ABSTRACTS OF

9TH INTERNATIONAL SCIENTIFIC CONFERENCE

“BALTIC APPLIED ASTROINFORMATICS AND SPACE DATA PROCESSING”

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The BAASP Conference Series serves as a platform for establishing and strengthening cross-border partnerships and knowledge exchange internationally in the Baltic region and globally. These conferences unite astronomers, space researchers and engineers, as well as experts in related disciplines including informatics, electronics, satellite technologies, geodesy, remote sensing, and environmental sciences.

Conference Theme

Space science is increasingly driven by the Big Data requiring robust data acquisition, management, processing, and interpretation capabilities. The interdisciplinary nature of astroinformatics combines space science with high-performance computing, AI, and machine learning, leading to breakthroughs in observational astronomy, satellite technologies, and Earth-space interactions.

In recent years, Europe has continued to play an important role in next-generation astronomy. The continued expansion of the **Low Frequency Array (LOFAR),** antenna array telescope network across the continent, including the Baltic region, has enabled high-resolution studies of cosmic magnetism, solar activity, and transient radio phenomena. The **European VLBI Network (EVN)** has further enhanced its real-time e-VLBI capabilities and broadband sensitivity, with support from UK-based facilities such as **Jodrell Bank and e-MERLIN**. These advancements have contributed significantly to the precise localization of fast radio bursts and compact extragalactic sources.

Technical developments also facilitate automated, rapid-response observation modes, which are essential to advancing multimessenger astronomy. This emerging field integrates radio, optical, gravitational wave, and neutrino data to probe energetic cosmic events such as neutron star mergers and magnetar outbursts.

Concurrently, breakthroughs in AI-driven data mining, edge computing for satellite payloads, and quantum-enhanced algorithms are opening new frontiers in real-time analysis and autonomous decision-making for both Earth observation and deep-space missions. Meanwhile, the growing use of CubeSats and modular satellite platforms is reshaping the landscape of low-cost, high-impact space research, demanding new models for data integration, security, and interoperability across domains.

BAASP 2025 will continue the dialogue on how emerging technologies transform **astronomy**, **space science, geoscience, and remote observation**.

CONTENTS

Advances in Solar Radio Astronomy: Automation and Imaging with the RT-32 Telescope at Irbene

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This work focuses on recent advancements in solar radio astronomy at the Ventspils International Radio Astronomy Centre (VIRAC), highlighting the modernization and automation of observational workflows using the RT-32 radio telescope. A comprehensive, full-stack web-based system has been developed and deployed to streamline solar observations at centimeter wavelengths.

The primary goal of this system is to provide a secure, user-friendly environment that allows operators to manage the entire observational pipeline—from planning and scheduling to data acquisition and image generation—with minimal manual intervention. At the core of the platform is a powerful web interface that enables users to generate precise position files for solar tracking, schedule observation sessions, and monitor the status of ongoing work in real time.

The system incorporates automated post-processing routines, including the creation, storage, and visualization of solar maps built from data collected via an antenna spiral scanning procedure. This raw data is processed using advanced image reconstruction techniques, such as bilinear interpolation and Gaussian filtering, which transform the raw observational samples into scientifically meaningful solar brightness maps.

The entire infrastructure was built using open-source technologies and Python-based astronomical libraries. The result is a robust, scalable, and fully operational platform that significantly enhances the efficiency, reproducibility, and accessibility of solar radio observations. This solution marks a substantial step forward in modernizing the workflows of single-dish radio telescopes.

Unraveling the Galactic Evolution of CNO: Precision Abundance Analysis Across Stellar Populations

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Carbon, nitrogen, and oxygen (CNO) are central to both stellar and Galactic chemical evolution, yet their enrichment history across the Milky Way is still not fully understood. This talk presents a project aimed at delivering a homogeneous and high-precision analysis of CNO abundances in a large and diverse sample of stars spanning all major Galactic components.

Our strategy combines new spectroscopic observations with data from large stellar surveys, anchored by a set of well-characterized reference stars. This enables accurate calibration of stellar parameters and abundance measurements, along with precise age determinations (~10%) via isochrone fitting. By integrating chemical abundances, stellar ages, and orbital dynamics, we perform a population-level and radial migration analysis to trace the spatial and temporal evolution of CNO across the Galaxy.

To fully exploit the rich datasets from modern surveys, we employ both classical physics-based spectroscopic methods and novel machine-learning techniques. This dual approach enhances the precision, consistency, and scalability of our analysis.

Beyond Galactic enrichment, the project investigates the role of stellar mixing and magnetic activity in shaping surface abundances—an area still lacking robust observational constraints. These effects are crucial for understanding abundance patterns in evolved stars and improving stellar evolution models.

