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Editors: Vladislavs Bezrukovs & Mikhail Ryabov & Artem Sukharev & Aija Kalniņa
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Observations of the solar radio emission during Sun eclipse on March 29, 2025

Bezrukovs D.

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

The partial eclipse of the Sun (phase 15-16%) on 2025, March 29 were visible in Irbene, Latvia and had been successfully observed with the radio telescope RT-32 of Ventspils International Radio Astronomy Centre (VIRAC) in microwaves.

Observations of radio emissions during eclipses of the Sun were developed and performed on the beginning of the solar radio astronomy with a purpose to increase the spatial resolution of “single dish” radio telescopes. Taking into account that the moon shadow could be expected as a kind of an interferometer observations of solar eclipses in microwaves offer a opportunity to obtain a distribution of brightness temperatures over the solar disk and active regions with a high spatial resolution.

Nowadays VIRAC implements microwave spectral polarimetric observations of the Sun in “single dish” mode with RT-32 radio telescope equipped by the multichannel low noise spectral polarimeter LNSP4. The spectral polarimeter covers the frequency range of 4.1-14.1 GHz (2.1-7.3 cm) divided to 12 independent frequency channels for right and left circular polarizations. The LNSP4 is integrated into the antenna drive control system and the data acquisition pipeline to provide automatic observations of the Sun, a storage of data into the multilevel archive and some primary processing of data.

During the eclipse of the Sun in the maximal optical phase the moon shadow covered some near-pole area of a relatively quiet Sun. So the point close to the limb of the Sun which was covered by the moon shadow were observed. Full fluxes of the RT-32 antenna at frequencies of 4.07, 6.42, 8.40 GHz were recorded simultaneously.

The presentation concerns to circumstances of the partial solar eclipse on 2025, March 29, technical issues of microwave observations with RT-32 radio telescope, an analysis of data observed and some evaluation of the spatial distribution of brightness temperatures of microwave emission in the near-pole area of the Sun for a set of frequencies.

Updates from the LOFAR station at the Irbene radio observatory

Šteinbergs J.

Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS)

LOFAR in the Irbene observatory has been operational since 2019. LOFAR allows a wide range of scientific studies, from Earth's atmosphere to extragalactic astronomy. VIRAC LOFAR team is part of multiple collaboration projects and studies a variety of science topics. In my presentation, I will show updates from the LOFAR station at the Irbene radio observatory. In my presentation, I will show results from Pulsar studies, Solar observation, space weather, and more.

Advances in Automated Solar Observations and Multidimensional Spectropolarimetric Imaging at Irbene

Aguirre E. [1], Bezrukovs V. [2], Bouzarhoun El Asry W. [1], Janices I. [1,2], Orbidans A. [2], Bezrukovs D. [2]

1 – Department of Electrical, Electronic and Communication Engineering of the Public University of Navarra (UPNA), Pamplona, Spain
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Ventspils, Latvia

In this work, we present the development and deployment of a comprehensive full-stack web-based system designed to streamline and automate the workflow of solar radio observations conducted with the RT-32 radio telescope at VIRAC. The primary goal of this system is to provide a secure, user-friendly, and feature-rich environment that allows operators to manage the entire observational pipeline from planning to data acquisition and image generation with minimal manual intervention.

At the core of this platform is a powerful web interface that enables users to generate position files for solar tracking based on astronomical calculations, schedule observations for desired time windows, and monitor the status of upcoming or ongoing sessions. The system also incorporates automated routines for post-processing, including the generation, storage, and visualization of solar maps, built from regular microwave observations using the Low Noise Spectral Polarimeter (LNSP4). Data collected through a spiral scanning procedure executed by the radio telescope's antenna around the computed solar disk center are processed using advanced image reconstruction techniques such as bilinear interpolation and gaussian filters, transforming raw observational samples into scientifically meaningful solar maps.

