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Program and Abstracts

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Bucharest University Faculty of Physics 2024 Meeting

1. **Atmosphere and Earth Science; Environment Protection**
   Location and Time: Rm. 27, 3rd fl. (11:15-17:30)
   Moderators: Lect. Dr. Gabriela IORGA, Assoc. Prof. Dr. Cristian NECULA

2. **Atomic and Molecular Physics. Astrophysics. Applications. Optics, Spectroscopy, Plasma and Lasers**
   Location and Time: Nuclear spectroscopy Lab (11:30-12:45)
   Moderators: Assoc. Prof. Dr. Mircea BERCU, Assoc. Prof. Dr. Vasile BERCU

3. **Biophysics; Medical Physics**
   Location and Time: Seminar Rm. 10 (11:15-15:30)
   Moderators: Prof. Dr. Aurel POPESCU, Assoc. Prof. Dr. Claudia CHILOM

4. **Nuclear and Elementary Particles Physics**
   Location and Time: Amf. 4 (11:15-17:30)
   Moderators: Prof. Dr. Alexandru JIPA, Prof. Dr. Ionel LAZANU

5. **Physics and Technology of Renewable and Alternative Energy Sources**
   Location and Time: Seminar Rm. 9 (11:15-17:00)
   Moderators: Lect. Dr. Sanda VOINEA, CSI Dr. Cornelia NICHITA

6. **Physics Education**
   Location and Time: Seminar Rm. 1 (11:15-13:45)
   Moderators: Prof. Dr. Ştefan ANTOHE, Assoc. Prof. Dr. Cristina MIRON

7. **Polymer Physics**
   Location and Time: Seminar Rm. 2 (11:15-14:15)
   Moderators: Prof. Dr. Valentin BARNA, Assoc. Prof. Dr. Cătălin BERLIC

8. **Solid State Physics and Materials Science**
   Location and Time: Amf. 1 (11:15-15:15)
   Moderators: Prof. Dr. Alexandru NEMNEŞ, Prof. Dr. Vlad-Andrei ANTOHE

9. **Theoretical and Computational Physics, High-Energy Physics, Applied Mathematics**
   Location and Time: Amf. 3 (11:10-16:15)
   Moderators: Lect. Dr. Roxana ZUS, CS I Dr. Călin ALEXA, Assoc. Prof. Dr. Radu Slobodeanu

Section 1: Atmosphere and Earth Science; Environment Protection

Location and time: **Rm. 27, 3rd fl.**

Moderators:

Lect. Dr. Gabriela IORGA

Assoc. Prof. Dr. Cristian NECULA

1.1 11:15-11:30 - Octavian BLAGOI, Iulian MOROIANU, Cristian DANESCU, Liliana DUMITRU
Introduction in Spectroheliography – Homemade instrument and first results

1.2 11:30-11:45 - Florin-Ioan CONSTANTIN, Eugeniu Mihnea POPESCU, Gabriel CHIRITOI, Florin Adrian POPESCU, Georgiana SIMIONESCU, Diana COSAC, Eduard NASTASE, Alexandra MUNTEAN
Performance of TEC Mapping Techniques over Romania during Solar Storms

1.3 11:45-12:00 - Cristian OMAT, Mirel BIRLAN, Vlad TURCU
Re-entry survivability analysis of ERS-2 satellite

1.4 12:00-12:15 - Alessandra-Nicoleta MIRONESCU, Claudia CHILOM, Adrian RADU, Bogdan-Ionut BITA
Purifying Water Through the Corona Discharge

1.5 12:15-12:30 - Andrei Paul BORSOS, Bianca Maria LINCA, Ileana RADULESCU, Alina Catrinel ION, Ion ION
Analysis of the radon concentrations in various natural mineral water using Lucas cell technique

1.6 12:30-12:45 - Ioana Aurelia Dinu, Dragoș Ene, Anca Dumitru, Bogdan Antonescu
Changes in the characteristics of tropical nights in Romania during the 21st Century

1.7 12:45-13:00 - Bogdan-Mihai CERBU, Eduard NASTASE, Dragos TATARU, Iliescu Alexandru-Iulian
Exploring Absolute Gravimeter Applications in Romanian Geophysics

1.8 13:00-13:15 - Daniel STOICESCU, Alfred VESPREMEANU-STROE, Luminita PREOTEASA
Assessment of redox condition in sediments using pyrite morphological features: a preliminary investigation using SEM-EDS

1.9 13:15-13:30 - Comaniciu Dima Daniela, Sanda Voinea
Attribution of the monthly cumulative number of warm spell days to anthropogenic and natural factors, based on observational data

1.10 13:30-13:45 - Adrian BERLIC, Mihai DIMA, Mihaela CAIAN
Using neural networks in temperature meteorological forecast

1.11 13:45-14:00 - Marilena Ioana ZUZEAC,Bogdan ANTONESCU,Dragoș ENE
Trends in Meteorological Phenomena Affecting Aviation Safety in Romania (1960-2022)

1.12 14:00-14:15 - Andreea BĂRĂSCU, Bogdan ANTONESCU
Tracing Tornadoes Through Time: Enhancing Tornado Climatology in Romania with Historical Data and Modern Analysis

1.13 14:15-14:30 - Andreea CRISTIAN, Gabriela CIOCAN, Marilena ZUZEAC, Alexandru POPESCU, Bogdan ANTONESCU
Thunderstorm Climatology in Romania: Insights from ERA5 Reanalysis and ATDnet Lightning Data

1.14 14:30-14:45 - Genica–Liliana SĂFTOIU GOLEA, Bogdan ANTONESCU, Sabina ȘTEFAN, Gabriela IORGA
A preliminary study of stratocumulus drizzle parameters over Bucharest-Magurele

1.15 14:45-15:00 - Alex VLAD, Gabriela IORGA, Bogdan ANTONESCU
Fog events in the Bucharest Henri Coandă International Airport area

1.16 15:00-15:15 - Andrei MIHAI, Mircea RADULIAN, Victorin Emilian TOADER, Iren-Adelina MOLDOVAN
Two Decades of Geomagnetic Studies Near the Seismic Vrancea Zone: Links to Seismic Activity and Meteorological Conditions

1.17 15:15-15:30 - Marius Mihai, Mircea Radulian, Andreea Craiu, Marius Craiu, Raluca Dinescu, Alexandru Marmureanu
Development and Application of a refined 1-D Velocity Model for Enhanced Earthquake Hypocenter Localization in the Tg. Jiu area

1.18 15:30-15:45 - Alexandru TUDOR, Alin SCARLAT, Gabriela IORGA
Study of greenhouse gases in Romania in the period 1970-2021 in a European and global context

1.19 15:45-16:00 - Alin SCARLAT, Alexandru Tudor, Gabriela IORGA
Analyzing the Romania's greenhouse gas emissions at regional scale

1.20 16:00-16:15 - Ana-Maria Rosianu, Sabina Stefan, Gabriela Iorga
Temporal Analysis of Fluorescent Bioaerosol Concentrations in Bucharest, Romania: implications for human health

1.21 16:15-16:30 - Bianca Mihalache, Marilena Colt, Sabina Stefan, Gabriela Iorga
New insights into Ploiesti's air quality: assessment, sources, temporal patterns and trends

1.22 16:30-16:45 - Bianca Mihalache, Sabina Stefan, Gabriela Iorga
Atmospheric Pollution in South-Eastern Romania is dominated by anthropogenic activities

1.23 16:45-17:00 - Alexandru Tudor, Alin Scarlat, Gabriela Iorga
Past and recent changes in SO2 emissions in Romania: an analysis based on EDGAR database

1.24 17:00-17:15 - ANCA DUMITRU
Effect of synthesis methods of polyaniline-derived nitrogen doped carbon nanostructures for oxygen reduction reaction in alkaline media

1.25 17:15-17:30 - Ioana Iurescu, Anca Dumitru
Comparative study of polyaniline-based nanocomposites doped with different metal oxide nanoparticles

1.1 Introduction in Spectroheliography – Homemade instrument and first results

Octavian BLAGOI[1], Iulian MOROIANU[2], Cristian DANESCU[1], Liliana DUMITRU[1]

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Keywords: Sun, spectral lines, spectroheliograph

We built a demonstrative Littrow Spectroheliograph with available optical components to learn the basics of spectrography and applying the principles to image the Sun on narrow band spectral lines, obtaining 2D images with dedicated spectroheliograph reconstruction software (SHG v.4.3). We present the first images in different wavelengths and the capabilities of the instrument.

1.2 Performance of TEC Mapping Techniques over Romania during Solar Storms

Florin-Ioan CONSTANTIN[1,2], Eugeniu Mihnea POPESCU[1], Gabriel CHIRITOI[1], Florin Adrian POPESCU[1], Georgiana SIMIONESCU[1,2], Diana COSAC[1], Eduard NASTASE[3], Alexandra MUNTEAN[3]
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Keywords: TEC map, TEC, solar storm

The solar magnetic activity cycle is currently approaching its maximum values, producing the greatest solar flares seen in the past decade. These intense solar flares have resulted in the occurrence of aurora borealis even in latitudes as low as 45 degrees. This heightened solar activity provides a unique opportunity to test and evaluate the performance of mapping techniques employed by the Ionospheric Monitoring Service to produce Total Electron Content (TEC) maps over the territory of Romania. In this study, we assess the accuracy and reliability of our mapping techniques under conditions of increased ionospheric disturbances, such as the storm that produced aurora borealis over Romania on the night of 6th to the 7th of November 2023, as the TEC maps generated during this period of elevated solar activity are crucial for understanding the impact of geomagnetic storms on communication and navigation systems. The results have been compared to maps produced by the International GNSS Service (IGS), as well as the German Aerospace Center (DLR).

1.3 Re-entry survivability analysis of ERS-2 satellite

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Keywords: ERS-2, debris, decay, satellite, DAS, re-entry

During its operational period (April 29, 1996 to Sept 5, 2011), the ERS-2 satellite (European Remote Sensing Satellite) was placed into a Sun-synchronous polar retrograde orbit at 780 km mean altitude. This allow a 100 minutes orbital period at a speed of about 7.5 km per second (eoPortal, 2024). In September 5, 2011, after more than 5,500 operational days, the

satellite altitude has been lowered from 780 km to 573 km, a common practice during end-of-life maneuvers to hasten its re-entry into the Earth's atmosphere.
On February 21, 2024 the ERS-2 satellite completed its atmospheric re-entry over the North Pacific Ocean, somewhere between Alaska and Hawaii at approximately geographic coordinates: 37°24'00.0"N and 151°54'00.0"W, around 18:17 CET (17:17 UTC). During this phase astronomical observations has been recorded by Cluj-Napoca Observatory (Astronomical Institute of the Romanian Academy). According to the ESA's predictions, the major breakup was possible at "an altitude of roughly 80 km" (ESA, 2024).
The major objectives of our work was to find out the value of major breakup altitude of the satellite, the demise altitude or a quantitative estimations of the probability of hitting the sea surface for components which have survived the re-entry phase. For this scope, we modeled the atmospheric re-entry of ERS-2 using Debris Assessment Software (DAS). Results of the re-entry phase of the ERS-2 satellite are presented.

References:
eoPortal: 2024, https://www.eoportal.org.
ESA: 2024, https://www.esa.int/.

Acknowledgement:
The work use observations facilities of the Astronomical Observatory of Cluj-Napoca, Astronomical Institute of the Romanian Academy

1.4 Purifying Water Through the Corona Discharge

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Keywords: Plasma, Corona Discharge, Environmental purification, Filtration solutions, Fluorescence spectroscopy

Air and water pollution play major roles in environmental deterioration, which has gained international attention in recent years. The need to create effective and environmentally responsible techniques for air and water purification is increasing. Applications for corona discharge have been investigated, including the purification of environments. Because of its capacity to produce reactive species like ozone and other active oxygen species, it offers a special chance for disinfection and pollutant elimination. In this work we aimed to clarify the relationships involved in corona discharge-based purification procedures by using an approach that incorporates concepts from physics, biology, chemistry and engineering, through an electrical circuit that produces induction plasma. Thus, during the experimental process, we used an electrical device that produced a small corona discharge, which was then introduced into water. Smoke was produced, followed by a strong smell of ozone. Gathering three samples of water (tap water, plasma-purified water and water purified through reverse-osmosis – added for comparison), we tested each of them with the help of three colorimetric tests, to see the concentration levels of different pollutants. For the next part of the experiment, we used a fluorescence spectrometer, in order to see if there were any microorganisms left in the liquid after the purification process, and if they emited in the UV-visible spectrum. Several conclusions were made afterwards, the most important stating that plasma does purify the water (seen in the increased nitrite concentrations and lack of microorganisms in the fluorescence spectrum), and that the plasma-treated water emits in the UV-visible spectrum (since it also emits UV radiation in the environment). This study aims to contribute to the continuing efforts to reduce environmental pollution and protect human health by offering insightful information about the application of corona discharge as a sustainable and effective method for purifying air and water.

1.5 Analysis of the radon concentrations in various natural mineral water using Lucas cell technique

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Keywords: Lucas cell, radon, natural mineral water

Abstract The aims of this study were to determine the radon concentration in various natural mineral water. In the last years have been an increase of water consumption natural mineral, many sources and producers being available on the market. Thus, the radiologic parameters of water must be in compliance with the Drinking Water Directive (DWD)[1]. Thus, the study presents an assessment of the radioactivity due to 222Rn in several mineral natural water samples from Romania, based on the Romanian legislation [2]. The method used was based on Lucas scintillation and Pylon system for measuring radon activity concentrations. The results of this work showed that the geology and rock types clearly influence the water radon concentration. The radon concentration is lower in the water that passes through sedimentary rocks than that passing through granitic rocks. The values determined for the samples collected are below the recommended reference levels, but the more important aspect is that this study emphasizes the importance of checking these waters from the point of view of radon concentration.

References:
1. Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption
2. Law no. 301/2015 on establishing the requirements for the protection of the population's health with regard to radioactive substances in drinking water

Acknowledgement:
This research was performed in the frame of Project No. PN 19 06 02 03 (Romanian Ministry for Research and Digitalization).

1.6 Changes in the characteristics of tropical nights in Romania during the 21st Century

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Keywords: temperature, tropical nights

High temperature events in summer such as extreme heat and tropical nights have a major impact on various sectors such as public health or energy. This study investigates the changes in the frequency of occurrence of tropical nights, defined as nights with minimum temperatures exceeding 20°C, in Romania. Utilising datasets from the Romanian National Meteorological Administration and EURO-CORDEX climate models under RCP4.5 and RCP8.5 scenarios., the research examines historical data from 1971-2000 and projects future conditions up to 2100. The research reveals a significant increase in the number of tropical nights, particularly in southern and southeastern Romania. Historical data shows a moderate increase, with the highest number of tropical nights along the Black Sea coast and the Danube Delta. Projections indicate that under the RCP4.5 scenario, the annual number of tropical nights will continue to rise throughout the 21st century, with some areas expected to experience over 35 tropical nights annually by the century's end. Under the more

extreme RCP8.5 scenario, southern Romania and the Danube Delta could see over 40 tropical nights per year, with the Danube Delta experiencing up to 70 tropical nights annually. Results also highlight potential public health impacts, as increased tropical nights are associated with higher mortality rates due to heat stress. Urban areas, especially major cities like Bucharest, Cluj-Napoca, Iași, Constanța, and Timișoara, are projected to experience more frequently tropical nights, exacerbating health risks and increasing energy demands for cooling. The findings contribute to understanding regional climate impacts and provide a basis for informed policy-making in response to global warming.

1.7 Exploring Absolute Gravimeter Applications in Romanian Geophysics

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Keywords: Geophysics, Gravimmetry, Absolute Gravimeter

The modern use of the A-10 gravimeter in Romania and its future application for characterizing mud volcanoes are proposed in this study. Gravimetry, a fundamental tool in geophysical research, offers unique insights into subsurface geological structures. There is no available data due to national regulation constraints, all the published gravity maps being post-processed from the same initial classified data sets. This is why the utilization of the A-10 gravimeter represents a turning point in Romanian geophysics, providing researchers with precise gravity measurements for the first time. We began our approach by familiarizing ourselves with the equipment and its capabilities. This involved gathering data from gravity control points of class A0 in Timișoara, Constanța, Bucharest, and other A1-class points across Romania. On a national level, it is a rare and unique opportunity to compare two A-10 Gravimeters, the second one having been recently acquired by the National Center for Cartography. To take full advantage of this situation, we plan field methods, tests, and measurement campaigns at the aforementioned class points.
Building upon this foundation, our research aims to collect and interpret micro-gravimetric data to enhance our understanding of Berca Mud Volcanoes in Romania. Much of the existing literature aims at characterizing the deep reservoir from which expelled fluids are anticipated to originate. Another segment of research focuses on the study of the shallow system of mud volcanoes, which potentially impacts short-term fluctuations in their activity. Our objective is to gather and analyze a novel dataset of micro-gravimetric data to understand the Berca Mud Volcanoes in Romania, aiming to address both the deep reservoir and shallow system aspects.
Once we gather the data around the volcano, we'll conduct thorough research and employ advanced data analysis techniques to reach meaningful conclusions. We anticipate that the application of micro-gravimetric data will provide invaluable contributions to our approach into mud volcano characterization, facilitating informed decision-making in hazard assessment and resource management.

