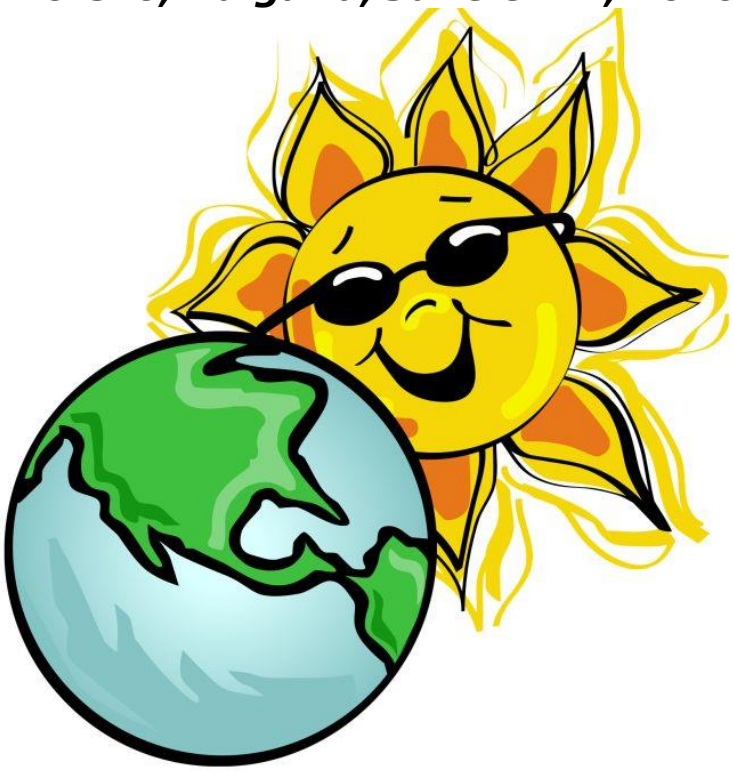
E I G H T E E N T H W O R K S H O P

Solar Influences on the Magnetosphere, Ionosphere and Atmosphere

Primorsko, Bulgaria, June 8–12, 2026



Book of Abstracts

SPACE RESEARCH AND TECHNOLOGY INSTITUTE

BULGARIAN ACADEMY of SCIENCES

Eighteenth Workshop
Primorsko, Bulgaria, June 8–12, 2026

Scientific Organizing Committee

Katya Georgieva (Space Research and Technology Institute, BAS, Sofia, Bulgaria) – *Chair*
Atila Özgüc (Boğaziçi University, Kandilli Observatory, Istanbul, Türkiye)
Crisan Demetrescu (Institute of Geodynamics, Romanian Academy, Romania)
Dragan Roša (Zagreb Astronomical Observatory, Croatia)
Jean-Pierre Rozelot (Université Côte d'Azur, France)
Ke Wang (Technology and Engineering Center for Space Utilization, CAS, China)
Nat Gopalswamy (NASA Goddard Space Flight Center, USA)
Olga Malandraki (IAASARS, National Observatory of Athens, Greece)
Petra Koucká Knížová (Institute of Atmospheric Physics, Czech Republic)
Vladimir Obridko (IZMIRAN, Moscow, Russian Federation)

Topics:

Sun and Solar Activity
Solar Wind-Magnetosphere-Ionosphere Interactions
Solar Influences on the Lower Atmosphere and Climate
Solar Effects in the Biosphere and Lithosphere
Instrumentation for Space Weather Monitoring
Data Processing and Modelling

Local Organizing Committee:

(Space Research and Technology Institute, Sofia, Bulgaria)

Boian Kirov – *Chair*
Simeon Asenovski
Kostadinka Koleva
Ivan Nikolov
Nikolay Nikolov
Volodymyr Komendant

SPACE CLIMATE GROUP

In collaboration with
Technology and Engineering Center for Space Utilization
Chinese Academy of Sciences

The 18th Workshop is supported by
the Bulgarian National Science Fund
(Grant No КП-06-МНФ/43)

Supported by
the Scientific Committee on Solar Terrestrial Physics (SCOSTEP)

DOI: https://doi.org/10.31401/WSoz.2026.abs

CONTENTS

Sun and Solar Activity

Solar Wind-Magnetosphere-Ionosphere Interactions

Data Processing and Modelling

Instrumentation for Space Weather Monitoring

Solar Influences on the Lower Atmosphere and Climate

Solar Effects in the Biosphere and Lithosphere

Special Session: China Space Station (CSS)

Sun and Solar Activity

GLE 77 Charged-Particle Spectrum: Four-Region Interpretation

Chilingarian A., Sargsyan B., Zazyan M.
CRD YerPhI

Ground Level Enhancements (GLEs) offer a rare chance to study the highest-energy solar protons through atmospheric secondary particles detected at ground level. We examine the charged-particle energy-deposit spectrum of GLE 77 (November 11, 2025), recorded by the SEVAN Light spectrometer at Aragats (3200 m a.s.l.), and compare it with a unified CORSIKA+GEANT4 forward-modeling chain for monoenergetic primary protons of 7.3, 10, 15, and 20 GeV. The recovered differential spectrum reveals four distinct physical regions: (i) a common 10–20 MeV low-deposit branch where experiment and simulations nearly match; (ii) a 20–40 MeV transition region where the experiment diverges from the steep decline seen in the harder monoenergetic templates; (iii) a prominent 40–70 MeV hump, identified as the detector's signature of single-muon-like deposits, which is much stronger in the data than in any simulation; and (iv) a true hard tail above 100 MeV, characterized by its extension. The measured tail endpoint at about 206 MeV coincides with the 10 GeV template, is slightly above the 7.3 GeV case, and clearly shorter than the 15 and 20 GeV simulations. Therefore, the key physical trait of the hard tail suggests a relatively soft, cutoff-limited primary population. The overall shape of the four regions indicates that GLE 77 was primarily driven by solar protons just above the local geomagnetic cutoff, with effective upper energies near 9–10 GeV.

Solar Drivers of Space Weather: Building Cross-Border Observatory Facilities and Network

Dechev M.[1], Simić Z.[2], Bachev R.[1], Strigachev A.[1]
[1] IANAO
[2] AOB

This poster presents a three-year joint research project (2026–2028) between the Institute of Astronomy with NAO (Bulgarian Academy of Sciences) and the Astronomical Observatory Belgrade (Serbia). Solar active phenomena, particularly prominence eruptions (PEs) and coronal mass ejections (CMEs), are the primary drivers of heliospheric space weather, significantly impacting satellite operations, power grids, and communication systems. The central objective of this collaboration is to establish a formal bilateral network and a unified virtual observatory by integrating existing solar observational facilities in both countries. By combining Bulgaria's expertise in spectroscopy and the solar corona with Serbia's renowned experience in solar flare statistics and sunspot studies, the project aims to provide continuous, multi-wavelength monitoring. This "distributed" observatory model will overcome the limitations of single-site observations, such as weather interruptions and night-time gaps, creating a more complete and synoptic dataset. The project roadmap includes the development of a shared, cloud-based data portal, coordinated observing campaigns, and joint scientific publications, ultimately enhancing the international visibility and research output of both nations.

Why Was the CME Productivity Enhanced During the Declining Phase of Solar Cycle 24? A Possible Role of Sunspot Magnetic Fields

Georgieva K., Kirov B., Asenovski S.
Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria

Coronal mass ejections are one of the main solar drivers of space weather disturbances, especially of intense geomagnetic storms. Since CMEs originate mainly from magnetically complex active regions, their occurrence rate is usually expected to follow the sunspot cycle. However, observations during the recent solar cycles show that the relationship between sunspot number and CME occurrence is not strictly proportional.

In this study, we focus on the enhanced CME productivity during solar cycle 24, with special attention to its declining phase. Although cycle 24 was much weaker than cycle 23 in terms of sunspot activity, the number of CMEs per sunspot was comparatively high. This indicates that each sunspot, or each sunspot group, was more efficient in producing CMEs than would be expected from sunspot number alone. A similar deviation from the simple sunspot–CME relationship was observed during the declining phase of cycle 23, when the CME rate formed a broad plateau instead of following the decrease in sunspot number.

We discuss several possible explanations for this behavior, including changes in the SOHO/LASCO observational cadence, reduced heliospheric pressure, weaker polar magnetic fields, and changes in the large-scale coronal structure. Particular attention is paid to the possible role of sunspot magnetic fields. Strong magnetic fields in active regions and in the overlying corona may suppress or delay eruptions, because a CME must overcome the surrounding magnetic confinement before escaping into the heliosphere. In contrast, weaker magnetic fields may reduce this constraint and allow even relatively weak active regions to become CME-productive.

The aim of the study is to examine whether the unusually high CME-per-sunspot ratio during the declining phase of cycle 24 can be partly explained by changes in the magnetic properties of sunspots. CME occurrence from the SOHO/LASCO CDAW catalogue will be compared with sunspot activity and with available measurements or proxies of sunspot magnetic field strength. The results may help to clarify why a relatively weak solar cycle can nevertheless produce an enhanced number of CMEs and may improve our understanding of the magnetic conditions controlling solar eruptive productivity.

A Value-added List of Large Solar Energetic Particle Events

Gopalswamy N.[1], Mäkelä1 P.[1,2], Yashiro S.[1,2], Xie1 H.[1,2], Akiyama1 S.[1,2], Mohan A.[1,2]
[1] NASA Goddard Space Flight Center
[2] Catholic University of America

We present a catalog of large solar energetic particle (SEP) events identified in the observations of GOES energetic particle events residing at the CDAW Data Center, NASA Goddard Space Flight Center (https://cdaw.gsfc.nasa.gov/CME_list/sepe). The list has four major categories of information: (i) the SEP event, (ii) associated coronal mass ejection (CME), and (iii) flare, and (iv) type II radio burst in the metric and decameter-hectometric (DH) domains. For each SEP event, the associated CME is identified from the SOHO/LASCO CME catalog (https://cdaw.gsfc.nasa.gov/CME_list). Under SEPs, the onset and peak time are given, followed by the intensity of the event in pfu, and the existence and intensity of an energetic storm particle event (ESP). For CMEs, we list the time of first appearance in the SOHO/LASCO field of view, the linear speed, and the angular width in the sky plane. The angular width is denoted by H for halo CMEs. The soft X-ray flare information includes the source location, start and peak times, followed by flare class. The type II burst information includes the onset times in the metric and DH domains. Entries in various columns are linked to plots, measurements, and javascript movies involving coronagraph images, EUV images, soft X-ray light curves, and radio dynamic spectra. After a detailed description of the catalog, we present some statistical results on SEPs as a function of the solar cycle.

The Cyclic Variation in the Great Soft X-Ray Solar Flare Occurrence

Katsova M.M.[1], Obridko V.N.[2], Sokoloff D.D.[2,3 4]
[1] Sternberg Astronomical Institute, Lomonosov Moscow State University
[2] IZMIRAN, Troitsk, Moscow, Russia
[3] Department of Physics, Lomonosov Moscow State University
[4] Moscow Center of Fundamental and Applied Mathematics, Russia

It is believed that powerful non-stationary processes such as flares and coronal mass ejections are detected primarily near solar cycle maxima. This is true for distributions of all kinds of flares. However, our analysis of data on the great flares since 1975 when the GOES monitoring started, lead us to other more refined conclusions. We traced the latitudinal distribution of the X-class flares throughout four cycles – dependence of the X-class on the phase of the cycle. Besides, we compared directly their positions with the magnetic field structure. We found that the relatively weak X4-7 flares occur at relatively high latitudes, 15-20 degrees, where two waves of activity converge – one, moving toward the equator, and the second, the wave of the next cycle, directed poleward. Such events are observed almost constantly, appearing ~1-2 years before the cycle maximum. At the same time, the number of the powerful X-ray flares increases sharply during the maximum phase, but the greatest >X10 flares are observed at the beginning of the decline phase, where wave interactions still persist, and throughout the decline phase. Note that they are practically absent during the cycle's growth phase.

Thus, we conclude that the greatest X-ray flares begin to appear ~1-2 years before the maximum number of sunspots in the overlapping phase, when various kinds of activity waves coexist on the Sun at relatively high latitudes, and then continue to appear at the boundary separating the wave of local fields and the poleward wave of the next cycle.