The entire infrastructure has been developed using open-source technologies and Python-based astronomical libraries, and it has been successfully deployed following a series of validation tests. The result is a robust, scalable, and fully operational platform that greatly enhances the efficiency, reproducibility, and accessibility of solar radio observations. By integrating both backend and frontend components into a single cohesive system, this solution marks a significant step forward in the modernization and automation of observational radio astronomy workflows.

Current status and trends on space debris issues

Jotkus N.[1,2]

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

The growing proliferation of space debris has been a serious concern for several decades, and current trends indicate that the problem is far from diminishing. The accumulation of debris in Earth orbit poses significant risks—not only to human life in space—but also to satellites critical for communication, navigation, scientific research, and defense operations.

Although the underlying dynamics of space debris evolution are not yet fully understood, the increasing density of objects in orbit raises the risk of entering a scenario known as Kessler syndrome—a cascade effect where collisions between orbital objects generate additional debris, which in turn leads to further collisions. Reaching such a critical threshold could render certain orbital regions unusable for extended periods.

A statistical analysis based on datasets from the European Space Agency (ESA) confirms a continuous rise in debris populations, particularly in near-Earth orbits. This increase is driven by two primary factors:

- The growing number of space missions, resulting in more objects being launched and tracked in orbit.
- Advancements in detection technologies, which now allow for the identification of smaller debris particles that previously went undetected.

Beyond observational data, this study provides an overview of the regulatory frameworks influencing space activity. It examines legislative measures, the roles of major spacefaring nations, and the effectiveness of existing international space law in addressing debris-related risks. Particular focus is placed on evaluating the adequacy, enforcement capacity, and jurisdictional reach of current legal instruments in mitigating the escalating threat posed by space debris.

Updates on the Visit to the Paris Observatory and the Nançay Observatory: Discussion on Collaboration Perspectives

Bezrukovs V.

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

This presentation provides an overview of recent visit to the Paris Observatory and its Nançay Radio Astronomy Station, focusing on potential avenues for collaboration in radio astronomy.

The Paris Observatory, a central institution in French astronomy, encompasses multiple sites, including the Nançay Radio Observatory. The Nançay facility is equipped with several significant instruments.

Grand Radiotélescope de Nançay: Inaugurated in 1965, this large decimetric radio telescope remains one of the world's largest and continues to contribute to international radio astronomy efforts.

Nançay Decametric Array: Constructed between 1974 and 1977, this phased array consists of 144 spiral antennas and operates at wavelengths between 3m and 30m. It is primarily used for observing the Sun's corona and Jupiter's magnetosphere.

NenuFAR (New Extension in Nançay Upgrading LOFAR): This very low-frequency phased array, optimized for 10–85 MHz, aims to detect and study exoplanetary magnetospheres and the epoch of reionization.

The visit coincided with the 60th anniversary of the Grand Radiotélescope de Nançay, celebrated on May 13, 2025. This milestone highlights the observatory's enduring contributions to radio astronomy since its inauguration by General de Gaulle in 1965.

Discussions during the visit emphasized the potential for collaborative research, particularly in areas such as low-frequency radio observations, pulsar studies, and the development of advanced radio instrumentation. The Paris Observatory's expertise in designing and operating observatory instruments positions it as a valuable partner for future joint projects.

Ionospheric scintillations spectra at middle latitudes during strong geomagnetic storms

Shepeliev[1] V.O., Lytvynenko[2] O.O., Panishko[2] S.K., Derevyagin[2] V.G., Pidgornyi[1] G.S

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – URAN-4 Observatory of Institute of Radio Astronomy NASU, Ukraine