Introducing the post-doctoral project: Revealing the physical mechanism of mass ejection around young massive stars via CH3OH masers

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This project aims to shed light on the physical mechanism driving those striking outflows observed ubiquitously around young stars in our Galaxy. The large amount of gas and dust ejected away along the polar directions of a young star is generally referred to as an "outflow". Outflow phenomena are strictly related to the process of mass accretion into a star, regulating the time-scale of the accretion process and, in turn, the final stellar mass. Therefore, their understanding is fundamental to assessing our paradigm of star formation. Here, I propose to exploit the information coming from methanol maser emission, a unique tracer observed at the base of protostellar outflows, to systematically study, for the first time, how circumstellar gas is blown away at radii of a few 100 au (or less) from the star. Overall, this project is designed on a fine tuning between scientific objectives and instrumental facilities, with the aim to still enhance its impact with next-decades observational facilities and to maximize my chances of becoming a major expert in the field.

Microwave Observations of Coronal Holes at the 25th Solar Cycle

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Studies of coronal holes and coronal hole-like areas with reduced brightness temperatures in microwaves have a significance to understand manifestations of the solar activity, distributions of plasma parameters in the solar corona and conditions of the creation of the solar wind and space weather. It's well known that the microwave emission of coronal holes has a low contrast to clearly observe and its visibility depends on the phase of the solar cycle and features of an instrument as well.

The radio telescope RT-32 of Ventspils International Radio Astronomy Centre (VIRAC) provides routine 2D cartography of the polarized microwave emission of the Sun in wavelengths of 7.5-2.3 cm (4.1-14.2 GHz) with the low noise multichannel spectral polarimeter. Taking into account that the microwave emission is created at different heights into the corona spectral polarimetric observations offer the possibility to analyse the reduction of plasma densities and its distribution into coronal holes.

The presentation concerns comparison of the microwave emission of some characteristic coronal holes observed with the radio telescope VIRAC RT-32 in 2019-2020 and 2024-2025 (the minimum and maximum of 25th solar cycle). Some attempts to evaluate the height distribution of plasma electron densities in the corona are presented also.

Inspiring the next generation of students through active participation in radio astronomy research via international partnerships

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The rapid expansion of radio astronomy and space science projects in Europe calls for a new generation of talented and motivated students equipped with interdisciplinary skills in physics, engineering, and data science. Building upon the achievements of the Erasmus+ project Radio Astronomy Collaboration between European Universities: Developing Scientific and Technological Skills Through Astronomy (RACOBEU), this presentation explores effective strategies for inspiring and training young researchers through collaborative, hands-on learning.

Implemented jointly by the Public University of Navarre (Spain), Ventspils University of Applied Sciences (Latvia), and Adam Mickiewicz University (Poland), together with associated high schools, RACOBEU integrates real scientific research into the educational process. Students engage in activities such as constructing and remotely operating radio telescopes, analyzing astronomical signals, and conducting solar and maser observations in cooperation with professional researchers. The project has demonstrated that direct involvement in research significantly enhances student motivation and interest in STEM disciplines, particularly in radio astronomy.
At VUAS, the initiative is closely linked to the research infrastructure of the Ventspils International Radio Astronomy Centre (VIRAC), including the RT-32, RT-16 and LOFAR telescopes. These facilities provide a unique environment for student participation in state-of-the-art studies of solar activity and space weather phenomena.

The presentation will highlight recent results from collaborative workshops, discuss survey-based insights into student engagement, and outline pathways for integrating emerging talents into ongoing and future international radio astronomy projects. Nurturing young scientists is essential for sustaining innovation, developing new research instrumentation, and ensuring the long-term success of European astrophysical research.

Multi-Epoch Radio Variability of BL Lacertae Observed with the Irbene Interferometer and MOJAVE Archival Data

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We present new results on the radio variability of the blazar BL Lacertae (J2200+420), based on observations conducted between February 2024 and November 2025 with the Irbene single-baseline interferometer as part of the project "A Single-Baseline Radio Interferometer in a New Age of Transient Astrophysics." The dataset comprises over a dozen flux measurements revealing multiple flares that occurred in spring and autumn 2024. These events coincide with high-brightness states recorded in the MOJAVE VLBA 15 GHz monitoring program, where the source exhibited flux densities peaking near 12 Jy in May 2024 and remaining above 7 Jy throughout the latter half of the year.

The combined Irbene and MOJAVE observations confirm that BL Lacertae remained in a highly active state during 2024–2025, displaying rapid flux and polarization variability. The VLBA images reveal a compact, one-sided jet structure with evolving morphology, consistent with the shock-in-jet model in which relativistic disturbances compress magnetic fields and accelerate particles, enhancing synchrotron emission. Polarization changes (4–10%) and rotations of the electric-vector position angle indicate dynamic magnetic-field reconfiguration, potentially linked to magnetic reconnection or helical jet motion.

These results highlight the growing role of single-baseline interferometry in time-domain AGN studies, demonstrating its capability to complement global VLBI monitoring programs in tracking the evolution of relativistic jets and their transient behavior.

