1st CREDO Visegrad Workshop 2024

Report of Contributions

https://indico.ifj.edu.pl/e/CREDO-CRACOW24

Contribution ID: **1** Type: **not specified**

Exploring Phase Space Deformation through a Correspondence between Modified Gravity and Generalized Uncertainty Principle, and Earthquakes as Testing Grounds

Wednesday, January 17, 2024 2:30 PM (30 minutes)

I will briefly explore the connection between modified theories of gravity and models based on the generalized uncertainty principle. This connection enables the examination of gravity proposals through tabletop experiments. Using the Landau model of liquid helium as an illustrative example, we will delve into the details. Additionally, I will demonstrate the application of Earth seismic data to constrain quantum and modified gravity proposals. Further, we will discuss essential enhancements needed for this method.

Presenter: Dr WOJNAR, Aneta (Universidad Complutense, Madrid, Spain)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **2** Type: **not specified**

An update on the cosmo-seismic correlations: a manifestation of a charged dark matter stream?

Wednesday, January 17, 2024 12:00 PM (1 hour)

I'll report on progress with understanding the physics of the cosmo-seismic correlations. The main observations associated with the effect point to the role of both solar magnetism and lunar gravitational forces, although the latter does not appear to have a tidal character. In addition we observe a clear appearance of the sidereal day periodicity in both cosmic ray and earthquake data. None of the conventional scenarios considered so far does not seem to match the whole range of properties of the cosmo-seismic effect and its main properties, and it opens the stage for alternative explanations. Presently, the best candidate scenario we qualitatively take into account is a stream of charged dark matter particles which would be heavy enough to induce a seismic effect after being lensed or modulated by the nearby massive bodies and magnetic fields, and which could induce or generate radiation observable with standard means. The scale of consequences of such a scenario would be immense. For instance, we should be able to predict some earthquakes by monitoring cosmic ray sources moving within the Solar System, and we would have to revisit all the climate change models by considering the newly discovered external factor. An impact of a nearby dark stream could possibly be hardly noticed by individual, narrowly-focused observatories, but the observational chances should grow with adopting an unbiased, interdisciplinary approach where a combination of weak indications from distinct research areas could give a strong, unquestionable signature. We attempt to implement such an approach in CREDO, and everybody is invited to be a part of this quest.

Primary author: Dr HOMOLA, Piotr (Institute of Nuclear Physics PAN)

Presenter: Dr HOMOLA, Piotr (Institute of Nuclear Physics PAN)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **3** Type: **not specified**

Exploitation of Cyclostationarity and its Generalizations for Science Data Analysis

Wednesday, January 17, 2024 11:30 AM (30 minutes)

Antonio Napolitano
Department of Engineering
University of Napoli "Parthenope", Italy

https://sites.google.com/site/antnapol
antonio.napolitano@uniparthenope.it

Presentation of the main research topic related to CREDO collaboration at the University of Napoli "Parthenope", Italy:

Exploitation of Cyclostationarity and its Generalizations for Science Data Analysis

Cyclostationarity is a statistical property of science data generated by the combination/interaction of periodic and random phenomena. These data have second- or higher-order statistical functions that are periodic functions of time. More general models can account for the presence of multiple, possibly incommensurate, and irregular periodicities ([2], Chapters 1,2). Even if the observed signals are not periodic, the hidden periodicities can be restored by estimating statistical functions from the
data. These statistical functions contain information on the generating mechanism of the data that cannot be extracted starting from the classical stationary modeling of the observed signals.

In the case of relative motion between a transmitting source and the receiver, time dilation effects must be accounted for in the received signal ([1], Chap. 6). In such a case, generalizations of cyclostationarity are appropriate models for the received signal ([1] Chaps. 2–5, [2] Chaps. 12–14).

Within the CREDO collaboration, the cyclostationary model has been exploited to confirm the main results presented in [3]. Specifically, in [3], the average variation of the cosmic ray detection rate, the earthquake sum magnitude, and the Sunspot monthly mean are shown to be pairwise jointly cyclostationary time series and the Fourier coefficients of their cross statistical functions are estimated. The results show the existence of periodic correlation or statistical dependence between pairs of these time series.

[1] A. Napolitano, Generalizations of Cyclostationary Signal Processing: Spectral Analysis and Applications. John Wiley & Sons, Ltd., IEEE Press, 2012.

[2] A. Napolitano, Cyclostationary Processes and Time Series. Theory, Applications, and Generalizations. Elsevier, 2019.

[3] P. Homola, V. Marchenko, A. Napolitano, et al. , "Observation of large scale precursor correlations between cosmic rays and earthquakes with a periodicity similar to the solar cycle", Journal of Atmospheric and Solar-Terrestrial Physics, Vol. 247, art. 106068, 2023.

Primary author: NAPOLITANO, Antonio (University of Napoli Parthenope, Italy)

Presenter: NAPOLITANO, Antonio (University of Napoli Parthenope, Italy)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **4** Type: **not specified**

The Global Network of Optical Magnetometers for Exotic physics searches (GNOME)

Tuesday, January 16, 2024 10:40 AM (20 minutes)

Not only optical magnetometers are the most sensitive magnetic-field sensors, but they may also be used to search for non-magnetic spin couplings, including those associated with hypothetical dark-matter interactions. The performance of the sensors will be discussed in the context of searches for exotic spin couplings using a network of synchronized magnetometers [1], which extends the searching possibilities to transient and spatially correlated perturbations. Search targets and developed dark-matter detection schemes [2] will be discussed.

[1] Szymon Pustelny et al. "The Global Network of Optical Magnetometers for Exotic physics (GNOME): A novel scheme to search for physics beyond the Standard Model". In: Ann. der Physik 525.8-9 (2013), p. 659.

[2] Samer Afach et al. "What Can a GNOME Do? Search Targets for the Global Network of Optical Magne- tometers for Exotic Physics Searches". In: Ann. der Physik (2023), p. 2300083.