1.8 Assessment of redox condition in sediments using pyrite morphological features: a preliminary investigation using SEM-EDS

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Keywords: sediments, pyrite, SEM-EDS, framboids

Framdoidal pyrite is one of the most intriguing types of textural features, its occurrence being noted in sediments from all geological time frames. Hence, its morphological features became, together with other proxies, a well-established method to derive paleo-redox conditions in marine or lacustrine environments. The present study presents a preliminary

analysis performed through scanning electron microscopy coupled with an energy-dispersive spectrometry detection system. The current analyses were performed on a batch of 5 samples derived from a Balea lake sediment core, which were priorly geochemically examined with a Cox Itrax sediment core scanner. Two of the currently investigated samples, corresponding to depths where peaks of S and Fe concentrations were identified have shown the presence of pyrite framboids. Measurements performed on the BSE images show that the framboids have an average value situated between 16 and 18 μm with a standard deviation between 3 and 6 microns, thus suggesting the presence of an oxic-dysoxic environment. Despite the preliminary character and the need for more data for a better assessment of the pyrite occurrence in sedimentary structures, the present analysis is well supported by other findings of framboids presenting similar morphological features reported in the literature.

1.9 Attribution of the monthly cumulative number of warm spell days to anthropogenic and natural factors, based on observational data

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Keywords: attribution, warm spell days,anthropogenic and natural factors

The warm spell days have a significant impact on the human health, on economy and agriculture, on ecosystems. In a warming world, their frequency is expected to increase. The attribution of warm spell days to specific forcing factors is of significant importance and is usually performed through numerical simulations. However, the accuracy of the attributions through this method is limited by the model imperfections. For example, some recent such extreme events were more pronounced that anticipated by model integrations. Alternatively, in present study we attempt the attribution based on observational data. Monthly warm spell days persistency is defined here as the total number of days in a month above the 90th percentile, in which only groups of at least 3 consecutive days are counted. Two persistency fields are constructed, for months May and August, for the 1950-2023 period. The dominant modes of the two global fields of warm spell days persistency are identified using the Empirical Orthogonal Functions (EOF) method, with the goal to use their corresponding time components in order to associate them with specific forcing factors, through correlations. The results have the potential to quantify the contributions of anthropogenic and natural factors to the warm spell days in different regions. As the model have limitations in simulating internal variability, this can not be performed in an optimal way based on numerical simulations.

1.10 Using neural networks in temperature meteorological forecast

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Keywords: weather forecast, temperature, data modelling, neural networks, artificial intelligence

We employ Artificial Intelligence (AI) technologies in weather forecasting, with focus on temperature predictions. The main objective is to assess the applicability of Neural Networks for medium to long-term meteorological and climate forecasting. Neural Networks were chosen due to their ability to learn high-level representations directly from data, capturing complex patterns governing the climate system without explicitly defined causal relationships. The study spans three distinct geographical areas in Romania—Sulina coastal, Fundulea plains, and Făgăraş mountains—to ensure a comprehensive evaluation across diverse topographies and climatic conditions. Preliminary results indicate significant potential for neural networks in temperature prediction, showing satisfactory accuracy and underscore their utility in modeling and predicting temperature fluctuations based on historical data sets. This highlights AI's potential to revolutionize weather forecasting, paving the way for developing more precise and reliable prediction systems capable of managing the inherent complexity and variability of climate systems.

1.11 Trends in Meteorological Phenomena Affecting Aviation Safety in Romania (1960-2022)

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Keywords: aviation hazards, baseline climatology, thunderstorms, low-level wind shear, snowfall, limited visibility, trends

The increasing air traffic at Romanian airports in recent years has necessitated a heightened focus on aviation safety standards. Simultaneously, climate change has altered the frequency of meteorological phenomena that impact aviation activities. This study aims to establish a baseline climatology and identify evolving trends of hazardous weather phenomena for the main airports in Romania between 1960 and 2022. The study utilizes ERA5 data to derive the most important parameters to study the occurrence of thunderstorms, low-level wind shear, reduced visibility, and snowfall, the weather phenomena that are relevant for the air traffic safety. The results show an increase in the number of hours with thunderstorms in the eastern part of the country and a rising trend in events with low-level wind shear in the western and central regions. Conversely, events with significant snowfall are decreasing in the eastern Carpathians and Muntenia region, while those with limited visibility are decreasing in the coastal regions and northeastern Romania. These findings can inform aviation safety regulations and help mitigate the impact of hazardous weather conditions on aviation activities.

1.12 Tracing Tornadoes Through Time: Enhancing Tornado Climatology in Romania with Historical Data and Modern Analysis

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Keywords: tornado, climatology, tornadogenesis, historical archives

How tornadoes form? is a seemingly simple question, yet the answer is quite complex. Much remains to be discovered about tornadoes, tornadogenesis and the forecasting of tornadoes. One way of improving our current understanding about tornadoes is to develop detailed tornado climatologies. In this study, we are expanding the existing Romanian tornado database by meticulously documenting additional tornadic events found in historical sources. Thus, we have conducted searches in recently available digital newspaper archives for tornado reports using keywords such as "tornado", "waterspout"("tromba" in Romanian, a term also used in newspaper for tornadoes over land), "hurricane" (uragan), "cyclone" (ciclon), and "orcane" (orcan). The search yielded records dating as far back as the late nineteenth century, with the earliest events recorded in 1880. To the existing 191 tornadoes from the Romanian tornado database, we have added another 37 verified events. These 228 tornadoes reported between 1634 and 2023 were then used construct a new climatology of tornadoes in Romania (i.e., spatial, annual, monthly, hourly distribution). The evironments in which some of these tornadoes (aftere 1940) developed and evolved were analyzed using the ERA5 reanalysis data. Based on ERA5 data between 1940 and 2022, a series of convective indices were derived (e.g., CAPE, CIN, vertical wind shear). The comprehensive analysis of tornado records spanning over three centuries and the inclusion of newly documented events significantly contribute to our understanding of tornado climatology in Romania. This study not only enhances our knowledge of tornadic events in the region but also provides valuable insights into the environmental conditions conducive to tornado formation, thereby improving tornado forecasting and mitigation strategies.

1.13 Thunderstorm Climatology in Romania: Insights from ERA5 Reanalysis and ATDnet Lightning Data

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Keywords: Thunderstorms, Climatology, Reanalysis, Trends, Lightning, Climatic drivers

This study presents an analysis of the climatology of thunderstorms in Romania spanning the period from 1940 to 2022, utilizing ERA5 reanalysis data and ATDnet lightning data. Thunderstorms represent a significant meteorological phenomenon impacting various sectors. The methodology involves the extraction and analysis of variables, such as CAPE, CIN, CP, LCL_HGT, EL_HGT, WMAX_SHEAR, to identify thunderstorm occurrences and their associated features. Significant trends are identified, including changes in thunderstorm frequency, duration, and intensity over the study period. Moreover, the analysis highlights the impact of climatic drivers on thunderstorm variability, providing insights into potential future changes in thunderstorm activity. Following the processing of the available data, threshold values for identifying convective phenomena have been obtained (CAPE > 150 J/KG and CP > 0.075 mm/h). Winter months show the lowest lightning percentages, gradually increasing from March to June, then declining through December. Hourly, values remain stable from 1 to 8 UTC, sharply rise until 13 UTC, then gradually fall. June and July have the highest occurrences, with sporadic rises in April and October, while January, February, March, November, and December stay below 1%. Mountainous regions have high lightning hours (270-390 h), peaking in the western Southern Carpathians and northern Western Carpathians. Dobrogea and Moldavia see fewer occurrences (below 150 h), while eastern areas, particularly Dobrogea, central Moldavia, and the Curvature Carpathians, show a positive trend with isolated decreases. This study offers a fresh perspective on Romania's storm climatology, shedding new light on this dynamic weather phenomenon.

1.14 A preliminary study of stratocumulus drizzle parameters over Bucharest-Magurele

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Keywords: stratocumulus clouds, drizzle, Cloudnet, CERES

Stratocumulus clouds are low level clouds which form in the planetary boundary layer. These clouds represent one of the key components of the Earth's radiative balance. Drizzle is light precipitation with liquid droplets having diameters between 40 and 500 µm. Detecting drizzle below stratocumulus clouds is important for studying the transition from cloud water to rainwater, process that is called the autoconversion. The aim of the study was to bring some insights into the early stages of autoconversion process over a suburban area under a strong influence of pollution coming from a large city, Bucharest. Time period for analysis was chosen from December 2019 to December 2020, period which included the COVID-19 pandemic. We have identified cases of stratocumulus clouds using CERES database in the Bucharest-Magurele area and analyzed the meteorological target classification using the Cloudnet algorithm, highlighting the stratocumulus clouds (radar reflectivity), characteristics of stratocumulus clouds (liquid water path) and drizzle parameters (median diameter and number concentration). Following the comparison from the satellite data with Cloudnet, we identified 21 cases

with drizzle out of 29 cases with stratocumulus clouds. Results help us better understand drizzle below stratocumulus clouds and might help for parameterization of autoconversion process in the global climate models.

Acknowledgement:
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1.15 Fog events in the Bucharest Henri Coandă International Airport area

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Keywords: Fog, METAR, visibility

Because of the visibility reduction, a high risk for air traffic appears when fog phenomenon appears in the vicinity of airports. Therefore, we look for fog events around the largest Romanian Airport Otopeni (OTP, 44.57°N, 26.1°E, 95 m a.s.l.). Due to its geographic position, the OTP airport is an important air traffic hub on the routes between western and eastern world destinations.
We used METAR observational data - Present Weather (PW) Group, from January 2010 to December 2023. A number of 100031 observations (frequency - 30 min) were analyzed, fog was defined as the event lasting more than 1h. A total of 1461 fog events were identified during the studied period. Statistical analysis was performed using Openair R package. A database of fog events for 2010-2023 was established. We found a mean climatological number of 104 events per year. The highest number of events (about 175) was in 2014, followed by a decrease (about 3.5 times) to about 50 events in 2023. Fog appears mostly during winter months (November, December, January) and during late evening and early morning, peaks shortly after the sunrise, then dissipates due to daytime heating. This correlates well with the presence of air moisture. Associations with prevailing winds on NE-SW directions were found. The longest fog event was encountered in December 2011 and was classified as an advection fog event.

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1.16 Two Decades of Geomagnetic Studies Near the Seismic Vrancea Zone: Links to Seismic Activity and Meteorological Conditions

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Keywords: geomagnetic variations, seismic energy release, standard deviation, correlation coefficient, temperature, humidity

This study presents the long-term behavior of the geomagnetic field measured in proximity to the Vrancea zone from 2002 to 2021. All seasonal variations recorded on the eastern component were identified by comparing them with a geomagnetic reference station located 100 km away. The variability observed on the By component was analyzed by calculating the standard deviation for each identified variation. To discriminate the variations caused by solar activity, we also calculated the standard deviation for the reference station. This method helps distinguish the global variations generated by magnetosphere-solar interactions from the abnormal ones. For each identified variation, we calculated the cumulative

seismic energy release to determine if there is a relation between the variability recorded on By and the seismic energy release. To verify the true nature of these variations, we used additional data from a new magnetometer installed at the same location, an indoor temperature and humidity sensor, and a professional weather station installed outside. To validate the relationships between By variability and seismic energy, temperature, humidity, and the Kp index, we used a statistical measure that quantifies the relationship between two continuous variables. The results of the correlation coefficient show a good correlation (r = 0.81) between By variability measured at the reference station and the mean Kp indices. A weak positive correlation (r = 0.29) was obtained between By variability measured at Muntele Roșu and seismic energy. In contrast, a strong positive correlation (r = 0.84 and r = 0.79) was found between By variability and indoor temperature and humidity. The new magnetometer installed in 2019 also shows a good correlation with temperature but with negative signs, which is normal for fluxgate magnetometers when the factory temperature compensation is some error degree.

Acknowledgement:
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1.17 Development and Application of a refined 1-D Velocity Model for Enhanced Earthquake Hypocenter Localization in the Tg. Jiu area

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Keywords: seimic area, velocity models

In seismology, the use of a one-dimensional (1-D) velocity model is standard practice for determining earthquake hypocenters. This study introduces a refined 1-D velocity model with station delays for the Tg. Jiu seismic region in Romania, developed using the VELEST code. This model is essential for accurate earthquake localization and provides a basic framework for future three-dimensional (3-D) seismic tomography studies. A dataset consisting of 1,039 P-wave and 888 S-wave travel times has been compiled from 46 seismic events that occurred during the seismic sequence that started in February 2023 in the Tg Jiu area. The seismic events were selected based on a high degree of location accuracy, with each event having at least 25 P-wave arrivals. These events were recorded by 38 seismic stations operated by the National Institute for Earth Physics (NIEP). Three input velocity models, each with different layer thicknesses extending to a depth of 41 km, were evaluated to identify the optimal velocity structure. The results of the VELEST inversion led to minimal discrepancies between observed and computed first arrival times of P and S waves. Following 50 iterations, the root-mean-square (RMS) values of travel time residuals showed a significant reduction, nearing a minimum value. The vertical hypocenter distribution revealed that seismic activity in the Tg. Jiu region is predominantly confined to the upper 20 km of the crust, with a sparse distribution of events at greater depths. The developed 1-D velocity model for Tg. Jiu exhibits slightly higher velocity values compared to standard global models, such as IASP91. Station delays for P and S-waves reflect lateral geological variations that correspond with surface geology. This comprehensive velocity model enhances the accuracy of earthquake hypocenter determinations and provides deeper insights into the seismic and geological characteristics of the Tg. Jiu area.

1.18 Study of greenhouse gases in Romania in the period 1970-2021 in a European and global context

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Keywords: greenhouse gases, Romania, EDGAR database, GMI database, statistical methods

Greenhouse gases have a considerable influence on the climate and are one of the most pressing problems facing modern society. This study investigates the evolution and trends of emissions of three major greenhouse gases: methane, carbon dioxide and nitrous oxide in Romania during the period 1970-2021 and places the results in a European and global context. Data available in the EDGAR (The Emissions Database for Global Atmospheric Research) and GMI (Global Methane Initiative) databases from various activity sectors were used for analysis. To examine trends and variations in greenhouse gas emissions, the Mann Kendal test combined with the Sen's Slope method and CPA (Change-point analysis) were applied. The study highlights the levels and status of greenhouse gas emissions in Romania and identified periods of increase or decrease in emissions that can be associated with economic, technological, or social changes in a local, European or global context. The analysis by activity sector revealed the different contributions to the total emissions, underlining the importance of adapting environmental policies to the specifics of each sector. These outcomes are essential for understanding the impact of human activities on the environment and for developing effective policies. The present study also contributes to the understanding of the dynamics of greenhouse gas emissions at the Romanian scale compared to their evolution at the European and global scale.

1.19 Analyzing the Romania's greenhouse gas emissions at regional scale

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Keywords: Romania, GHGs gases, EDGAR database, change point analysis

The constant global concern about the effects of greenhouse gas (GHG) emissions on climate stability requires a comprehensive examination. This study investigates the evolution of three primary greenhouse gases—carbon dioxide, methane, and nitrous oxide—from 1990 to 2021, across the macro-regions of Romania, that were created in 1998 by the association of county councils to coordinate the regional development necessary for Romania to join the European Union. The macro-regions are Bucharest-Ilfov, North-East, Center, North-West, West, South-East, South-Muntenia and South-West-Oltenia. Utilizing data sourced from the EDGAR (Emissions Database for Global Atmospheric Research) database, which categorizes emissions by sectors of activity, we gain insights into the contribution of each sector to total GHG emissions in Romania. Change Point Analysis is used to understand the shifts in CO2, CH4, and N2O levels over time. Were identified dominant change-points alongside with minor fluctuations, all significant at the 99% level. Additionally, temporal trend analysis using the non-parametric Mann-Kendall’s test and Sen’s method identify and quantify monotonic annual trends in GHG levels. Overall, this study significantly contributes to the understanding of the evolution of GHG emissions in Romania over the past three decades, highlighting regional and national emission trends. Moreover, it shows the contributions of different activity sectors at the regional scale, enhancing our understanding of their long-term trends. These findings serve as a good basis for developing targeted policies aimed at mitigating GHG emissions and adapting to future climate challenges.