The UTR-2 and URAN radio telescopes are used to study inhomogeneities of electron density in the ionosphere at decameter wavelengths via the scintillation method. As is known, fluctuations in signals received from cosmic radio sources are affected by space weather phenomena. Our previous studies have shown that the ionospheric scintillation index correlates well with interplanetary shock waves driven by coronal mass ejections (CME) and corotating interaction regions (CIR) of the solar wind. Observations conducted on May 11, 2024, also indicate that during the extreme geomagnetic storm triggered by a CME, the scintillation spectrum can broaden significantly. Analysis of data obtained from 2021 to 2024 revealed that a similar broadening of scintillation spectra was observed during magnetic storms with Dst index values below -100 nT. The Fresnel frequency in this case increases from the typical ionospheric scintillation values of approximately 0.01 Hz to over 0.1 Hz. This change implies a substantial increase in the drift velocity of ionospheric irregularities during intense geomagnetic storms.

Solar radio emission at low frequencies as an indicator of ionosphere

Melnik V.[1], Brazhenko A.[2], Dorovskyy V.[1], Frantsuzenko A.[2], Shevchuk M.[1]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Poltava Gravimetric observatory, Institute of Geophysics of the National Academy of Sciences of Ukraine (NASU), Ukraine

The X1.4 class solar flare happened at the eastern limb on 22 September 2011. It was accompanied by the CME with mass $2.1 \cdot 10^{16} g$ and velocity about 2000 km/s and decameter Type IV burst. A group of Type III bursts were observed before Type IV burst. It began at 10:40 UT. Fluxes of Type III bursts and Type IV burst were $5 \cdot 10^{3} s.f.u.$ and $80 s.f.u.$ correspondingly at 30 MHz. A strong absorption was visible at frequencies lower than 14 MHz during about 60 min. Before the group of Type III bursts, the background radio emission was about 25 s.f.u. It was decreased for about 15 min to the value of about 0.2 s.f.u.. We connect this effect with absorption in ionosphere plasma due to its ionization when electron density increases up to $2.4 \cdot 10^{6} cm^{-3}$. Such ionization seems to be caused by strong X-ray or/and ultraviolet emissions of the flare with maximum about 11:00 UT.

Spectral, polarization and spatial properties of two successive Type IV bursts observed on 21 August 2015

Dorovskyy, V. V.,[1] Melnik, V. N.[1], Shevchuk, M.V.[1], Brazhenko, A.I.[2]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Poltava Gravimetric observatory, Institute of Geophysics of the National Academy of Sciences of Ukraine (NASU), Ukraine

We discuss spectral, polarization and spatial properties of the two successive type IV bursts observed by Ukrainian decameter radio telescopes UTR-2 and URAN-2 on 21 August 2015. These bursts were associated with the CME initiated by the M1.4 flare occurred in AR NOAA12403 (S17E26) at 9:34 UT. This CME was almost Earth-directed and hence appeared to be geo-effective, causing moderate magnetic disturbance on Earth two days later. The two discussed Type IV bursts differ from each other in time, frequency, polarization and morphology. The first one was short (~10 min) and respectively narrowband (from 23 to 70 MHz). The emission itself was structureless and unpolarized. The second Type IV burst lasted much longer, almost 2 hours, extended over much wider frequency band (from 20 MHz and beyond the upper limit of the NDA radio telescope, i.e. >80MHz). This burst consisted of fine structure in the form of short (1-2s) and fast drifting (-5-10MHz/s) fiber bursts. The polarization of these fiber bursts was about 20%. Interferometric observations show that the sources of these two bursts didn't move with time, which characterizes them as stationary Type IV bursts. More important is that the locations of these two bursts sources were different. Besides, for the first time spatial properties of fiber-bursts of the second Type-IV burst were obtained. We assume that sources of the observed Type-IV bursts were located in coronal plasma disturbances appeared there after the CME passage.

Usage of the solar energy for the solar radio observations with mobile antenna array

Shevchuk M. V., Bubnov I. M., Dorovskyy V. V., Ulyanov O. M., Stanislavsky L. A., Zakharenko V. V., Konovalenko A. A., Stanislavsky A. A., Reznichenko A. M., Selin V. Yu., Belov A. S., Yerin S. M., Tokarsky P. L., Shevchenko V. V.

Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine

The first results of registration of the various solar radio bursts with broadband (meter-decameter range) compact mobile quickly-deployable antenna array which can operate autonomously in field conditions, i.e. away of stationary alternating-current power network, being powered only by solar energy are presented in the report. The main characteristics of the antenna and the solar power station are also given.

Regarding the relationship between strong geomagnetic disturbances and the Earth's internal magnetic field in the vicinity of the Struve Geodetic Arc

Orlyuk M.[1], Romenets A.[1], Marchenko A.[1], Orliuk I.[1]

1 – Subbotin Institute of Geophysics of the National Academy of Sciences of Ukraine, Ukraine

The report presents the results of a study of the nature of the magnetic storm on May 10-13, 2024, depending on the module and anomalies of the geomagnetic field induction module along the Struve Geodesic Arc. To characterize the Earth's internal magnetic field [Alken, 2021; Meyer, 2017], digital maps of the induction module and its anomalies at heights of 4 and 100 km were developed, and to characterize the magnetic storm, the results of observations of variations in the northern, eastern, and vertical components of the geomagnetic field induction module in 7 magnetic observatories were used. For each observatory, we calculated the induction modulus of the internal magnetic field $\boldsymbol{B_{int}}$, the modulus of the main magnetic field (core field) $\boldsymbol{B_{IGRF}}$, the amplitude and mean value of the geomagnetic field variation, as well as the variation of the parameter $\boldsymbol{\Delta D}$, which reflects the ratio of the anomaly of the geomagnetic field induction modulus to the B_{IGRF} field. According to the results of statistical analysis, the dependence of the amplitude of the external geomagnetic field variations and their average values on the modulus of the main magnetic field of the Earth $\boldsymbol{B_{IGRF}}$ was revealed ($\boldsymbol{R^2_{A\delta B/BIGPH}}$ = 0.96 and $\boldsymbol{R^2_{\delta B\_average/BIGPH}}$ = 0.7, respectively) and naturally increases depending on the latitude of the observatory, from 265 nT (SUR) and 457 nT (ODE) to 1502 nT (NUR) and 2408 nT (SOD). A slightly lower correlation dependence was observed for the $\boldsymbol{Bx}$ component of the geomagnetic field and $\boldsymbol{B_{IGRF}}$ ($\boldsymbol{R^2_{Bx/BIGRF}}$=0.89). The amplitude of variation of the spatio-temporal perturbation of the geomagnetic field $\boldsymbol{\delta(\Delta D)}$ is also characterized by a high correlation dependence on the $\boldsymbol{B_{IGRF}}$ module ($\boldsymbol{R^2_{A\delta(\Delta D)/BIGPH}}$= 0.96). The revealed regularity is confirmed by a stronger manifestation of the magnetic storm on May 10-13, 2024 and a shift of its maximum disturbances by 4 degrees to the south compared to the magnetic storm of November 29-31, 2003 [Kärhä, 2024], during which the $\boldsymbol{B_{IGRF}}$ field induction module for the northern part of the Struve Geodetic Arc increased by 830÷930 nT. The connection between the maximum manifestation of the geomagnetic storm and regional magnetic anomalies on the Earth's surface and their superposition at an altitude of 100 km was revealed. The maximum magnitude of the magnetic disturbance is recorded at the Pello station, which is located in the region of the maximum anomalous magnetic field (more than 90 nT at an altitude of 100 km), in contrast to the Mikkelvik station – in the zone of the minimum geomagnetic field, which is partially confirmed by the variation *of* $\boldsymbol{\Delta B}$ anomalies due to the magnetization of their sources by the variation of the external field. The most probable reason for the connection between the amplitude of external field variations and the modulus of the main magnetic field of the $\boldsymbol{B_{IGRF}}$ and the anomalous magnetic field $\boldsymbol{\Delta B}$ is their effect on the formation of ionospheric currents.