Primary authors: ŁUKASIEWICZ, Grzegorz (Jagiellonian University); Prof. PUSTELNY, Szymon (Jagiellonian University)

Presenter: ŁUKASIEWICZ, Grzegorz (Jagiellonian University)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **5** Type: **not specified**

Radiation detection and particle tracking with pixel semiconductor Timepix detectors

Tuesday, January 16, 2024 3:00 PM (20 minutes)

Advacam detectors of the Timepix family with the pixelated semiconductor chip developed within Medipix Collaboration at CERN allow for radiation energy detection with precise position information in a wide range of deposited energies. Their capabilities will be demonstrated on the results of several space projects where space radiation fields were composed of components with diverse particle origins and energy.

Presenter: SYKOROVA, Katerina (Advacam)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **6** Type: **not specified**

Muography: imaging with cosmic particles

Tuesday, January 16, 2024 12:20 PM (20 minutes)

Naturally occuring cosmic particles, mostly muons, reach the Earth surface continuously and nearly uniformly, and due to their high energy can cross as much as 10-1000m of rock. Since muons propagate along straight lines, one can use these particles for imaging the internal density structure of large objects. More than five decades ago, this method has been used to search for hidden chambers in a pyramid, and subsequently to study various challenging structures: mines, caves, volcanoes, nuclear reactors. Since the turn of the last century, there has been a rapid increase of interest towards muon imaging –with a new research field, called "Muography"emerging –and the application possibilities broadened along with drastic reduction of instrumentation cost, at improved detection efficiency, portability and imaging resolution. The most relevant application possibilities include mining, archeology, volcanology, nuclear industry and border control. Measurements related to volcanology span three continents, and revealed magma movement and erosion effects. Mining applications allow cost reduction (less drilling) and improved operational safety, thus contributing to a sustainable future.

Muography is not only becoming a consistent research field, but there is an international community which facilitates information exchange, critical assessment of the quality of new results, and promotes technology transfer towards an increasing number of industrial partners.

Primary author: VARGA, Dezso (HUN-REN Wigner Research Centre for Physics)

Presenter: VARGA, Dezso (HUN-REN Wigner Research Centre for Physics)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **7** Type: **not specified**

A few technical comments on the CREDO project

Tuesday, January 16, 2024 10:20 AM (20 minutes)

For several months, PTMA has been actively participating in the CREDO project by the Institute of Nuclear Physics of the Polish Academy of Sciences in Krakow. To detect secondary cosmic radiation particles, participants build measuring stations consisting of Samsung mobile phones. The long period of operation allowed me to formulate a few technical comments regarding the operation of the station. They include issues related to hardware and software, IT security elements, power and cooling requirements, problems with Android system support, as well as the possible evolution of detectors from the point of view of the "Particle Hunters" participants.

Primary author: Mr WIĘCKOWSKI, Marek (Polish Society of Amateur Astronomers (PTMA))

Presenter: Mr WIĘCKOWSKI, Marek (Polish Society of Amateur Astronomers (PTMA))

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **8** Type: **not specified**

Observations from the publicly available data of the CREDO experiment

Wednesday, January 17, 2024 10:20 AM (20 minutes)

The author statistically evaluates the public data from the CREDO science project.[1]
Starting from observations on the live website data, some effects will be investigated looking through the whole available data set.
Especially I will focus on how long users and devices contribute.
There an interesting divergence between live data and stored data is observed.
Another effect which can be observed is that regularly, that there are events when one user reports several observations at the same time.
Multiple detections show all the three types of cosmic ray observations that were discussed in the paper by Bibrzycki et al..[2]
These can be found in nearly 5% of the observations, one can find up to 10 observations at the same time.
Of course a double detection is most likely and then the possibility goes down.
All is still work in progress and can be either included in the scientific evaluation of the experiment or in the improvement of the experience of the users that contribute to the project.

1 P. Homola, et al. (CREDO Collab.), "Cosmic Ray Extremely Distributed Observatory", Symmetry 2020, 12(11), 1835, 2020. [arXiv:2010.08351, DOI:10.3390/sym12111835].
2 Ł. Bibrzycki et al. [CREDO], PoS ICRC2021 (2021), 227 doi:10.22323/1.395.0227 [arXiv:2110.00297 [physics.ins-det]].

Primary author: LIEBING, Simon (Institute of Theoretical Physics, TU Bergakademie Freiberg. Freiberg, Germany)

Presenter: LIEBING, Simon (Institute of Theoretical Physics, TU Bergakademie Freiberg. Freiberg, Germany)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **9** Type: **not specified**

The Cosmo-Seismic Task Report

Wednesday, January 17, 2024 5:20 PM (5 minutes)

Presenters: ÁLVAREZ CASTILLO, David (Institute of Nuclear Physics PAS); Dr ZABARI, Noemi

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **10** Type: **not specified**

The Machine Learning Task Report

Wednesday, January 17, 2024 5:25 PM (5 minutes)

Presenter: PIEKARCZYK, Marcin (AGH University of Krakow)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **11** Type: **not specified**

The Visibility Task Report

Wednesday, January 17, 2024 5:15 PM (5 minutes)

Presenter: Prof. KAMINSKI, Robert (Insititute of Nuclear Physics PAN)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **12** Type: **not specified**

The CREDO-Maze Task Report

Wednesday, January 17, 2024 5:00 PM (15 minutes)

We would like to give a brief overview of the idea behind the CREDO-Maze project realised at the University of Lodz and summarise its status today. For some time now, we have been testing and continuously improving the design of the detectors and their electronics, adding various components that may not be necessary for CREDO itself, but may be useful for other purposes, including education. We have developed a technique that involves high school students in the construction of 'their' detector stations, and the idea is working. We are currently trying to work out the final format of the data acquisition and the IT issues of data transfer. In parallel, we are developing teaching materials on cosmic ray physics for teachers and prospective students.