Chaotic Behavior of Selected Solar and Geomagnetic Activity Indices during the Last Three Solar Cycles

Kilcik A.[1], *Ozguc A.*[2]
[1] Department of Space Science and Technologies, Faculty of Science, Akdeniz University, Antalya 07058, Turkey
[2] Kandilli Observatory and Earthquake Research Institute, Bogazici University, Istanbul 34684, Turkey

In this study, we investigated the cycle-to-cycle chaotic variations in SSN, Ap, ScalarB, and solar wind speed data by applying the Surrogate Test, Hurst exponent, Lyapunov exponent, and correlation dimension analyses. In results of our analysis we found followings; i) the Hurst Exponent analysis show that the ScalarB has the lowest memory and the SSN has the highest memory, ii) the surrogate test analysis show that all data sets have some level of noise, iii) based on the Lyapunov Exponent analysis we found that solar cycle 24 is more chaotic than the solar cycle 23 and solar cycle 25 is more chaotic than solar cycle 24, iv) Crassberger-Proaccia analysis results gave correlation dimensions between 1.48 and 3.47 for all the investigated data sets and cycles.

Kinematics of the Prominence Eruption on May 27, 2013, Observed from Three Viewpoints

Koleva K., Duchlev P., Nacheva Y.
Space Research and Technology Institute, Bulgarian Academy of Sciences

We present our analysis of the dynamic activity of the prominence eruption, occurring on May 27, 2013, using the multi-spacecraft observations. Three perspectives are used to examine the eruption's morphology evolution and kinematics. We used high-resolution data from the two Solar Terrestrial Relations Observatory (STEREO) satellites and the Atmospheric Imaging Assembly (AIA) on board the Solar Dynamics Observatory (SDO) for our investigation. The STEREO spacecraft were separated by 81.4° during this event. The eruption was associated with a Partial Halo coronal mass ejection, registered by both the Large Angle and Spectrometric Coronagraph (LASCO) on board (SOHO) and COR A and COR B STEREO coronagraphs.

Can EUV Power-Spectral Indices Reveal Imminent Solar Flares?

Kolotkov D.[1,2]
[1] CFSA, University of Warwick
[2] VIRAC, Ventspils University of Applied Sciences

Solar EUV intensity fluctuations exhibit broadband coloured-noise spectra that are commonly described by segmented power laws, ($S(f) \sim f^{-\alpha}$), with different scaling behaviour at low and high frequencies. Although such spectral properties are widely reported in solar physics, their physical interpretation and diagnostic potential for flare forecasting remain largely unexplored.

In this work, we investigate the spatial and temporal evolution of power-spectral indices in flare-hosting active regions observed by SDO/AIA. Motivated in part by frequency-response analysis techniques used in other areas of physics and engineering, we examine whether changes in coronal spectral properties can provide insight into the flare onset.

We show that the low-frequency spectral index (α_{lf}) closely follows the morphology of coronal EUV structures, providing a new observational proxy for underlying plasma dynamics. While non-flaring regions exhibit relatively stable spectral properties, flare-productive regions display pronounced temporal variability prior to eruption. Analysing 14 flare events, we find that significant changes in (α_{lf}) systematically appear at flare locations within minutes before flare onset. In several events, variations in the spectral contrast between low- and high-frequency indices (α_{lf} - α_{hf}) emerge 30–90 minutes in advance.

These results suggest that the frequency response spectra of coronal emission contain measurable signatures of imminent flare and may provide useful diagnostics for short-term flare precursor studies. This proof-of-concept investigation highlights the potential of power-spectral analysis for probing coronal plasma dynamics and improving flare prediction capabilities using high-resolution EUV observations.

Statistical Analysis of the B-Star Drag Term and Solar and Geomagnetic Activity Indices

Komendant V.
Space Research and Technology Institute, Bulgarian Academy of Sciences

Vast increase in population of the artificial Earth satellites (AES) in near-Earth space, and prediction of their lifetime and location, maintain modeling and prediction of the state of the upper Earth atmosphere relevant for decades. The availability of modern processing tools and the increase of computational possibilities don't provide accurate prediction results. The data of the atmospheric models are used in the models of prediction of movement of the AES for the fast and approximate calculation of the ephemerides of the satellites. One of the popular prediction models are SGP models. They are use the two line elements (TLE) format for their calculations. There is the B-star drag term (B-star) among them. It is the modified ballistic coefficient which is used to account for atmospheric drag.

The B-star for satellites that move in an uncontrolled mode were taken for analysis. The study period for the drag term and indices of solar and geomagnetic activity is: end of the 23rd solar cycle, the 24th solar cycle, and minimum between them.

This work is the compilation of three statistical methods for processing the B-Star, and the solar and geomagnetic indices. They are: windowed Fourier transform, multiple regression models, and cross-spectral analysis of two time series. The first method gives periodic components in the studied data and time of their existence. With the second method, I select the indices of solar and geomagnetic activity that had the greatest impact on the B-star. The third method allows to track relationship between the found periods in the frequency domain.

Long-Term Asymmetries in Solar Activity

Muraközy J.
HUN-REN Institute for Earth Physics and Space Science

Solar activity varies on nearly decadal timescales as well as on longer timescales, i.e., over several Schwabe cycles. Not only do the number, area, and position of the sunspot groups observed on the solar disc vary, but the activity of the two hemispheres also changes. Thus, a 2x4 north-south solar asymmetry can be identified: the northern hemisphere leads over four Schwabe cycles, after which the southern hemisphere takes over this role for the following four cycles. This pattern was observed during the Greenwich-era and, to some extent, also on the pre-Greenwich cycles. In this presentation, we discuss whether this rule also applies to recent solar cycles and whether it can be observed in other parameters as well.

Main Magnetic Lines of the Pre-flare Arcade Surface with Increased Current Density: Analysis of the Field Configuration Obtained by MHD Simulation to Determine the Position of the Solar Flare

Podgorny A.[1], *Podgorny I.*[2]
[1] Lebedev Physical Institute RAS
[2] Institute of Astronomy RAS

The analysis of the pre-flare configuration on May 26, 2003, above the active region AR 10365 three hours before the M 1.9 flare at 05:50:03, was continued. The configuration was obtained by MHD simulation in the corona. To study the physical processes occurring in the solar corona during a flare, it is necessary to define configurations with the property of accumulating magnetic energy of a solar flare and causing flare instability. However, this is difficult problem in the real field of the solar corona due to the superposition of additional field configurations. It is necessary to solve this problem for studying the physical mechanism of solar flares, with the aim, in particular, of creating a system for predicting solar flares based on an understanding of their physical mechanism, using the results of MHD simulation. For this purpose, all the main magnetic lines of the arcade were found, which pass through three-dimensional current density maxima that form a chain, or which pass through plane current density maxima in planes perpendicular to the main magnetic lines. Areas on the main arcade lines were found where the properties of configuration promote the occurrence of a flare. Such properties appear in the section of lines located at the top of the loop and continuing in the region projected along the line of sight onto the bright region of the flare emission on the solar disk.

Solar Orbiter's Insights into the Solar Activity: A Metis Coronagraph Perspective

Romoli M., and the Metis Team
Università di Firenze, Italia

The middle corona (1.5 to 6 Rs) represents a critical transition region where the solar wind and coronal transients undergo their primary acceleration. Observing this region is essential for identifying the physical mechanisms governing solar wind and transient energization. The Metis coronagraph provides a unique vantage point by performing simultaneous observations from 1.7 to 3.4 Rs in both linearly polarized visible light and the HI Lyman-alpha line. These combined datasets are fundamental for the study of transients and for applying the Doppler dimming technique to derive the solar wind expansion velocity. In this talk, we present recent results on solar wind acceleration and propagation, and discuss the new observational perspectives offered by Solar Orbiter's current out-of-ecliptic mission phase, which allows for an unprecedented view of the solar poles and high-latitude coronal features.

Statistical Study of Type-II Spicules Utilizing Chromospheric Imaging Data from the Goode Solar Telescope

Şahin S.S.[1,2]
[1] Big Bear Solar Observatory
[2] Akdeniz University

Type II spicules are highly dynamic chromospheric jet-like structures that are considered potential contributors to coronal heating and solar wind mass supply. In this study, we investigate on-disk Type II spicules observed with the Goode Solar Telescope using high-spatial and high-temporal resolution Hα data acquired at ±0.8 Å from line centre. To enhance and systematically identify fine-scale elongated structures, we applied the Rolling Hough Transform (RHT), marking the first implementation of this method to high-resolution on-disk Type II spicule data. Our analysis revealed a significant asymmetry between the two Hα wings, with approximately eight times more spicules detected in the −0.8 Å images compared to the +0.8 Å images. Radial velocity measurements exhibit a broad distribution ranging from approximately −100 to +100 km s^{-1}, indicating highly dynamic plasma motions. However, the mean velocities remain close to zero, varying between roughly −2 to +2 km s^{-1} for both wavelength positions. These findings suggest that although individual structures display substantial line-of-sight motions observed as notable Doppler shifts, the overall population does not exhibit a strong net flow preference. The results demonstrate the effectiveness of combining chromospheric imaging with RHT-based detection techniques for investigating the dynamics and morphology of on-disk Type II spicules and other small-scale features, thus opening new opportunities for statistical analyses of chromospheric fine structures at unprecedented resolution.

Development of Hydrogen – Helium Mixture Modeling, Application to Solar Plasma

Sakan N.M.[1], Simić Z.[2], Srećković V.A.[1], Dechev M.[3]
[1] University of Belgrade, Institute of Physics, PO Box 57, 11001 Belgrade, Serbia
[2] Astronomical Observatory, Volgina 7, 11060 Belgrade, Serbia
[3] Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences, 72, Tsarigradsko Shosse Blvd. Sofia, Bulgaria

The article describes a way to find the average potential for perturbing ions in plasmas that are moderately coupled. It is derived from the Boltzmann-averaged occupancy of ionic states. The hydrogen and helium mixture is used for two reasons: first, because there is a lot of it in solar plasma, and second, because the pseudo-potentials have a very specific shape. The temperature dependence is very important for helium and almost none for hydrogen in the temperature range given. This method is used to find the temperature-averaged pseudo-potentials for hydrogen, helium, and a 90%–10% mixture of the two at temperatures between 10 kK and 40 kK, which is useful for both laboratory and solar chromosphere conditions. The results show that averaging temperatures improves the ionic-core structure in the pseudo-potentials. This effect is strongest for lighter species, like hydrogen. The mixture potential demonstrates intermediate behavior that eludes simple superposition of bare Coulomb potentials. These calculated potentials provide a basis for further research into bound-state energies and broadening, free states and phase shifts affected by the plasma environment, Stark broadening, and opacities in both astrophysical and laboratory plasmas. This study signifies a preliminary progression towards the improved modeling of the ionic component of plasma influence via FCC (Face Centric Cubic) - like lattice averaging, as evidenced in previous publications.

Multi-Spacecraft and Multi-Instrument Observations of the Martian Radiation Environment During Solar Cycles 24 and 25

Semkova J.[1], Bankov N.[1], Benghin V.[2], Dachev Ts.[1], Drobyshev S.[2], Georgiev G.[1], Golovin D.[3], Gopalswamy N.[4], Jordanova M.[1], Koleva R.[1], Krastev K.[1], Litvak M.[3], Lukyanov N.[3], Maltchev St.[1], Matviichuk Yu.[1], Mitrofanov I.[3], Mokrousov M.[3], Sanin A.[3], Shurshakov V.[2], Tomov B.[1]
[1] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] State Research Center, Institute of Biomedical Problems, Moscow, Russia
[3] Space Research Institute, Russian Academy of Sciences, Moscow, Russia
[4] NASA Goddard Space Flight Center, Greenbelt Maryland, USA

Presented are multi-spacecraft – Trace Gas Orbiter (TGO), Mars Odyssey, Mars Science Laboratory, etc. and multi-instrument observations of the particle radiation environment in Mars vicinity during solar cycles 24 and 25. According the observations conducted by the dosimeter Liulin-MO onboard TGO at Martian orbit from May 2018 to April 2026, lowest dose equivalent rates for a 6-months period – the approximate time for a transit to Mars or vice versa, are registered during the decreasing phase, near to the maximum of solar cycle 25 – they are about 1.5-2 times less that the dose rates during the other phases of solar cycles 24 and 25. Highest dose rates are registered around the minimum of solar cycle 24 as a result of the galactic cosmic rays contribution. Particular attention is drawn to the results for the radiation parameters obtained by multiple detectors located at the orbit and on the surface of Mars during the most intensive solar particle events (SPEs) registered up to the moment during solar cycle 25 – those in October 2021, February 2022, May 2024, and August 2025. Responsible for most of these SPEs are halo coronal mass ejections associated with major X and M class flares. The results show the importance of long-term multipoint measurements of the radiation conditions in Mars vicinity. Such measurements will provide the data necessary for the planning of future manned missions to the planet. The data on the observed SPEs add details regarding the solar activity during solar cycle 25.