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25th cycle of solar activity – the main manifestations of space weather.

Ryabov M.I. [1], Sukharev A.L. [1,2], Komendant V. [3]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Space Research and Technology Institute of Bulgarian Academy of Sciences, Bulgaria

The 25th solar activity cycle, contrary to forecasts, demonstrates significant differences from previous cycles. Integral data on the dynamics of changes in Wolf numbers and radio flux at the 10.7 cm wavelength show extreme values significantly exceeding those of the previous 24th cycle. At the same time, in terms of sunspot group areas and the number of days with geomagnetic storms, the 25th cycle falls behind previous cycles. The study examines features of the 25th cycle, specifically the differences in the development of activity in the northern and southern hemispheres of the Sun. During growth phase of the 25th cycle, unlike previous cycles, solar activity manifested in the simultaneous increase in the number of sunspot groups in both hemispheres. Later, the northern hemisphere took the lead, forming the first peak of the cycle. In 2024, the southern hemisphere became dominant, forming in August of this year the second main peak of the cycle. Further convergence of sunspot formation zones in the northern and southern hemispheres is expected to contribute to extreme manifestations of activity during the maximum and decline phases of the 25th cycle. These characteristics of the cycle led to the formation of activity complexes, which resulted in the extreme manifestation of space weather on May 9–11, 2024—one of the most powerful events of the last 50 years. The features of the 25th cycle were identified using wavelet analysis to detect periodic processes in the activity of the northern and southern hemispheres of the Sun.

Review of the effects of solar eclipses in the Earth's ionosphere.

Ryabov M.I. [1], Sukharev A.L. [1,2], Orlyuk M.I. [3], Zabora D.A. [4]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Institute of Geophysics of the National Academy of Sciences of Ukraine, Ukraine
4 – Odessa I.I. Mechnikov National University, Department of Theoretical Physics and Astronomy, Ukraine

Observations and studies of total solar eclipses are usually limited to depicting the dynamics of the Moon covering the Sun, allowing for a view of the panorama of the solar corona and chromosphere. Partial solar eclipses only demonstrate the degree of the Moon's coverage of the Sun. However, all types of solar eclipses manifest their unique effects on the ionosphere. This is due to the fact that the "shutdown" of ionizing solar emission in the eclipse path leads to a sharp decrease in ionization in the eclipse zone. This triggers wave disturbances in the ionosphere, which propagate over long distances from the eclipse observation site. Another complementary effect is the blocking of the solar wind flow by the Moon, which influences space weather manifestations. The study presents research results on the effects of solar eclipses in the ionosphere and introduces observation programs with using radio astronomical and magnetometric methods.

About the preliminary results of appearance the solar eclipse on March 29, 2025 according to magnetometric observations along the "Struve Arc"

Sukharev A.L. [1,2], Orlyuk M.I. [3], Ryabov M.I. [1], Romenets A. [3], Sumaruk Yu. [3], Kashuba V.I. [1]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Institute of Geophysics of the National Academy of Sciences of Ukraine, Ukraine

Solar eclipses temporarily reduce the flow of solar emission, causing a decrease in electron density in the ionosphere, changes in radio wave propagation, and the formation of acoustic-gravity waves. They also affect to magnetosphere, weakening the solar wind and generating local geomagnetic variations. The solar eclipse on March 29, 2025, was partial and observed in the Northern Hemisphere. The maximum eclipse phase was seen in Canada (at 10:48 UTC near the Ungava Peninsula), where the Moon covered nearly 94% of the Sun's disk, creating a twilight-like illumination effect. The penumbral shadow of the eclipse extended over Europe, North America, Russia, and the Arctic, including the North Magnetic Pole. In Ukraine, the eclipse was visible with a significantly smaller phase (Kyiv and Lviv - 0.6%). The report presents a preliminary review of observational effects of the March 29, 2025 eclipse, based on magnetometric measurements along the "Struve Geodetic Arc" area. According to magnetometer data from the URAN-4 Observatory of the Radio Institute of the NAS of Ukraine (Mayaky village), an unusual burst of irregular variations (Bx-component) was recorded in the period range of 22 – 60 seconds, starting at 11:00 GMT and ending at 14:00 GMT. The report also presents observational results of rapid geomagnetic field variations from other geomagnetic observatories near the "Struve Geodetic Arc" area.