1.20 Temporal Analysis of Fluorescent Bioaerosol Concentrations in Bucharest, Romania: implications for human health

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Keywords: bioaerosol, pollen, allergens, meteorology, aerobiology, Romania

Bioaerosol concentrations in the atmosphere cause serious health risks, due to their allergenic character. Weather conditions directly affect the development and growth of plants, thus leading to changes in atmospheric bioaerosol, including pollen, concentrations. The present study focused on analyzing measured fluorescent bioaerosol concentrations using the automatic Rapid-E real-time particle collector. This counter offers significantly higher temporal resolution for measurement of bioaerosol concentrations compared to the semi-automatic Hirst trap. Data regarding fluorescent bioaerosols were collected hourly from 2018 to 2021 in Bucharest-Magurele and were segregated by particle size in small fluorescent particles (less than 10 micrometers), and large fluorescent particles (greater than 10 micrometers). The comparative values obtained both with the Hirst trap (2014-2019) and those obtained with the Rapid-E instrument (2018-2021) on common time period show a similar evolution. The meteorological parameters were extracted from the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5 single level products and pressure level products. The increase in fluorescent bioaerosol concentrations is confirmed to be in spring and early summer, as in the case of those obtained with the Hirst trap. The implications for human health were also studied. A statistically significant correlation between the concentrations of different categories of pollen and respiratory pathologies, as well as the number and type of hospitalizations for their treatment was obtained.

1.21 New insights into Ploiesti's air quality: assessment, sources, temporal patterns and trends

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Keywords: air quality, pollution episode, statistical analysis, urban area, temporal pattern, temporal trend

This paper is focused on assessment of atmospheric major pollutants (particulate matter (PM10, PM2.5) and gaseous pollutants (NO2, CO, SO2, O3, VOCs) mass concentrations in urban agglomeration of Ploiesti in order to understand the typical pollution level by particulate matter over the entire city area, from inner part to outskirts. We also aimed to identify the pollution sources within the area and to investigate the pollutants temporal pattern (annual, seasonal, weekly, daily) and trends. A synthetic database consisting of time series of hourly and daily values of major pollutants and meteorological observations (temperature, relative humidity, pressure, wind speed and direction, atmospheric boundary layer) was constructed. Statistical analysis was performed using R package. Longitudinal analysis spanning back to 2008 elucidates temporal trends in pollutant concentrations, providing insights into the dynamics of air quality. To highlight shorter-term temporal and spatial variations, a four-year period (2018-2021) of data was investigated. Results indicate the air pollution is not specific to a limited area of the city. Although there are a few days and hours in a day when pollution is most intense in a certain location, the phenomenon is widespread throughout the city. Apart from the mean situation of air pollution, pollution events were analyzed and comparatively presented. It has been shown that the atmospheric stability has an important role in the pollutants accumulation at the scale of Ploiesti urban agglomeration. A special attention was dedicated to the identification of major pollution sources that contribute the measured concentrations. Despite its modest size, Ploiesti's industrial footprint exerts a substantial influence on local air quality.

1.22 Atmospheric Pollution in South-Eastern Romania is dominated by anthropogenic activities

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Keywords: air quality, statistical analysis, urban area, temporal pattern, temporal trend

Atmospheric pollution degrades air quality and also exerts significant influences on climate patterns and human health. Meteorological observations suggest that the South-Eastern Romania (SERO) region is experiencing recent climate changes. Therefore, it became of high interest to investigate the spatial variations in key trace gases (NO2, CO, SO2, O3, VOCs) and particulate matter (PM10, PM2.5) over this area. Present study focuses on assessing pollutant levels and their variations across urban, suburban, and rural sites within SERO, in order to see the main source categories and temporal and spatial patterns of pollutants across the region. A dataset spanning 2019 to 2021 was investigated for each site within this region, incorporating ground-based measurements from the Romanian National Air Quality Network and remote-sensing data from the Sentinel 5P TROPOMI instrument. Additionally, data from the Pandonia Global Network (PGN) Pandora instrument was added for the analysis for one of the surveyed sites. Meteorological parameters were integrated from various ERA5 datasets from the European Centre for Medium-Range Weather Forecasts (ECMWF). Results of the temporal and spatial analyses, including univariate and bivariate local indicators of spatial association (LISA) cluster mapping, point to the interplay between local and regional pollution sources, socioeconomic factors, and development levels of sites. Evidence of trans-regional pollution between different areas within the SERO region was found. Principal component analysis indicates the dominance of anthropogenic sources over natural sources at all locations. Study suggests the atmospheric pollution is related to more than just the identification of pollution sources. It implies the necessity to take into account additional metadata. The study offer insights to policymakers helping them in formulating targeted measures to mitigate pollutant emissions within the SERO region.

1.23 Past and recent changes in SO2 emissions in Romania: an analysis based on EDGAR database

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Keywords: air pollution, SO2 emissions, EDGAR, change-point analysis, trend analysis

In the context of the decrease of major pollutant emissions at European scale, a progressive general downward trend of SO2 emissions was evidenced in Romania. However, over the past five decades, Romania has experienced a large spectrum of economic and societal changes that involved some distinct regimes of SO2 emissions. Additionally, Romania made efforts to implement the European directives regarding industrial and power generation emissions and the use of sulfur content in fuels. Data used in the analysis were extracted from the EDGAR (Emissions Database for Global Atmospheric Research, https://edgar.jrc.ec.europa.eu/) database. In order to detect a significant change and to identify the dominant change-points in the mean of the SO2 time series, a segmentation algorithm based on dynamic programming was used. Further on, the non-parametric Mann-Kendal test and the Sen’s slope method have been used to identify and quantify the trends. This research evidences the significant changing points and point to their possible determinants. The results also show SO2 emissions changed drastically over time; changes were quantified, and compared with changes reported in other European countries. Moreover, these changes were found to be region-scale and activity-sector dependent. This study gives a relevant overview on past and recent changes and trends, which are useful for planning further cost-effective actions.

1.24 Effect of synthesis methods of polyaniline-derived nitrogen doped carbon nanostructures for oxygen reduction reaction in alkaline media

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Keywords: polyaniline, nitrogen-containing carbon nanostructures, oxygen reduction reaction

In the recent years, the nitrogen-containing carbon nanostructures (NCNS) have received increasing attention especially because of their applicability in the fabrication of new catalysts, electrocatalysts, and electrode material for supercapacitors. The aim of this study is the investigation of electrocatalytic activity toward oxygen reduction reaction of NCNS. The carbonization of polyaniline nanostructures as nitrogen containing precursors was used for the preparation of NCNS. Polyaniline nanostructures were synthesized using three different template free polymerization methods. In the present work we compared the efficiency of these materials for oxygen reduction reaction (ORR) in alkaline media. The electrochemical behavior was correlated with data obtained from X-ray Photoelectron Spectroscopy, Scanning Electron Microscopy and Raman Spectroscopy.

1.25 Comparative study of polyaniline-based nanocomposites doped with different metal oxide nanoparticles

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Keywords: conducting polymers, metal oxide nanoparticles, nanocomposite, electrochemical behavior

Polyaniline as a conducting polymer (CP) possess several advantages such as tunable electrical and electronic properties, facile and low-cost synthesis, good electrochemical properties, biocompatibility and environmental stability that make them attractive alternatives to traditional inorganic electronic materials. These advantageous features of CPs have motivated researchers to explore their potential as alternatives to inorganic electronic materials in diverse application fields. Furthermore, the interactions between inorganic semiconductors and conducting polymers can give rise to interesting and unique properties that are distinct from those of the individual components. These synergistic effects can lead to the development of novel hybrid materials with enhanced performance characteristics, opening up new opportunities in various technological domains. The present investigation highlights the synthesis of polyaniline (PANI) based nanocomposites doped with metal oxide nanoparticles such as CuO, Fe3O4 and Fe2O3&NiO via oxidative polymerization method in acidic medium, using ammonium persulfate (APS) as an oxidant. Scanning Electron Microscopy (SEM), X-ray diffraction (XRD), UV-VIS spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR) measurements were used to characterize the PANI and PANI based nanocomposites. The electrochemical behaviors of the nanocomposites in alkaline media were investigated.

Section 2: Atomic and Molecular Physics. Astrophysics. Applications. Optics, Spectroscopy, Plasma and Lasers

Location and time: **Nuclear spectroscopy Lab**

Moderators:

Assoc. Prof. Dr. Mircea BERCU

Assoc. Prof. Dr. Vasile BERCU

2.1 11:30-11:45 - Izabela GÎJGĂ, Leonard GEBAC
Investigating High-Pressure Behavior of Hydrogen Atoms Encapsulation in a Dodecahedrane Cage. A Molecular Dynamics Study

2.2 11:45-12:00 - Liliana DUMITRU, Octavian BLAGOI, Cristian DANESCU
Evolution of photospheric fields during the production of explosive events

2.3 12:00-12:15 - Stefan MATEICA, Leonard GEBAC
Exploring Helium Beam Interference via Naphthalene Rings: A MD Approach

2.4 12:15-12:30 - Georgiana SIMIONESCU, Eugeniu Mihnea POPESCU, Florin Adrian POPESCU, Gabriel CHIRITOI
CONSTELATION ACQUISITION SENSOR SPOT CENTROIDING

2.5 12:30-12:45 - Diana-Ioana COSAC, Eugeniu Mihnea POPESCU, Gabriel CHIRIȚOI, Florin Adrian POPESCU
Thermal invariant positioning for optical mounts

2.1 Investigating High-Pressure Behavior of Hydrogen Atoms Encapsulation in a Dodecahedrane Cage. A Molecular Dynamics Study

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Keywords: dodecahedrane cage, high-pressure hydrogen, metallic hydrogen, hydrogen encapsulation

An investigation of the encapsulation of six hydrogen atoms has been conducted using ab initio molecular dynamics simulations within the density functional theory (DFT) approximation. By expanding the configuration of the cage with a scaling factor of 1.2 at the beginning of the simulation, the cage then compresses, entering a radial breathing mode (RBM), which is a special radial symmetry normal vibration mode. The evolution of the H6@C20H20 system under the influence of the aforementioned radial symmetry normal vibration mode is thoroughly examined. Various geometric, energetic, and thermodynamic parameters, as well as the correlation between several physical quantities of interest, have been analyzed. Notably, it has been observed that the compression of the exterior dodecahedrane cage causes the compression of the encapsulated hydrogen atoms, with the interior system undergoing several structural modifications, which have been analyzed by monitoring the volume change of the H6 system's structural configuration. Furthermore, extreme pressures, in the range of hundreds of GPa, have been observed during the compression process. Therefore, for every timestep, the H6 system explores a significant region of the hydrogen phase diagram, which is of high interest in high-pressure hydrogen physics. This theoretical/computational approach could open new ways of obtaining hydrogen at high densities, further advancing the search for metallic hydrogen.

2.2 Evolution of photospheric fields during the production of explosive events

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Keywords: Active region, solar flares, velocity fields, coronal magnetic field, magnetic flux.

We analyzed a solar active region that produced several strong solar flares in the ascending phase of solar cycle 25. We used Spaceweather HMI Active Region Patch (SHARP) vector magnetograms from the Helioseismic and Magnetic Imager (HMI) on board the Solar Dynamics Observatory (SDO). Our attention is focused on the evolution of photospheric flows during the production of explosive events. We determined the velocity fields using different algorithms to compare them before and after an eruption. Also, we extrapolated the coronal magnetic field from the photospheric magnetograms and calculated the unsigned magnetic flux highlighting its variations before, during and after the occurrence of a solar flare.

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2.3 Exploring Helium Beam Interference via Naphthalene Rings: A MD Approach

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Keywords: Atom Interferometry, Double Slit Interference Pattern, Molecular Dynamics

We have conducted several Molecular Dynamics simulations in GAMESS in which we launched a beam of helium atoms towards a naphthalene molecule. The molecule's two rings served as a double slit. We then looked at the trajectories of

transmitted helium atoms, and we were able to observe an interference pattern. We have also tried to determine the ring in which the incident atoms were able to pass through.

2.4 CONSTELATION ACQUISITION SENSOR SPOT CENTROIDING

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Keywords: CAS, LISA, CoG

LISA (Laser Interferometer Space Antena) is a NASA-ESA space mission aimed at observing sources of gravitational waves in a low frequency range. The Constellation Acquisition Sensor helps to maintain the positioning and the alignment of the three satellites. The CAS configuration, with a laser spot size on the sensor of ~ 100 μm, two centroiding methods have been studied and implemented, namely: the simple 5x5 pixels centroiding window CoG (Center of Gravity) method, a modified CoG method with a 5x5 pixels centroiding window and a 7x7 pixels border for background subtraction. The precision testing method in this case consisted of placing the laser spot at different locations on CAS sensor (by mechanically displacing the sensor and keeping the laser direction fixed) and taking 10 successive images of the spot at a one location. All two centroiding methods were applied to each such set of 10 images, and for each centroiding method the average centroid position was calculated as well as centroid position standard deviation, and the latter was compared to the reference centroiding resolution of 0.2 μrad in the sky (which translates into a 3.41 μm resolution on the sensor in the CAS experimental configuration). The displacement measurement accuracy testing method is an extension of the precision testing. The sensor was displaced mechanically, with the help of the micrometer stage and starting from its approximate center, in the vertical and the horizontal direction with respect to the optical axis of the CAS, in steps of 500 μm. At each spot position on the sensor, 10 successive spot images were taken, each of the two centroiding methods was applied to these image sets to estimate the spot position on the sensor by averaging, the distance between such consecutive centroids was calculated using simple Euclidean geometry and the resulting estimated spot displacement was compared to the reference micrometer displacement of 500 μm.

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2.5 Thermal invariant positioning for optical mounts

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Keywords: thermal expansion, optical mount

In this presentation we will discuss a method for determining a point whose position is invariant under thermal expansion for an optical mount used for the CAS system on the ESA LISA mission satellites and we will analyze the displacement distributions for various geometries of the baseplate that supports the optical mount.