Exploring VIRAC's Capabilities for Radio Detection of Quasi-Periodic Pulsations in Solar and Stellar Coronae

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Solar flares and coronal mass ejections (CMEs) are among the most energetic manifestations of magnetic activity in the solar system, releasing vast amounts of energy through magnetic reconnection processes. Understanding these explosive events—and their analogues on other stars—is crucial for unveiling the mechanisms governing stellar coronae and space weather phenomena. One of the most intriguing features accompanying such flares are Quasi-Periodic Pulsations (QPPs)—rhythmic modulations observed across the electromagnetic spectrum, from radio to gamma rays. These pulsations, often associated with magnetohydrodynamic (MHD) oscillations or repetitive magnetic reconnection, provide valuable diagnostics of coronal plasma dynamics.

While QPPs are routinely detected in solar flares, their identification in stellar flares remains rare and technically demanding due to limited sensitivity and temporal resolution. To address this, the Ventspils International Radio Astronomy Centre (VIRAC), within the framework of the Latvian Science Council-funded project Multi-Wavelength Study of Quasi-Periodic Pulsations in Solar and Stellar Flares, is exploring the use of the Irbene Single-Baseline Radio Interferometer (ISBI). This system—comprising the 32 m RT-32 and 16 m RT-16 antennas—operates in the 4.5–8.8 GHz range with one-second time resolution, optimized for capturing short-period radio QPPs.

Since late 2023, VIRAC has conducted nine observational campaigns targeting magnetically active M-dwarf stars such as EV Lac and AD Leo, known for their frequent and powerful flares. Dual-polarization observations enable simultaneous monitoring of total intensity and magnetic field variability. Preliminary results confirm that the interferometric configuration substantially enhances sensitivity and suppresses radio frequency interference (RFI), outperforming single-dish observations.

Advanced SFXC, AIPS, and ParselTongue pipelines—originally developed for Galactic maser studies—support high-precision continuum variability analysis. Future observing campaigns will incorporate coordinated optical monitoring to enable multi-wavelength QPP studies and to better constrain their physical origins.

Variations in the radio continuum emission of high-mass protostars

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High-mass star formation has recently deepened its presence in the realm of time-domain astronomy. In the past decade alone, the observational confirmation of accretion bursts and subsequent radio jet launching has entered the spotlight as such phenomena have been identified by maser flares, infrared enhancements, and changes in the radio continuum emission intensity and morphology. In this contribution we introduce new results from the IVARS (Interferometer for Variable Astronomical Radio Sources) project revealing enhancement of the radio continuum emission of a high-mass protostar G034.244+0.1, obtained with high-cadence, single-baseline interferometric observations.

Asteroid Observations from the Minor Planet Center Database: Opportunities and Challenges for Light Curve Analysis

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This work investigates 35 main-belt asteroids with Earth MOID values of less than 1 AU. Photometric data used in the analysis were obtained from the Minor Planet Center archive, comprising observations from eighteen observatories. The time-series analysis was carried out using the Lomb–Scargle method. For twenty-eight asteroids, a stable rotation period was derived, corresponding to spin-axis orientations approximately perpendicular to their heliocentric orbital planes. For the remaining seven objects, only approximate estimates could be obtained due to significant deviations of their spin axes from this perpendicular alignment. The three slow rotators (3459, 4331, 4396 with P>80 h) are asteroids that possibly formed more than 4.5 billion years ago, together with the Solar System. The four fast rotators (1964, 2614, 4273, 4320 with P< 3 h) are objects of a younger generation, whose age is 100 million years or less. Although the proposed statistical approach is computationally demanding, its automation would enable the determination of rotation periods for thousands of asteroids. This could be achieved using lower-precision brightness measurements—routinely acquired as a by-product of astrometric observations — thus eliminating the need for additional dedicated photometric campaigns.

This research is funded by the European Regional Development Fund, project "ERA Chair in Astrophysics, 350 Instrumentation, Ground Segment Technologies and Space Photonics at the University of Latvia", project No. 351 1.1.1.5/2/24/A/004.

Temperatures of dust grains in some circumstellar environments

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Temperature of cosmic dust grains is important for grain growth and evaporation, and the growth and evaporation of layered “ice” mantles. Dust temperature determines the observable infrared radiation, as well as speed of multiple chemical reactions on grain surfaces and inside the mantles. Often it is assumed that at the given spatial point dust temperature spans over some narrow interval, or even dust is characterized by a single temperature. This study is devoted to testing such assumptions.

Monte Carlo radiative transfer calculations using the code RADMC-3D were performed for models of circumstellar dust clouds containing dust grains of several kinds with some variety of chemical composition and size. Thermal equilibrium between the dust and the local radiation field was assumed. The central star and the interstellar radiation field are assumed to be the primary sources of energy. Morphologies of the dust cloud include homogeneous spherical cloud, and spherically symmetric radial outflow with constant speed leading to inverse square dependence of density on radius

It was found that dust temperature in circumstellar conditions is primarily, very strongly and very nonlinearly determined by the chemical composition. Temperatures of various kinds of dust particles at one and the same place, inside one and the same radiation field can differ by up to 1500 K, and it is explained by the interplay between the dependence of complex refractive index on wavelength and the spectrum of radiation. Dependence of dust temperature on grain size exists, but in most cases, with some exceptions, it is considerably less significant than that on grain material.