Solar Activity Cycles During Grand Minima in a Simple Solar Dynamo Model

Sokoloff D.[1,2], Makarova I.[1], Yushkov E.[1], Obridko V.[2]
[1] Moscow State University
[2] IZMIRAN

Solar grand minima including the famous Maunder minimum are quite long epoches (about half a century) of very weak solar activity. It is not obvious to what extent the very solar cycle persists at such exceptional times and if it persists what are the cycle duration and form. We investigate the problem in the framework of a simple solar dynamo model. We obtain that the cycle does persist and its properties are to some extent similar to that one of the normal cycles.

Declining Phase of the 11-Year Solar Cycle and Structure of the White-Light Corona

Teneva D., Stoeva P., Stoev A.
Space Research and Technology Institute, BAS

Structure of the solar corona and its form are different and depend on the level of solar activity in the 11-year solar cycle. Declining phase is longer (6-7 years) and it gradually decreases in contrast to the rising phase, which rapidly increases and is shorter (4-5 years). Their analysis is important for the study of the origin and evolution of solar magnetic fields and solar activity. For the declining (descending) phase is characteristic an expansion of polar coronal holes to lower solar latitudes, creating high-speed solar wind streams. We investigate the form and structure of the white-light solar corona using photographs from our ground based observations during the considered 2006 and 2008 total solar eclipses, which are during the declining phase of the 23rd Solar Cycle and 2017 and 2019 total eclipses from the declining phase of the 24th Solar Cycle. The white-light corona photographs were obtained with 250/2000mm, 300mm objectives, and 2000mm Macsutov-Cassegrain telescope using high resolution digital cameras. Photographs were taken with different exposures, from 1/2000 sec to 5 sec. The eclipsed images of the Sun are compared with near-simultaneous SOHO EUV and SOHO LASCO visible-light coronagraphic images. The derived Ludendorf flattening indices and phase of the solar cycle show that white light corona is an intermediate pre-maximum type.

Solar-Like Corona of the Thin Disk in the AGN

Yankova K.[1], Dimitrijević M.[2], Srećković V.[3], Vujčić V.[2]
[1] SRTI – BAS
[2] AOB
[3] IPB

We have built a model of a hot advective disk in aim to unify the physical behavior of the central object in dormant and active galactic nuclei. Here we will use our work to show the possibility of the thin disk component to develop and maintain a solar-like corona. We will investigate the behavior of two real sources, representatives of the respective studied groups Syg A* (dormant) and NGC 3516 (AGN).

Soft X Ray Flux Estimation for Behind the Limb Solar Flares Using Recent STEREO/EUVI Observations

Yashiro S.[1], Gopalswamy N.[2], Akiyama S.[1], and Mäkelä P.[1]
[1] Catholic University of America
[2] NASA Goddard Space Flight Center

Soft X-ray (SXR) flux in the 1–8 Å band measured by the GOES satellites serves as the standard scale for classifying solar flares. EUV observations from the STEREO mission have previously been used to estimate the corresponding SXR fluxes (Nitta et al. 2013; Chertok et al. 2014). During intense flares, CCD pixels on the STEREO/EUVI telescopes become saturated, producing horizontal streaks on both sides of the flare core in EUV images. The length of these streaks increases with flare strength (Chertok et al. 2014), so the number of saturated pixels can act as a proxy for EUV brightness. We find that the GOES 1–8 Å SXR flux correlates well with the number of saturated EUVI CCD pixels, yielding a correlation coefficient of 0.74. As in previous studies, the scatter around the regression line is larger for weaker events. When considering only 243 strong flares (M3 and above), the correlation improves to 0.86. We also identify a temporal change in the regression relationship due to degradation of the STEREO/EUVI instruments. This degradation must therefore be taken into account when estimating SXR fluxes for far-side flares.

Solar Wind-Magnetosphere-Ionosphere Interactions

Heliospheric and Geomagnetic Conditions During Recent Solar Cycle Minima

Asenovski S., Georgieva K., Kirov B.
Space Research and Technology Institute, Bulgarian Academy of Sciences

Solar Cycle 24 was characterized by significantly weaker activity compared to the preceding solar cycles, continuing the tendency toward reduced solar activity observed during recent decades. The availability of several solar cycles with markedly different activity levels now provides an opportunity to investigate whether solar cycle minima and their influence on heliospheric and geomagnetic conditions also exhibit long-term changes related to the overall level of solar activity. In this study, heliospheric and geomagnetic conditions during recent solar cycle minima are investigated using solar, interplanetary, and geomagnetic parameters. The analysis includes solar wind speed, interplanetary magnetic field variations, heliospheric current sheet configuration, recurrent high-speed solar wind streams, and geomagnetic activity indices. Particular attention is devoted to comparing minima associated with both relatively strong and weak solar cycles in order to evaluate possible differences in their heliospheric structure and geomagnetic response. The study examines whether the reduced overall solar activity observed during recent cycles is accompanied by corresponding changes in recurrent geomagnetic activity and large-scale heliospheric dynamics during minimum conditions. Variations in geomagnetic indices are compared with heliospheric parameters to evaluate the role of recurrent solar wind structures and magnetic sector organization during prolonged low-activity periods. The results indicate that despite substantial differences in sunspot activity between solar cycles, geomagnetic activity during minima may not scale directly with the overall cycle amplitude.

Verification of Empirical Models for Forecasting Critical Ionospheric Frequencies in the Conditions of Geomagnetic Storms on 12- 13 November 2025

Bojilova R., Mukhtarov P.
National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Sciences

The present study provides an opportunity to verify the quality of the created empirical models for forecasting the critical frequencies of the ionospheric E and F regions for the territory of Sofia-Bulgaria. The work examines the anomalies in the behavior of the ionospheric F2 region critical frequency (foF2) and the ionospheric E region critical frequency (foE) under the conditions of the geomagnetic storms on 12-13 November 2025. Data from selected European ionospheric stations were used to compare the model values of the critical frequencies for Sofia. The choice of these stations is related to the fact that this ionosondes are located at the geographic latitude close to the latitude of Sofia, which suggests similar behavior of the ionosphere. In addition, the determination of the relative deviation of foF2 has been introduced. The results of the comparison of the model and measured values for both ionospheric characteristics show a good coincidence during the considered time interval. In the data for foE no anomalous behavior is observed during the storms, but for foF2 a decrease is observed during the first geomagnetic storm, while an increase is observed during the second. The relative deviation of foF2 illustrates the inertia in the response of the quantity and its anomalous behavior of a negative response, followed by a positive anomaly, which is observed in both cases. The results of this study can be used to improve the created empirical models for forecasting the critical frequencies of the ionosphere for the territory of Bulgaria.

Interplanetary Drivers of Different Types of Magnetospheric Substorms

Despirak I.V.[1], Kleimenova N.G.[2], Lubchich A.A.[1]
[1] Polar Geophysical Institute, Apatity, Russia
[2] Schmidt Institute of Physics of the Earth, RAS, Moscow, Russia

Studying the drivers of magnetospheric and ionospheric disturbances is important because the identification of geoeffective solar wind types and streams will enable us to explore the fundamental capabilities of space weather forecasting, i.e., disturbances in the solar wind-magnetosphere-ionosphere system. One of the actual problems of space weather is the identification of the interplanetary drivers of substorms. Disturbances that typically occur when the IMF is antiparallel to the geomagnetic field and are associated with the accumulation and release of magnetospheric energy—magnetospheric substorms—can be observed at different geomagnetic latitudes, in quiet and disturbed conditions, both during the development of magnetic storms and in nonstorm conditions. Accordingly, different types of substorms can be distinguished: substorms within a contracted auroral oval (so-called "polar" substorms), in disturbed conditions, within an extended auroral oval (so-called “expanded” or “high-latitude” substorms), and very intense substorms (so-called supersubstorms). This paper attempts to provide a common picture of the influence of the large-scale structure of the solar wind on various types of substorms associated with Earth's passage through various solar plasma streams (slow or high-speed streams, sporadic disturbed plasma streams associated with coronal mass ejections (CMEs), etc.). Specifically, the solar wind and IMF conditions that lead to the occurrence of substorm disturbances at high latitudes and supersubstorms will be determined. Some discovered features in the development of "polar," "high-latitude," and supersubstorms, and their relationship to the interplanetary drivers, are discussed.

Multistep Electron Acceleration in Multiple Dynamic Electron-Scale Current Sheets

Grigorenko E.E.[1], Du C.[2,3], Leonenko M.V.[1], Fu H.[2,3], Zelenyi L.M.[1]
[1] IKI-RAS
[2] School of Space and Environment, Beihang University, China
[3] Key Laboratory of Space Environment Monitoring and Information Processing, Ministry of Industry and Information Technology, China

Multiple Electron-scale Current Structures (ECSs) are usually observed in the Plasma Sheet (PS) during propagation of ion Bursty Bulk Flows (BBFs) generated by the remote X-line. The BBF arrival is followed by compression, magnetic flux pile-up and increase in convection electric field. These phenomena supposedly trigger electron-only Secondary Reconnection (SR) near the MMS location. We report the accompanying physical effects as elementary bricks of the collisionless energy conversion from macro-scale to electron kinetic scales via generation of Cascading Electron Current Sheets (CECSs), which evolution leads to an additional electron acceleration and affects local electron anisotropy. The proposed scenario of CECSs formation is as follows. The SR(s) accelerates field-aligned electron jets generating current filaments in the SR’s outflow. The external drivers provided by the ion BBF force the filament merging and formation of 1D field-aligned layers. Their thinning generates the inductive electric field directed along the current (Ej). This field provides: i) an additional energy gain to current-carrying electrons up to ~1 keV resulting in generation of new field-aligned layer; ii) contributes to E×B drift of magnetized electrons generating a new electron jet and the related perpendicular current with $Jper \sim -e \cdot n \cdot [E \times B]/B^2$. The Jper increase generates a new inductive Ej' directed along the Jper. This field accelerates electrons perpendicular to B until the E×B drift exists. Such cascade electron acceleration explains the appearance of ECSs with arbitrary current directions in different PS locations until the external drivers transfer the BBF’s energy from macroscale to electron kinetic scales.

This work was supported by the Russian Science Foundation (grant #25-42-00028)

Extreme Space Weather Events of May and October 2024: High Latitude Geomagnetic Effects

Gromova L.I.[1], Kleimenova N.G.[2], Gromov S.V.[1], Malysheva L.M.[2]
[1] IZMIRAN, RAS, Troitsk, Moscow, Russia
[2] Schmidt Institute of Physics of the Earth, RAS, Moscow, Russia

The geomagnetic storms of 10-11 May and 10-11 October 2024 were the strongest geomagnetic events in over two last decades. Both storms were caused by the arrival of powerful magnetic clouds. While the May storm demonstrated the geomagnetic effects of the impact of the magnetic cloud body, the October storm exhibited mainly the Sheath effects. Several very large substorms with SML index from −1500 to − 4000 nT have been observed during both storms. They represented not only the "classical" (Akasofu-type) substorms but some convection magnetic bays as well. It was found that the all intense substorms regardless of their driver have been accompanied by the development of large-scale clockwise rotating ionospheric vortex in the morning sector indicating an increase of the downward field-aligned currents. In the noon sector of polar latitudes, the specific magnetic bay-like disturbances were found, the sign of which was controlled by the sign of the By IMF. The global distribution of the high-latitude geomagnetic disturbances has been studied by applying the planetary maps of the ionospheric currents derived from the magnetic measurements on 66 LEO (780 km) satellites of the AMPERE project.

Study of the Midlatitude Positive Bays observed at the Bulgarian station Panagyurishte during the SC25 Maximum

Guineva V.[1], Raykova L.[1], Werner R.[1], Bojilova R.[2]
[1] Space Research and Technology Institute (SRTI) – Bulgarian Academy of Sciences, Stara Zagora Department, Bulgaria
[2] National Institute of Geophysics, Geodesy and Geography (NIGGG) - Bulgarian Academy of Sciences, Sofia, Bulgaria

Substorms originated over Europe are often accompanied by midlatitude positive bays (MPB) which can be registered at the midlatitude Bulgarian station Panagyurishte (PAG). In previous studies, it was found out, that the most intense MPB at PAG were related to substorms, originated during geomagnetic storms, under disturbed interplanetary conditions. The maximum of solar cycle 25 is observed in 2024. It is characterized by a large number of days with high geomagnetic activity resulting from the conditions in the solar wind and the Interplanetary Magnetic Field. In 2024, 170 MPB's were detected at PAG. It was ascertained, that the distribution of MPB's by intensity in 2024 differ from the previous years. The number of MPB's with higher maxima is higher: the number of cases with Xmax>20 nT is 6.94%, and with Xmax>30 nT – 5.56%. The highest maximal MPB values were over 60 nT and were observed during the geomagnetic superstorm on 10-12 May 2024. In addition to this superstorm, a number of strong storms occurred during 2024, as the severe storm on 10 October 2024, and the strong storms on 19 April 2024, 12 September 2024, 06 October 2024, 8 November 2024. We studied the MPB's, accompanied the substorms in the midnight MLT interval during these highly disturbed geomagnetic conditions. The monthly distribution of the MPB's by number and amplitude during 2024, their distribution by the different structures in the solar wind at their development, and by the phase of the geomagnetic storm or non-storm conditions have been examined and discussed.