Presenter: Prof. WIBIG, Tadeusz

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **13** Type: **not specified**

Haptic Arduino and CME Mass Calculation

Monday, January 15, 2024 4:55 PM (20 minutes)

Due to the limited sensibility of vision, astronomers usually only "look at"computer purified data sets. Auditory and tactile means provide brand-new ways for us to examine the sky. Inspired by Harvard Astronomy Lab and Clay Telescope's Orchestar (color arduino), we present the proof of concept of a very sensitive yet simple device to transfer color into sounds and haptic motion built by Adafruit components.

The device shows potential for calculating the masses of coronal mass ejection (CME) and other astronomical quantities. Using techniques similar to sonification analysis, we could hear and feel more hidden information and thus extract valuable critical points out of the chaotic data set.

Primary authors: LAN, Ruoning (Brown University); Dr DIAZ-MERCED, Wanda (Universidad del Sagrado Corazón)

Presenter: LAN, Ruoning (Brown University)

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **14** Type: **not specified**

Machine Learning @CREDO

Wednesday, January 17, 2024 9:50 AM (30 minutes)

The recent, ongoing as well as planned CREDO ML research activities will be discussed. So far CREDO ML focused on the analysis of individual cosmic ray events including the filtering of artifacts and hardware noise and attepmts to associate event shapes with particular particle types. In terms of ML methodologies these were supervised binary and multi-class problems, respectively. We also applied non-supervised schemes to extract the most representative features of events or isolate outliers and novelties. The projects recently undertaken focus on generative models which enable the modelling of collective cosmic ray phenomena like Extensive Air Showers, in particular studying particle distributions or unfolding detector effects.

Primary author: BIBRZYCKI, Łukasz (AGH University of Krakow)

Co-authors: PIEKARCZYK, Marcin (AGH University of Krakow); NIEDŹWIECKI, Michał (Cracow University of Technology); BAR, Olaf (Cracow University of Technology); STUGLIK, Sławomir (Institute of Nuclear Physics PAS); HACHAJ, Tomasz (AGH University of Krakow)

Presenter: BIBRZYCKI, Łukasz (AGH University of Krakow)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **15** Type: **not specified**

Sonification: Better science

Monday, January 15, 2024 2:30 PM (45 minutes)

Sonification has a long history in the space sciences. The technological advancements brought it to pass from being on the forefront to behind the scenes in space sciences. Despite the sciences and mathematics continue facing challenges to avoid estationarization and linearisation of the changes/data/telemetry acquired. In this presentation I will talk about some aspects sonification may support to address in space science and talk about the possibility of a framework to put in place the things needed for the current scientific economy to do a transition to multisensorial practices for its uses in the data exploration endeavours.

Presenter: DIAZ-MERCED, Wanda (Universidad del Sagrado Corazón)

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **16** Type: **not specified**

Probing the Power of Sonification for Asteroseismology

Monday, January 15, 2024 3:15 PM (20 minutes)

Within the vast field of Astrophysics, the study of variable stars is expansive and inclusive. Groundbreaking discoveries can be made with modest instrumentation and small telescopes, also by amateurs, and treasure troves of new unexplored data are available to the scientific community and the public. Therefore, this field lends itself perfectly to involving more people in astronomical research, sharing a cosmic perspective on our human scientific endeavors, and using it as a "hook"for STEAM education.

AstroSounds is a citizen science project investigating the extent to which the human ear can distinguish the timbre of different pulsating star types. At the same time, it is an educational project inspired by the research field of asteroseismology, naturally linking different STEAM curriculum topics, such as physics, mathematics, biology, chemistry, and music education. The multimodal exploration of data, including the auditory channel, opens the field of astronomy to people with visual impairments.

In the successful pilot project of AstroSounds, which ran in Belgium from 2020 onwards and was funded by the Flemish government, numerous light curves, gathered with space missions and ground-based telescopes, were used for sonification.
In this contribution, I will briefly describe the work behind the scenes to set up our citizen science project and its STEAM education component, as well as the sonification method. Subsequently, I would like to exchange on potential synergies and avenues of collaboration with the CREDO network.

Presenter: KOLENBERG, Katrien

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **17** Type: **not specified**

TBA

Monday, January 15, 2024 3:35 PM (20 minutes)

Presenter: CLARKE, Christine (Oxford University)

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **18** Type: **not specified**

Sonification of Squeezed Vacuum State of Light: Unveiling Quantum Dynamics through Sound

Monday, January 15, 2024 3:55 PM (20 minutes)

The nature of quantum states of light is inherently governed by the Heisenberg uncertainty principle, leading to the presence of zero-point energy. A squeezed vacuum state emerges as a reshaped fluctuation of this zero-point energy. To characterize and comprehend a squeezed vacuum, the utilization of a bright field becomes pivotal. This bright field not only amplifies the squeezed vacuum but also elevates it above the classical photodetectors' detection threshold. Transforming the detected electrical signals of the squeezed vacuum into sound via speakers provides an additional auditory dimension to grasp the intricacies of this quantum concept.

In this presentation, I will introduce a device designed for generating a squeezed vacuum. A simple and cost-effective headphone has been ingeniously modified to convert electrical signals into sound, enabling us to explore various points in the squeezed vacuum generation system. Throughout the talk, we will experience the steady sound of a squeezed vacuum state. By systematically scanning the phase difference between the squeezed vacuum and the bright field, we can discern the intricate structure of the squeezed vacuum.

This exploration into sonification not only enhances our understanding of quantum dynamics but also demonstrates a practical and accessible approach to studying squeezed vacuum states.