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Section 3: Biophysics; Medical Physics

Location and time: **Seminar Rm. 10**

Moderators:

Prof. Dr. Aurel POPESCU

Assoc. Prof. Dr. Claudia CHILOM

3.1 11:15-11:45 - Aurel I. POPESCU, Claudia G. CHILOM
Teaching Biophysics III. Biophysical Approach of Biomolecular Motors

3.2 11:45-12:00 - Marius-Valentin COSTACHE, Madalina CROITORIU
Photon Beam Attenuation in Radiotherapy: The Influence of Treatment Couches

3.3 12:00-12:15 - Nicoleta CAZACU, Marilena DOBRESCU
Advanced MRI Applications in Clinical Diagnosis and Monitoring of Neurological Disorders

3.4 12:15-12:30 - Andreea IONESCU BAICAN, Decebal IANCU, Radu ANDREI, Mihai STRATICIUC, Mihai RADU, Aurel POPESCU, Mihaela BACALUM
Investigation of high-dose rates proton beam effects on B16 melanoma cells

3.5 12:30-12:45 - Diana-Lavinia STAN, Mihaela BACALUM
Effects of Gramicidin A on membrane fluidity

3.6 12:45-13:00 - Roxana-Andreea BADEA, Constantin Augustin Dan PISTOL, Andrei BARBORICĂ
AI methods for the analysis of Stereoelectroencephalographic recordings

3.7 13:00-13:15 - Adina Monica TODERAȘ, Darius Maximilian MANGRA
Evaluation of silymarin and curcumin as potential pan-FGFR inhibitors through a molecular docking approach

3.8 13:15-14:00 - Denisa-Mihaela DUMITRU, Mirabela DUMITRACHE
Dosimetric comparison in Volumetric Intensity Modulated (VMAT) planning for pelvic cancer using a variable number of arcs

3.9 14:00-14:15 - M. -I. IVAN, C. NICHITA, V. IFTIMIE, M. -E. BARBINTA-PATRASCU
Silver nanoparticles generated from Geranium Robertianum: biophysical characterization

3.10 14:15-14:30 - Bianca-Alexandra IORDAN, Raducu POPA
Dosimetric assessment in interstitial needle brachytherapy

3.11 14:30-14:45 - Irina - Maria DUMITRU, Mădălina CROITORIU, Amalia CONSTANTINESCU, Mircea SAVU, Ancuța-Elena BACIU
Traceability and treatment of cervical cancer patients in the High Energy Radiotherapy Laboratory

3.12 14:45-15:00 - Daria-Maria FLOREA, Mihai SUDITU
Evaluation of the dosimetric impact of rotational errors in the radiotherapy treatment of nasopharyngeal cancer

3.13 15:00-15:15 - Tia POPESCU, Mihai BARHALA, Madalina CROITORIU, Valentin COSTACHE, Ionut DUMITRU, Corina DRAGOI, Gratiela NITESCU, Mirela RADU
Evaluation of stereotactic treatment plan quality indexes

3.14 15:15-15:30 - A. -E. CIUBOTARU, S. PETROVIC, M. -E. BARBINTA-PATRASCU
Biohybrids based on lipid nanoparticles, plant extracts and metallic nanoparticles: Biophysical aspects

3.1 Teaching Biophysics III. Biophysical Approach of Biomolecular Motors

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Keywords: Linear motors, rotary motors, proton pump, purple membrane, ATP-synthase, vesicular transport, filaments, tubules, actomyosin complex, dynein, kinesin

This work describes, in an accessible manner, the structures and functions of biomolecular motors. These are complex supra macromolecular structures which convert directly chemical energy into mechanical one and vice versa, accomplishing important cellular functions: chromosome migration during mitosis phase of cell cycles, DNA semiconservative duplication, vesicle transportation along filaments and tubules, DNA synthesis etc. They can be classified as linear (e.g., actomyosin complex into sarcomeres, DNA helicase and polymerase) and rotary motors (e.g., ATP synthase, procaryotic flagella), eucaryotic undulating flagella, and beating cilia (e.g., in eucaryotic cells). These nanomolecular motors are fuelled by ATP hydrolysis, although ATP synthase is driven by energy of a proton gradient performed by oxidative phosphorylation in mitochondria or by light in the case of chloroplast thylakoids and purple membrane of bacterium Halobacterium salinarum

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3.2 Photon Beam Attenuation in Radiotherapy: The Influence of Treatment Couches

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Keywords: Beam Attenuation, Dose Calculation, Ionization Chamber, SRS MapCheck Detector, Point Dose Evaluation, Gamma Analysis

This study investigates the impact of treatment couches on the attenuation of a clinical photon beam in radiotherapy, specifically utilizing the TrueBeam STX linear accelerator with HD120 multi-leaf collimator. Accurate dose delivery is crucial in radiotherapy, and any attenuation caused by objects in the beam path, such as the treatment couch, can alter the treatment efficacy. Point dose evaluation was conducted by performing multiple plans with and without the couch using multiple dose calculation algorithms (e.g. Analytical Anisotropic Algorithm and Acuros AXB), utilizing the Exradin MicroPoint Ionization Chamber placed inside water equivalent blocks fitted inside a StereoPhan holder of a SRS MapCheck detector from Sun Nuclear Corporation. Clinical SBRT cases (high dose treatments inside a small volume), are also investigated using Gamma Analysis with criteria as low as 2% dose difference and 1% distance to agreement. Results show a difference of up to 3% absorbed dose for an overall treatment fractionation, which highlights the necessity of accounting for couch-induced attenuation by inserting the couch model inside the dose calculation. This practice enhances the dose accuracy and overall therapeutic effectiveness of a treatment plan for patients undergoing radiotherapy.

3.3 Advanced MRI Applications in Clinical Diagnosis and Monitoring of Neurological Disorders

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Keywords: Magnetic Resonance Imaging, Neurological Disorders, MRI pulse sequences, MRI applications

Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic tool that plays a prime role in various disease aspects, including diagnosis, prognosis, and treatment response assessment. Recent advancements in MRI technology, especially in brain imaging acquisition and post-processing, have substantially contributed to our comprehension of disease-specific pathogenetic mechanisms. MRI serves as a crucial technique in diagnosing and planning the treatment of neurological disorders by offering detailed and precise images of the brain and spinal cord. In MRI different sequences are used, each tailored to different diagnostic needs: T1-weighted images for anatomy and tissue characterization, T2-weighted images for detecting various types of pathology, including edema, inflammation, cysts, and certain types of tumors, fluid-attenuated inversion recovery (FLAIR) for enhancing the visibility of abnormalities by suppressing cerebrospinal fluid signal, susceptibility (SWI) or gradient echo imaging (GRE) for detecting small amounts of hemorrhage, blood products or calcium, diffusion-weighted imaging for diagnosing acute strokes and post-contrast imaging, typically T1-weighted with fat suppression, to highlight the integrity of the blood-brain barrier. Neurological disorders such as multiple sclerosis (MS), Alzheimer's disease, Parkinson's disease, stroke, epilepsy, and brain tumors are just a few examples of neurological disorders that could be diagnosed and monitored using MRI. Numerous research projects are underway to progress the development of algorithms and image analysis methods for more precise disease progression detection and prognosis.

3.4 Investigation of high-dose rates proton beam effects on B16 melanoma cells

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Keywords: flash radiotherapy, hadron therapy, protons, cancer, melanoma

Cancer remains a pressing issue in the field of health, exhibiting a trend of increasing incidence rates. Approximately 1 in 5 individuals develops some form of cancer throughout its lifetime. Melanoma is a type of malignant tumour originating from mutations in melanocytes, provoking their uncontrolled division (1). This form of cancer accounts for the majority of skin cancer deaths and contributes to 0.7% of cancer related fatalities (1,2). Current treatment methods utilized in cancer include chemotherapy, surgery, hormone therapy, hyperthermia, immunotherapy, and radiotherapy. However, for certain types of cancer, only radiotherapy remains an effective form of treatment. The proton therapy can lead to a reduction in side effects on healthy tissues compared to phototherapy (3). FLASH radiotherapy involves delivering a high dose of radiation to the tumour volume at high dose rates. This technique results in the protection of healthy tissues, simultaneously providing an effective control over tumour tissues (4). The aim of this study is to administer high-dose rates (1.500 Gy/s, 1.000 Gy/s, 250 Gy/s, 50 Gy/s) of protons using the 3MV Tandetron particle accelerator to B16 melanoma cells, in order to assess cellular viability, the formation rate of reactive oxygen species, and the induction of senescence. This endeavor aims to enhance understanding in these areas, which may further contribute to advancements in the field of hadron therapy.

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3.5 Effects of Gramicidin A on membrane fluidity

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Keywords: Gramicidin A, membrane fluidity

In recent years, antimicrobial peptides have garnered significant attention due to their anti-cancer properties. Among these peptides, Gramicidin A (GA) has been of particular interest for its ability to form selective ion channels within cell membranes (1). Utilizing Laurdan, an organic compound that is sensitive to changes in polarity (2), the alterations in membrane fluidity subsequent to GA incorporation was investigated. This research started with analyses on membrane models from POPC in which we studied both temperature variation (from 10 ℃ to 60 ℃ in step of 10 ℃) at a constant concentration of GA (1 μM and 25 μM) and the variation in the concentration of peptides (1 μM, 2.5μM, 5 μM, 10 μM, 15 μM, 20 μM, 25 μM) at a fixed temperature (20 ℃ and 37 ℃). The same analysis of the variation of the GA concentration was also examined for two distinct cell lines, HCT-116 and HT 29. Further, the study was expanded to include the impact of nanoparticles with GA on membrane fluidity. Finally, we assessed cell viability post-treatment with GA and the aforementioned nanoparticles. Following the generalized polarization (GP) calculation it can be concluded that the peptides have been inserted into the membrane.

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3.6 AI methods for the analysis of Stereoelectroencephalographic recordings

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Keywords: EEG, SEEG, IED spikes, Python, AI, CNN, Machine Learning

This paper explores the application of artificial intelligence methods to the analysis of stereoelectrographic recordings, with the primary aim of improving the detection of interictal spikes (IED) by increasing the values of sensitivity, precision, and accuracy. Time-frequency maps were generated for multiple recording channels, and a convolutional neural network (CNN) was employed. This CNN underwent a fine-tuning process to adapt it to the specific characteristics of the dataset. The algorithm was run on the dataset from the N. Roehri database, where the ground truth consisted of spike markers that indicate interictal spikes. These markers were manually annotated by the authors of the dataset using AnyWave. This dataset contains 960 channels, with each channel having an average of 25 spikes. Initially, the pre-trained model applied to one channel from the N. Roehri dataset achieved approximately 61% sensitivity, 42% accuracy, and 88% precision. After fine-tuning, the model was tested on new channels from the dataset to evaluate its performance. The results of the fine-tuned CNN were then compared with the ground truth on several channels, as well as with the initial results obtained from the pre-trained model on the same channels prior to fine-tuning. Additionally, the study underscores the efficacy and applicability of the proposed method in the field of neurological signal analysis. The results indicate that the adapted CNN can serve as a powerful tool for the detailed analysis of stereoelectrographic data, providing insights that are crucial for both clinical and research applications in neurology.

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3.7 Evaluation of silymarin and curcumin as potential pan-FGFR inhibitors through a molecular docking approach

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Keywords: molecular docking, curcumin, silymarin, FGFR, inhibition

FGFRs represent a protein family comprising four transmembrane receptor tyrosine kinases (RTK). They are fundamental to the PI3K/ AKT/mTOR signaling pathway, which regulates survival, cell proliferation and differentiation. Two polyphenols, Silymarin and Curcumin, have demonstrated encouraging outcomes in in vitro investigations. Consequently, this research aims to assess their theoretical pan-FGFR inhibitory potential through molecular docking simulations. We compared the outcomes of futibatinib (a covalent, non-selective FGFR inhibitor), lirafugratinib (a covalent-selective FGFR2 inhibitor), resigratinib (a pan-FGFR inhibitor), and Blu9931 (a covalent FGFR4 inhibitor) with those of silymarin and curcumin. The polyphenols did not demonstrate lower binding energies compared to the co-crystallized ligands, and their inhibition constants were also higher. Nevertheless, our observations revealed that curcumin and silymarin successfully formed hydrogen bonds with the specific Cysteine residue in some cases. Silymarin formed a hydrogen bond in FGFR 1, 3, and 4, while curcumin did so in FGFR3 and 4. This suggests their potential as adjuvant methods in pan-FGFR inhibition. Aditionally, the polyphenols examined obey to Lipinski's rule, and their various ADMET properties have also been assessed.

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3.8 Dosimetric comparison in Volumetric Intensity Modulated (VMAT) planning for pelvic cancer using a variable number of arcs

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Keywords: VMAT, DVH, Gamma analysis, homogeneity index (HI), conformity index (CI)

Prostate, rectal and cervical cancer are the most common types of cancer spread throughout the world, representing a percentage of 80 - 90 %. The prevention of the expansion of these tumors can be achieved by radiotherapy, or the combination of radiotherapy and chemotherapy, when the tumor has exceeded stage II. The degree of complexity of the tumor, but also the choice of the specialist are the basic criteria for the application of a treatment method and its planning.

The present study uses the Volumetric Intensity Modulated (VMAT) method, with a variable number of arcs for certain types of pelvic cancer. Thus, the study was based on the idea of treating 30 patients diagnosed with a type of pelvic cancer. Therefore, for 10 patients it was used a single arc, for another 10 patients two arcs were used, and for the last 10 patients, an arc and a partial arc (PA) were used. The final analysis, the evaluation of the treatment plan and the comparison of the results were carried out using special tools, such as the dose-volume histogram (DVH), represented by homogeneity (HI) and conformity (CI) indices that provide a precise quality of the treatment plan. For the comparison of dose distributions between the reference and the evaluated one, the Gamma analysis method was used.

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3.9 Silver nanoparticles generated from Geranium Robertianum: biophysical characterization

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Keywords: Phytosynthesized silver nanoparticles; antioxidant activity; urease activity

Phytosynthesis of metallic nanoparticles is a new trend in “green” nanotechnology, a great interest being given to silver nanoparticles (AgNPs). In this study, silver nanoparticles (phyto-AgNPs) were phytosynthesized by using an aqueous extract of aerial parts of Geranium robertianum. Different types of phyto-AgNPs were prepared by varying the ratio of vegetal extract/precursor salt solution. The obtained phyto-AgNPs were characterized by UV-Vis absorption spectroscopy, and we chose the phyto-AgNPs obtained with the best yield. These were further characterized by various biophysical methods. Their physical stability was checked by zeta potential measurements, and their size was evaluated by Dynamic Light Scattering (DLS) measurements. The phytosynthesized AgNPs showed urease inhibitory activity (estimated by conductometric assay), and also good antioxidant properties (evaluated by chemiluminescence technique). These findings could be exploited in the biomedical field for the development of novel urease inhibitors.

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3.10 Dosimetric assessment in interstitial needle brachytherapy

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Keywords: cervical cancer, brachytherapy, radiotherapy, dose,overdose, parameters

In this study, 10 patients with cervical cancer were evaluated by brachytherapy in order to analyze the following parameters: coverage index (CI), relative dose homogeneity index (DHI), overdose volume index (ODI) and dose non-uniformity ratio (DNR) . Each patient underwent 2/3 sessions of interstitial needle brachytherapy for better coverage of the tumor volume. The conclusion of this study was that for some patients, the interstitial parameters were not in the desired range because the organs received different doses during the external radiotherapy.

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3.11 Traceability and treatment of cervical cancer patients in the High Energy Radiotherapy Laboratory

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Keywords: Cervical cancer, external beam radiotherapy, brachytherapy

Cervical cancer is among the most common types of cancer affecting women worldwide. This scientific work highlights all the stages of preparation, scanning, planning, and verification of radiotherapeutic treatment for patients diagnosed with malignant cervical tumors and the delivery of treatment. Two types of treatment using ionizing radiation are presented and evaluated: External Beam Radiotherapy (EBRT) and three dimensional Intracavitary Brachytherapy High Dose Rate (3D-HDR) with a sealed source of Iridium 192. Planning, optimization, and quality assurance of treatment are precursor stages to quality assurance activities of radiological facilities and personnel training in the laboratory by medical physicists. The others of the medical activities and the delivery of treatment sessions fall within the responsibilities of medical assistants and radiotherapists. External Beam Radiotherapy (EBRT) is a standard treatment for cancer and the most common form of radiotherapy. It uses a machine to deliver beams of energy that destroy tumors. Brachytherapy is a treatment technique that uses sealed radiation sources (Ir192) to deliver a dose of radiation directly to the planned target volume (PTV). It allows precise delineation of the target and volumes of organs at risk. Conclusions: The treatment of this disease is radiochemotherapy, external RT, followed by brachytherapy, and in certain cases, surgical treatment. In early tumors, with small volume and low-grade staging, radiochemotherapy and intracavitary brachytherapy are indicated. 3D HDR brachytherapy allows the best coverage of the area by the reference dose with simultaneous protection of critical organs.

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3.12 Evaluation of the dosimetric impact of rotational errors in the radiotherapy treatment of nasopharyngeal cancer

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Keywords: Nasopharyngeal cancer, dosimetric impact, rotational error, radiotherapy

The study aimed to retrospectively evaluate the dosimetric impact of rotational patient positioning errors when using the VMAT irradiation technique accompanied by IGRT in treating nasopharyngeal cancer. The study's objectives were to evaluate the impact that rotational set-up errors have on the radiation dose distribution in the radiotherapy treatment of nasopharyngeal cancer, and the advantages brought by using a six degrees of freedom (6DoF) treatment table that allows the correction of these errors. Ten patients with nasopharyngeal cancer were included in the study, treated with the volumetric modulated arc therapy (VMAT) irradiation technique accompanied by image-guided radiotherapy (IGRT).