Application of digital filtering methods for selecting radio source signals under interference conditions on URAN system radio telescopes.

Sukharev A.L.[1,2], Ulyanov O.M.[1], Ryabov M.I.[1], Zabora D.A.[1]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Kharkiv, Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia

Radio astronomical observations in the decameter radio range (10–30 MHz) are often affected by random interference and noise, also with anthropogenic origin. At the URAN-4 Observatory of the Radio Institute of the NAS of Ukraine (Mayaky village, Odesa region), radio interference has recently significantly limited daytime observation capabilities. The report examines the application of several simple and effective methods for cleaning observation data from the URAN-4 radio telescope from such interference. The chi-square method is used to detect and remove anomalous points (interference) in radio astronomical data. It helps determine which measurements significantly deviate from the expected data distribution and may be caused by external factors such as technical failures or interference. The interquartile range (IQR) method is a statistical approach for identifying outliers in data. It is based on analyzing the central 50% of values and helps determine points that significantly deviate from the overall distribution. The median absolute deviation (MAD) method calculates deviations from the median and helps detect outliers. The report presents results from applying these methods using model data and real recordings of cosmic radio sources observed by the URAN-4 radio telescope.

Observations of the effects of the solar eclipse of March 29, 2025 using measuring complex of the Sodankyla observatory in Finland - preliminary results

Sukharev A.L.[1,2], Usoskin I.[3], Kero A.[3], Bezrukovs V.[2], Steinbergs J.[2]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Sodankylä Geophysical Observatory of University of Oulu, Finland

Preliminary results of solar eclipse observations at the Sodankylä Geophysical Observatory, Finland are presented. The study examines fast variations in cosmic ray intensity on the day of the March 29, 2025, solar eclipse, as well as observations from pulsation magnetometers, and riometers. The observatory is located in the polar region, where the eclipse phase reached 0.69. The partial solar eclipse began at 12:11 local time, with its maximum phase at 13:19 and ending at 14:26. This combination of factors presents a particular scientific interest, and some results will later be compiled and thoroughly analyzed to identify the solar eclipse effects in greater detail.

On the formation of the database of observations of monitoring of powerful space radio sources on the RT URAN-4 for the period of the 22nd solar cycle

Zabora D.A.[1], Ryabov M.I.[1], Sukharev A.L.[1,2]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia

Since its commissioning in 1987, the URAN-4 radio telescope has been conducting a monitoring program for the fluxes of powerful cosmic radio sources, including supernova remnants Cassiopeia A and Taurus A (3C 461, 3C 144), as well as the radio galaxies Cygnus A and Virgo A (3C 405, 3C 274) at frequencies of 20 and 25 MHz. Observations of cosmic radio sources are carried out in modes of their passage through the directional diagram of the radio telescope at intervals of 40 minutes (3C 144, 3C 405, 3C 274) and 60 minutes (3C 461), two hours before and two hours after their culmination. This monitoring provides diagnostics of ionospheric conditions based on data regarding radio source scintillations and flux variations. A particularly interesting aspect is the study of space weather phenomena during the 22nd cycle of solar activity. To compare radio astronomical observation data with the state of geomagnetic disturbances, a catalog of geomagnetic storms covering the period 1987–2009 was compiled in collaboration with the Institute of Geophysics of the National Academy of Sciences of Ukraine, using data from its Odessa Magnetic Observatory. From 1987 to 1992, observations were recorded in an analog format using chart recorders, which limited the ability for detailed processing and comparison with magnetometric measurements. A method for "reviving" analog records and converting them into a digital format using pattern recognition techniques has been developed. This approach will be applied to the digitization of the entire archive of analog observations. A special priority is given to the analysis of unique manifestations of space weather during the 22nd cycle of solar activity.