Presenter: ZHAO, Yuhang

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **21** Type: **not specified**

A sonification atlas for CREDO cosmic ray detections: Basis for Dark Matter and Dark Photon Investigations

Monday, January 15, 2024 5:15 PM (20 minutes)

The search for the unseen matter will persist as desirable as a pinnacle discovery for humankind. The opportunity about the ethereal richness of the information composing the universe is not a delusion, but a disposition of curiosity although seemingly without an answer up to this date. The infinity of suspicions whether dark matter is (un)real do not rest on anticlimactic futility of knowing less after knowing more the fundamental implicitness of the universe, which we define in accord to epistemology of the standard model (SM). Positivism dictates (dis)approval, but the exploration of the pieces of (mis)detected information about dark matter is counterintuitive: we process the analyses within a silo of 'methodical reductionism'(i.e., subtracting noise from data and polishing all statistical asymmetries) and yet unification is sought desperately from missing representations of dark matter alluded to signals from ordinary matter. Restipulation of infinity in the context of discourses about this unknown matter declares multiple, 'strange complexities' (i.e., beyond an observer's ability to reconcile scientific inquiries with available methods). The held principal conjecture is a featureless energy landscape and a departure of the quantumness of matter from the effects of classical gravity. This dichotomy is not a binominal reality to approach rather a paradox full of uncertainty where a proposed grand measurement will neither satisfy nor come close to the demand for scientific prudence and erudition for current physics skeptics.

The construct about mass applied to dark matter studies poses to be an 'irrelevant conception'(simply arbitrary) and becomes 'illusory to absurd'(mathematically perceptible somehow but astonishingly less risky in contemplation than avoid a controversy) to try forge a model of irradiance (h) indirectly by elusive particles. Modeling of ordinary matter takes the foreground measurement while the background detection may assume dark matter. Unsurprisingly, measurement leaves incompleteness either by evidence or explanation of results. Thus, gaps will be patched up abductively. We may propose that ordinary matter superimposes dark matter and if the former can be peeled off then it is groundbreaking methodically. Another is to imagine them looping on either side of a continuous string-like Möbius membrane and a puncture across after forcing a great amount of energy over ordinary matter will unleash elusive particles just as particle colliders operate and offer a glimpse of intricacies of matter within matter.

On the trail of thought connected to the previous paragraph, asking why versus how particles are elusive at the realm of data analysis yields to a frugal numerical output. Infinity in-calculation bifurcates: first to a technical limitation and second to a premature impulsivity when denoting representation of the unaccountable, invisible matter by showing a numerical depreciation. Imaginary numbers translate to infinite ignorance of the computations even at both ends of the bifurcation. Exhaustive rigor in the analysis of data is relative to the level of explanatory ignorance to resolve the frustration in value approximation and this cannot be succinct exploratorily with numerical representations. So, for a nontechnical individual who desire to understand incredible (work on the) big data will not persist. Presentation of scientific data to convincing facts may look arrogant due to the richness of its meanings. Communication to the public becomes highly decorated with charts embedded with impressive statistical jargons.

Elusive numerical frequencies are locked into incognito in the detected cosmic rays, but we operationalize the signal detection with what the SM has like using photons to accept the hypothesis of dark photons. Dark matter and dark photons cuts SM boundaries. Nominating particle candidates for dark matter offers a leeway. Reframing how we look at SM would be unorthodox.

The consequence is accentuating its gray areas. However, this consequence should create new windows for physics. Specifically, inclusion of diverse interpretivism of particle detections accomplished through data sonification. We have to cleverly and creatively improve the interpretability of particle physics so it stays relevant to society wherein everyone can engage regardless of educational background, profession, socioeconomic status, and humanitarian crises (e.g., war, pandemic, etc.). Candidly, the equations framing particle physics may tirelessly (or may not) appeal among who can(not) articulate a connection between 'objective eroticism'(nonorganic
pleasure of wanting complexity) and paralysis from 'uncomprehensible cognitive load'(deep thinking).
The phenomenon in question exists as whole data. Methodical rigor involves (expensive) data extraction and manipulation. The latter gives rise to novel distortion instead of preserving natural perturbations as true anomalies in the frequency details (e.g., astrophysical event detections), but then is knowingly remodeled to fit into or (ful)fill what the naked eye can account.
The oversight of data proceeds to overarching answers despite there is fragmentation in data patterns. Therefore, we lose the phenomenon in question each data processing. Further, data analysis is tainted by unfounded priori, which are actually general claims when expecting dark matter to be (or must be) very unusual findings. So, the story out of the data can (or must) appear fancy based on asymptotic signal fluctuations against the behavior of signals from ordinary matter.
However, conventional elucidation of cosmic ray detections is until the frontiers of data
visualization. Sophistication of experiments reported in literature fail to provide meaningful depth of interpretation of the phenomenon using visual inferences. To divorce dark matter from analysis of ordinary matter representation in the data is thought acceptable by mass difference determination. Alternatively, dark matter can be the relocation of energy buried in the unattractive data patterns. Zooming into these patterns visually does not guarantee salience to the observer.
Through sonification, minuteness between data points (despite simultaneous with overlaps) can be resonated and amplified with the opportunity of equivocal synopsis of correlative findings while matter in query is audibly and visually interpreted. Peculiarities can mean unveiling the (ambiguous) interphase of ordinary matter and dark matter.
We should aim for malleable reproduction of data analysis techniques so we can generate and weave empirical evidence together through practice of interdisciplinarity. Also, we take advantage of knowledge cross-fertilization. High-energy astrophysics could be helpful in the development of space nursing research focusing on cosmic radiation and health of astronauts and space tourists if nurse scientists will understand astrophysics data. Same predicament with communication if researchers are unable to laymanize and disseminate varying levels of scientific content to nontechnical stakeholders including students. However, to bring synergy between many disciplines and lucrative investment opportunities supporting research endeavors, it is imperative
to move the goals of understanding (astrophysics) data up to speed along with public engagement in science because it is worth everybody's interest.
Data sonification is not a segway to (over)simplification of data analysis rather it is
instrumental to discover and rediscover what truly matters when the eyes more often find ordinary results. Feynman diagrams are blueprints of possible particle interactions. On the other hand, towards an ingenious data representation, hearing how a Feynman diagram sounds is a remarkable experiential learning of particle physics.
The extensive data analyses shown in the presentation aims to provide: (1) a sonification atlas using CREDO cosmic ray detections; (2) unique interpretation of data by sonification; and (3) representation of plausible dark matter and dark photon in the data.