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3.13 Evaluation of stereotactic treatment plan quality indexes

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Keywords: Brain, Stereotactic, Radiosurgery, Radiotherapy treatment plan

Brain tumor control plays an important role in the patient’s neurological integrity and quality of life. The principle underlying radiosurgery treatments is the delivery of large doses, up to 24 Gy/fraction (1), to the tumor, sparing the healthy normal tissues. In order to obtain the best results a very precise delivery is necessary, which depends on several factors, such as immobilization devices, daily imaging, surface guidance, and a rigorous quality assurance program to maintain a sub-millimeter accuracy. The closer the prescription dose is matched to the treated target and the steeper the dose gradient around the target, the less normal tissue is irradiated. For most rigorous evaluation of stereotactic treatment plans, parameters such as gradient index, conformity index or the gradient in millimeters must be evaluated (2). All these parameters depend on volume position, dimension, their position in relation to other critical structures or the beam energy. This work aims to compare the indices used in the evaluation of stereotactic treatments by making several treatment plans, in several radiotherapy departments, to see the variability from planner to planner and how far can go in conforming doses for such treatments, thus in order to standardize the quality of plans. The selected patients have single brain metastases, with

volumes ranging from 0,3 cm3 to 100 cm3, some of them being close to critical structures. This analysis is based on comparing the values obtained in clinical practice with an experimental model which is based on a phantom, treated with a hypothetical treatment, which cannot be achieved in practice.

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3.14 Biohybrids based on lipid nanoparticles, plant extracts and metallic nanoparticles: Biophysical aspects

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Keywords: Green nanoparticles; liposomes; chlorophyll; urease activity

Green strategies are more and more used in nanotechnologies, considering the current global context. In this study, an eco-friendly approach was used to develop biohybrids containing liposomes, green AgNPs and vegetal extract. Fresh Citrus peels were used to generate silver nanoparticles (AgNPs). These nanoparticles were loaded into liposomes labeled with chlorophyll (Chl). Chl was used as an optical sensor to monitor in vitro, by UV-Vis absorption and fluorescence emission spectroscopy, the biohybrid development. The biohybrids were also characterized by FTIR ATR spectroscopy. Conductometric assay was used to check the potential inhibitory action against urease. Our findings show that the obtained biohybrids can be used in biomedical or in environmental applications to develop new urease inhibitors.

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Section 4: Nuclear and Elementary Particles Physics

Location and time: **Amf. 4**

Moderators:

Prof. Dr. Alexandru JIPA

Prof. Dr. Ionel LAZANU

4.1 11:15-11:45 - Alexandru JIPA
Atomic and Nuclear Physics Chair in the fifty years of the Faculty of Physics on the Măgurele Physics Platform

4.2 11:45-12:00 - Daniela CHIRIAC, Alexandru NEGRET, Adina COMAN, Marian BOROMIZA
Proton inelastic cross sections measurements on 24Mg

4.3 12:00-12:15 - Roxana Maria MOCANU, Alexandru JIPA, Florin MACIUC
Production of Drell-Yan bosons in p-p collisions at sqrt{s}=13 TeV

4.4 12:15-12:30 - Mihaela PARVU, Ionel LAZANU
Searches for Axion anti-Quark Nuggets using dosimetric signals in minerals used as detectors

4.5 12:30-12:45 - Denis BARBU, Mihaela PARVU, Ionel LAZANU
Nuclear effects in proton decay

4.6 12:45-13:00 - Andrei NECSOIU, Diana COCIOABA, Simona BARUTA, Dana NICULAE, Alexandru JIPA
Production of Ga-68 on solid targets at the TR-19 cyclotron

4.7 13:00-13:15 - Raluca-Andreea MIRON, Violeta IANCU, Gabriel V. TURTURICĂ
Pixelated scintillators for high-energy gamma imaging

4.8 13:15-13:30 - Alexandra CORBU, Mihaela PARVU, Ionel LAZANU
Neutron shielding studies of interest for neutrino physics experiments

4.9 13:30-13:45 - D. GURAU, D. STANGA1*, L. DONE, O. SIMA, G. ILIE
A Novel Method for Computing the Full-Energy Peak Efficiency of Coaxial High-Purity Germanium Detectors for Cylindrical Sources

4.10 13:45-14:00 - Iuliana BACIOIU
Flux variation of cosmic muons

4.11 14:00-14:15 - Valentin BUGAESCU, Mihaela PÂRVU, Ionel LAZANU
Exploring 8-B solar neutrino detection in LArTPCs

4.12 14:30-14:45 - Angelica GHERGHELAS, Ana-Maria BLEBEA-APOSTU, Alexandru JIPA
Radon measurements in „Ion Creangă" National College building

4.13 14:45-15:00 - Mihai-Stefan BARHALA, Tia POPESCU
The influence of the linear accelerator and beam scanning system mechanical components in relative dose measurements

4.14 15:00-15:15 - Alexandru JIPA, Oana RISTEA, Marius CĂLIN, Ionel LAZANU, Tiberiu EȘANU, Dănuț ARGINTARU, Nicolae ȚUȚURAȘ, Murat ABLAI, Diana DEARĂ, Vlad Andrei BÂSCEANU
On the equation of state of the nuclear matter for high excited and dense nuclear matter. Possible ways for investigation

4.15 15:15-15:30 - Alexandru JIPA, Oana RISTEA, Marius CĂLIN, Ionel LAZANU, Tiberiu EȘANU, Dănuț ARGINTARU, Nicolae ȚUȚURAȘ, Murat ABLAI, Diana DEARĂ, Vlad Andrei BÂSCEANU
Physical bases for the investigation of the stellar matter in terrestrial experiments

4.16 15:30-15:45 - Bogdan Octavian TEMELIE, Gabriel TURTURICĂ, Violeta IANCU
Position Sensitive Scintillation Detector for Gamma Spectroscopy

4.17 15:45-16:00 - Alexandru-Florin BEREVOIANU-MIRA, Ahmed OMAR, Mohamed M. Y. MOHSEN, Raluca MĂRGINEAN, Keunhwan KIM, Larisa-Maria GANEA, Ana-Maria PINTILIE, Decebal IANCU, Radu ANDREI, Dragoș MIREA, Andrei I. APOSTOL

Study of Elemental Impurities present in Natural Uranium Samples for Nuclear Forensics and Safeguards Applications by Ion Beam Analysis at 3MV Tandetron TM

4.18 16:00-16:15 - Decebal IANCU, Ion BURDUCEA, Radu-Florin ANDREI, Mihai STRATICIUC, Alexandru JIPA, Gihan VELIȘA
In-situ temperature measurements during ion implantation

4.19 16:15-16:30 - Alexandru-Florin BEREVOIANU-MIRA, Andrei I. APOSTOL, Keunhwan KIM, Larisa-Maria GANEA
Implementation of a nuclear security course at the Faculty of Physics, University of Bucharest

4.20 16:30-16:45 - Tudor-Alexandru Calafeteanu, Paula-Gina Isar, Emil-Ioan Slusanschi
An optimal method of selecting candidate radio detectors with high predicted signal-to-noise ratio for extensive air shower simulations

4.21 16:45-17:00 - Cristiana Oprea, Alexandru Ioan Oprea
Forward-Backward Asymmetry Coefficient in Slow Neutrons Capture by 109Ag Nucleus

4.22 17:00-17:15 - Daniel DOROBANȚU, Theodor ASAVEI, Mihail CERNĂIANU, Domenico DORIA, Petru GHENUCHE, Alexandru MĂGUREANU, Viorel NĂSTASĂ, Deepak SANGWAN, Lucian TUDOR
Study of the helical laser beam profile on the particle acceleration

4.23 17:15-17:30 - Eugenia-Simona BĂDIȚA, Paul-Emil MEREUȚĂ, Cristina BURDUCEA, Chivuta-Ramona BĂDIȚA
CHARACTERIZATION OF SILICA OPTICAL FIBRE AS RADIATION DETECTOR

4.1 Atomic and Nuclear Physics Chair in the fifty years of the Faculty of Physics on the Măgurele Physics Platform

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Keywords: Atomic and Nuclear Physics, Physics platform, history and achievements, collaborations and future

In the long history of the Physics studies at the ”Academia Domnească” and University of Bucharest, the new headquarter of the Faculty of Physics built on the Măgurele Physics Platform represented a important and interesting step in the evolution of the Physics studies at the university level. This work tries to remember a few important moments of this history.

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4.2 Proton inelastic cross sections measurements on 24Mg

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Keywords: Nuclear reactions, Nucleon induced nuclear reactions

Two experiments were conducted at IFIN-HH's Tandem Accelerator (Bucharest) to determine proton inelastic cross-sections on 24Mg. The primary aim was to measure the most intense transitions from the inelastic channel and to potentially compare 24Mg(p, p’γ)24Mg and 24Mg(n, n’γ)24Mg reaction cross sections in the future. The setup for the experiment included two HPGe detectors positioned at 110° and 150° relatively to the direction of the incoming proton beam, both with 100% relative efficiency. The incident protons with energies between 3 and 17 MeV were scattered on two targets of various

thicknesses and a Faraday cup was employed to integrate the beam current. The data analysis method and the results of γ-production cross sections for the strongest transitions in 24Mg will be outlined.

Acknowledgement:
This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847552".
The work was supported by the Romanian Ministry of Research, Innovation, and Digitization, CNCS/CCCDI-UEFISCDI, through Projects No. PN-III-P4-PCE-2021-0490.

4.3 Production of Drell-Yan bosons in p-p collisions at sqrt{s}=13 TeV

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Keywords: event generators, Z boson

The Standard Model elegantly describes the electromagnetic, weak, and strong forces, mediated by photons, W and Z bosons, and gluons, respectively. Among these, the electroweak theory stands as a pivotal achievement, unifying the electromagnetic and weak forces into a single theoretical framework. The Drell-Yan process is the process in which a quark and an antiquark annihilate, producing a Z boson or a gamma that subsequently decays into lepton-antilepton pairs. In this work, we present a comparative study of a Drell-Yan simulated process in p-p collisions at an LHC energy of sqrt{s}=13 TeV using two general-purpose Monte Carlo event generators, PYTHIA and Herwig, and data from HEPData of two measurements, one from LHCb [1] and one from CMS [2]. Both the minimum bias event and the Z production event were studied and compared, with analyses on transverse momentum, rapidity, pseudorapidity and multiplicity distributions, cross sections in LHCb and CMS acceptances, and final state particle distributions and ratios, such as baryon-to-meson ratio. Since Z bosons are unable to transport color charges, the properties of the underlying event can be studied effectively through the Drell–Yan process. The simulations were realized both for LO (leading order) and for NLO (next-to-leading order) precision. The results have shown that LO calculations presented a good distribution shape, but only NLO calculations gave cross section values close to experimental data. Various tunes were also used for PYTHIA to highlight the importance of tune parameters.

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4.4 Searches for Axion anti-Quark Nuggets using dosimetric signals in minerals used as detectors

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Keywords: Dark Matter, Axion anti-Quark Nuggets, direct detection

This communication presents a new idea for the detection of Dark Matter, in particular Axion anti-Quark Nuggets (AQNs) using dosimetric signals accumulated in different minerals used as paleo-detectors. The existence Axion anti-Quark Nuggets as exotic constituent particles of dark matter (DM) have a long history, beginning with the pioneering work of Witten [1], De Rujula and Glashow [2], until their detailed definition by Zhitnitsky [3]. If these particles exist, they can naturally and directly restore the symmetry between matter and antimatter in cosmology.

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4.5 Nuclear effects in proton decay

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Keywords: proton decay, detection, nuclear effects

The proton decay detection would be one of the best ways to test some theories that are Beyond the Standard Model. For this reason, there is a significant number of experiments that are searching for such a decay using different detection techniques. The principal techniques are water Cherenkov and liquid noble gas TPC detectors, however geochemical and radiochemical methods, (liquid) scintillators, or iron calorimetry are also considered. Because in the most cases the proton is not a free particle, in this work we studied some nuclear effects that must be considered in proton decay, i.e., Fermi motion of the nucleons and final state interactions. The two decay channels that were studied are: $p \rightarrow K+ \bar{\nu}$ and $p \rightarrow \pi+ \bar{\nu}$. The analyze was done for three different mediums that are used in these experiments, H2O, LAr and LXe. In this sense, we have calculated the energy distributions for both kaon and pion using the Fermi Model of the nucleus. In order to describe the FSI, we have also provided data for cross sections and mean free paths of kaon and pion in the three mediums, by applying different parametrizations on the poor existing experimental data of these mesons. The results for cross sections and mean free paths were calculated for two different cases, i.e., interactions inside the residual nucleus and with the nuclei of the medium. Because in such interactions the kinematics can change drastically, with the possibility of vanishing in the case of pion, the probabilities for the particles to not interact with the nucleons of the residual nucleus or with the nuclei of the medium were obtained.

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4.6 Production of Ga-68 on solid targets at the TR-19 cyclotron

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Keywords: Ga-68, TR-19 cyclotron, solid target, PET imaging, TRIM

Gallium-68 is a radioisotope commonly used in nuclear Medicine, due to its decay characteristics and half-life of 68 min being suitable for Positron Emission Tomography (PET) imaging. It is often employed in conjunction with specific tracers that target specific tissues or biological processes, making it valuable for diagnostics in neuroendocrine tumours and prostate cancer. Moreover, its short half-life allows for high-resolution imaging while minimizing radiation exposure to

patients. This study presents the production method of Ga-68 radioisotope by proton irradiation of the Zn-68 target on the cyclotron, with an emphasis on the production on solid targets using the TR-19 cyclotron (CCR, IFIN-HH). For Zn-68(p,n)Ga-68 nuclear reaction, relevant experimental values of the production cross-section have been extracted from the nuclear database (Experimental Nuclear Reaction Data – EXFOR) and discussed in relation with TR-19 energy window. The optimal energy for this nuclear reaction correlated to the maximum value of cross section from the EXFOR database was estimated using TRIM simulation code (the Transport of Ions in Matter).

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4.7 Pixelated scintillators for high-energy gamma imaging

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Keywords: pixelated scintillators, Geant4 simulations, spatial resolution

Structured scintillators have been developed to meet the demand for enhanced visibility of finer details across a wide range of applications, including gamma beam diagnostics and radiography. These advanced materials offer improved detection efficiency, enhanced spatial resolution and overall superior image quality compared to classical scintillators. While numerous studies have explored the use of patterned scintillators for low-energy X-ray detection, their response to high-energy photons remains unexplored.
In this work, GEANT4 Monte Carlo simulations were performed to investigate the response of various scintillator detector panels to gamma radiation and optimize a pixelated structure. These panels varied in thickness between 0.5 and 2 mm and were made of different scintillator materials, including CsI(Tl), LYSO and BGO. Here we present and discuss the dependence of deposited energy, spatial distribution of energy deposition and the absorbtion efficiency for incident beam energies ranging from 0.1 to 10 MeV. The optimization of the pixel size was done by analyzing the spatial distribution of deposited energy and the modulation transfer function. After optimizing the pixel parameters, pixelated panels were simulated and evaluated for spatial resolution using the modulation transfer function metric. Additionally, we will discuss laboratory testing that evaluated the performance of two scintillators - a plain scintillator and a columnar (nanostructured) scintillator - using a gamma beam profiler setup.

4.8 Neutron shielding studies of interest for neutrino physics experiments

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Keywords: neutrino physics, neutrons, radioactive background

One of the key objectives for the next generation of experiments in rare process physics, particularly those involving neutrinos, is to enhance the physics program by constructing detection systems with minimal radioactive background. Neutrons are a major source of this background. To address this, we initiated a series of studies to determine the energy dependence of the neutron attenuation coefficient in various materials of interest. These studies were conducted through simulations using the FLUKA code and experimental measurements. In this communication, I will present preliminary results from both simulations and measurements.

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4.9 A Novel Method for Computing the Full-Energy Peak Efficiency of Coaxial High-Purity Germanium Detectors for Cylindrical Sources

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Keywords: gamma spectrometry, full-energy peak efficiency, computational method, Matlab code

Computed values of the full-energy peak (FEP) efficiency are widely used in gamma spectrometry measurements because the relative method of measurement has severe restrictions. Monte Carlo (MC) simulation codes are often used for computing the FEP efficiency but they are rather complicated, time consuming and require skilled people for their use and the calibration of the detector model. The deterministic codes, are usually simpler and faster than MC simulation codes providing sufficiently accurate values of the FEP efficiency. In many cases, it is more convenient the use of deterministic codes, especially when the sample geometry is poorly known. In this work a simple and fast method was developed to compute the FEP efficiency of coaxial HPGe detectors for cylindrical sources measured by gamma spectrometry laboratories. It is based on an integral expression for computing the FEP efficiency via computing the detector responses and the attenuation factors of point sources embedded in the source matrix. The detector response was computed using the grid based linear interpolation and the FEP efficiency response in grid points was computed using a MC simulation code with a properly calibrated detector model. The attenuation factor was computed using MC integration and the FEP efficiency for cylindrical sources was computed according to the integral expression mentioned above using numerical integration. The method was implemented as a Matlab code, which was written for computing the FEP eficiency of a Canberra detector model GC3018. The Matlab code was extensively verified by intercomparisons with GESPECOR code to evaluate the intrinsic errors of the method and LabSOCS code. In both intercomparisons, the Matlab code provided satisfactory results with the average and the maximum absolute values of the relative deviations between its results and the results of the other two codes smaller than 2 % and 9.5 %, respectively.