Modeling Cosmogenic Isotopes as a Tool to Study Solar Energetic Events

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Understanding the long-term behaviour of the Sun is essential for both astrophysical research and assessing the potential impacts of extreme solar activity on Earth. Direct observations of solar energetic particles (SEPs) cover only the past few decades of the space age. To investigate stronger and rarer events over millennia, indirect evidence preserved in natural archives is required. One of the most powerful approaches relies on cosmogenic isotopes such as radiocarbon (14C) in tree rings, and beryllium-10 (10Be) and chlorine-36 in polar ice, which are produced in the atmosphere when cosmic rays or solar particles interact with nitrogen and oxygen nuclei.

Numerical modeling of isotope production provides a link between measured concentrations in archives and solar processes. By combining physics-based simulations of particle transport in the atmosphere with carbon cycle and climate models (e.g. SOCOL model), it becomes possible to reconstruct the intensity and timing of past solar energetic particle events. This approach has revealed several extreme historical events that exceed anything observed during the instrumental era by orders of magnitude.

We demonstrate how isotope modeling quantifies the magnitude and occurrence time of past solar particle storms, outline uncertainties related to atmospheric dynamics and data resolution, and place reconstructed events in the context of modern observations. Such reconstructions not only expand knowledge of solar variability but also help assess potential risks from extreme space weather to present-day technology.

Cometary activity modelling for ESA's Comet Interceptor mission

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ESA's Comet Interceptor will perform a rapid flyby of a dynamically new comet originating from the outer Solar System, potentially preserving materials that predate the Solar System itself. Because such objects follow highly eccentric orbits and are often discovered only a few months before perihelion, the mission will wait at the Sun-Earth L2 point until a suitable target is identified. This "unknown target" paradigm complicates pre-launch planning, since instrument development and calibration typically rely on well-characterized bodies.

We address this challenge with physics-based models that span plausible comet activity states, including coma, transient outbursts, collimated jets, and resulting tail morphology. These models are embedded in a Blender based digital twin of the flyby, producing synthetic observations for MIRMIS, OPIC, and EnVisS across a range of phase angles, spin states, and activity levels. The environment enables assessment of data quality against instrument objectives as well as showcases unplanned scenarios of data acquisition.

By leveraging the physically based Cycles rendering engine, we simulate light scattering of dust particles using phase functions and density fields derived from our models, yielding photometrically consistent imagery. We present representative scenarios, comparisons to previous observational data, and ongoing work to refine dust dynamics and photometric fidelity. This capability advances instrument readiness and operations planning when the real target remains unknown until late in the mission timeline.

Visualization Tools for Real-Time Near-Field RFI Monitoring at the LOFAR Station in Irbene

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Radio Frequency Interference (RFI) remains a critical challenge in low-frequency radio astronomy, particularly for software-defined arrays like LOFAR (Low Frequency Array). This study presents a comprehensive approach to near-field RFI detection and visualization at the LOFAR station in Irbene, Latvia, operated by the Ventspils International Radio Astronomy Centre (VIRAC). Leveraging single-station interferometry and internal visibility data, we developed a modular imaging pipeline capable of generating near-field power maps across frequency, time, and height dimensions.

The system integrates calibration routines, sweep-based imaging, and a real-time multithreaded processing engine with a web-based interface. This enables live monitoring of interference sources and supports field testing with controlled emitters. Field campaigns conducted at Irbene validated the system's ability to detect and localize RFI sources with meter-level precision, even under constrained conditions.
Key contributions include:

- Adaptation of the open-source lofarimaging framework and use in near-field.
- Implementation of sweep routines for dynamic RFI characterization.
- Development of a real-time imaging and control interface with live tracking.
- Deployment of a Docker-based environment for reproducibility and portability.

This work improves LOFAR's awareness of local interference and establishes a foundation for operational, station-level RFI monitoring tools. The system is publicly available via GitHub and supports future integration into broader diagnostic frameworks."

The latest developments and patterns related to space debris issues.

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The issue of space debris is escalating due to an increasing number of satellite launches, ageing defunct satellites and fragments resulting from collisions and anti-satellite tests. Recent developments indicate technological and regulatory progress aimed at mitigating this risk, though significant challenges remain.

The ESA has updated its Space Debris Mitigation Policy and Requirements (as of November 2023), shortening the disposal phase for Low Earth Orbit (LEO) objects from 25 years to 5 years, raising the success probability threshold for disposal operations and introducing interfaces to facilitate servicing or removal in the event of satellite failure.