Presenter: HERNANDEZ, Dr. JOANNES PAULUS

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **22** Type: **not specified**

The LightSound Project: Experiencing a Solar Eclipse with Sound

Monday, January 15, 2024 5:35 PM (20 minutes)

Solar eclipses are profound experiences. LightSound is a sonification tool designed for solar eclipses. The device converts light to sound for blind, low-vision, or non-visual learners as a way to observe solar eclipses through sound. The LightSound team is building 750+ devices to be donated for the upcoming April 2024 total solar eclipse. I will provide an update on the project and give future prospects.

Presenter: ALLYSON, Bieryla

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **23** Type: **not specified**

Sonification of Gravitational Waves: Effective or not?

Monday, January 15, 2024 5:55 PM (20 minutes)

Accurately decomposing the data into its many oscillation modes is one of the priorities of science. The gravitational wave telemetry is not an exception to this. In this presentation I will present the techniques I used to embed the usage of sound as an alternative to support the scrutinization of these events and the following comparative studies going on towards proving or discarding the effectiveness of the use of audio to analyse these data sets.

Presenter: KENDALL, Shane

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **24** Type: **not specified**

Open discussion for all participants

Monday, January 15, 2024 6:35 PM (35 minutes)

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **25** Type: **not specified**

SpES, studying solar-terrestrial physics from a global Earth science perspective

Wednesday, January 17, 2024 4:30 PM (10 minutes)

In this contribution, we present to the CREDO community the SpES (Space & Earth Sciences) research group of the University of Extremadura, which is a member of the CREDO consortium. This research group attempts to make significant advances in Earth sciences using a global perspective. Its main research areas are Solar-Terrestrial Physics, Climatology, Meteorology, and History and Teaching Geosciences.

This research group has worked intensively over the last two decades to provide the international community with a better reconstruction of solar activity over the last four centuries from documentary sources [1-3]. Currently, it is responsible for guarding the HASO (Historical Archive of Sunspot Observations). In addition, it has demonstrated the ability to analyze and diagnose large solar-terrestrial events of the past such as the intense geomagnetic storms of 1870 [4] and 1903 [5]. In particular, it has used statistical analyzes to demonstrate that, from a space weather point of view, we do not expect events significantly larger than those already observed [6-7] .

Finally, we would like to highlight the interest of SpES in history [8], teaching [9] and the dissemination of Earth and Space sciences, where the interest of this research group in the CREDO experiment is clearly manifested [10].

1. F. Clette et al. 2014. Space Science Reviews 186, 35. DOI: 10.1007/s11214-014-0074-2
2. A. Muñoz-Jaramillo, J.M. Vaquero. 2019. Nature Astronomy 3, 205. DOI: 10.1038/s41550-018-0638-2
3. R. Arlt, J.M. Vaquero. 2020. Living Reviews in Solar Physics 17, 1. DOI: 10.1007/s41116-020-0023-y
4. J.M. Vaquero et al. 2008. Journal of Geophysical Research 113, A08230. DOI: 10.1029/2007JA0129431870
5. H. Hayakawa et al. 2020. Astrophysical Journal Letters 897, L10. DOI: 10.3847/2041-8213/ab6a18
6. F.J. Acero et al. 2018. Astrophysical Journal 853, 80. DOI: 10.3847/1538-4357/aaa406
7. F.J. Acero et al. 2018. Geophysical Research Letters 45, 9435. DOI: 10.1029/2018GL079676
8. J.M. Vaquero. 2017. History of Geo- and Space Sciences 8, 53. DOI: 10.5194/hgss-8-53-2017
9. I. Tovar, J.M. Vaquero. 2023. The Physics Teacher 61, 100. DOI: 10.1119/5.0058890
10. P. Homola et al. 2020. Symmetry 12, 1835. DOI:10.3390/sym12111835

Primary author: VAQUERO, José Manuel (Universidad de Extremadura)

Presenter: VAQUERO, José Manuel (Universidad de Extremadura)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **26** Type: **not specified**

”Playing with the Universe” - audiovisual, interactive, Ephemeral Art performance.

“Playing with the Universe” - One of the main drivers of the CREDO mission.

Update, perspective on further actions. Exploration.

To what extent are the random signals we observe a coincidence? Can cosmic radiation be a carrier of signals from autonomous systems - the ‘cosmic ether’?

“Playing with the Universe” An artistic endeavor engaging all willing participants present during the performance. I utilize CREDO detectors installed on participants’ smartphones, which, through a local network and desktop application, transmit control impulses to a tone generator subject to chaotic reactions. Simultaneously, while performing on an instrument, I try to resist the established sound image. I attempt to transform the unattainable into the real. The result is playing with the Universe. In this case, music becomes an immeasurable subset of events - unpredictable and unique due to the moment.

I am asking a question about the artist’s attitude, the idea of art today, I Am trying to go out of the set area of meanings. If everything has already been, everything will be soon, that what has been is barely and more a bridge to what is going to happen.

The performance is accompanied by a visual part - an interactive projection of cosmic radiation particle detections in the form of images recorded by matrices embedded in participants’ smartphones.

Primary author: BATYJEWSKI, Krystian

Presenter: BATYJEWSKI, Krystian

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **27** Type: **not specified**

Cosmic Watch based detector array - measurements and simulations

Tuesday, January 16, 2024 10:00 AM (20 minutes)

Creating a perfect cosmic ray detector for the purpose of CREDO is a task that has been undertaken not once in the past by projects like CosmicPi, CREDO-Maze or Astro-tectonic . Diversity of used detectors can become an advantage in the search of new cosmic ray related phenomena but it requires a good understanding of used devices. We would like to present our proposition of a device that should be affordable by most educational institutions or even some committed individuals, at the same time being able to measure cosmic ray flux and observe Extensive Air Showers (EAS). We believe that this sort of equipment could become an important part of future CREDO related data collection system, as they should be able to collect data directly to the server for months without interruption. However, before distribution of such we have to understand all their properties and problems that may occur during operation. In order to do so, we performed simulations of our detectors in interaction with most numerous cosmic ray particles in different conditions. We would also like to present results of first measurements and discuss prospects for future development of our project.