Interaction of Solar Wind with the Jovian Magnetosphere

Kesri K.[1,2], Louis C.K.[2], Waters J.E.[2,3], Rutala M.J.[4], Cecconi B.[2], Boudouma A.[2,5], Prangee R.[2], Zarka P.[2], Jackman C.M.[6], Kurth W.S.[7]

[1] Sorbonne Universite, Paris, France
[2] LIRA, Observatoire de Paris, Paris Sciences et Lettres, Paris, France
[3] LAM, Aix-Marseille Universite, Marseille, France
[4] University of Alberta, Canada
[5] Institute of Atmospheric Physics, Prague, Czech Republic
[6] Dublin Institute of Advanced Studies, Dublin, Ireland
[7] University of Iowa, Iowa City, United States of America

NASA's Juno mission, launched in August 2011 and inserted into a polar orbit around Jupiter in July 2016, has provided nearly a decade of in-situ observations of the Jovian magnetosphere. One of its primary objectives is to characterize the magnetic field and plasma environment of Jupiter. Unlike the magnetospheres of Earth and Saturn, which are largely driven by solar wind forcing, Jupiter's magnetosphere is predominantly controlled by internal processes such as rapid planetary rotation and internal variations. Consequently, Jovian radio emissions are only partially modulated by external solar wind conditions. However, among the various emission components, the auroral broadband kilometric emission (bKOM) is thought to exhibit the strongest response to solar wind variations.

In this study, we combine catalogued Juno's radio emission observations (Boudouma et al., 2025) with outputs from a solar wind propagation model (the Multi Model Ensemble System for the outer Heliosphere, MMESH, Rutala et al., 2024) to investigate the coupling between upstream solar wind parameters and Jovian magnetospheric dynamics. Specifically, we focus on the temporal evolution of bKOM intensity and its correlation with modeled solar wind parameters, with the goal of establishing a statistically robust relationship rather than relying on qualitative associations. We perform a statistical analysis over X years of Juno mission to examine how compressions of the magnetosphere, traced through solar wind dynamic pressure, velocity and temperature, relate to variations in radio emission intensity.

Ultimately, this study aims to improve our understanding of solar wind - magnetosphere coupling at Jupiter and to enable the use of remote observations of Jovian auroral radio emissions as diagnostics of magnetospheric conditions. Such capability is particularly valuable for interpreting observations that depend on upstream solar wind conditions, including ultraviolet auroral measurements from the Hubble Space Telescope and in situ plasma measurements from current and upcoming missions such as JUICE and Europa Clipper. In a broader context, this work also contributes to improving predictive models of radio emissions from magnetized exoplanets.

Relationship between Sunspot Magnetic Field Strength, CME Activity, and Geomagnetic Storms with Sudden Commencement

Kirov B.[1], Georgieva K.[1], Kirov B.B.[2,3,4], Asenovski S.[1]
[1] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Faculty of German Engineering Education and Industrial Management (FDIBA), Technical University of Sofia
[3] BioInfoTech Laboratory, Sofia Tech Park, 111 Tsarigradsko Shose Blvd., 1784 Sofia, Bulgaria
[4] Department Industrial Automation, Technical University of Sofia, 1756, Sofia, Bulgaria

A Coronal mass ejections are one of the principal solar drivers of geomagnetic disturbances. Although their occurrence rate generally follows the level of sunspot activity, this relationship is known to vary from one solar cycle to another and even during different phases of the same cycle. Therefore, sunspot number alone cannot fully describe CME productivity or the expected geomagnetic response.

In this study, we investigate the relationship between sunspot magnetic field strength, CME activity, and geomagnetic storms with sudden commencement. The working hypothesis is that, for comparable levels of sunspot activity, periods with stronger magnetic fields in sunspots may be associated with higher CME productivity and a greater probability of geoeffective events. Geomagnetic storms with sudden commencement are used as a proxy for geoeffective solar eruptions, since they are commonly related to the arrival of interplanetary shock waves driven by CMEs.

The study compares temporal variations of sunspot number, sunspot magnetic field strength, CME occurrence, and the number of geomagnetic storms with sudden commencement. Particular attention is given to intervals in which CME activity deviates from the sunspot-number trend, as these intervals may reveal the role of magnetic field strength in modulating the efficiency of active regions in producing geoeffective CMEs.

The results are expected to clarify whether sunspot magnetic field strength can be used as an additional diagnostic parameter for the assessment of CME activity and geoeffectiveness. This may provide a useful contribution to understanding cycle-to-cycle variations in solar–terrestrial coupling and to improving empirical approaches to space-weather forecasting.

Observation of Sporadic E During Enhanced Geomagnetic Activity

Mosna Z., Koucka Knizova P.
Institute of Atmospheric Physics, Czech Academy of Sciences

We investigate the response of formation of Sporadic E layers (*Es*) to the enhanced geomagnetic activity during Solar Cycle 25, focusing on the extreme geomagnetic storms of May 2024 ("Mother's Day storm") and November 2025 ("Veterans Day storm"). The analysis is based on high-temporal-resolution Digisonde observations from several mid-latitude European stations, including Pruhonice, Dourbes, and Sopron Ionospheric Observatory.

The observations show a clear enhancement in the occurrence and variability of Es layers during geomagnetically disturbed periods. Increased Es activity frequently coincides with intervals of intensified auroral and geomagnetic forcing, suggesting a strong coupling between ionospheric dynamics and storm-time thermospheric processes. Significant variations were observed in both Es critical frequency and virtual height, accompanied by rapid temporal changes in layer structure. The results confirm that Sporadic E occurrence at mid-latitudes is strongly modulated by geomagnetic activity and associated changes in neutral wind dynamics and ionospheric plasma transport during major geomagnetic storms.

Geomagnetic Substorm Signatures at Mid-Latitudes: The March 23, 2023 Case Study from Panagyurishte

Raykova L.[1], Tsvetkov Ts.[2], Guineva V.[1], Werner R.[1], Bojilova R.[3]
[1] SRTI-BAS
[2] IANAO-BAS
[3] NIGGG-BAS

This study analyzes the genesis and terrestrial consequences of the strong G4-class geomagnetic storm that began on March 23, 2023. At the core of the disturbance lies a relatively rare solar event characterized as a filament-driven CME and two CME interaction observed by SOHO/LASCO coronagraphs. Analysis of H-alpha solar imagery from El Teide and AIA 304 Å data confirms that the event was driven by filament eruptions rather than strong X-ray flare.

The energy transfer from these solar sources resulted in a powerful geomagnetic storm, with the DST and SYM-H indices reaching minimum values of -163 nT and -170 nT, respectively. The ground-based response to the event was investigated in detail using high-resolution data from the IMAGE, SuperMAG, and INTERMAGNET networks, with a specific focus on the Panagyurishte Magnetic Station (PAG). Additionally, field-aligned currents were analyzed using data from the AMPERE system, which provides space-based magnetic measurements from the Iridium satellite constellation.

Four Midlatitude Positive Bay (MPB) events were recorded at the Panagyurishte station, occurring as a result of substorm development at auroral and high latitudes. The substorm presence was verified by the SuperMAG substorm lists, as well. The results of the study show that local magnetic disturbances follow closely the global and regional disturbances represented by the SML and IL auroral indices. These observations illustrate the process of energy transfer from high to mid-latitudes during geomagnetic disturbances.

Research Activities in Cosmic Ray and Space Weather Physics at the Belgrade Muon Station, Institute of Physics Belgrade, Serbia

Savić M., Veselinović N., Dragić A., Maletić D., Joković D., Banjanac R.
Institute of Physics Belgrade

Continuous measurements of cosmic ray muons have been carried out at the Belgrade Muon Station, part of the Low-Background Laboratory at the Institute of Physics Belgrade, since 2002, both at ground level and at shallow underground depth, using several generations of detector setups based on plastic scintillators. During this period, extensive studies of heliospheric modulation of primary cosmic rays have been performed, including spectral analysis of periodic variations as well as investigations of transient events such as Forbush decreases.

Special attention has been given to the study of atmospheric effects on the measured muon flux, particularly the influence of pressure and temperature. These studies led to improved atmospheric correction methods and increased detector sensitivity to cosmic ray variations of non-atmospheric origin. In addition, the connection between transient cosmic ray variations and their solar and heliospheric causes has been investigated, together with their relevance for space weather studies and related geomagnetic disturbances.

Space-Time Evolution of Solar Cycle 25 Intense Geomagnetic Storms

Stefan C., Dobrica V.
Institute of Geodynamics, Romanian Academy

We studied three of the most intense geomagnetic storms of solar cycle 25 namely, May 10-11 2024 (Dst= -406 nT), October 10-11 2024 (Dst= -333 nT) and January 1st 2025 (Dst= -212 nT), on one hand by investigating the spatial-temporal characteristics of the north component of the geomagnetic field during the storms, and on the other hand by means of sources of perturbations based on EOF and wavelet coherence analysis. We show that the ring current is the primary driver of the perturbations recorded in ground base data at the northern hemisphere scale. Also, using maps created at every 3 hours during the storms we highlight the areas where the perturbations are most intense.

Examination of Extremely Big Mesospheric Electric Fields from Rocket-Borne Measurements on October 21 1989

Tonev P.
Space Research and Technology Institute, Bulgarian Academy of Sciences

We examine a profile of the vertical electric field Ez in the region 24 - 69 km obtained by rocket borne measurements on October 21 1989 over the South Indian Ocean (Zadorozhny, Kikhtenko, et al., 1994, J. Geophys. Res., 99, D10, 21,059-21,069). The rocket experiment coincides with a major geomagnetic storm and a GLE event. The profile of Ez is characterized by well expressed peculiarities. Ez reaches extremely big maximums of both polarities in the mesosphere and in the upper stratosphere. At altitude 58 km Ez is oriented downwards and is 12.3 Vm^{-1}. At altitude 46 km Ez is orientated upwards and is 9.8 Vm^{-1}. The change of polarity of Ez is at 50 km. An explanation of this peculiar Ez profile is proposed based on a hypothetic mechanism of gradual decrease of conductivity in atmospheric regions of reach of solar energetic protons with the progress of SEP caused by accumulation of aerosol particles.

Peculiar Oscillations of Atmospheric Electric Field Preceding SEP of April 15 2001 – Interpretation

Tonev P.
Space Research and Technology Institute, Bulgarian Academy of Sciences

Studied are the peculiar variations of atmospheric electric field Ez at ground level demonstrated by measurements (Shumilov, Kasatkina et al., 2016) at Apatity (Russia). These peculiar variations are related to SEP event on April 15 2001. The most striking feature is a very strong oscillation of Ez which occurs just before the onset of the SEP event. Initially Ez, being downward as usual, increases to 600 V/m in about 15 minutes. Then, in another ~15 minutes Ez decreases and becomes upward reaching more than 1 kV/m. Finally, Ez becomes downward again. The extremely big jumps of atmospheric electric field Ez reached within short time of few tens of minutes cannot be result of changes of the air conductivity at surface - these are determined by variations in the vertical electric current Jz. We show that oscillations of Jz (thus, of Ez) can be explained as result of strong dynamics of conductivity in mesosphere and above caused by combined effect of: i) the enhanced ionization by solar X-ray well before the SEP onset; ii) variations of energetic proton flux.

Multiscale Dynamics of Intense Geomagnetic Storms, Observations from Dusheti, Georgia in Early 2024

Tsulukidze L.[1,6], Kharshiladze O.[1], Sorriso-Valvo L.[2,3], Elbakidze Kh.[4], Yordanova E.[5]
[1] Mikheil Nodia Institute of Geophysics of Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia
[2] Department of Electromagnetics and Plasma Physics, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Stockholm, Sweden
[3] Institute for Plasma Science and Technology (ISTP), National Research Council (CNR), Rende, Italy
[4] Business and Technology University, Tbilisi, Georgia
[5] Swedish Institute of Space Physics (IRF), Uppsala, Sweden
[6] Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

Intense geomagnetic storms give rise to both global and local hazards, such as satellite malfunctions, astronaut safety risks and power grid disruptions. Therefore, it is essential to have localized monitoring to better understand the regional impacts of space weather. This talk explores the complex solar wind-magnetosphere coupling dynamics using geomagnetic recordings of the Dusheti Geophysical Observatory in Georgia during three major storms in early 2024 (March 3, March 24 and May 11). Using a combination of cross-correlation, wavelet coherence and detrended fluctuation analysis (DFA), we characterize the multiscale nature of these events. Our analysis reveals ~200-minute time lag in solar wind parameters, specifically the z-component of interplanetary magnetic field, Bz, and the dynamic pressure. We also identified a distinct 12.5-hour coherence shift in a plasma beta interactions, which likely reflects the internal structure of impinging interplanetary coronal mass ejections (ICMEs) and the preconditioning of the magnetosphere. Furthermore, DFA uncovers measurable regime changes in the Hurst exponent, indicating an increase in system self-organization immediately preceding storm onset. These findings provide critical insights into localized space weather phenomena and showcase the value of regional observations in understanding and mitigating risks of severe geomagnetic disturbances.