Meanwhile, the proposed EU Space Act (due to be introduced in mid-2025) seeks to standardise regulations across Member States, ensuring the safety, resilience and environmental sustainability of space operations. This includes the introduction of stricter rules for debris tracking and mitigation.

There is also increasing industry cooperation: the ESA's “Zero Debris Charter” encourages entities to commit to preventing new debris, and dialogues are taking place (e.g. with commercial operators) about joining these voluntary charters.

Paths of formation for interstellar dense cloud cores

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The starless cores of interstellar clouds are a standard case for simple astrochemical modelling, often used to test new methods and theories. The physical formation of such dense cores is regulated by large-scale processes and cannot be described by an isolated evolution scenario of the core itself. We describe several paths how evolving physical conditions arrive at those characteristic for dense cores. The validity of each scenario is tested with an astrochemical model by comparing calculated abundances of interstellar ice species to observations. Five central density evolution paths were considered: exponential, linear, sigmoid (S-type), and asymptotic growth, as well as gravitational infall. Two time-scales – 1 Myr and 3 Myr – were applied for each case. Increase of the central density was accompanied by contraction of a spherical (1D) molecular cloud with a constant mass. Results. The exponential, infall, linear, and sigmoid density evolution scenarios are apparently all able to replicate observed ice composition, each with its own time-scale. Additional chemical evolution in long-lived cores with steady conditions is essential for explaining disagreements in ice abundances. The results indicate a consistent 0.5 Myr-long active growth stage for dense cloud cores, in addition to periods of slower contraction before or after the active stage. Finally, we find that the often-used simple models starting with atomic chemical composition in dense core conditions produce ice species' abundances that are incompatible with observations.

Structure and variability of astrophysical masers

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We observed 2 methanol maser sources G32.03+0.06, G35.20 -1.74 (W48) at 6.7 GHz using the European VLBI Network (EVN). These masers have been systematically monitored over the past five years with the Irbene 16 m and 32 m radio telescopes [1]. Selected sources have different variability types periodic, quasi-periodic, long-term dimming. Our primary objectives are to investigate the proper motions, variability mechanisms, source morphology, and cloudlet structure evolution of these masers. We aim to identify the physical processes driving maser variability and improve our understanding of the underlying astrophysical conditions.

[1] A. Aberfelds, J. Šteinbergs, I. Shmeld, R. A. Burns, ‘’Five years of 6.7-GHz methanol maser monitoring with Irbene radio telescopes” Monthly Notices of the Royal Astronomical Society,Volume 526, Issue 4, December 2023, Pages 5699–5714, https://doi.org/10.1093/mnras/stad3158

Recent developments in Irbene antenna complex

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During the last few years, multiple projects have been carried out to continuously upgrade the receiving capabilities of the Irbene antennas RT-32 and RT-16, as well as to establish transmitting capabilities for both antennas. Development of new feed horns, RF networks, receivers, and cryostats etc. has been undertaken with the goal of enabling deep-space communications, with special emphasis on future Lunar missions.

In parallel, the needs of radio astronomy are being addressed through the development of new cryogenic L/S-band receiver and by supporting various international scientific projects. These improvements significantly enhance the overall sensitivity and operational flexibility of the Irbene antenna complex, positioning it as a key infrastructure for both scientific research and space mission support.

During this talk, the audience will be introduced to the current technical capabilities of the Irbene antennas, recent development achievements, and future plans for expanding their role in deep-space and radio astronomical research.

Geomagnetic disturbances of the earth's magnetic field in the area of the Struve geodetic arc meridian

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At present, the issues of solar-terrestrial interactions are very relevant, especially the mechanisms of transmission of deep space disturbances to the Earth's surface. One of the main components of the solar-terrestrial interactions is the magnetic field. It, on the one hand, serves as a link between the Sun and the Earth, and, on the other hand, causes a different response to the same impact depending on the "relief" of the Earth's internal magnetic field. To do this, we investigated the "reaction" of the Earth's magnetic field to the coronal mass ejection of May 7, 2024, which reached the Earth's orbit on May 10, 2024, and the associated magnetic storm that lasted more than 24 hours. The influence of high-energy sources of external origin on magnetospheric-ionospheric processes and related perturbations of the Earth's outer and inner shells is well understood. The interaction of the magnetospheric-ionospheric geomagnetic disturbance with the Earth's internal magnetic field remains less studied. In this regard, we studied the perturbations of the Earth's magnetic field along the meridian Struve Geodetic Arc (SGA). The SGA meridian is characterized by significant changes in the Earth's main magnetic field (core field) and anomalous magnetic field (lithosphere field). There are 7 magnetic observatories in the vicinity of the SGA, which makes it possible to assess the nature of magnetic storm on May 10-13, 2024, depending on the global and regional characteristics of the Earth's internal magnetic field.