Primary author: PRYGA, Jerzy (University of the National Education Commission)

Co-authors: WOZNIAK, Krzysztof (Institute of Nuclear Physics PAS, Krakow, Poland); BIBRZYCKI, Łukasz (AGH University of Krakow)

Presenter: PRYGA, Jerzy (University of the National Education Commission)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **28** Type: **not specified**

Status and Future Simulation Prospects of Cosmic-Ray Ensembles Generated by Synchrotron Radiation

Wednesday, January 17, 2024 9:30 AM (20 minutes)

Cosmic rays are anticipated to give rise to cascades of product particles during their journey through space, resulting from interactions with fields, radiation, and matter. These phenomena, collectively known as cosmic-ray ensembles (CRE), are expected to exhibit variations in shapes, sizes, and constituents. Comprehensive studies of CRE necessitate an alternative approach to cosmic ray detection that considers their spatial and temporal correlations on a global scale. Despite the technical challenges, the potential observation of portions of CRE at Earth could significantly contribute to contemporary cosmic ray astrophysics. One prevalent scenario for CRE formation involves the synchrotron radiation of charged particles moving through ubiquitous magnetic fields. We present updated results from CRE simulations in this context, exploring the favorable physics conditions for observing such particle cascades and discussing the practical prospects of this research direction.

Primary author: SUSHCHOV, Oleksandr (INP PAS)

Presenter: SUSHCHOV, Oleksandr (INP PAS)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **29** Type: **not specified**

The REINFORCE EU citizen science project

Monday, January 15, 2024 6:15 PM (20 minutes)

The REINFORCE EU (Research Infrastructures FOR Citizens in Europe) was a three-year long SwafS project which engaged citizens in active collaboration with the scientists working in large research infrastructures across Europe. The overall aim was to bridge the gap between them and reinforce society's science capital. The citizen scientists had at their disposal data from four different "discovery demonstrators"hosted on the online Zooniverse platform.
The demonstrators asked for the citizen contribution to front-end research such as: gravitational wave astronomy, deep sea neutrino telescopes, particle search at CERN and cosmic rays. The task of the citizens was to help the scientists to optimize the detectors and/or the reconstruction algorithms. A separate dedicated working package was devoted to exploring the potential of frontier citizen science for inclusion and diversity. The emphasis was given to sonification for inclusion of visually impaired citizens, senior citizen science courses and artistic interventions.
The focus of the talk will be on the demonstrator titled "Search for new particles at CERN", where citizen-scientists visually inspected events collected by the ATLAS detector at LHC and searched for signatures of new particles. To make this possible, the demonstrator adopted a three-stage architecture. The first two stages used simulated data to train citizens, but also to allow for a quantitative assessment of their performance and a comparison with machine learning algorithms. The third stage used real data, providing two research paths: (a) study of Higgs boson decays to two photons, one of which could be converted to an electron-positron pair by interaction with detector material, and (b) search for yet undiscovered long-lived particles, predicted by certain theories Beyond-the-Standard-Model. The second stage events were sonified by CONICET.
The results of 360,000 classifications showed that citizen scientists can carry out complicated tasks responsibly, with a performance comparable to that of a purpose-built machine-based algorithm and can identify interesting patterns or errors in the reconstruction, in individual events. Moreover, the demonstrator showed that the statistical combination of user responses (user consensus) appears to be quite a powerful tool that can be further considered and exploited in fundamental scientific research.
The demonstrator approach to applying citizen science to high energy physics proved that users could contribute to the field, but also identify areas where further study is necessary.

Presenter: KOURKOUMELIS, Christine (National and Kapodistrian University of Athens)

Session Classification: Sonification of data, Citizen Science and Educational aspects of CREDO

Contribution ID: **30** Type: **not specified**

Modular Cosmic Ray Detector (MCORD) possible use in the cosmo-seismic project.

Tuesday, January 16, 2024 12:40 PM (20 minutes)

MCORD (Modular Cosmic Ray Detector) was designed as a tool that can be used both in large physics experiments and on a much smaller scale for observations in small projects. This is possible thanks to its segmented and scalable structure. The basic features of this detector will be presented as a tool that we propose to use when searching for local correlations between the level of earthquakes and the average flux of cosmic radiation reaching the Earth's surface.

Presenter: BIELEWICZ, Marcin (NCBJ - National Centre for Nuclear Research)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **31** Type: **not specified**

Astroteq.ai cosmic ray detection demonstration

Tuesday, January 16, 2024 1:00 PM (20 minutes)

Introducing the AstroTeq.ai Basic detector, a compact cosmic ray detector with advanced features. Designed for discreet cosmic ray analysis, it employs dual scintillators and SiPM in a TOP-BOTTOM coincidence setup. With GPS for precise location, WiFi for real-time communication, and an internal battery for uninterrupted operation, the device ensures reliable detection without disruption. The user-friendly design includes a small display and a single-button operation, complemented by a dedicated application for comprehensive functionality. Additionally, a visualization software with a control panel showcases the device's features for efficient data analysis and configuration.

Primary authors: KOPAŃSKI, Konrad (The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences); KATRANKOVA, katarzyna (Astroteq.ai)

Presenters: KOPAŃSKI, Konrad (The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Sciences); KATRANKOVA, katarzyna (Astroteq.ai)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **32** Type: **not specified**

Experimental particle physics at Andres Bello University (UNAB) in Chile

Tuesday, January 16, 2024 12:00 PM (20 minutes)

n this talk I will present the activities that we are carrying out at UNAB related with experimental astro/particle physics. I will also present our proyect related with earthquake precursors and other related projects.