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4.10 Flux variation of cosmic muons

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Keywords: cosmic radiation, energy spectrum, muon flux asymmetry.

The influences of the cosmic radiation effects on Terra, from space to the terrestrial atmosphere and underground have been discussed in the scientific community for many years, however many questions about the cosmic radiation remain

open. Nowadays, it is known that Universe's atoms reach the atmosphere of the Earth up to the sea level altitudes and downward in the Earth's crust. Most primary cosmic ray particles as a function of their kinetic energy reach the lower atmosphere of the Earth. Because the exposures at the ionizing radiation can affect both the health of the living organisms and electronics devices, the ionizing radiation monitoring is a working tool for radiation protection, to identify the presence of radiation dose above the standard allowable limits, assuming the Earth's atmosphere as one ionizing calorimeter and the Sun as a supplementary source of radiation, in the Earth's atmosphere. At sea level, cosmic rays are mainly galactic cosmic radiation consisting mostly of muons and other relativistic elementary particles such as the electrons, the positrons, the neutrinos, the photons and the neutrons. Based on studies of the variation of the muon intensity as a function of muon energy, the different geomagnetic latitudes and the altitude above sea level, this study research the cosmic ray muon flux anisotropy existence in the terrestrial atmosphere, in a lower muon momentum region where the geomagnetic effects and the solar-cycle variations become important. The present results are in good agreement with the scientific data of other authors with interests in the field of cosmic ray physics.

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4.11 Exploring 8-B solar neutrino detection in LArTPCs

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Keywords: neutrino, detection, MARLEY code, Monte Carlo simulation

A new direction in the liquid-argon neutrino detector technology is to extend the sensitivities of these experiments to the MeV energy range - expanding the physics region of interest of these next-generation detectors to include solar neutrinos. The goal is to observe solar neutrinos in a kton-scale detector and to demonstrate that the required background suppression and energy resolution can be achieved leading to a precise measurement of the 8-B flux and solar neutrino mixing parameters. We present the photon, neutron and proton spectra obtained in the interaction of 8-B neutrinos with LAr and we discuss the radioactive background that has to be taken into account in order to correctly identify these events.

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4.12 Radon measurements in „Ion Creangă” National College building

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Keywords: Radon activity concentration,indoor radon measurements

Radon is a subject of interest for governmental institutions and research communities worldwide in the context of public health concerns. Studies conducted in recent years confirmed the potential health risks associated with radon and provided essential data for the development and implementation of safety measures and strategies to prevent exposure to this harmful gas. Measurements of radon concentrations have been taken in indoor air in homes, schools, and workplaces, as well as in soil gas and water sources. In accordance with Directive 2013/59/EURATOM (European Atomic Energy Community), Romania has established a reference level for radon concentration of 300 Bq/m3 in indoor air. Nationally, several laboratories designated by National Commission for Nuclear Activities Control have been involved in measuring radon

concentrations in professional environments and residences. It is important to ensure that students are not exposed to dangerous concentrations of radon during their time at school. Therefore, we conducted a radon screening in the classrooms of the „Ion Creangă” National College in Bucharest. The measurements were carried out in collaboration with the Department of Life and Environment Physics at IFIN-HH. Measurements were taken in 13 classrooms located on three levels and in the basement. Values obtained ranged between 22,5 Bq/m3 and 265,38 Bq/m3, depending on the room position, confirming the significant absence of health risks for students and staff.

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4.13 The influence of the linear accelerator and beam scanning system mechanical components in relative dose measurements

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Keywords: Relative Dose Measurements, Linear Accelerator, Beam Scanning System, Measurement errors, Measurement uncertainty

Due to the tolerances given by the LINAC producer regarding the variability of mechanical movements, this work is focused on the influences of the mechanical components position in relative dose measurements such as PDDs and dose profiles [1]. Those measurements represent an essential role in modelling the radiation beam accurately in the TPS, such that the radiation therapy treatments can be delivered as intended. Another important factor that can influence the measurement quality, besides the one stated above, is the beam scanning system itself. This system must be checked properly so that the measured data can be trusted as intended. This includes the accuracy of movement via the three direction individual motors that control the position of the detector. Besides analyzing the interdependence of mechanical

and dosimetric components, one of the main aspects of this work is to estimate the measurement uncertainty itself by statistical means [2] and to provide a practical workflow to be performed prior to starting the dosimetric measurements

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4.14 On the equation of state of the nuclear matter for high excited and dense nuclear matter. Possible ways for investigation

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Keywords: relativistic and ultrarelativistic nuclear collisions, hot and dense nuclear matter, nuclear equation of state

Equation of state of dense and hot nuclear matter can help in the tentative to study the Universe's evolution, including stars' formation and apparition of special star types, as neutron stars. In this work we try to present some basic considerations, experimental results for older experiments, as well as some simulation results for future experiments. A special attention will be paid to the simulations and results for CBM and HADES experiments from FAIR-GSI.

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4.15 Physical bases for the investigation of the stellar matter in terrestrial experiments

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Keywords: cosmic rays, relativistic and ultrarelativistic nuclear collisions, nuclear matter, evolution of participant region, connections with Big Bang

Our Universe evolution seems to be well described by the different cosmological scenarios, including Big Bang. During the time, different particle sources have been considered for investigation of the complex phenomena and processes involved in these scenarios. Taking into account the difficulties related to the control of the properties of the cosmic rays

used in different reactions, as well as the significant improvement of the technologies associated with the particles and ions acceleration, many interesting information on this subject can be now obtained in nuclear reactions performed in experiments at large accelerator systems, both in laboratory and centre of mass systems. In this work we present some experimental results obtained during the time, as well as some simulation results on this subject.

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4.16 Position Sensitive Scintillation Detector for Gamma Spectroscopy

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Keywords: gamma spectroscpy, silicon photomultiplier, position of interaction, scintillation

Scintillation detectors are often used for gamma spectroscopy given their per- formance in measuring the energy and timing of gamma radiation. Typical detectors, that make use of photomultiplier tubes cannot provide accurate data regarding the particle interaction position. Such setups exist but their scale and position resolution make them unsuitable for practical applications. The introduction of silicon photomultipliers has transformed these setups into viable alternatives, overcoming the limitations of conventional detectors.
In my work I utilize a matrix of silicon photomultipliers and a thin scin- tillator to construct a detector capable of pinpointing the particles' interaction locations with high resolution. For this to be accomplished, the elaboration of a reliable testing platform and data processing procedure was necessary in order to test the precision and accuracy of such setups. Precise measurements of particle interaction positions were obtained by raster scanning the detector using a collimated 241Am gamma radiation source. For the data processing, special algorithms to extract the interaction position from data provided by the detector were used.

4.17 Study of Elemental Impurities present in Natural Uranium Samples for Nuclear Forensics and Safeguards Applications by Ion Beam Analysis at 3MV Tandetron TM

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Keywords: Nuclear forensics, Uranium, IBA

When it come to analysing nuclear material originating from the uranium fuel cycle one aspect which has to be taken into account is represented by the elemental impurities with various concentrations, including Rare Earth Elements (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, etc.). Elemental impurities may enter in the nuclear material at the different processing stages, thus making them a useful tool for identifying the production process, geolocation and the path that the analyzed samples have followed from production to their final destination. This information can be used within a criminal investigation which is

conducted when such materials are found outside of the regulatory control. This paper addresses the application of Ion Beam Analysis methods for the study of major, minor and trace elements within various UOC samples available at the safegurards deposit of IFIN-HH. The 3MV Tandem Particle accelerator of IFIN-HH was used for this purpose, coupled with external beam experimental set-up. The preliminary results regarding the elemental composition of the samples which were obtained through both proton induced x-ray emission and proton induced gamma ray emission will be presented. Some of the analysed samples are originating from Romania, while others have unkown origin. Based on the outcomes of this reserch, the obtained results will be used to assess the unkown origin of the samples.

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4.18 In-situ temperature measurements during ion implantation

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Keywords: ion implantation; measurement of temperature;3MV Tandetron accelerator

Accurate measurement of temperature during ion implantation/irradiation is required in both fundamental and applied physics experiments, because defect dynamics is strongly dependent on the irradiation temperature. In turn, this affects the properties of irradiated samples. In vacuum systems, there are a limited number of standard techniques for measuring sample surface temperatures. Such a development was implemented on the IIB, "Ion Implantation Beamline", one of the three beamlines owned by the 3MV HVEE Tandetron accelerator of IFIN-HH.

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4.19 Implementation of a nuclear security course at the Faculty of Physics, University of Bucharest

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Keywords: Nuclear Security, Security culture

As Romania is now committed to advancing its nuclear energy sector by refurbishing UNIT 1 and construction of UNITs 3 and 4 at Cernovoda Nuclear Power Plant (NPP) together with the implementing the first Small Modular Reactor based

NPP at Doicesti, the need for specialised work force in this filed is bigger than ever. In order to adress this need, the academic sector must enhance its efforts in forming new generations of experts and provide the students with proper curriculas that will help them fit in the dynamic work filed. This paper delves into the practicalities of implementing a nuclear security course as part of the optional curricula for the students of Faculty of Physics, University of Bucharest. The course was developed in order to address the dynamic challenges and threats within the realm of nuclear security, covering a wide area of topics including, but not limited to, nuclear non-proliferation, physical protection, cybersecurity, and emergency response. Through a blend of theoretical instruction, hands-on exercises, and real-world case studies, participants were able to acquire a profound understanding of the foundational principles and optimal strategies in nuclear security. With respect to theoretical training, the students enrolled in this course attended lectures from various experts in the field of nuclear forensics, nuclear security and physical protection of nuclear installations. Moreover, through a combination of practical exercises and tabel-top exercises, participants had the chance to gain practical experience not only in collecting, analyzing, and interpreting evidence related to nuclear incidents, but also in developing a Design Base Threat Analysis and conducting a cybersecurity investigation.

4.20 An optimal method of selecting candidate radio detectors with high predicted signal-to-noise ratio for extensive air shower simulations

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Keywords: cosmic rays, air showers, radio detection, Monte Carlo simulations

Over the last 20 years, several experiments have been measuring radio signals from cosmic rays induced air showers with different detector layouts, ranging from about 100 m^2, with the first deployed 10 radio antennas at the LOPES (LOFAR Prototype Station) experiment in Germany, to about 17 km^2, with 153 stations, at the AERA (Auger Engineering Radio Array) experiment in Argentina.
The radio emission from cosmic rays air showers is being understood very well so far, allowing to disentangle between the two main radio emission mechanisms, the geomagnetic and the Askaryan effects. High radio measurement statistics in comparison with detailed Monte Carlo simulations (e.g. the CORSIKA code with the CoREAS option) have played a key role to complementary estimate the main cosmic ray observables, up to high zenith angles of about 84 degrees. Although unique results have obtained so far in the field of Ultra-High Energy Cosmic Rays (UHECRs), still more are to be unraveled, such as the extra-galactic point sources, for which mass-sensitive measurements are currently aimed in increased statistics. Within the upgrade of the Pierre Auger experiment (AugerPrime), the radio signals of extensive air showers are going to be recorded over the entire array of 3000 km^2, equipped with radio detectors (RD) on top of each 1660 surface detectors (SD).
We present a simulation study in support to the AugerPrime RD, aimed to select candidate detectors with good registered signal-to-noise ratio, as input for faster and further extensive air shower simulations and data analysis.

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4.21 Forward-Backward Asymmetry Coefficient in Slow Neutrons Capture by 109Ag Nucleus

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Keywords: Angular correlation, symmetry breaking effects, forward-bacward coefficient, neutrons capture

Angular distributions in the 109Ag(n,gamma)110Ag reaction were evaluated in the framework of resonant-resonant approach and two-levels approximation. Angular correlation is a pondered sum of Legendre polynomial with coefficients that depend on the energy of neutrons, widths of neutrons gamma quanta, phases and other parameters. These coefficients are of interest in the evaluation of asymmetry and parity-breaking effects in slow neutrons induced processes. Computer modeling has been done to evaluate the influence of experimental conditions on the angular distribution and forward-backward asymmetry effect. The computer evaluation took into consideration the target's dimensions, attenuation of neutrons and gammas, the flux of incident neutrons, and other parameters. Analytical expression of the polar angle was also obtained by the Direct Monte-Carlo method. Computer analyses have shown that more than 10% of the gamma quanta are lost in the target for a thickness of 2 mm. In the case of a 10% forward-backward coefficient, edge effects can be neglected. For asymmetry and parity breaking effects, gamma attenuation, edge effects and target dimensions become significant at values below 0.1. For neutrons at around 32 eV, forward-backward effect is approximately 0.21. Absolute errors of the forward-backward effect were also derived under various experiment settings and cross-section experimental precisions

4.22 Study of the helical laser beam profile on the particle acceleration

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The understanding of the underlying mechanisms behind the interaction of radiation with the cell tissue represents the fundamental motivation behind any radiobiology study. Search for different ways of delivering the requested dose within the tumour while sparing the healthy tissue as much as possible led to the idea of using light ions i.e. protons and 12C due to their characteristic Bragg peak for treatment of certain tumours. While huge particle accelerators widely used for accelerating light ions at energies within the therapeutic window require heavy magnets and tremendous radioprotection shielding, laser-driven particle accelerators represent a completely new approach due to the new generation of the multi-PW laser class, where intensities of up to 10^23 W/cm^2 can be reached allowing the acceleration of protons and 12C at the required energies via the very well known TNSA (Target Normal Sheath Acceleration) mechanism leading to compact and robust radiotherapy platforms and also opening new research fields in radiobiology due to the huge brightness of the particle pulse. Such a radiobiology platform will be built at the ELI-NP (Extreme Light Infrastructure - Nuclear Physics) facility,

where multi-PW lasers are already running. A completely new approach in which a helical plasma mirror is used for changing the Gaussian profile of the laser beam to a helical one leading to the focusing of the accelerated particle beam within the produced plasma as an alternative to the heavy quadrupole magnets will be presented.

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4.23 CHARACTERIZATION OF SILICA OPTICAL FIBRE AS RADIATION DETECTOR

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Keywords: single mode optical fiber, radiation induced attenuation, degradation optical fiber

The potential and limitations of silica optical fibers used for radiation induced attenuation (RIA) - based radiation monitoring applications are evaluated. Under irradiation the macroscopic properties of the optical fibers are modified. The radiation induced attenuation phenomenon contributes differently to the degradation of the optical fiber performances depending on the fiber profile of use. Their radiation sensitivity has been observed with variation of dose rates, monitored wavelength and their recovery nature. The morphological changes of the optical fiber structure have been performed by Scanning Electron Microscopy and the Atomic Force Microscopy analysis.