Data Processing and Modelling

AE-Index Based Model for Predicting Ionosphere - Thermosphere Region Density Fluctuations

Abraham S.A., Antony S.
School of Pure and Applied Physics, Mahatma Gandhi University, Kottayam, Kerala, India

Thermospheric density enhancements during geomagnetic storms significantly increase atmospheric drag on low Earth orbit (LEO) satellites, affecting their orbital sustainability. In this study, we develop a simplified Auroral Electrojet(AE) index driven forecasting system for ITR response - density, drag and orbital decay (ASTRA - D3). The proposed model uses AE index as a proxy of Joule heating to predict ITR density enhancement and associated satellite drag and orbital decay. Thermospheric density observations from CHAMP and GRACE satellites are used to quantify density response to AE based Joule heating and the derived density is applied to compute satellite drag and orbital decay. The modeled orbital decay is validated against the decay derived from two line element (2LE) data. It is found that AE based Joule heating shows a lead time relative to ITR density and predicted orbital decay shows higher temporal correlation with 2LE derived decay. These findings suggest that ASTRA -D3 model can be used as a simplified satellite drag forecasting model during geomagnetic disturbances.

Photometric Reverberation Mapping through Theory-Agnostic Fitting of the Light Curves

Bachev R., Strigachev A., Dechev M.
Institute of Astronomy and NAO, Bulgarian Academy of Sciences

The term "theory-agnostic" describes a method or approach that is independent of a specific underlying theory, allowing analysis of phenomena and prediction making without the need of underlying assumptions about a particular framework. The approach is valuable since it can discover new physics that might be missed if one were only looking for effects predicted by a specific theory. It is often used in contemporary astrophysics, from analyzing gravitational waves from black hole mergers, to investigating temporal delays inherent in various solar and heliospheric processes, illustrating how solar activity affects the Earth and space environment over time. In this work we demonstrate similar technique, employing theory-agnostic polynomial fitting approach to find time delays between line and continuum variations of the active galactic nuclei (reverberation mapping), thus allowing probing the central regions and ultimately – measuring the central black hole masses. This method can work for time series, consisting of densely populated groups of points, separated from each other by a time interval much longer than the expected time delay – a common situation where very few (if any) other methods can successfully do the job. Among the objects we studied were the active galaxies (quasars) I Zw 1, UGC 6728, Mkn 478, PG 1448+273, II Zw 136, Ton 951, VII Zw 118, among others, all observed with a 60cm telescope of Belogradchik observatory, Bulgaria. Here we present some of the most promising first results of the application of this method.

Sources and Mechanisms of Activity of the Solar-Type Dwarf Star 61 Cyg A

Boneva D.[1], Yankova Kr.[1], Dimitrijević M.[2]
[1] Space Research and Technology Institute, Bulgarian Academy of Sciences
[2] Astronomical Observatory, Belgrade, Serbia

In this paper, we present results of our survey on the states of activity at different time intervals. We explore the sources of these states for the visual binary star 61 Cyg. The object contains a solar-type dwarf of a spectral type K5 - 61 Cyg A and a K7 dwarf - 61 Cyg B. We apply observational data, obtained from Transiting Exoplanet Survey Satellite (TESS), Swift/XRT telescope and XMM-Newton X-ray mission. The resulting light curves demonstrate variations in the light flux with periodic and non-periodic increases in values. Depending on the observational facility, these are represented as either the flux or count rate vs. time, respectively. The K5 component 61Cyg A is known as a strong X-ray source, which is related to its chromospheric activity. We examine the types of fluctuations in its chromosphere, whose properties are similar to those of the solar corona. A possibility of arising the Rossby instabilities in the object's chromosphere is discussed. We estimate an existence of horizontal types of Rossby vortices and their relationship with magnetic loops in the stellar corona, which is in analogy to the solar one. In accordance with the obtained accretion efficiency of 61Cyg A, which has a relatively low value but still active disc accretion, we could also suppose about its influence on the star's A component activity.

Influence of Solar Activity on Aluminum Alloy AA7075 (B95)

Bouzekova-Penkova A.
Space Research and Technology Institute, Bulgarian Academy of Sciences

Solar radiation is the primary source of electromagnetic energy in the Solar System and plays a key role in the physicochemical properties of materials used in the construction of spacecraft. The present study analyzes the impact of ionizing radiation, ultraviolet and solar radiation, as well as temperature fluctuations, on a novel type of composite based on aluminum alloy AA7075 (B95), which was exposed to outer space for 28 months. The results of the conducted experiment (DP-PM block), which is part of the space technology experiment "Obstanovka 1 – step", show that solar activity, although not record-high during the period 2013–2015, was entirely sufficient to cause thermal degradation, structural changes, and alterations in the mechanical properties of the investigated material. To confirm the reliability of the results, the space-exposed samples were compared with reference specimens stored under terrestrial conditions.

Data on Broadening of C I Spectral Lines by Collisions with Charged Particles for Solar Plasma Investigation

Dimitrijević M.S.[1,2], *Sahal-Bréchot S.*[2]
[1] Astronomical Observatory, Belgrade, Serbia
[2] LUX, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, F-92190 Meudon, France

Data on broadening of spectral lines by collisions with charged particles, or Stark broadening, are of interest for stellar plasma modelling and investigation, particularly for hot and dense stars like white dwarfs, where this is the principal pressure broadening mechanism. In the case of the Sun, Stark broadening may be of interest for infrared and Rydberg lines. Namely the influence of Stark broadening within a spectral series increases with the increase of the principal quantum number of the upper level, since the connection with the core of the atom becomes weaker and the optical electron becomes more sensitive to external electric fields. Also, Stark broadening is of interest for subphotospheric layers modeling and considerations, as well as for the calculation of radiative transfer through stellar plasma.

In order to provide the Stark broadening data of interest for solar plasma research, we have calculated line widths and shifts, determining line shape, for 15 spectral lines of neutral carbon, using the semiclassical perturbation theory.

In this contribution, we will discuss the significance of Stark broadening data for Solar plasma investigation and modelling and will present our new results for Stark broadening of C I spectral lines.

A New Framework for Data Analysis and Exploration from the Liulin-MO at ExoMars Trace Gas Orbiter

Georgiev G.[1,2], *Koleva R.*[1], *Semkova J.*[1], *Krastev K.*[1]
[1] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria

A new system for processing and analysis of data from the Liulin-MO at ExoMars Trace Gas Orbiter is currently under development. The system is based on modern software tools and workflows and will be cross-validated with the existing data processing chain to ensure consistent results and continuity with previous analyses.

The new framework will include improved visualization tools to make data exploration and interpretation easier and more efficient. It will also focus on automating data handling and routine processing tasks as much as possible, reducing manual work and improving reliability.

Study Radio-Propagation Characteristics of 3m Band with SYMORAIA-VHF Project

Georgiev G.[1,2], Simeonov R.[1,3], Simeonov L.[2], Kolev Z.[4], Shivachev S.[5]
[1] Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[3] Faculty of physics, University of Sofia, Sofia, Bulgaria
[4] Faculty of Telecommunications, Technical University of Sofia, Sofia, Bulgaria
[5] Compass Technic LTD, Sofia, Bulgaria

The SYMORAIA-VHF project aims to develop a system for data acquisition and analysis for studies of radio wave propagation in the 3 m VHF band and its relation to natural phenomena, with a particular focus on atmospheric conditions. The project combines the development of dedicated software, custom RF hardware, and the integration of commercially available software-defined radio (SDR) receivers into a system for systematic long-term monitoring of radio signal parameters.

Signals from the VHF Omnidirectional Range (VOR) ground-based navigation network are used as the primary signal source. VOR transmitters provide continuous and stable broadcasts and are distributed across a relatively dense network of transmission sites, making them well suited for propagation studies while minimizing the environmental footprint of the experiment.

As a result of the project, data from long-term systematic observations will be made available following FAIR principles. The collected datasets will be used to investigate possible correlations between radio propagation effects and atmospheric or other phenomena.

At the current stage of the project, the software for signal reconstruction, as well as the antenna systems and RF filters, are under active development. The conference contribution will present the current status of the project together with the first technical results and developments.

Forecasting of Hard SEP Events by Simultaneous Detection of Charged and Neutral GLE Fluxes at Aragats

Sargsyan B., Chilingarian A.
A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)

Rapidly identifying the most intense solar energetic particle (SEP) events is crucial for space-weather alerts because the detection of a multi-GeV proton component suggests the imminent arrival of dangerous 50–100 MeV protons that can harm satellites and other technological systems. We suggest an operational forecasting method based on the simultaneous detection of charged and neutral atmospheric secondaries at Aragats using the Aragats Solar Neutron Telescope and the SEVAN Light spectrometer. The main idea is to use local, energy-resolved neutron and muon observables instead of relying solely on global neutron monitor inversions. During GLE 77, both instruments recorded a two-peak temporal pattern, and the recovered neutron and muon spectra, along with the energy-dependent neutron-to-muon ratio, were best matched by primary protons slightly above the local cutoff rigidity, with effective upper energies near 9–10 GeV. This event shows that the spectral hardness of the solar-proton population can be estimated from ground-based detector data in near real time. In the proposed operational setup, a statistically significant muon increase serves as the initial trigger indicating a hard SEP component; precomputed CORSIKA+GEANT4 response templates are then used to compare with measured spectra and coincidence patterns, allowing classification of the event's hardness within minutes. Such a system provides a practical way to distinguish online between cutoff-dominated and genuinely hard SEP events, offering valuable warning time before the full hazardous proton population reaches near-Earth space.

New Trends in the Assessment of the Space Radiation Hazard

Shafirkin A., Benghin V., Shurshakov V.
Institute of Biomedical Problems of the Russian Academy of Sciences, Moscow. Russia

The assessment of the radiation hazard degree for human spaceflights has been carried out since the beginning of the space age and has now become a well-developed and detailed system used (with minor modifications) by all space agencies. Currently, in the new stage of space exploration with an emerging trend of commercial manned flights, there is a need to clarify the criteria and standards for assessing the radiation hazard in space.

One of the motivating reasons for our study was the emergence of a significant amount of experimental data on the effects in various living organisms caused by the space radiation high-energy charged particles. An analysis of radiobiological data over the past 30 years has shown that the maximum values of relative biological efficiency (RBE) coefficients at small radiation doses (from 0.1 to 0.5 mGy) are significantly (from 2 to 2.5 times) higher than the standard values of the quality factor coefficients for charged particles of galactic cosmic radiation. Accounting such data should lead to an increase in space radiation hazard assessments. At the same time, there is evidence of the effect of regenerative processes in the body during and after radiation exposure, which reduce the degree of the radiation damage. The short-term radiation effects during flight may affect the working capacity of astronauts. However, a significant decrease of radiation hazard caused by solar energetic protons during the development of powerful solar flares has been shown due to rapid regenerative processes at the cellular level in rapidly renewing radiosensitive body tissues.

In our study, both RBE increase and the rapid regenerative processes were considered as the two multidirectional factors and their influence on the radiation hazard for the manned flights beyond the Earth's magnetosphere was examined.

Mechanism of Preresonant Electrons Acceleration in Heliosphere and Solar Plasma

Shkevov R.[1], Zolnikova N.N.[2,3], Mikhailovskaya L.A.[2], Metodiev K.[1]
[1] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] Space Research Institute, Russian Academy of Sciences, Moscow, Russia
[3] Russian University of Transport, Moscow, Russia

A theoretical study of one of the preresonant interactions between electrons and electromagnetic waves is presented. The simulation assumes that the preacceleration stage is similar to the stages that occur before resonant wave-particle accelerations. Such interactions can take place in various types of space plasmas, including the solar one. Current research is conducted through the exact numerical solution of a second order nonlinear nonstationary differential equation for the wave phase on the charged particle trajectory. The calculations were made under the exact fulfillment of the conditions for the Cherenkovsky resonance. Numerical experiments based on different initial parameter sets for the differential equation demonstrated that interactions of this type can accelerate or decelerate the particles. The calculations results allow us to observe and analyze electrons energy dynamics and finally to estimate the particles energy at the end of the series of interactions. Most of the interesting results are presented in graphical form. Conclusions about the preresonant interactions as an originating source of particle streams from the heliosphere and solar plasma are made.