Primary author: JILBERTO ZAMORA SAÁ, Jilberto (Andres Bello University)

Presenter: JILBERTO ZAMORA SAÁ, Jilberto (Andres Bello University)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **33** Type: **not specified**

Active shield of low background gamma spectrometer as a tool for studying muon flux properties

Tuesday, January 16, 2024 3:20 PM (20 minutes)

In our laboratory two low background gamma spectrometers with germanium detectors are equipped with active shield. Such shield is a system of five large plastic scintillatior detectors sensitive for muons surrounding the massive cubic lead shield of spectrometer from five sides. The active shield works in the anticoincidence mode with germanium detector. In our spectrometers data is collected in the even by event mode and the antioincidence logical function is performed during of-line analyzes of time structure of data. The first spectrometer operates from September 2018, the second one from January 2021. The Fourier analyse for initial results from 18 months revealed, besides a day cycle two longer cycles close to one month and 70 days. Further analyses are planned.

Presenter: MIETELSKI, Jerzy Wojtek (Institute of Nuclear Physics Polish Academy of Sciences)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **35** Type: **not specified**

Proposal of a compact particle detector with commercial embedded systems

Tuesday, January 16, 2024 4:00 PM (20 minutes)

In this talk, the conceptual design of a compact particle detector will be presented, using the development of new systems such as embedded systems to be able to carry out signal preprocessing in real time, the system will make simultaneous measurements of atmospheric variables to be able to make subsequent or online corrections of the generated signals in the detector. The main idea of this project is to generate a prototype to be implemented in high schools.

Presenter: MORENO BARBOSA, Eduardo (FCFM BUAP)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **36** Type: **not specified**

Open discussion for all participants

Tuesday, January 16, 2024 5:00 PM (1 hour)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **37** Type: **not specified**

Pevatrons as a challenge in 21st century astronomy

Wednesday, January 17, 2024 3:40 PM (20 minutes)

PeVatrons are natural particle accelerators that can accelerate particles with energies of up to 1 PeV. Although the term PeVatron was coined by the High Energy Stereoscopic System (HESS) collaboration in 2016 through the analysis of the galactic center, its era began in 2021 thanks to the discovery of ultra-high energy gamma-ray sources by highly sensitive observatories such as the High Altitude Water Cherenkov (HAWC) Observatory in Mexico, the Tibet AS-gamma Experiment in Tibet (led by the University of Tokyo, Japan) and the Large High Altitude Air Shower Observatory (LHAASO-LHAASO-KM2A). In this contribution, we briefly overview the PeVatrons and explain why the analysis of molecular observations is essential for their study.

References and acknowledgments:

de la Fuente, E., et al, 2023, A &A, 675, id.L5, DOI: 10.1051/0004-6361/202346681

de la Fuente, E., et al, 2023, PASJ, 75, 546-566, DOI: 10.1093/pasj/psad018

The authors gratefully acknowledge the Inter-university Research Program of the Institute for Cosmic Ray Research (ICRR), University of Tokyo (UTokyo), grant 2023i-F-005. IT-J gratefully acknowledges the support of the Consejo Nacional de Humanidades, Ciencias y Tecnología (CONAHCyT), México, grant 754851.

Primary author: DE LA FUENTE ACOSTA, Eduardo (Departamento de Física, CUCEI, Universidad de Guadalajara, México)

Co-author: Mr TOLEDANO-JUAREZ, Ivan (Doctorado en Ciencias Fisicas, CUCEI, Universidad de Guadalajara)

Presenter: DE LA FUENTE ACOSTA, Eduardo (Departamento de Física, CUCEI, Universidad de Guadalajara, México)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **38** Type: **not specified**

Modular Cosmic Ray Detector (MCORD) possible use in the cosmo-seismic project.

MCORD (Modular Cosmic Ray Detector) was designed as a tool that can be used both in large physics experiments and on a much smaller scale for observations in small projects. This is possible thanks to its segmented and scalable structure. The basic features of this detector will be presented as a tool that we propose to use when searching for local correlations between the level of earthquakes and the average flux of cosmic radiation reaching the Earth's surface.

Primary author: BIELEWICZ, Marcin (NCBJ - National Centre for Nuclear Research)

Presenter: BIELEWICZ, Marcin (NCBJ - National Centre for Nuclear Research)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **39** Type: **not specified**

Institutional members review :: AGH University of Krakow

Wednesday, January 17, 2024 4:55 PM (5 minutes)

Presentation of AGH University of Krakow as an institutional member of the CREDO research collaboration. Discussing the role of the university, identifying the researchers involved in the collaboration, with particular emphasis on current and planned CREDO-related activities and future potential contributions to CREDO.

Primary author: Dr PIEKARCZYK, Marcin (AGH University of Krakow)

Presenter: Dr PIEKARCZYK, Marcin (AGH University of Krakow)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **40** Type: **not specified**

The Jánossy Underground Research Laboratory and the ongoing projects

Tuesday, January 16, 2024 3:40 PM (20 minutes)

The Jánossy Underground Research Laboratory (JURLAB) is part of the Vesztergombi High Energy Laboratory (VLAB). This one of the TOP 50 research infrastructures in Hungary and located in the Wigner Research Centre for Physics, Csillebérc, Budapest, Hungary. It has been built in the 50s for cosmic muon measurements and used intensively by Lajos Jánossy. Today, after several renovation, this special location is a 30m deep open laboratory, which is used for different experimental studies from gravity, seismic, innfrasound measurements, earthquake researches, cosmic muon project and low-background nuclear measurements. Here I present a short overview of the ongoing projects and the possibilities in the JURLAB.

Presenter: BARNAFOLDI, Gergely Gabor (MTA KFKI RMKI)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **41** Type: **not specified**

Selected properties of plastic scintillators for muon detection

Tuesday, January 16, 2024 11:00 AM (20 minutes)

We present application of plastic scintillating detectors with SiPM and coincidence readout electronics for muon detection. Selected properties are shown, measurements are compared with expectations. Despite the low energy resolution of this type of sensor, muon peak is observed in energy spectrums. Testing measurements were performed in the laboratory and underground.