The cyclicity of radio interference manifestation in the data of cosmic radio sources monitoring in the decameter wavelength range

Lytvynenko O.A., Panishko S.K.

Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine

A special feature of radio astronomical observations in the decameter wave range is the high level of radio interference, the main sources of which are broadcast radio stations, various radio engineering systems, industrial and natural sources of radio emission. Due to ionospheric propagation, radio interference signals entering the receiving path of the radio telescope through the central and side lobes of the antenna pattern can come from radio sources located at a distance of hundreds and thousands of kilometers from the radio telescope. The interference level is determined by the power and operating mode of radio interference sources, radio range congestion, ionospheric propagation conditions, which change depending on the time of day, season of the year, and phase of the solar activity cycle. Different types of interference manifest themselves in observational data in different ways. This depends on the observation technology, equipment used, and data processing methods. In this paper, we consider the interference environment by analyzing the manifestation of radio interference in radiometer signal records obtained during long-term monitoring of a group of compact space radio sources on the URAN-4 radio telescope (Odessa region, Ukraine). The results obtained can be used to improve the efficiency of planning radio astronomical observations, and also allow us to track trends in the change in the intensity of radio interference affecting radio astronomical observations.

Application of cluster analysis methods to spatial and temporal distribution of solar flares in different cycles

Didenko M.A.[2], Ryabov M.I.[1], Strakhov E.M.[2]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Odessa I.I. Mechnikov National University, Faculty of Mathematics, Physics and Information Technologies, Ukraine

The dynamics of solar flare activity during Cycles 23–25 have been analyzed. The analysis is based on data catalog from the World Data Network about powerful solar flares. These datasets include: Time, duration, and coordinates of solar flares, association with coronal mass ejection, presence of proton fluxes. A database and corresponding software have been developed to allow data selection for each activity cycle, enabling the identification of flare intensity levels and the movement of flare formation zones in the Northern and Southern hemispheres of the Sun. A particular focus is placed on the distribution of the most powerful flares, which are accompanied by coronal mass ejections and proton fluxes. Each cycle exhibits different temporal and spatial distributions of the strongest X-class and M-class solar flares. To determine trends in flare activity development, cluster analysis was applied to various parameters defining the state of space weather and the manifestations of planetary geomagnetic storms.

Study of the properties of geomagnetic variations in the Odesa magnetic anomaly. using continuous and discrete wavelet analysis methods.

Marmaliuk O.V.[3], Sukharev A.L.[1,2], Strakhov E.M.[3]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Odessa I.I. Mechnikov National University, Faculty of Mathematics, Physics and Information Technologies, Ukraine

The Odesa Regional Magnetic Anomaly (ORMA) is one of the largest in Ukraine, covering a significant part of the Odesa region. From 2018 to 2022, measurements of rapid geomagnetic field variations were conducted at the Odesa Astronomical Observatory, located in the central part of ORMA, to study the influence of the magnetic anomaly on the spectral shape and properties of regular and noise-like variations within the 10–600 second period range. This study has used applied programming methods and numerical data analysis. The main characteristics of these variations during geomagnetic storms were examined using continuous wavelet analysis and discrete wavelet decomposition. A comparison was made with the geomagnetic variations recorded on the same days at the Nurmijärvi Geomagnetic Station, Finland.

Modeling the relationship between data changes in the geomagnetic field, cosmic rays and solar wind using neural network and cross-spectral wavelet analysis methods.

