1st CREDO Visegrad Workshop 2024

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IFJ PAN, Krakow, ul. Radzikowskiego 152

Book of Abstracts

Contents

The CREDO Collaboration Meeting / 1

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

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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.

The CREDO Collaboration Meeting / 2

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

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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.

The CREDO Collaboration Meeting / 3

Exploitation of Cyclostationarity and its Generalizations for Science Data Analysis

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / **4**

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

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 5

Radiation detection and particle tracking with pixel semiconductor Timepix detectors

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 6

Muography: imaging with cosmic particles

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 7

A few technical comments on the CREDO project

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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.

The CREDO Collaboration Meeting / 8

Observations from the publicly available data of the CREDO experiment

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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]].

The CREDO Collaboration Meeting / 9

The Cosmo-Seismic Task Report

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The CREDO Collaboration Meeting / 10

The Machine Learning Task Report

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The CREDO Collaboration Meeting / 11

The Visibility Task Report

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The CREDO Collaboration Meeting / 12

The CREDO-Maze Task Report

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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 13

Haptic Arduino and CME Mass Calculation

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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.

The CREDO Collaboration Meeting / 14

Machine Learning @CREDO

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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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 15

Sonification: Better science

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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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 16

Probing the Power of Sonification for Asteroseismology

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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 17

TBA

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Sonification of data, Citizen Science and Educational aspects of CREDO / 18

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

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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 21

A sonification atlas for CREDO cosmic ray detections: Basis for

Dark Matter and Dark Photon Investigations

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 incalculation 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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 22

The LightSound Project: Experiencing a Solar Eclipse with Sound

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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 23

Sonification of Gravitational Waves: Effective or not?

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.

Sonification of data, Citizen Science and Educational aspects of CREDO / **24**

Open discussion for all participants

The CREDO Collaboration Meeting / **25**

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

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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].

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10. P. Homola et al. 2020. Symmetry 12, 1835. DOI:10.3390/sym12111835

Sonification of data, Citizen Science and Educational aspects of CREDO / 26

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

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“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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 27

Cosmic Watch based detector array - measurements and simulations

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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.

The CREDO Collaboration Meeting / 28

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

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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.

Sonification of data, Citizen Science and Educational aspects of CREDO / 29

The REINFORCE EU citizen science project

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 30

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

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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 pos- sible 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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 31

Astroteq.ai cosmic ray detection demonstration

Authors: Konrad Kopański[1]; katarzyna Katrankova[2]

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 32

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

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 33

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

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 35

Proposal of a compact particle detector with commercial embedded systems

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 36

Open discussion for all participants

The CREDO Collaboration Meeting / 37

Pevatrons as a challenge in 21st century astronomy

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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:

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Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 38

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

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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.

The CREDO Collaboration Meeting / 39

Institutional members review :: AGH University of Krakow

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 40

The Jánossy Underground Research Laboratory and the ongoing projects

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 41

Selected properties of plastic scintillators for muon detection

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 42

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

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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.

Interplay of the diverse cosmic rays detectors and standardisation of sharing and processing data / 43

The Czech Particle Physics Project

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The CREDO Collaboration Meeting / 44

Exploring cosmo-seismic correlation with machine learning

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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.

The CREDO Collaboration Meeting / 46

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

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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.

The CREDO Collaboration Meeting / 47

On the relationship between seismic activity and other natural phenomena

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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.

The CREDO Collaboration Meeting / 48

A few information about PTMA-CREDO collaboration

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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.

The CREDO Collaboration Meeting / 49

The CREDO Blockchain Task

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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?

The CREDO Collaboration Meeting / 50

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

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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.

The CREDO Collaboration Meeting / 51

The CREDO Bylaws Draft v.0.0 - Discussion

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?usp=s
Feel free to comment & suggest edits also before and after the session.

The CREDO Collaboration Meeting / 52

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

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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.