Presenter: BROULIM, Jan (Czech Technical University)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **42** Type: **not specified**

Acceleration and propagation of charged cosmic ray particles - recent progress from Opava

Tuesday, January 16, 2024 1:40 PM (20 minutes)

In this short contribution, I will show our recent results in cosmic ray particle physics and the involvement of our research group at the Institute of Physics, Silesian University in Opava, in the CREDO project. I will discuss charged particle acceleration models, focusing on particle dynamics in the combined gravitational and magnetic field around a rotating black hole. Application on PeV cosmic ray source, Sagittarius A* from our Galaxy center, will be provided.

Presenter: KOLOŠ, Martin (Institute of Physics, Silesian University in Opava)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **43** Type: **not specified**

The Czech Particle Physics Project

Tuesday, January 16, 2024 1:20 PM (20 minutes)

Presenter: SOPCZAK, Andre (IEAP CTU in Prague)

Session Classification: Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data

Contribution ID: **44** Type: **not specified**

Exploring cosmo-seismic correlation with machine learning

Wednesday, January 17, 2024 10:40 AM (20 minutes)

This research endeavors to forecast earthquakes with a magnitude of 6 or greater within a 1000 km radius from three cosmic ray stations, employing machine learning methodologies. Our approach incorporates a feature store library for streamlined data preparation, encompassing 360 hours of cosmic ray data and the time elapsed since the last earthquake. Utilizing a feature store library and a dual-module model, we achieve a test AP of 0.320, surpassing the baseline of 0.288. The earthquake-focused metric addresses the practicality of forecasts, revealing a promising ability to prognosticate a significant percentage of earthquakes with a false alarm rate below 30%. Statistical significance tests, comprising 300,000 experiments, establish a robust 6 sigma or more significance.

Presenter: ZABARI, Noemi (Astroteq.ai & CREDO.science)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **46** Type: **not specified**

Introduction of the new CREDO InstitutIonal member: Experyment Science Center in Gdynia

Wednesday, January 17, 2024 4:40 PM (10 minutes)

Presentation of Experyment Science Center in Gdynia. Since 2021 we are participating in citizen science collaborating with Institute of Oceanology Polish Academy of Science. I will tell about our experience in citizen science and about our plans connected with CREDO.

Primary author: Ms TAJTHI, Klaudia

Presenter: Ms TAJTHI, Klaudia

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **47** Type: **not specified**

On the relationship between seismic activity and other natural phenomena

Wednesday, January 17, 2024 3:00 PM (40 minutes)

I'm going to explain why why earthquakes are affected by tidal forces and then showing how quakes correlate with UAPs, using recent paper https://www.nature.com/articles/s41598-023-49527-x. In the end, I would mention the 10.1-10.2 year lunar periodicity as a reference to the cosmo-seismic effect reported in https://doi.org/10.1016/j.jastp.2023.106068.

Presenter: KOVALYOV, Mikhail

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **48** Type: **not specified**

A few information about PTMA-CREDO collaboration

PTMA as an organization has been an official member of the CREDO consortium since September 2022. Members of the Society give lectures and demonstrations of detection stations during internal PTMA meetings, science picnics and festivals, astronomical events and sky observing.

Primary author: Mr WIĘCKOWSKI, Marek (Polish Society of Amateur Astronomers (PTMA))

Presenter: Mr WIĘCKOWSKI, Marek (Polish Society of Amateur Astronomers (PTMA))

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **49** Type: **not specified**

The CREDO Blockchain Task

Wednesday, January 17, 2024 5:30 PM (5 minutes)

Are we one step away from tokenizing the CREDO detector?
Will the creation of a micro-payment system using Blockchain technology
and rewarding active CREDO app's users with CREDO tokens contribute
to the popularization and significant increase in the power of the detector?

Presenter: BATYJEWSKI, Krystian

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **50** Type: **not specified**

Low cost cosmic ray detectors at Clayton State University (video)

Wednesday, January 17, 2024 5:35 PM (5 minutes)

The use of the AI can bolster the community involvement in the science that also carries the educational aspect of learning about the LLM and can include local high schools to produce the materials for the learning of the metal networks. Additional school involvement can be in the forms of hosting simple hardware solutions as additional data collection stations, some of that may start under latest grant at CSU.

Presenter: BEZNOSKO, Dmitriy (Bard College New Orleans)

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **51** Type: **not specified**

The CREDO Bylaws Draft v.0.0 - Discussion

Wednesday, January 17, 2024 5:40 PM (20 minutes)

We will discuss the first draft of the CREDO Bylaws which would be the first step on the CREDO Organizational Road Map: https://docs.google.com/document/d/1pLpV3cPLvRpgYXowGbJs7WAqzqCFFk5vc6avjx9Vu9g/edit
Feel free to comment & suggest edits also before and after the session.

Session Classification: The CREDO Collaboration Meeting

Contribution ID: **52** Type: **not specified**

PTMA's participation in the promotion of CREDO.science as part of the international #CopernicusHUB project.

Wednesday, January 17, 2024 4:50 PM (5 minutes)

PTMA as an organization has been an official member of the CREDO consortium since September 2022. Members of the Society give lectures and demonstrations of detection stations during internal PTMA meetings, science picnics and festivals, astronomical events and sky observing.

From 2023, the CREDO.science promotion is also carried out as part of the international space education project #CopernicusHUB, which is coordinated by the Warsaw branch of PTMA.

In 2024 and 2025, the CREDO project is planned to be promoted using modern educational methods like computer game the Space Engine simulating the construction of the Universe.

In order to build the CREDO community, online meetings with other astronomy enthusiasts in Europe and around the world are planned as part of the #CopernicusHUB project.

Primary author: Mr WIĘCKOWSKI, Marek (PTMA)

Co-authors: Mr SZCZEŚNIAK, Krzysztof (PTMA); NOWAKOWSKI, Robert (PTMA)

Presenter: NOWAKOWSKI, Robert (PTMA)

Session Classification: The CREDO Collaboration Meeting