Khromov Eu.A.[3], Sukharev A.L.[1,2], Strakhov E.M.[3]

1 – Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine
2 – Engineering Research Institute Ventspils International Radio Astronomy Centre (ERI VIRAC) of Ventspils University of Applied Sciences (VUAS), Latvia
3 – Odessa I.I. Mechnikov National University, Faculty of Mathematics, Physics and Information Technologies, Ukraine

This study examines cross-spectral correlations between solar wind parameters (from the NASA OmniWeb catalog) and geomagnetic variations (measured at Sodankylä, Finland and Belsk, Poland stations), as well as cosmic ray intensity variations (from OULU Neutron Monitor) over the period January 1 – April 9, 2024. The research explores the possibility of short-term geomagnetic variation forecasting using different types of neural networks. The study applies cross-spectral FFT analysis method and wavelet coherence analysis to identify spectral correlations in the data. An approximating neural network was used for precise reconstruction of Forbush decreases and the detection of rapid cosmic ray intensity variations in the declining region. The experimentally observed wave activity effects, caused by solar wind flows to the geomagnetic field and cosmic ray intensity, provide some new insights into regional differences in solar activity responses between the polar and mid-latitude regions of Earth.

The possibility of signal intensity restoration on radio telescopes with a small effective area in the VLBI system.

Lytvynenko O.O., Shepeliev V.O.

Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine

The configuration of low-frequency VLBI systems investigating space objects is usually based on the use of a powerful leading radio telescope with a large effective antenna area and smaller "auxiliary" radio telescopes. A similar configuration is used in the URAN system of dekemeter-wave radio interferometers of the National Academy of Sciences of Ukraine. The effective area of the UTR-2 leading radio telescope significantly exceeds the effective area of the "auxiliary" radio telescope. During VLBI studies in the URAN system, the integral flux density of most of the studied space radio sources does not exceed the sensitivity of the "auxiliary" radio telescopes. When processing radio interferometric data, if it is not possible to measure the signal intensity on the "auxiliary" radio telescope, calculated values are used that do not take into account the effects of radio source scintillation. The paper considers the possibility of reconstructing signal intensity fluctuations on an “auxiliary” radio telescope, based on the use of the results of processing radio interferometric data. The reconstruction of signal intensity fluctuations on “auxiliary” radio telescopes opens up the possibility of simultaneous multi-position studies of cosmic radio sources scintillations, including those based on archival records.

Classification of radio interference and its manifestation in cosmic radio sources radiometric records on the URAN-4 radio telescope

Lytvynenko O.O., Derevyagin V.G., Yasynskyi V.V.

Institute of Radio Astronomy (IRA) of the National Academy of Sciences of Ukraine (NASU), Ukraine

The efficiency of observations of cosmic radio sources in the decameter wave range largely depends on the level and type of radio interference. The same radio interference manifests itself differently depending on the observation mode, the equipment used, and the data processing technology. Therefore, monitoring of radio interference at the location of the radio telescope is important. Monitoring data can be used to plan observations, select interference suppression technology. In this paper, we consider the implementation of joint simultaneous radio astronomical observations and monitoring of radio interference on the URAN-4 radio telescope.

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

Komendant V.

Space Research and Technology Institute, Bulgarian Academy of Sciences

Cross-spectral analysis of time series is a technique in spectral analysis that is used to study the relationship between two time series in the frequency domain. It is especially useful when you are interested not just in whether there is a relationship, but also in the frequencies at which that relationship is expressed. Regression models were used to obtain the set of indices that have the greatest influence on the studied parameter of satellites drag. Then these indices were used in cross-spectral analysis. For a joint analysis, the drag coefficient was taken for three satellites moving at mid-latitudes. Interrelated periods for the satellite drag coefficient and the selected indices of solar and geomagnetic activity were obtained. The strength and linearity of the obtained interrelations are shown graphically. The phase shifts present between the interrelated periods are shown.

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