Light Pollution – New Measurements: the UrbObsBel Project

Simić Z.[1], Samurović S.[1], Pavlović R.[2], Cvetković Z.[2], Damljanović G.[1]
[1] Astronomical Observatory Belgrade
[2] Institute of Physics Belgrade

The Urban Observatory of Belgrade (UrbObsBel) is a three-year project funded by the Science Fund of the Republic of Serbia developed as an urban observatory for the systematic monitoring of light pollution in Belgrade, also using the measurements of sky brightness at the Astronomical Station Vidojevica, one of the last remaining dark spots in Serbia, employing proven astronomical techniques and multiple complementary instruments. At both stations we have Unihedron SQM-LE and TESS-W photometers, and in Belgrade we have also been using two hyperspectral imaging sensors (HSIs). In this contribution we present our measurements obtained so far. We show that Belgrade is subject of strong light pollution. This research is supported by the Science Fund of the Republic of Serbia, grant no. 6775, Urban Observatory of Belgrade - UrbObsBel.

Deep Learning Architectures for Monitoring Spruce Forest Health via Sentinel-2 Multi-Spectral Data: A Review of Current Trends

Tsvetkova M., Filchev L.
Space Research and Technology Institute, Bulgarian Academy of Sciences

The escalating frequency of extreme climatic events, driven by solar-terrestrial interactions and global atmospheric shifts, has significantly increased the vulnerability of Picea abies (Norway spruce) ecosystems. In recent years, the synergistic use of ESA's Sentinel-2 satellite constellation and Deep Learning (DL) algorithms, such as Convolutional Neural Networks has emerged as a transformative tool for forest health monitoring. This poster presents a comprehensive literature review of research from the period 2019–2025, focusing on the detection of early-stage forest decline and bark beetle infestations.

Based on the conducted review, it is evident that Deep Learning (DL) architectures, specifically Convolutional Neural Networks (CNNs) and Vision Transformers, offer superior accuracy in processing Sentinel-2 multi-spectral bands compared to traditional vegetation indices. The analysis highlights that the 'Red Edge' spectral channels are critical for identifying 'green-attack' stages before symptoms become visible to the human eye. However, our synthesis of recent studies suggests that while these models achieve high precision in mapping forest disturbances, their effectiveness remains limited by challenges in data labeling and model transferability across different bioclimatic regions. We conclude that integrating multi-spectral remote sensing with advanced AI is essential for developing resilient 'early warning systems' to mitigate the impact of climate-induced stressors on coniferous forests.

The VAMDC Ecosystem: Enabling Solar Atmospheric Physics through Interoperable Atomic and Molecular Data

Vujčić V.
Astronomical Observatory Belgrade

We will present an ongoing effort in developing, maintaining and upgrading Atomic and Molecular databases and services as a part of VAMDC interoperable ecosystem. We will present the importance of such microscopic data in macroscopic modeling, relevant to Solar atmospheres and various other scientific use cases. This presentation will highlight recent work on theoretical data on reactions such as molecular ion photodissociation, for the species pertinent to Solar region.

Development of the Total Ozone Column over Sofia Between 1979 and 2022

Werner R.[1], Guineva V.[1], Raykova L.[1], Bojilova R.[2], Petkov B.[3]
[1] Space Research and Technology Institute (SRTI) – Bulgarian Academy of Sciences, Stara Zagora Department, Bulgaria
[2] National Institute of Geophysics, Geodesy and Geography (NIGGG) - Bulgarian Academy of Sciences, Sofia, Bulgaria
[3] Institute of Polar Sciences (IPS) - National Research Council (CNR), Venezia, Italy

Since the restriction of ozone depleting substances by the Montreal Protocol 1987 the global ozone depletion was stopped and after an onset phase that has now lasted more than 30 years, an increase of ozone is already expected. The trends of total ozone column (TOC) depend on the latitudes and vary from region to region. This study examines the development of TOC over Sofia from 1979 up to 2022. Using the monthly ozone overpass data based on Multi Sensor Reanalyse (MSR2), we have performed trend analysis by help of a linear multiple regression model. We have analysed the distribution and the scedasticity of the residuals. The residuals of the series, which covers all months, are neither normally distributed nor homoscedastic. The reason of the heteroscedasticity lies in the high variability of the ozone levels during the winter periods, when subtropical air masses are frequently replaced by air masses from polar origin. We have divided the TOC series into the ozone winter (DJFM) and the ozone summer (MJJASO) ones. The residuals of these series are close to or are normally distributed and the series are homoscedastic. The stratospheric temperature at 100 hPa has a significant influence on TOC over Sofia. A lag of only some months was observed for the solar flux during ozone summer. In contrast the lag during the ozone winter is of the order of three years, depending on which predictors are included in the regression. The cause could be related to the age of the ozone within the vortex. With regard to the zonal stratospheric winds, the best results were obtained with a lag of almost one year. After the turnaround point, no statistically significant increase in TOC was observed over Sofia.

Some Examples of Reflectionless Propagation of Electromagnetic Waves in Nonuniform Space Plasma

Zolnikova N.N.[1,2], *Shkevov R.*[3], *Mikhailovskaya L.A.*[1]
[1] Space Research Institute, Russian Academy of Sciences, Moscow, Russia
[2] Russian University of Transport, Moscow, Russia
[3] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria

We study the possibility of reflectionless propagation of electromagnetic wave through complicated space plasmas structures, which in general case can be opaque. This problem is of interest in particular for transmission of electromagnetic signals from a source located in the near-Earth plasma through the surrounding evanescent regions. We show that for some distinguished profiles of dielectric permittivity the effective transillumination of electromagnetic wave can happen. Applying numerical calculations to exact solution of one-dimensional linear Helmholtz equation, we demonstrate that under some choice of a wave number and the corresponding profile of dielectric permittivity the monochromatic electromagnetic wave can pass through opaque regions without reflection. In contrast with the standard WKB approximation, this approach has no restrictions on the relationship between the length of inhomogeneity and the length of incident wave. Some new profiles of the normalized amplitude of the electromagnetic wave, the effective plasma permittivity and the dimensionless wave number are presented and discussed.

Instrumentation for Space Weather Monitoring

Microwave Spectral Solar Observations at Irbene: Advances in Automation and Imaging with RT-32

Bezrukovs V.[1], Bezrukovs D.[1], Šteinbergs J.[1], Orbidans A.[1], Aguirre E.[2], Wassim Bouzarhoun E.A.[2], Janices I.[2]

[1] Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Ventspils, Latvia

[2] Department of Electrical, Electronic and Communication Engineering of the Public University of Navarra (UPNA), Pamplona, Spain

It is well known that spectral observations of microwave (1–10 cm) polarized solar emission provide a powerful diagnostic tool for direct measurements of plasma parameters and magnetic field strengths in the upper chromosphere and lower corona, at heights above the photosphere. Therefore, microwave solar observations are highly relevant for studying a wide range of solar physics problems, including the mechanisms of solar activity and the origins of space weather.

In recent years, the Ventspils International Radio Astronomy Centre (VIRAC) of Ventspils University of Applied Sciences, Latvia, has developed and carried out systematic spectral polarimetric microwave observations of the full solar disk and its individual active regions. Observations are performed with the RT-32 radio telescope operating in a single-dish mode. The system is equipped with a 12-channel spectral polarimeter and operates in the 2.1–7.4 cm (4.1–14.3 GHz) wavelength range, providing simultaneous measurements of both circular polarization components.

Alongside the observational programme, significant progress has been made in the automation of the observing workflow and in the development of imaging techniques for single-dish solar radio data. A dedicated software system has been implemented to automate observation scheduling, antenna pointing, data acquisition, and preliminary processing. In parallel, image reconstruction methods have been developed to transform scanning observations into two-dimensional microwave brightness maps of the Sun, enabling improved visualization and analysis of active regions.

The presentation addresses the current status of solar microwave observations at VIRAC, including technical and methodological developments, with a particular focus on automation and imaging solutions for the RT-32 system. In addition, ongoing and potential applications of these observations in solar physics are discussed. These include the study of coronal holes and coronal hole-like structures (such as coronal corridors, coronal partings, and the S-web), which are associated with open magnetic field regions and may act as sources of the slow solar wind. The analysis of microwave flux variability in active regions preceding solar flares is also considered as a promising diagnostic of pre-flare activity.

Bulgarian Instruments for Aircraft, Space and Ground Based Radiation Dosimetry and Their Main Scientific Results

Dachev Ts.[1], Tomov B.[1], Matviichuk Yu.[1], Dimitrov P.[1], Mitev M.[1], Jordanova M.[1], Semkova J.[1], Koleva R.[1], Maltchev St.[1], Bankov N.[1], Krastev K.[1], Mitrofanov I.[2], Golovin D.[2], Litvak M.[2], Sanin A.[2], Shurshakov V.[3], Benghin V.[3], Ivanova O.[3], Ploc O.[4], Kubancak J.[4], Häder D.-P.[5], Lebert M.[6], Schuster M.T.[6], Reitz G.[7], Horneck G.[7], Uchihori Y.[8], Kitamura H.[8], Tobiska W.[9], Hogan B.[9], Gersey B.[9], Okuyama K-I.[10], Tapia I.[10], Fajardo I.[10], Saganti P.[11]

[1] Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria
[2] State Research Center Institute of Biomedical problems, Russian Acad. of Science, Moscow, Russia
[3] Space Research Institute, Russian Acad. of Science, Moscow, Russia
[4] Nuclear Physics Institute, Czech AS, Prague, Czech Republic
[5] Neue Str. 9, 91096 Möhrendorf, Germany
[6] Friedrich-Alexander-Universität, Department for Biology, Erlangen, Germany
[7] DLR, Institute of Aerospace Medicine, Köln, Germany
[8] National Institute of Radiological Sciences-STA, Chiba, Japan
[9] Space Environment Technologies, Los Angeles, CA, USA
[10] College of Science and Technology, Nihon University, Chiba, Japan
[11] Radiation Institute for Science and Engineering Prairie View A&M University, Prairie View, TX, USA

The paper summarize information for Bulgarian build aircraft, space and ground based radiation dosimetry instruments and their main scientific results. The first Liulin-type spectrometer-dosimeter was developed for the scientific program of the second Bulgarian cosmonaut Alexander Alexandrov in 1986-1988. Forty-one Liulin-type spectrometers-dosimeters were developed. Twenty-two of them were tested and qualified for operation in space. Three of them did not reach the planned orbits around Earth and Mars due to technical problems with the carriers. The scientific objectives of 12 of these 20 Liulins were to measure the variations of the flux and dose rate of cosmic radiation on satellites and space stations in orbit around the Earth. Eight of the spectrometers support biological and chemical experiments in space with up-to-date information on the history of dose accumulation. Nineteen instruments worked on aircraft and on the ground. The RADOM instrument operated on the track to Moon and in circular orbit around the Moon. The Liulin-MO dosimeter is active since 2016 on the track and in a 400 km circular orbit around Mars.

Ionospheric and Space Weather Monitoring Using HF Radio Signals from the Amateur Bands

Ivanov Zh.
Space Research and Technology Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria

High-frequency (HF) radio signals in the amateur bands (3–30 MHz) provide a globally distributed, low-cost means of monitoring ionospheric variability and space weather disturbances. HF skywave propagation is highly sensitive to electron density, ionospheric layer structure, and geomagnetic conditions, so changes in signal strength, propagation mode, and circuit availability can be used to infer both gradual ionospheric trends and transient events driven by solar and geomagnetic activity. This overview article examines how routine amateur radio transmissions—including continuous-wave beacons, digital modes, and voice/data signals—can be exploited as a passive sensor network for ionospheric and space weather diagnostics. The NCDXF/IARU beacon network is discussed as one example of a stable, time-controlled reference system whose multi-band transmissions help track long-distance propagation changes under different geophysical conditions. By combining automated reception networks, crowdsourced signal reports, and ionospheric models, HF signals in the amateur bands support the detection and characterisation of geomagnetic storms, traveling ionospheric disturbances (TIDs), sporadic E layers, solar flares, and eclipse-related ionospheric perturbations. Overall, amateur radio infrastructure is shown to offer a valuable and complementary observational resource for real-time ionospheric and space weather monitoring.