A Transformer-Based Forecasting Model for GNSS-VTEC and its Application Study Over Nigeria

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This paper presents a novel approach using channel-independent patch time series Transformer (PatchTST) for GPS-VTEC forecasting. This is the first time that a Patch Time Series Transformer (PatchTST) framework has been integrated into GPS-VTEC forecasting, demonstrating its applicability to ionospheric prediction. We construct the GPS-VTEC dataset using observations from Nigeria, leveraging data collected from ionospheric monitoring stations. Factors influencing GPS-VTEC variations, such as seasonal changes, diurnal patterns, magnetic activity, and solar activity, are identified and incorporated as input parameters for the models. Training is conducted using data from the year 2012–2021, while the model performance is evaluated using the year 2022 data, a period of high solar activity. We compare the performance of PatchTST, MLP, LSTM, BiGRU, and CNNBiGRU models, evaluating their forecasting accuracy using root mean squared error (RMSE), mean absolute percentage error (MAPE), and correlation coefficient (R). The PatchTST model achieves an RMSE of 4.731 TECU, a MAPE of 2.351%, and an R-value of 0.986, outperforming traditional deep learning models in short-term (1-day) and mid-term forecasting. The hybrid CNNBiGRU model also shows strong predictive capability, achieving an RMSE of 3.046 TECU and an R-value of 0.896, effectively capturing diurnal variations of GPS-VTEC. Additionally, uncertainty analysis reveals that PatchTST exhibits superior adaptability to model uncertainty, showing a 62.9% improvement in mean error (ME) and a 40.5% improvement in standard mean error (STDE) compared to benchmark models. Comparisons with IRI-2016 and NeQuick-2 models indicate that while PatchTST provides more accurate predictions than all the models including the deep learning models and the empirical models in capturing seasonal variations across the dataset.

Solar eruptions near elongated regions of open magnetic fields

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Solar flares and coronal mass ejections (CMEs) are the most powerful phenomena on the Sun believed to be caused by instabilities in solar magnetic fields. We examine how narrow elongated regions of open magnetic fields relate to these phenomena. For this purpose CMEs and the associated solar flares are traced near an elongated open-field region during January - March 2013. By modelling coronal fields with the Potential Field Source Surface model (PFSS), we reveal high squashing of field lines. Since such high squashing promotes reconnection of magnetic field lines, we recognize there the potential for triggering the eruptions. A set of extreme ultraviolet images from the AIA instrument on board the Solar Dynamic Observatory also implies long-lasting (up to 5 - 10 hours) events of magnetic reconnection in the post-flare arcade and the coronal dimming accompanying a CME. We conclude that by enabling sustained field line reconnection the narrow regions of open-fields are possibly linked to the nearby solar eruptions.

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On the programs of monitoring studies of space weather based on radio astronomical and magnetometric observations

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Since its commissioning in 1987, the URAN-4 radio telescope of the RI NASU has been conducting a program for monitoring the fluxes of powerful radio sources in order to identify the properties and effects of space weather.

Among the observed radio sources are the remnants of supernova explosions CAS A and TAU A , radio galaxies CYG A and VIR A .

Since 2017, joint research programs have been launched with the Ventspils International Radio Astronomy Centre in Latvia to study the variability of extragalactic radio source fluxes and the effects of space weather manifestations. Observations were carried out using the RT-32, RT-16 and LOFAR radio telescopes, in 2019-2022, 2025 to the present, at frequencies of 5, 6.1, 6.7, 8-8.7 GHz (RT-32 and RT-16), LOFAR dynamic spectrum frequency band 30-60 MHz.

Since 2017, radio astronomical observations of space weather manifestations in the zone of the Odessa Magnetic Anomaly have been supplemented by magnetometric observations of the Institute of Geophysics NASU at observatories in Kyiv, Odesa and Lviv.

Observations of the 2025 solar eclipses were carried out with the participation of the LOFAR (Latvia), URAN-4 (Ukraine) observational data from the KAIRA radio telescope, magnetometers and riometers of the SODANKYLA observatory in Finland, as well as a network of magnetometric stations of the Institute of Geophysics NASU.

The implemented comprehensive program has become the basis for the implementation of the Latvian LZP grant "Characterisation of Extreme Space Weather Effects on the Ionosphere" for the study of the manifestation of local effects of space weather along the "Struve geodetic arc" with the participation of Latvia, Finland and Ukraine.

PauseMaker: Satellite communications with the mowing object

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Satellite communications with the mowing object, e.g., an infantry fighting vehicle.
The purpose of the device is to ensure uninterrupted satellite communication with a ground server in the presence of interference along the route, which results in frame loss.
The algorithm is as follows:
1) determining the coordinates of the nearest interference,
2) generating and transmitting information about the interference, taking into account the vehicle speed and road surface,
3) prioritizing transmission from the satellite to the ground server,
4) inserting empty frames in the communication session with the object (to avoid information loss),
5) prioritizing transmission from the ground server via satellite to the object.