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Section 5: Physics and Technology of Renewable and Alternative Energy Sources

Location and time: **Seminar Rm. 9**

Moderators:

Lect. Dr. Sanda VOINEA

CSI Dr. Cornelia NICHITA

5.1 11:15-11:30 - Sarah ALMASOODI, Ali ALSHAREA, Esmaeil JALALI LAVASANI
Integration of nuclear power plant in electrical power systems

5.2 11:30-11:45 - Vlad TUDORACHE PROHNITCHI, Sanda VOINEA
Single Family Home Heating System Using Mixed Alternative Fuels as Testbed for Residential Binary Cycle Power Plants

5.3 11:45-12:00 - Florian POMPIERU
Enhancing energy density in Lithium-ion batteries through increased electrode thickness: challenges and limitations

5.4 12:00-12:15 - Adina Diana DOBRIN
Exploration of the Electrocatalytic Oxidation Processes of Urea in Fuel Cells

5.5 12:15-12:30 - Maria Gabriela PRODAN GÂDEA, Sanda VOINEA, Cornelia DIAC
A comprehensive analysis of metal contaminations in drinking water: Case study of different train stations near Bucharest

5.6 12:30-12:45 - Marc TORFEH, Adriana-Elena BĂLAN, Alexandra Maria Isabel Trefilov
Performance evaluation of proton exchange membrane fuel cell with graphene as microporous layer

5.7 12:45-13:00 - Daniel DEACU, Cornelia DIAC, Sanda VOINEA
ICP-OES analysis of heavy metals in diverse soil environments: A comparative study across agricultural, industrial, and recreational areas

5.8 13:00-13:15 - Traian TROFIN, Adriana-Elena BĂLAN
Passive thermal management in microelectronics using phase change materials

5.9 13:15-13:30 - Mihai Adrian DĂRLĂU, Mihai ZAMFIR, Anca CRIVEANU, Nicu Doinel SCĂRIȘOREANU
Oxide nanostructures obtained by laser ablation in liquid for applications in econanotechnologies

5.10 13:30-13:45 - Catalin HULEA, Sanda VOINEA
3D simulation of particles movement in a gas

5.11 13:45-14:00 - Daniel-Ionuț VLĂDULESCU, Sanda VOINEA
Comparative Study between Passive Houses and Net Zero Energy Buildings

5.12 14:00-14:15 - George IONESCU, Bogdan DOBRICĂ, Adriana-Elena BĂLAN
Real-Time monitoring and optimization of photovoltaic systems using Maximum Power Point Tracker Charge Controllers for autonomous operation

5.13 14:15-14:30 - Ana ASMARANDEI PIPĂ, Tom IACOB, Sanda VOINEA
Design of a photovoltaic system to supply a single house in Neamt county. Energy efficiency study

5.14 14:30-14:45 - Petronela LUPU, Sanda VOINEA
Recycling and re-use of plastics

5.15 14:45-15:00 - Mariana BUTNARU VĂLEANU, Sanda VOINEA
Exploring solutions for reducing carbon footprint and improving energy efficiency of a school building in Neamț

5.16 15:00-15:15 - Matei-Tom IACOB, Bogdan Ciprian MITREA, Cornelia DIAC
MFCs as a testing tool for NPs producing bacteria

5.17 15:15-15:30 - Cornelia DIAC, Matei-Tom IACOB, Bogdan Ciprian MITREA
Optimized Electrochemical Protocol for Efficient Gold Recovery from Electronic Waste

5.18 15:30-15:45 - Bogdan Ciprian MITREA, Cornelia DIAC, Tom Matei IACOB, Cornelia NICHITA
The Impact of V2C MXenes on VRFB Energy Storage

5.19 15:45-16:00 - Daniel SILIȘTE, Sanda VOINEA
Advanced heating solutions for sustainable houses

5.20 16:00-16:15 - Amal TAQI
Manufacturing and Production biodegradable - future from the waste food industry: a techno-economic and life-cycle assessment

5.21 16:15-16:30 - Cornelia NICHITA, Marcela-Elisabeta Barbinta-Patrascu
Antioxidant effect of polyphenolic selective extracts obtained from Coriandrum sativum L. leaves.

5.22 16:30-16:45 - Bogdan Ciprian MITREA, Cornelia DIAC, Tom Matei IACOB, Bogdan Ionut BITA, Cornelia NICHITA, Marcela-Elisabeta BARBINTA-PATRASCU
Eco-synthesis of copper oxide nanoparticles based on plant extract obtained from Menta piperita L. species.

5.23 16:45-17:00 - Ali ALSHAREA, Sarah ALMASOODI, Esmaeil JALALI LAVASANI
Phase change materials and their applications in storing thermal energy as clean energy

5.1 Integration of nuclear power plant in electrical power systems

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Keywords: nuclear energy as clean energy, produces electricity, reduces carbon dioxide and, through the nuclear power plant (NPP), converts the nuclear energy into thermal energy through fission process;

A large number of great scientists created wonderful innovations that led to electric power systems as we know them today. Today, dependence on electric power is so entrenched in our societies that we cannot imagine our lives without electricity. We indeed take electricity for granted, so when we experience an outage, we realize how our lives are dependent on electricity. This dependency creates a formidable challenge for engineers to make the power system the most reliable and efficient complex system ever built by humans. Because of the overall development and the growing need for electricity, all this requires finding new and environmentally friendly ways to produce electricity. One of the most important of these methods is the use of nuclear energy as clean energy to produce electricity. Because of the need to reduce carbon dioxide emissions from burning fossil fuels to avoid climate change, nuclear power can be considered to be able to address this problem. However, this method, although important, is also less safe and more expensive due to some considerations, such as nuclear fuel, which includes natural uranium, enriched uranium, or plutonium. as well as serious accidents in nuclear reactors that occurred, such as Three Mile Island in the United States in March 1979, Chernobyl in Ukraine in April 1986, and Fukushima in March 2011 in Japan. All these factors have led to the non-use of this method compared to other renewable energies such as solar, wind and hydropower. This thesis examined one of the ways to produce electricity by renewable energy, especially nuclear power, Operating the nuclear reactor will produce a huge amount of heat, which can be used to rotate the turbine, which will generate the required electricity. An electrical nuclear power plant (NPP) consists of two major parts: The reactor, which converts the nuclear energy into thermal energy through fission process; and The classical part of the power plant, which converts the thermal energy into mechanical energy. It is also touched on safety requirement as important part while using the nuclear reactor, the Fission process, the basic components of power system and its main parts. Due to the distribution system is playing a very important role in the power system, this thesis confused on some examples, such as the transmission line and transformer.

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5.2 Single Family Home Heating System Using Mixed Alternative Fuels as Testbed for Residential Binary Cycle Power Plants

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Keywords: residential heating, waste heat recovery, energy transition, Organic Rankine Cycle

In light of the unstable energy market and decarbonization, an independent residential heating and electrical generation system is becoming increasingly sought after by homeowners. This paper aims to assess some of the systems that are commercially available to rural/remote homeowners, and to propose an original system for home heating and power generation. The energy transition has brought significant funding to research pertaining to solar cell and battery technology, however waste heat recovery systems are also a crucial and often overlooked aspect. The energy transition is about finding the balance in employing the technologies we have already developed for an intelligent use of resources and energy management, it is as much of a technical challenge as it is a societal one.

5.3 Enhancing energy density in Lithium-ion batteries through increased electrode thickness: challenges and limitations

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Keywords:

To enable the development of high energy density lithium-ion batteries (LIBs), one effective method is to increase the thickness of the electrodes. This strategy improves the active to passive material ratio by reducing the number of layers in the cell stack. Thin NMC (Nickel Manganese Cobalt) cathodes are typically referred to as high-power electrodes, capable of operating at high current densities. In contrast, cells with ultra-thick NMC cathodes are known as high-energy electrodes, which are applicable only at lower current densities due to transport limitations. Cells with thick NMC cathodes, however, exhibit significant capacity losses, up to 40%, when cycled at above C/2 rate. The underlying physics-based factors that limit the energy and power density of thick electrodes include increased cell polarisation and the underutilization of active materials. These issues are primarily caused by two factors: Li-ion diffusion in the active materials and Li-ion depletion in the electrolyte phase. The increased cell polarisation results from the difficulty in transporting Li-ions through the thicker electrode structure, which leads to uneven utilisation of the active material and hence reduced overall performance. Increasing the thickness of electrodes in lithium-ion batteries can enhance energy density but comes with several other significant downsides: 1. Thicker electrodes lead to higher internal resistance, causing increased cell polarization. This results in greater voltage drops during discharge and higher voltage spikes during charge, reducing the battery's overall efficiency and performance.
2. The transport of Li-ions becomes more difficult in thicker electrodes. The diffusion paths for Li-ions are longer, leading to slower ion transport. This can cause uneven distribution of lithium, resulting in underutilization of active materials and decreased capacity.
3. Thicker electrodes can lead to higher heat generation due to increased internal resistance. Effective heat dissipation becomes more challenging, potentially leading to thermal management issues and reduced safety.
4. Batteries with thicker electrodes have reduced rate capabilities, meaning they cannot charge or discharge as quickly as those with thinner electrodes. This limits their use in applications requiring high power output or fast charging.
5. Thicker electrodes are more prone to mechanical stress, which can cause cracking, delamination, or other structural failures over repeated charge and discharge cycles. This affects the battery's longevity and reliability.

5.4 Exploration of the Electrocatalytic Oxidation Processes of Urea in Fuel Cells

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Keywords: urea, electrocatalysts, fuel cells

In the current context concerning pollution and environmental protection, the need for efficient valorization of alternative sources has emerged. Urea, a common by-product in agriculture, industry, and human activity, presents significant opportunities for valorization as an energy source, as well as for the production of useful secondary products such as hydrogen and nitrogen. Catalysts play a crucial role in this process, improving the efficiency and selectivity of urea decomposition reactions. This paper provides an overview of recent progress in the development and application of catalysts for urea decomposition, discussing both platinum-based catalysts, which have demonstrated excellent performance in terms of activity and stability, but the high cost of these metals is limiting their applicability on a large scale, and non-platinum metal-based catalysts, such as nickel, which offer a balance between performance and cost, as well as composite material catalysts, which combine the advantages of different materials to improve performance. Another topic addressed is the mechanisms that occur in the urea decomposition process and the factors influencing catalyst performance, including composition, structure, particle size, and reaction conditions. Finally, we identify current challenges and future research directions in this field, including the need to develop more efficient and durable catalysts, to better understand reaction mechanisms, and to optimize reaction conditions to maximize energy production and useful secondary products.

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5.5 A comprehensive analysis of metal contaminations in drinking water: Case study of different train stations near Bucharest

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Keywords: water quality, heavy metals contamination, health standards

The quality of water, characterized by its purity, mineral content, and absence of contaminants, holds a significant position in maintaining human health. It is instrumental in ensuring the optimal functioning of various bodily systems, contributing to overall well-being. Therefore, maintaining high water quality standards is not just an environmental concern, but a crucial public health issue as well. This thesis analyzes the physico-chemical parameters that signify the concentration of metal pollution in potable waters from train stations in the vicinity of Bucharest. The aim is to assess their compliance with international health standards.This study identifies parameters that exceed legal limits and examines their impact on human health. It employs analytical methods such as optical emission spectroscopy with inductively coupled plasma and UV-VIS spectroscopy, in conjunction with Merk kit methods. These techniques identify and quantify elements that surpass permissible limits. The study includes a set of samples from Bucharest and its neighbouring regions, gathered from fountains, wells, and urban distribution networks. The findings reveal considerable variations in drinking water quality, contingent on the source and geographical location. At certain railway stations, contaminant levels exceed permissible limits, posing a significant risk to human health. Notable contaminants include nitrates, iron, lead, and hardness. The research offers recommendations for improving the monitoring and management of drinking water quality. These include the necessity for more stringent regulatory policies and the deployment of more effective water treatment systems. The importance of public education about contamination sources and water purification methods is also underscored. In

conclusion, this study highlights the urgent need for measures to ensure drinking water quality and safeguard public health. By implementing the suggested recommendations, the risk associated the consumption of contaminated water can be substantially mitigated, ensuring a reliable water source for the population.

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5.6 Performance evaluation of proton exchange membrane fuel cell with graphene as microporous layer

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Keywords: Graphene, Microporous layer, PEM fuel cell

Proton exchange membrane fuel cells emerged as promising substitute to fossil fuels, since the working principle is implies a clean convertion of the chemical energy of a hydrogen into electricity over a proper catalyst having water as by-product. Water management- membrane humidification and removal of excess water from the cathode- and also fuel feeding to the catalyst layer, temperature, and contact resistance is affected by the microporous layer (MPL). MPL is the intermediate layer between the catalyst and gas diffusion layer. In this work, we have tested the overall performance of a proton exchange membrane fuel cell with commercial graphene as MPL. The membrane-electrode assembly (MEA) of the fuel cells was made from a Nafion electrolyte with Pt/C (60%) nanoparticles as a catalyst. The gas diffusion layer was obtained by spraying graphene and 10% Teflon solution as MPL onto carbon paper. Graphene MPL- MEA performances were studied at different values of humidity and temperature and compared to a similar MEA with carbon black as MPL. The reference MEA was prepared and tested under the same experimental conditions. Enhanced performances up to 8% in power density under a wide range of humidity conditions and temperatures prove that graphene is a potential MPL material in fuel cells, due to its high electrical and thermal conductivity.

5.7 ICP-OES analysis of heavy metals in diverse soil environments: A comparative study across agricultural, industrial, and recreational areas

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Keywords: soil contamination, heavy metals, ICP-OES

Soil contamination with heavy metals is a major environmental problem that affects the health of ecosystems and human populations. Sources of pollution include industrial activities, intensive agriculture, and improper waste management. Consequently, soil analysis for the determination of heavy metal concentrations, such as cadmium, lead, cobalt, and arsenic, is essential for assessing the impact of human activities on the environment and implementing effective remediation and protection measures. This study investigates the levels of these metals in soils from four distinct areas: agricultural land, a wastewater treatment plant, an industrial zone, and a park. Soil samples were systematically collected from each area and analyzed using inductively coupled plasma optical emission spectrometry (ICP-OES), a precise and sensitive method for

detecting heavy metals. In the agricultural area, potential contamination sources include the use of pesticides and fertilizers. Soils near the wastewater treatment plant are susceptible to contamination from residual sludge used in soil amelioration. The industrial zone reflects historical and current pollution generated by industrial processes, while soil in the park, intended for recreation, may be affected by atmospheric sources and traffic. This analysis highlights the importance of continuous soil monitoring, especially in areas susceptible to pollution. Identifying and accurately quantifying heavy metals through ICP-OES provides essential data for implementing effective environmental remediation and protection measures. The study contributes to understanding the distribution of heavy metals in soils and the impact of various pollution sources, offering a solid foundation for environmental policies and more sustainable agricultural practices.

5.8 Passive thermal management in microelectronics using phase change materials

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Keywords: phase change materials, passive thermal management, latent heat

The study aims to evaluate the capability of organic phase change materials to passively regulate the temperature in electronics. Paraffin has been selected owing to the high latent heat, chemical stability, availability and cost. Furthermore, paraffin has been additivated with graphite to increase the thermal conductivity, thus potentially improving the overall thermal storage efficiency of the phase change material. The graphite was mixed with the paraffin through a powerful ultra-high shear mixer at a speed of 1500 rotations per minute for 5 minutes. Firstly, the latent heat was estimated by differential scanning calorimetry. The experimental approach followed a series of steps to verify the effectiveness of paraffin and paraffin-graphite composite for cooling the Raspberry Pi processor. In the experiments, paraffin and paraffin-graphite composite samples of approximately 0.6 g were placed onto a Raspberry Pi processor. A code in the Python programming language was used to monitor the CPU temperature while running intensive calculus. The efficiency of the paraffin in the CPU cooling process and the solid-to-liquid phase transition of the paraffin blocks were evaluated.

5.9 Oxide nanostructures obtained by laser ablation in liquid for applications in econanotechnologies

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Keywords: Nanoparticles, Lanthanum doped BiFeO3, laser ablation

Multiferroic materials have attracted increasing attention for developing multi-effect coupling between different physical properties and exploring the possibility of environmental application. In this work, La-doped BiFeO3 (BLFO) nanoparticles were obtained by pulsed laser ablation in liquid media (PLAL). For laser ablation experiments distilled water was used as interaction media. Laser ablation was carried out using the third harmonic, second harmonic and fundamental wavelength of a pulsed Nd:YAG laser (355 nm, 532 nm and 1064 nm) at 10 Hz repetition rate and 10 ns pulse width. The time of ablation was 20 minutes for all experiments and laser fluence for each laser wavelength was 1 J/cm2, 2 J/cm2 and 1 J/cm2. The surface morphology and particle size distribution of the as-synthesized powder samples were analyzed by a scanning electron microscope (SEM) and Dynamic Light Scattering (DLS).