SEVAN Light Spectrometer for Solar Physics and High-Energy Atmospheric Physics: Data Processing and Modelling

Karapetyan T., Abovyan S., Pokhsraryan D., Sargsyan B.
A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)

SEVAN Light is a compact spectrometric detector designed for simultaneous measurements of charged and neutral secondary particles produced during solar energetic particle events and high-energy atmospheric phenomena. The detector combines a 20 cm thick, 0.25 m² spectrometric scintillator with a 1 cm thick, 1 m² veto scintillator and uses logarithmic ADC electronics to capture energy deposits in the 5–300 MeV range. Coincidence channels (“01”, “10”, “11”) enable event classification into neutral-enriched and charged-enriched samples, while one-minute histograms of deposited energy form the basis for detector-level spectroscopy. We describe the data-processing and modeling chain developed for SEVAN Light, including background subtraction, conversion of detector pulses into energy-deposit histograms, inverse retrieval of particle energy spectra using GEANT4-derived response matrices, and comparison with atmospheric cascade simulations generated by CORSIKA. This framework has been applied to thunderstorm ground enhancements and GLE 77, allowing direct recovery of muon- and neutron-dominated spectra as well as the construction of energy-dependent observables such as the neutron-to-muon ratio. For solar-particle studies, the detector-response chain is integrated with libraries of precomputed atmospheric templates, enabling comparison of measured spectra with model expectations for different primary proton energies and real-time identification of spectral hardness. Thus, the instrument bridges the gap between traditional counting detectors and full calorimetric systems: it offers a compact, autonomous, and operationally useful source of spectrometric data for both space-weather monitoring and high-energy particle acceleration studies in the atmosphere.

Cosmic Ray Detection Using the Liulin-MO Instrument aboard ExoMars Trace Gas Orbiter: Numerical Analysis

Krastev K.[1], Semkova J.[1], Koleva R.[1], Benghin V.[2], Drobijshev S.[2]
[1] SRTI - BAS
[2] IMBP - RAS

This work presents results from numerical simulations of the telescope system for detecting cosmic radiation in the Liulin-MO instrument. Simulations were carried out for different particle types over a range of energies. The main effects leading to distortions in the response of the telescope system are presented and analyzed. The secondary particles produced by interactions of primary cosmic rays with the spacecraft structure of ExoMars Trace Gas Orbiter and the Liulin-MO instrument are analyzed.

Ground-Based Monitoring of Global Solar Radiation and UV Irradiance

Minev M., Tsvetkov Ts., Petrov N.
Institute of Astronomy and National Astronomical Observatory, BAS

We present results from continuous ground-based monitoring of global solar radiation and ultraviolet irradiance in the UVA and UVB spectral ranges, based on measurements performed with Kipp & Zonen instrumentation at Rozhen National Astronomical Observatory of the Bulgarian Academy of Sciences. The observations of global solar radiation cover a period of two and a half years, while systematic UV measurements have been conducted for nearly one year.

The analysis focuses on the seasonal variability of the radiation fluxes, as well as on evaluation the influence of atmospheric conditions on the recorded values. Comparisons between global radiation and its UVA and UVB components are presented in order to identify correlations and characteristic relationships related to atmospheric transparency and cloud cover.

The results reveal a well-defined seasonal variability and highlight the importance of long-term observations for a reliable assessment of the radiation balance. The study contributes to a better understanding of local radiative characteristics and has potential applications in atmospheric physics, environmental studies, and UV exposure assessment.

Research of the Impact of Solar Activity over Upper Atmospheric and Stratospheric Layers (10 – 30 km) and Testing Aerospace Equipment by Aerostat with Autonomous Returning Module

Nikolov I.
Space Research and Technology Institute, Bulgarian Academy of Sciences

Earth's atmosphere is separated into several main layers in altitude, according to their density, composition and physical properties. Since the physical impact of solar activity over the throposphere have been studied relatively well, using ground instruments and aviation, we have less scientific data about the upper atmosphere, as research methods tend to be very expensive. One relatively cost-effective and reliable way of research is the use of hydrogen filled balloons with attached scientific equipment, which can climb altitudes up to 30-34 km. the disadvantage of this method is that the precious scientific equipment is usually lost in the end. This problem can be overcome by the use of aircraft type returnable carrier, which can deliver back the scientific equipment. She will be guided back to Earth autonomosly by an autopilot, meanwhile sustaining reliable two ways telemetric, video and data radio link with the ground station. It can also transmit real-time live scientific data to a server on the ground.

Atmospheric Dosimetry

Nikolov N.
Space Research and Technology Institute, Bulgarian Academy of Sciences

The paperwork deals with the atmospheric dosimetry. Atmospheric dosimetry measures radiation (cosmic rays and secondary particles) within the Earth's atmosphere.

Nowadays the significance of atmospheric dosimetry increases with the rapid development of air transportation. Global airline traffic in 2025 reached over 5 billions passengers. Most commercial airplanes fly at altitudes between 10 and 12 000 meters, where the radiation exposure is 10 to 40 times higher than at sea level. The now common trans-polar routes expose passengers to double and triple levels of radiation, compared to the lower-latitude ones. The increasingly popular long haul commercial flights increase the time of radiation exposure to over 15 hours. The more and more accessible business aviation, with over 5 million passengers in 2025, commonly use flight altitudes between 12 500 and 15 500 meters, where the typical radiation dose can be up to 100 times higher than the natural background radiation at sea level.

Nowadays, the atmospheric dosimetry benefits of all modern technologies, such as low-cost and reliable radiation detectors, often Internet-connected and providing real time data. Lightweight, low-consumption and safe instruments are available to be placed onboard commercial aircrafts, performing measurements for extended periods of time. Other techniques include automated high-altitude balloon probes and unmanned aerial vehicles (UAV).

There are significant achievements in software development, with applications such as CARI, which calculates the effective dose of cosmic radiation received by an individual on an aircraft, based on flight path, altitude, flight duration and solar activity.

Complex Observation of the Ionosphere for Enhanced Satellite Trajectory Planning

Ognianov O.
Space Research and Technology Institute, Bulgarian Academy of Sciences

The operation of space-based assets is increasingly threatened by various forms of space weather, leading to significant disruptions in satellite functionality. These anomalies are primarily driven by solar phenomena such as Coronal Mass Ejections (CMEs), High-Speed Solar Winds (HSS), and Solar Proton Events (SPEs), particularly affecting satellites in Low Earth Orbit (LEO). Changes in drag caused by elevated air particles during these events necessitate orbit elevation to maintain velocity, requiring predictive information on Sudden Ionospheric Disturbances (SIDs). This study proposes a method that combines multiple data sources to create a real-time 3D representation of the ionosphere, ultimately achieving a 4D model for effective trajectory planning. Key components of the study include: Customized Software: Developed to display a chart plotting channel power vs. time, useful for detecting solar flares, CMEs, and Gamma Ray Bursts (GRBs) via SIDs. The signal source typically involves Very Low Frequency (VLF) signals from distant transmitters, such as those used by navies for submarine communication (e.g., GQD/HWU/NAA). Data Integration: The analysis incorporates additional data sources to determine the cause of SIDs: X-ray data from GOES satellites for visual correlation with VLF power measurements. Images and videos from the Solar Dynamics Observatory at EUV wavelengths to visually confirm solar flares. GRB events measured by satellites like Fermi and Swift. Solar flare events detected by the STIX X-ray instrument on the Solar Orbiter. Proton flux measurements from GOES satellites.

SWARM Satellite Data: By integrating observations from the SWARM satellite constellation, a flagship mission of the European Space Agency (ESA), this study enhances our understanding of the Earth's magnetic field and the ionosphere. The mission's three identical satellites provide continuous, precise measurements, invaluable for developing and validating 4D ionosphere models that describe the dynamic state of this crucial atmospheric region over time and space.

On the Investigation of the Variability of the Ionosphere over Africa – A Review: Instruments, Research Results, Modelling and International Cooperation

Rabiu B.[1,2,3], Adeika J.O.[3]
[1] National Space Research and Development Agency, Abuja, Nigeria
[2] African University of Science and technology, Abuja, Nigeria
[3] Network of Space-Earth Environmentalists, Abuja, Nigeria

This work presents a review of recent results that revealed the spatio-temporal variability of ionosphere over Africa. The results were obtained from the multiple ionospheric/space weather monitoring equipment that have been deployed to Africa in the past 2 decades which include: magnetometers, GNSS receivers. Optical imagers, Fabry Perot Interferometers, among others. The manifestation of equatorial electrojet (EEJ) and its counter electrojet was examined over Africa. The EEJ appear stronger in East than West Africa. There is clear indication that equatorial ionosphere exhibits longitudinal variability over Africa. Over Nigeria, at sunrise (sunset) TEC decreases westwards (eastward) across all the latitudes. This variability pattern is attributed to the time-related depreciation in the ionization due to the relative motion of the earth with respect to the position of the Sun. The Equatorial Plasma Bubble (EPB) intensities are greater during seasons with high occurrence rates. The post-sunset EPB intensities are greatest in the Atlantic region, followed by the African region, then the American, Australian, Asian, and Pacific regions in that order. The post-midnight intensities are greatest in the African region, followed by the Atlantic, American, Australian, Asian, and Pacific regions in that order. These and other results are presented showcasing a better understanding of the ionosphere over Africa. This work also presents the first regional TEC model developed over the entire African region (known as AfriTEC model) using empirical observations along with its storm time upgraded version.

Mini Neutron Monitor at National Astronomical Observatory: Calibration and First Measurements

Tsvetkov Ts.[1], Petrov N.[1], Mishev A.[2], Poluianov S.[2], Minev M.[1]
[1] Institute of Astronomy and National Astronomical Observatory, Bulgarian Academy of Sciences
[2] University of Oulu, Sodankyla Geophysical Observatory and Space Physics and Astronomy Research Unit

A mini neutron monitor station (MNM-ROZH) was recently deployed at the National Astronomical Observatory of the Bulgarian Academy of Sciences at 1730 m and has been operational since June 2025. The instrument includes three compact neutron monitor units equipped with BF3 proportional counters (type LND2043). The main scientific goal of the instrument is to measure variations, including transients, of the incoming cosmic rays – high-energy particles produced in a variety of astrophysical environments, including explosive stellar phenomena and processes related to solar activity. They are composed mainly of protons, along with heavier nuclei and electrons, and their flux near Earth is strongly influenced by solar-driven disturbances in the heliosphere.

We summarize the initial results from the first year of operation of the station. Calibration procedures have been carried out, including the derivation of the barometric coefficient, as well as initial assessments of temperature and snow-related effects. The reliability of the measurements is illustrated by the clear detection of a significant Forbush decrease in January 2026. These results demonstrate the station's capability to contribute to continuous cosmic ray monitoring and to studies of solar-terrestrial interactions.

Real-Time Space Weather Observations Using gLOWCOST Global Network of Low-Cost Muon Detectors

Veselinović N.[1], Savić M.[1], Mudiyanselage E.H.[2], Hettiarachchi T.G.[2], Mila Ranitović M.[3], Xiaochun He X.[2]

[1] Institute of Physics Belgrade, University of Belgrade, Serbia
[2] Georgia State University, USA
[3] Department of Physics, Faculty of Sciences, University of Novi Sad, Serbia

The gLOWCOST (global LOW-COST cosmic ray muon detector network for monitoring dynamic changes in space and terrestrial weather) network, is a cost-effective global network of portable muon detectors. It provides continuous ground-based monitoring of space weather through a globally distributed array of low-cost cosmic-ray muon detectors. The network currently comprises more than 20 detector stations operating across 10 countries.

A key advantage of the gLOWCOST network is its capability to monitor space weather disturbances on a global scale, enabling comparative studies among sites with different latitudes, longitudes, altitudes, and geomagnetic cutoff rigidities. In addition to applications in space weather monitoring, gLOWCOST also provides a framework for atmospheric tomography using global cosmic ray observations and additionally promotes international scientific cooperation and STEM education. This presentation introduces the detector concept and reports preliminary global observations from the gLOWCOST network during several extreme events of Solar Cycle 25. By leveraging detectors sensitive to different cosmic ray energies, determined by their specific locations, the network yields complementary data to traditional cosmic ray observatories. These multi-site, energy-dependent measurements enhance the characterization of space weather events and improve our understanding of their spectral response.

Solar Influences on the Lower Atmosphere and Climate

The Imprint of Solar Variability on Climate Indices

Dobrica V., Mares C., Mares I., Demetrescu C.
Institute of Geodynamics, Romanian Academy

The study investigates the imprint of solar variability on certain climate indices by examining the statistical relationships between solar/geomagnetic activity, described by Wolf sunspot number and the aa geomagnetic index, and large-scale modes of atmospheric and oceanic variability, quantified by climate indices, such as Greenland-Balkan Oscillation Index (GBOI), North Atlantic Oscillation Index (NAOI), Arctic Oscillation (AO), Atlantic Multidecadal Oscillation (AMO), Southern Oscillation Index (SOI) and Bivariate ENSO Timeseries (BEST). By applying elements from information theory and wavelet transform analysis we explore the extent to which solar signals can be identified within selected climate indices, with particular focus on temporal coherence, spectral characteristics, and possible lagged responses. The analysis pointed out periods of enhanced coupling between solar and climate variability, suggesting that solar forcing may contribute to modulating regional and global climate patterns through complex atmosphere–ocean interactions.