Preliminary results of observing ionosphere activity using 3C sources

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LOFAR is currently undergoing a major upgrade to LOFAR2.0, which includes new hardware developments such as dual-beam capability for HBA antennas, as well as the introduction of the LOFAR Space Weather Module. These upgrades also involve significant software improvements, enabling continuous 24/7 data recording. This functionality is crucial for producing long-term ionospheric data products to benefit the space weather community and support LOFAR's dynamic scheduling.

As part of this initiative, an observational program was implemented at the LOFAR station LV614 in Latvia. Traditionally, ionospheric studies with LOFAR rely on strong radio sources such as Cassiopeia A or Cygnus A. In our work, we explored the potential of additional sources from the 3C catalogue, focusing on 3C147 and 3C295. Approximately 100 observations were carried out at LV614, spanning both daytime and nighttime conditions. Amplitude scintillation in single-station power spectra was successfully detected from both sources. Parallel observations of Cassiopeia A allowed for direct comparisons with established methods, while test observations with LOFAR2 stations extended the study further.

Our results demonstrate that 3C sources can be effectively used for ionospheric monitoring, broadening the set of available targets. Simultaneous observations of multiple sources provide information on the spatial distribution of ionospheric irregularities. When combined with measurements from other LOFAR stations, the results are comparable to GNSS-based monitoring. Furthermore, integrating LOFAR data with external datasets offers new opportunities for multi-instrument studies.

Long-term observations confirm the feasibility of continuous ionospheric data product generation with LOFAR. The geographic position of LV614 enables investigations of both mid-latitude ionospheric dynamics and auroral oval phenomena. These first results support the future development of ionospheric maps as part of the LOFAR Space Weather Module and highlight the role of LOFAR2.0 in advancing space weather research.

MSCA Doctoral Network E-Sailors: Electric solar wind sail doctors

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The E-Sailors Doctoral Network is a new project, funded by Marie Skłodowska-Curie Actions, with 8 universities and 4 companies as partners. The network of 15 PhD students will develop all aspects of the electric solar wind sail (E-sail) technology, starting from mission and payload designs to the concept of operations and control algorithms. One of the PhD students will be hired by Ventspils University of Applied Sciences with the goal to develop communication and radio frequency ranging for ESTCube-LuNa in the Moon's orbit. This talk will introduce the E-Sailors network and contributions by each university and future PhD student.

Ionospheric and magnetospheric responses to the 2025 solar eclipses

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The solar eclipses provide a unique opportunity to investigate the effects of ionospheric scintillations of cosmic radio sources and fast geomagnetic variations caused by the transient weakening of solar ionizing radiation, as well as other accompanying phenomena. The 29 Mar 2025 partial solar eclipse was visible in Western and Northern Europe, the northern part of Eastern Europe, northeastern North America, Greenland, the North Atlantic, and the polar Arctic region. On 21 September 2025, a partial solar eclipse occurred, observable across the southern Pacific Ocean, Australia, New Zealand, and Antarctica. In the southernmost region of New Zealand, including Stewart Island, solar obscuration reached up to 80%. The absence of direct visibility of the 21 September 2025 solar eclipse in the Northern Hemisphere does not preclude its potential impact on geophysical parameters, particularly through long-range propagation mechanisms. One such mechanism involves the generation of atmospheric acoustic-gravity waves (AGWs), triggered by the rapid decline in solar irradiance and temperature within the eclipse zone. This study examines properties and distinctions of ionospheric and geomagnetic effects associated with the partial solar eclipses of 29 March and 21 September, based on observations of ionospheric scintillations of cosmic radio sources conducted using LOFAR LV614 (Latvia), KAIRA (Finland), and URAN-4 (Ukraine) radio telescopes, as well as data from magnetometric stations in Ukraine and across Europe located within region of the "Struve Geodetic Arc", and from pulsation magnetometers operated by Sodankyla Geophysical Observatory (Finland). The relevance of this research is driven by the need to refine our understanding of the mechanisms underlying short-term geomagnetic variability and radio-scintillations induced by solar eclipses, particularly in mid- and high-latitude regions. Partial eclipses, despite their limited degree of solar disk obscuration, are capable of producing pronounced disturbances in ionospheric plasma and the geomagnetic field, especially in areas proximal to magnetically conjugate points.

Irradiation-Induced Structural Changes in Amino Acids: A Theoretical Study

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The detection of amino acids in primitive meteorites and in the interstellar medium bears on our understanding of the origin of life. Various models explain how amino acids form in space, but few studies have examined how the harsh conditions of space alter their structures and, as a consequence, chemical properties. Hence, our investigation aims to gain the first insight into the amino acid structural change under irradiation.

To foresee the influence of irradiation on the structure of amino acids, we investigated the interaction of Leu and Ile with dipole electric (DE) and electromagnetic (EM) radiation fields, conducting a comparative study between these isomers. These amino acids were chosen because the composition of Leu and Ile is identical; thus, distinguishing them by mass is a non-trivial task. The cc-pVTZ basis was modified by the introduction of correction coefficients to the molecular wave functions in order to reflect the elongation of electron orbitals and densities caused by the magnetic field and more precisely describe the influence of the EM to the fragmentation process. These coefficients were calculated following the procedure of the Anisotropic Gaussian-type orbital method.

