of the solar photosphere: comparison of results

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Abstract

Our Contribution describes a simple approach which can be used for comparison of the spectroscopic results derived for the solar photosphere in two complementary ways: via synthesis of the spectral line profiles from numerical simulations of convection in the solar photosphere, and using high resolution spectroscopic observations of the solar photosphere. Application of the method is presented to search for the observational and numerical evidences of the shocks in the solar photosphere using numerical results of Wedemeyer and his team (Astronomy and Astrophysics 414, 1121 (2004)) and our VTT echelle observations (Astronomy and Astrophysics 420, 1141 (2004)).

High resolution observations of the solar photosphere: comparison of results from adaptive optics and correlation tracker

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Abstract

Our contribution describes two sets of spectral observations of the solar photosphere in Fe I and Fe II lines taken with the VTT at Observatorio del Teide, Izaña in 2002 and 2004. Comparison of accuracy of data is made for the sets taken with correlation tracker and with adaptive optics, respectively. We discuss the temporal and spatial changes of accuracy of the spectral characteristics derived from the spectra.

What we can learn about magnetic reconnection within the frame of MHD

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Abstract

Magnetic reconnection is an energy conversion process, where magnetic energy is transformed into kinetic energy leading to fast plasma flows and heating of a plasma. The first model to describe reconnection imposed by an external force like a plasma flow is the Sweet-Parker approach. Here, two antiparallel fields are pushed together forming a strong current sheet between each other, and plasma is assumed to diffuse into the current layer along its whole length. Sweet-Parker

reconnection, which is valid only for a homogenous resistivity, was confirmed in many numerical simulations and also in experiments. However, it works far too slowly to account for many reconnection processes, especially in solar flares. A way out was found by Petschek, who proposed that the magnetic energy can be converted via shock waves set up in the plasma. Due to a localized resistivity, larger reconnection rates can be achieved. Thus, the diffusion region becomes much smaller than the scale size of the system, so that most of the inflowing plasma crosses the shock waves and not the diffusion region anymore. Later, the Petschek model was extended to compressible plasmas and asymmetric and skewed magnetic field configurations. Also time-dependent solutions were developed, where the outflow regions are bounded by shocks leading to tear-drop shaped flux ropes of heated and accelerated plasma connecting the separated plasma populations. Such energetic particles were detected by satellite observatories such as Yohkoh and SOHO, indicating that reconnection is an important process to explain the heating of the solar corona and the topology of coronal loops.

The canopy structure above a light bridge

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Abstract

An analysis of high-resolution Stokes observations of a light bridge in active region NOAA 8990 is presented. The observations were recorded on May 13 2000 with the La Palma Stokes Polarimeter attached to the 0.5-m Swedish Vacuum Solar Telescope. The stratification over the solar atmosphere of different physical parameters is retrieved from these data using the Stokes Inversion based on Response functions (SIR). Coming out from the the stratification of the magnetic field strength and orientation of the magnetic field vector, we suggest a canopy structure above the light bridge.