From Space to Land: Impact of Two Large Solar Events on Key Climate Indicators from Land Surface Stations Globally

Ivanova E., Koleva K.
Space Research and Technology Institute, Bulgarian Academy of Sciences

In our study, we investigate the possible influence of solar activity on the global climate. For this purpose, we took two cases of big solar eruptions: the so-called Halloween solar storms, which included solar flares and coronal mass ejections from mid-October to early November 2003, peaking around October 28–29, and series of strong solar eruptions that took place from May 10–13, 2024, during solar cycle 25. We then compared these with important climate indicators, such as daily surface temperatures, during the same time periods for remote stations on the Earth’s surface at latitudes between 60 and 80 degrees. We used historical records of air temperature (average and maximum) measured at 1.25 to 2 meters above the land surface, provided by the World Meteorological Organization (WMO) through the NOAA platform.

Temperature Dynamics in Crevasse-Drainage Systems of Antarctic Glaciers

Parov Ts.
Space Research and Technology Institute, Bulgarian Academy of Sciences

During the 32 and 33rd Bulgarian Antarctic Expedition, field studies were conducted to examine the internal microclimate of crevasse-drainage systems of the three glaciers located on Livingston island - Antarctica: Balkan Ice Field, Johnsons and Contell Glaciers. The research is focusing on the relationship between fluctuations of surface meteorology parameters, internal air glacier temperatures in to the crevasses and possible connection with solar activity. The total duration of the study exceeds 60 days, making it the longest temperature monitoring of glacier crevasses in Antarctica. Measurements of air temperature, humidity, and atmospheric pressure were carried out using autonomous sensors, while ultrasonic anemometers recorded airflow direction and speed inside the crevasses. The study identified a distinct temperature gradient at 3-meter intervals and mapped the depth of zones with persistently negative temperatures. Increased solar activity was associated with lower internal glacier temperatures and stronger air circulation. A negative correlation was found between solar activity and both temperature and downward airflow within crevasses.

Troposphere–Ionosphere Coupling During Warm-Season Derecho-Associated Mesoscale Convective Systems in Central Europe

Potužníková K., Koucká Knížová P.
IAP CAS

The coupling between the troposphere and the upper atmosphere during intense convective events has been the subject of extensive investigation. In this study, we focus on potential ionospheric responses to derecho-type meteorological events, which are widespread, long-lived severe windstorms associated with fast-moving mesoscale convective systems (MCSs). Specifically, we analyse the development of the sporadic E (Es) layer and irregularities in the F2 layer recorded by ionosonde measurements, and investigate their possible association with particular tropospheric events. The organisation and intensity of the tropospheric systems were examined using meteorological radar data and standard surface meteorological observations, supplemented by microphysical measurements from a 2D video disdrometer as well as surface and upper-air pressure reanalysis charts.

Preliminary statistical results indicate an increased occurrence of ionospheric irregularities, including enhanced Es layer activity, during periods of MCSs associated with derecho events over Central Europe. The analysed cases occurred under geomagnetically quiet conditions and stable solar activity, reducing the likelihood of direct ionospheric forcing by space weather. Therefore, the observed ionospheric response may be linked to atmospheric gravity waves generated by the tropospheric MCSs.

First Major Eruption of Solar Cycle 25: Impacts of the 3 July 2021 X1.59 Solar Flare on the Ionosphere

Sreckovic V.
Institute of Physics Belgrade, UB

The X1.59 solar flare observed on 3 July 2021 was the first X-class flare of Solar Cycle 25, and the first event of this magnitude since 10 September 2017. A distinctive feature of this flare was the occurrence of a geomagnetic crochet, a brief and localized disturbance in Earth's magnetic field coinciding with the flare's peak intensity. To our knowledge, this work presents the first analysis of this event using very low frequency (VLF) measurements, as well as the first multi-instrument study dedicated to it. VLF signal data from the NAA and DHO transmitters were analyzed to examine the ionospheric response, focusing on amplitude and phase variations. From these observations, important lower-ionosphere parameters were determined, including the effective reflection height, sharpness factor, time delay, and electron-density profiles. The results indicate a rapid ionospheric reaction strongly correlated with peaks in X-ray flux, with sudden disturbances in signal amplitude and phase pointing to enhanced ionization in the lower ionosphere and confirming the presence of the geomagnetic crochet effect.

Influence of Strong Solar Proton Events of the 23rd Solar Cycle on the High-Latitudinal Atmosphere of the Northern Hemisphere

Veretenenko S.[1], Koval A.[2]
[1] Ioffe Institute, Russian Academy of Sciences, St Petersburg, Russia
[2] St Petersburg State University, St Petersburg, Russia

In this work we study variations of the atmospheric characteristics at high latitudes of the Northern Hemisphere associated with strong Solar Proton Events (SPEs) of the 23rd solar cycle, the data from MERRA-2 archive being used. Three series of SPEs were considered: 1) the Halloween events on 26, 28, 29 October, 2 and 4 November, 2003; 2) the events on 15, 16, 17 and 20 January, 2005; 3) the events on 5, 6 and 13, 14 December, 2006. It was found that, in the lower atmosphere, all the studied SPE series were accompanied by an intensification of cyclone regeneration (re-deepening) near the south-eastern coast of Greenland and a noticeable increase of the North Atlantic Oscillation index. In the middle atmosphere, an intensification of the stratospheric polar vortex was found after the beginning of all the studied series, with the increase of zonal wind speed being strongest in the North Atlantic region. The SPEs under study were also accompanied by pronounced variations in planetary wave (PW) activity which was characterized by the amplitudes of PW1 and PW2 (waves with zonal numbers 1 and 2, respectively), as well as by the vertical component of the Eliassen-Palm flux. The polar vortex intensification associated with the events of January, 2005 and December, 2006 was followed by its weakening which results in the development of a stratospheric warming about 2 weeks after the last event of the series.

Solar Effects in the Biosphere and Lithosphere

Determining the Influence of Solar Radiation on the Dynamics of Lake Srebarna's Water Surface Area through Remote Sensing

Jelev G.[1], Ivanova I.[1], Tsvetkova M.[1], Zhelezov G.[2], Benderev Al.[2], Chanev M.[1]
[1] Space Research and Technology Institute, Bulgarian Agricultural Academy
[2] Geological Institute, Bulgarian Academy of Sciences

This publication examines the impact of solar radiation on the state of the open water surface of Lake Srebarna, the most significant site within the Srebarna wetland system. Data from the Sentinel 2A and 2B satellites, along with index imagery (NDVI, NDWI), were utilized to determine the water surface area for the period from January 1, 2025, to December 31, 2025. For the area of the NATURA 2000 protected zone, the monthly amounts of area solar radiation were calculated. The values were obtained based on a Digital Elevation Model (DEM) with a pixel size of 30x30 m, derived from the Shuttle Radar Topography Mission (SRTM). The correlation between the amounts of surface solar radiation and the water surface area of Lake Srebarna was investigated. An analysis of the obtained results was performed.

Special Session: China Space Station (CSS)

Space Science and Utilization of CMSP: Prosperity and Sustainable Development for Humankind

Ke Wang
Technology and Engineering Center for Space Utilization (CSU), Chinese Academy of Sciences

This speech provides a concise overview of the China Manned Space Program (CMSP) and its space science and utilization philosophy, emphasizing how the program contributes to prosperity and sustainable development for humankind. The speaker first outlines the development of CMSP, from its early milestones to the completion of the China Space Station (CSS), highlighting the program's steady progress in human spaceflight capabilities.

The role of the Technology and Engineering Center for Space Utilization (CSU), Chinese Academy of Sciences, is then introduced as the leading entity responsible for the overall planning, integration, and full-lifecycle management of scientific payloads and experiments aboard the CSS. CSU ensures that the space station operates as a space laboratory, maximizing its return for both fundamental research and applied sciences.

The speech further emphasizes the strategic vision behind the Space Utilization System, focusing on the CSS as an open platform that enables cutting-edge research across multiple disciplines while supporting the long-term sustainability of space activities. In conclusion, this talk reaffirms China's commitment to using the CSS as a tool for shared human advancement, welcoming global participation and fostering collaborative research that addresses challenges facing our planet and future space exploration.

Research Progress and Planning for Microgravity Sciences on China Space Station

Zhang Wei
Utilization and Development Department, Technology and Engineering Center for Space Utilization (CSU), Chinese Academy of Sciences

This presentation provides a comprehensive overview of the research progress and future planning for microgravity sciences aboard the China Space Station (CSS). The speaker begins by introducing the major research fields under the space utilization program, including space life sciences, microgravity fluid physics, space materials science, microgravity combustion science, and microgravity fundamental physics.

In space life sciences, the research focuses on understanding the effects of microgravity and space radiation on living organisms, supporting astronaut health, and enabling long-duration human spaceflight. In microgravity fluid physics, the focus is on novel hydrodynamic phenomena, multiphase flow and heat transfer, complex fluids and soft matter. In space materials science, the emphasis is on revealing material processing mechanisms under microgravity, including solidification of high-performance metal alloys, crystal growth, and space fabrication of composite materials. Microgravity combustion science addresses ignition characteristics, material fire safety in spacecraft, and clean combustion technologies. Microgravity fundamental physics covers ultracold atomic physics, Bose-Einstein condensation, quantum precision measurement, and tests of gravitational theories.

Representative scientific achievements are highlighted, including new discoveries in granular physics under microgravity, successful space-based solidification of advanced alloys, novel observations of boiling heat transfer behavior in reduced gravity, validation of functional materials exposed to the space environment, and in-orbit operation of cold atom interferometers for fundamental physics studies. In space life sciences, notable progress includes rodent research aboard the CSS, such as mouse rearing experiments that allow scientists to investigate physiological, behavioral, and genetic adaptations to the space environment, providing valuable insights for biomedical research and deep-space exploration.

Finally, the speaker discusses future planning for microgravity on the CSS, including expanded research topics, enhanced payload capabilities, and continued open access for global researchers. The presentation concludes with the vision of leveraging the CSS as a national space laboratory to advance fundamental scientific knowledge and enable practical applications for sustainable human development in space.

Resources and Perspectives of International Cooperation in Space Science and Utilization

Dong Miao
Science and Technology Department, Technology and Engineering Center for Space Utilization (CSU), Chinese Academy of Sciences

This presentation provides an overview of international cooperation resources and mechanisms for space science and utilization aboard the China Space Station (CSS). The speaker first introduces the Technology and Engineering Center for Space Utilization (CSU), the leading entity responsible for the space utilization system of the China Manned Space Program, which supports thousands of research projects across four major disciplines.

The presentation then outlines CSU's global partnership network, including joint project calls with UNOOSA (seven projects from 17 countries selected in the first round), successful cooperation with ESA across multiple disciplines, bilateral collaborations with Italy (HERD facility) and Pakistan (SUPARCO), as well as agreements with UNESCO, the Bulgarian Academy of Sciences, and the Egyptian Space Agency. Key cooperation modalities include joint calls, bilateral agreements, platform and fellowship programs, and international conferences and training workshops.

The speaker also explains the application and implementation process for international cooperation projects. Interested researchers and institutions can respond to open calls, submit proposals for peer review, and upon approval, proceed with payload integration, launch, in-orbit operation, and data sharing. CSU provides full-lifecycle support from proposal to post-mission analysis.

In conclusion, the speaker reaffirms CSU's commitment to win-win cooperation, inviting global partners to utilize the CSS as an open orbital laboratory for shared scientific advancement and peaceful uses of outer space.

Author Index

The 18th International Workshop “Solar Influences on the Magnetosphere, Ionosphere and Atmosphere” continues its long-standing tradition of bringing together scientists, researchers, engineers, and young investigators from a broad range of scientific institutions working in the fields of solar-terrestrial physics, space weather, atmospheric physics, radiation environment, instrumentation, climate studies, and data analysis.

The 2026 edition of the Workshop demonstrates a strong international character, including more than 190 authors and numerous international scientific collaborations involving universities, observatories, space agencies, and research institutes from across the world.

One of the main purposes of the Workshop is to provide an open scientific environment for sharing ideas, presenting new scientific results, establishing new collaborations, and strengthening existing scientific partnerships and friendships within the international scientific community. Special attention is also devoted to encouraging young researchers and promoting interdisciplinary cooperation between different scientific domains related to Sun–Earth interactions and space science.

Scientific and Local Organizing Committees

18th International Workshop
“Solar Influences on the Magnetosphere, Ionosphere and Atmosphere”

Primorsko, Bulgaria
8–12 June 2026