Results obtained indicate that in the DE and EM fields, Leu was partially deformed. In the case of Ile, increasing the dipole electric field strength leads to the -H and N-H bond rotations, and strong EM could cause the formation of the zwitterion form. Additionally, the studies of electrostatic potential indicating the charge distribution allow us to foresee different behaviour of Leu vs Ile in the DE or EM fields.

The numerical calculations with the GAUSSIAN09 package were performed at the High-Performance Computing Center of Vilnius University, Faculty of Mathematics and Informatics. The author thanks Dr. T. Kirova for the introduction of correction coefficients to the molecular wave functions.

Using Jupiter's Radio Storms to Probe the Solar Corona

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Low-frequency observations of various types of bursts generated in the solar corona have one common feature. In the decameter-meter ranges, they all have predominantly one circular polarization. This polarization is associated with the normal mode of that ordinary/extraordinary wave, which has a lower attenuation coefficient. One possible explanation for these polarization characteristics of low-frequency solar bursts is that they originate at relatively high altitudes (1.5-2 Rsun), where the intensity of the magnetic field in the solar corona is ~ 1G. Furthermore, propagating towards Earth, one of these waves attenuates more than the other due to greater interaction with the Sun's magnetic field and, accordingly, greater optical thickness. However, this explanation is incomplete, as it does not explain how magnetic fields with low intensities keep subrelativistic electron beams, which generate various types of bursts, from Coulomb repulsion. On the other hand, the circular polarization may be imposed by the moving electrons themselves over large sections of the coronal magnetic field, in which case the polarization of solar bursts is determined by the electron's motion.

For a more detailed study of the corona plasma properties, observations of Jupiter's eclipse by the Sun's corona were carried out. These observations were carried out from May to August 2025. In this case, decameter radio storms, which occurred episodically in the Jupiter-Io tube, were considered by us as a point broadband pulsed source of elliptically polarized radiation. This radio emission was used to probe the Sun's corona at various elongations. In particular, we managed to record a Jupiter radio storm 2 degrees from the Sun center. To determine the parameters of the solar corona plasma, we will study such propagation effects as scattering and dynamic rotation measure, which will allow us to estimate the parameters of magnetized plasma in the Sun's corona.

Millennium-scale solar eruptive events: Extreme space hazards

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The Sun is a variable star, sometimes producing eruptive events such as flares and coronal mass ejections, which can disrupt the near-Earth environment and pose significant threats to modern technological society. As discovered recently using indirect proxy data, the Sun can rarely produce extreme solar particle events (ESPEs). Presently, seven events and two candidates are known for the past 14 millennia, making them millennium-scale events. ESPEs can be orders of magnitude stronger than the strongest events directly observed during the last decades. A summary of the current knowledge of the occurrence rates and reconstructed parameters of the ESPEs is discussed in the context of the possible terrestrial effects, such as radiation dose and regional climate.

Burst hub: get astronomical bursts together

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In the era of multi-messenger multi wavelength astronomy, it is of critical importance to make joint observations with various telescopes and instruments in a timely manner.
These observations usually will be reported as various types of Messages in different platforms, which is somewhat inconvenient for researchers.

We collect these Messages from various platform and group them into astronomical burst Events with AI and provide statistics of all and the latest Events and Messages and highlight the most popular Events (called Hot Events).

Power-law Indices of EUV Intensity Power Spectrum in Flaring Coronal Active Regions

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Solar intensity power spectra are usually characterised by coloured noise, with the spectral energy following a segmented power-law function of frequency, $S(f) \propto f^{-\alpha}$ over different frequency ranges. Typically, the power-law index exceeds 1 in the low-frequency part (α_lf) and is around 0 at high frequencies (α_hf). This work investigates the spatial and temporal evolution of the power-law indices of coronal EUV intensity power spectra in flare-hosting active regions.

The spatial distribution of the power-law index in the low-frequency domain (α_lf) closely mirrors EUV intensity images, indicating that α_l can reveal the dynamics of coronal plasma structures.

Temporally, α_lf remains stable in quiescent active regions, but it exhibits significant variability before the flare onset. Motivated by this behaviour, we analysed 14 flare events, quantifying the temporal variation of the indices α_lf and α_hf as potential flare precursors. In all flare events considered, notable deviations of α_lf beyond a defined threshold consistently occurred at the flare site within a few minutes before the flare. In some cases, the change in the value of α_lf − α_hf was detected within 30–90 minutes before the flare. These findings suggest that the temporal variation of the power-law indices in coronal EUV intensity power spectra could potentially serve as short-term precursors of solar flares, which needs to be validated on a larger flare sample.


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