5.10 3D simulation of particles movement in a gas

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Keywords: 3D simulation, molecules, kinetic theory, Van der Waals, Lennard Jones, Morse, Windows

There are many simulations showing the molecules of a gas moving on the screen. It is interesting to see how such a very simple simulation could be written in C++. In this work, starting from the kinetic theory of gases, the first simulation is based on elastic collisions of rigid spheres, where molecules are represented by these spheres. The laws that determine the collisions are discussed in the paper. Some physical parameters are computed during the simulation, such as pressure, temperature and internal energy; the thermal equation of state of the ideal gases is computed and the small error obtained allows us to verify that the simulation is correct.
The second simulation is made for Van der Waals gases, where the molecules attract each other at medium range. As a consequence of this attraction, the pressure on the walls is smaller than that of the ideal gases. At microscopic level, the molecular interactions are described by Lennard-Jones potential, which is attractive at medium range, and repulsive at very short range. Also, in this case the Van der Waals equation of state is computed in order to validate the simulation. In both simulations, a histogram with distribution of particles by velocities is displayed; we can see this is the Maxwell distribution, as expected. The user can choose the number of molecules: 100, 1000 or 10000, and the program runs properly on an average contemporary laptop. Three different atomic species can be selected, with their appropriate parameters: oxygen, hydrogen or nitrogen. The last simulation shows how diatomic molecules are formed by atoms interacting via Morse potential. This is a stronger potential than Lennard-Jones, and it only acts at short range, inside the molecules. On the screen, you can see many pairs of atoms, each rotating around their center of mass.

5.11 Comparative Study between Passive Houses and Net Zero Energy Buildings

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Keywords:

This study addresses the fundamental concepts and advanced technologies associated with net-zero energy buildings and passive houses, emphasizing the characteristics, design, concrete examples, and relevant policies for each type of building. Net-zero energy buildings are structures designed to produce annually the same amount of energy they consume, using renewable sources such as solar and wind energy. These buildings significantly contribute to reducing carbon emissions and promoting a more sustainable built environment. Passive houses, on the other hand, are designed to minimize energy consumption through advanced insulation techniques, high-performance windows, and efficient ventilation systems. These houses offer enhanced thermal comfort and reduced operating costs in the long term. The study explores in detail the lifecycle of passive houses, analyzing the initial costs and long-term economic and environmental benefits, as well as their potential to create new job opportunities in the construction and green technology sectors. Through comparative analysis, the similarities and differences between net-zero energy buildings and passive houses are highlighted. Although both types of buildings aim to increase energy efficiency and reduce environmental impact, they adopt different approaches to achieve these goals. Comparing these two paradigms provides a deep understanding of how each contributes to the sustainability of the built environment and the transition to a low-carbon economy. The experimental part of the dissertation focuses on evaluating the energy efficiency of buildings by developing a method for calculating the annual energy requirement using Visual Studio Code. This method allows for determining the annual energy requirement in kWh, from which the annual fuel requirement and CO2 emissions can be deduced. The tool also offers customized solutions for improving the energy efficiency of buildings, helping to optimize energy consumption and reduce greenhouse gas emissions. By integrating theory and experimental practice, this dissertation offers a comprehensive perspective on the design and implementation strategies of net-zero energy buildings and passive houses, highlighting their essential contribution to sustainable development and environmental protection.

5.12 Real-Time monitoring and optimization of photovoltaic systems using Maximum Power Point Tracker Charge Controllers for autonomous operation

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Keywords: Real-Time monitoring, photovoltaic systems, energy efficiency

In this study, a Raspberry Pi 4 Model B is used to create and install a complete monitoring system for a photovoltaic (PV) panel. Intending to optimize the PV panel's energy harvesting process, the system guarantees effective power management and real-time data monitoring. A Maximum Power Point Tracker (MPPT), which is essential to the setup and improves the PV panel's energy extraction efficiency, is the key to optimizing the system's performance in a range of environmental circumstances. The central processing unit of the monitoring system is a Raspberry Pi 4 Model B, which communicates with the MPPT, the PV panel, and the lead acid battery. To ensure self-sufficiency, the Raspberry Pi not only controls the data gathering and processing tasks but also gets its operating power from the PV panel via the MPPT. The Raspberry Pi's dual function demonstrates the effectiveness and usefulness of the device in renewable energy applications. Real-time monitoring of several key metrics, including voltage, current, temperature, and PV panel power output, is one of the system's key characteristics. These indicators are essential for evaluating the PV system's health and performance. The gathered data is processed and displayed on a simple platform that can be accessed from a distance, making it easier to monitor and analyze the data continuously. The importance of the MPPT is highlighted in terms of maintaining ideal power delivery to the Raspberry Pi and the lead acid battery, assuring reliable and effective energy storage and utilization. This project demonstrates how reliable and effective renewable energy systems can be made by integrating affordable, easily accessible technology, such as the Raspberry Pi, with modern power management technologies. The results show notable gains in energy efficiency and offer insightful information about the functioning of solar systems, which advances the field of sustainable energy solutions.

5.13 Design of a photovoltaic system to supply a single house in Neamt county. Energy efficiency study

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Keywords: energy efficiency, photovoltaic system, green house

This paper addresses the issue of energy efficiency in housing and the reduction of solid fuel consumption and energy consumption. It simulated the cost and efficiency of a photovoltaic system and a hybrid system consisting of an air-water heat pump supported by a photovoltaic system. In the first part, the solid fuel requirements for heating the house were calculated taking into account the materials used in the construction of the house and the insulation. At the same time, data on the location of the dwelling and the area in which it was built were also used. It was noted from the calculation that CO2 emissions are high over a year. Thus the use of green energy was chosen. Furthermore, the energy efficiency of the house was studied by using a photovoltaic system. In order to optimise the hW requirements of the photovoltaic system the software Homer Pro was used. With the help of it we obtained data on the cost per kW for several PV system variants. Calculations were made for the cost of a hybrid air-water heat pump system supported by a PV system. This system brings the house closer to a green house. In conclusion, even if the initial cost is high, the advantages of using green energy are many. In addition, the investment pays for itself over time.

5.14 Recycling and re-use of plastics

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Keywords: plastic waste, recycling, environmental impact

Plastic waste is a major environmental problem with significant economic and environmental implications. Recycling is a crucial solution for efficient waste management, as it allows reuse of raw materials and reduces negative environmental impacts. Plastic production has grown rapidly in recent years, leading to an increase in plastic waste generation globally. The recycling rate of plastic waste is still relatively low, highlighting the need to improve waste management practices and infrastructure. The main challenges in managing plastic waste include the lack of an effective recycling infrastructure, low recycling rates and the difficulty of collecting and sorting plastic waste due to its diverse composition and shapes. In addition, greater awareness and behavioural change among individuals is needed to promote recycling.

5.15 Exploring solutions for reducing carbon footprint and improving energy efficiency of a school building in Neamț

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Keywords: energy efficiency, carbon footprint, renewable energy sources

This paper evaluates the potential and efficiency of renewable energy use in a school in Neamț County, Romania. The research focuses on identifying sustainable and efficient energy solutions tailored to the geographic and climatic specificities of the region, aiming to model a "green" educational institution. Utilizing the HOMER software for modelling and optimizing renewable energy systems, the study highlights how technology and innovation can facilitate the transition to sustainable energy education. Key objectives include assessing the current energy performance, exploring passive and active improvement strategies, and evaluating the feasibility and sustainability of proposed solutions. Findings suggest significant potential for reducing the school's carbon footprint and improving energy efficiency through the implementation of solar photovoltaic systems and other renewable energy sources. The study addresses current needs for energy reduction and environmental protection.

5.16 MFCs as a testing tool for NPs producing bacteria

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Keywords: metal reducers, bioelectrochemical devices, bioproduced nanoparticles

Bioproduced nanoparticles (NPs) are attracting significant interest due to their potential advantages in safety, environmental footprint, and unique properties. This study explores the application of microbial fuel cells (MFCs) as a screening tool to expedite the discovery of biomanufacturing strains for sustainable nanoparticle production These bioelectrochemical devices harness the electron transfer abilities of electroactive microorganisms, often metal reducers, to generate electricity from organic matter. The ability to donate electrons during metabolism makes these bacteria prime candidates for biogenic nanoparticle synthesis. This approach leverages the inherent connection between bacterial electron

flow and potential nanoparticle production mechanisms. By monitoring the electrical output of MFCs inoculated with different bacterial cultures, researchers can potentially identify those with enhanced electron transfer associated with nanoparticle synthesis. This offers a rapid and simple initial screening method compared to traditional techniques.

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5.17 Optimized Electrochemical Protocol for Efficient Gold Recovery from Electronic Waste

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Keywords: electrochemistry, gold recycling, PCB, circular economy

The escalating demand for precious metals and the environmental impact of traditional mining have necessitated the development of sustainable and efficient recovery methods. This study presents an optimized electrochemical protocol for the recovery of gold from printed circuit boards (PCBs) using cyclic voltammetry with a gold disk electrode. A series of electrolyte solutions containing chlorides, nitrates, and sulphates were evaluated to determine their efficacy in the gold recovery process. Subsequent variations in the concentration of hydrochloric acid (HCl) and adjustments to the operational temperature were conducted to refine the protocol. The optimal conditions were identified at a 1M HCl concentration with a temperature setting of approximately 40°C. These parameters facilitated a superior recovery rate, indicating a promising avenue for the recycling of gold from electronic waste. The findings suggest that the application of this refined electrochemical approach could significantly enhance the sustainability and economics of gold recycling from PCBs.

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5.18 The Impact of V2C MXenes on VRFB Energy Storage

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Keywords: VRFB, Battery, MXene

The potential of Vanadium Redox Flow Batteries (VRFBs) for large-scale energy storage is attributed to their safety, longevity, and eco-friendliness [1]. VRFB technology employs vanadium species in different oxidation states within their

electrolyte solutions to efficiently store and retrieve energy [2]. Nonetheless, the challenge of low energy density and instability persists [3]. MXenes have shown potential in enhancing the anodic performance of VRFBs by acting as electrocatalysts for the V2+/V3+ reaction, leading to improved battery efficiency [4]. One viable approach to address this challenge involves the utilization of V2C MXenes to enhance the anodic performance and overall efficiency of VRFBs. The integration of V2C MXenes has demonstrated a substantial increase in ion storage capacity and rate performance. The optimisation strategies and the resultant performance of the VRFBs were assessed via two primary experimental techniques: cyclic voltammetry, which was employed to probe the redox and catalytic reactions, and polarisation curve analysis, which was utilised to measure the correlation between the battery voltage and current during the charge/discharge cycles. These methodologies provided a comprehensive and rigorous evaluation of the effectiveness of the enhancements incorporated into the VRFBs.

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5.19 Advanced heating solutions for sustainable houses

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Keywords: sustainable house, heat pump, biomass plant

This study deals with the subject of the sustainable house and presents solutions to achieve the objective. Electricity generation will be done using photovoltaic panels, and its storage using the latest and advanced systems. The main theme of the study is home heating, for which both heat pumps will be used, but the use of biomass in the form of pellets for this problem will also be presented. Biomass plants are considered neutral in terms of carbon emissions, which makes them a very good alternative to gas or wood plants. The study will highlight the yields of both heat pumps and biomass power plants and graphs about the annual electricity production and consumption.

5.20 Manufacturing and Production biodegradable - future from the waste food industry: a techno-economic and life-cycle assessment

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Biopolymers are biodegradable without residue and are produced without the addition of chemical substances such as plasticizers, stabilizers, etc. They could be consumed by humans and animals without this leading to health effects. They do

not release any hazardous substances into the environment during the decomposition process and this product can be biodegraded within a few weeks. Basically, this material can even be used as fertilizer in agriculture after use. This would also have great advantages for the recycling process. Complex recovery of raw material with high material and energy loss is no longer necessary. Packaging can be composted and does not have to be. In addition, no valuable resources are wasted. The raw material for production is a waste product from the food industry. After the first processing and use, it gets a new purpose and can be used a second time. If the composting of the bioplastic is included, a raw material has been used three times before it is returned to the natural cycle as fertiliser. Thus, the natural cycle closes again and no residues remain. It is a novel process for producing bioplastics. Waste food industry, e.g. from beer production, is a specially coordinated process. After the fermentation process, extracted plant substances are added and processed into a homogeneous mass. This is heated to a suitable temperature and then dried and pressed into granule form. These granules can then be used in a wide variety of manufacturing processes for packaging materials, etc. The plastic that is created is resistant and water-soluble. It can be used in the food industry or in the cosmetics industry as a packaging material.

5.21 Antioxidant effect of polyphenolic selective extracts obtained from Coriandrum sativum L. leaves.

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Keywords: Coriandrum sativum L. polyphenolic extracts, antioxidant effect, chemiluminescence

Coriandrum sativum L, family Apiaceae has a complex chemical composition that includes a variety of compounds such as limonene, linalool, geraniol, and borneol, which are responsible for its characteristic aroma and flavor. Additionally, Coriandrum sativum L. leaves contain flavonoids, phenolic acids, and terpenoids, which have been reported to exhibit antioxidant, anti-inflammatory, and antimicrobial properties. Amount and profile of phenolics in Coriandrum sativum L. leaves extracts depend on several factors, such as their place of origin, solvent and the methodology used for their extraction. The paper investigates the antioxidant effect of extracts obtained from Coriandrum sativum L. leaves by employing the Soxhlet extraction method, procedure followed by filtration at normal pressure and concentration the crude extract by roto-evaporation under vacuum. By UV-VIS (Jasco, Japan, V-570 spectrophotometer) spectrometric method were determined: total flavonoid contents (TFC) expressed as rutin (mg/RE g-1), by aluminum chloride colorimetric assay, caffeic acid derivatives content (CADC) expressed as 3,4-dihydroxycinnamic acid (mg/CAg-1) by using Arnows' reagent and total polyphenolic contents (TPC) expressed as gallic acid (mg/GAE g-1) using the Folin-Ciocalteu reagent, in according to the protocol described in European Pharmacopoeia 6th edition. The antioxidant effect of Coriandrum sativum L leaves extracts was evaluated in vitro non cellular assays, by chemiluminescence method in 5-Amino-2,3-dihydrophthalazine-1,4-dione-hydrogen peroxide system, by DPPH(2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2′-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) free radical scavenging assay. All investigation methods revealed a linear correlation between the antioxidant effect and the content of phenolic compounds.

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5.22 Eco-synthesis of copper oxide nanoparticles based on plant extract obtained from Menta piperita L. species.

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Keywords: CuO NPs, Eco-synthesis, Menta piperita L extract, phenolic compounds

Eco-synthesis represents a green strategy for obtaining nanoparticles and is of particular interest because it is an environmentally friendly, sustainable, extremely fast, and efficient technological process which involves the use of natural resources. In this context the current paper presents the eco-synthesis of CuO NPs using an aqueous extract of Menta piperita L. In a first stage, the aqueous extract from the Menta piperita L. species was obtained by applying a solid- liquid extraction and then was characterized from the point of view of the total content of polyphenols (TPC) by spectrometric Folin-Ciocalteu method and the antioxidant activity was determined by the DPPH(2,2-diphenyl-1-picrylhydrazyl) method. Subsequently, copper oxide particles were eco-synthesized and characterized by UV-Vis absorption spectroscopy. Particle size distribution of the phytosynthesized CuO NPs have been evaluated by dynamic light scattering, and their physical stability was estimated by zeta potential measurements.

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5.23 Phase change materials and their applications in storing thermal energy as clean energy

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Keywords: Phase change materials, thermal energy storage, thermal conductivity, clean energy, carbon dioxide emissions

Clean energy is considered one of the priorities of countries in the world, as finding alternatives to fossil fuels is one of the most difficult difficulties facing countries that are poor in these sources of energy. Therefore, these countries focus all their research on finding solutions and alternatives, as most research centers and universities focus on developing and supporting researchers and urging them to This field has been of great importance to the whole world for several decades. Researchers are working to find solutions to this problem by developing alternative energy (clean energy) such as solar energy and wind energy, benefiting from the Earth’s natural resources through solar energy, wind energy, and water, and exploiting them in this aspect. Scientists and researchers in this field have focused their research on finding modern and advanced clean methods (clean energy). Even if the high cost is the most important of these alternatives to clean energy, what is meant here is clean energy free of any carbon dioxide emissions, thermal energy and making use of materials that may be able to retain heat and preserve thermal energy for a period of time as potential energy and benefit from it. According to studies, it has been found that one of the most important materials that can be worked on in this field are phase change materials (PCMs), as this material can be used to provide energy for a period of time. The nature of this material and

its phase change depending on the type of material. Some research has focused on the fact that water is one of the materials. Which changes its phase by changing its state and changing its phase. However, there are other materials that have the ability to provide energy, such as solid solid or liquidliquid. Research has developed in this field to take advantage of modern technology, as it can be used and applied in thermal conductivity through insulators or through storage. Thermal energy and its release, as in heat sinks used in electronics.

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Section 6: Physics Education

Location and time: **Seminar Rm. 1**

Moderators:

Prof. Dr. Ştefan ANTOHE

Assoc. Prof. Dr. Cristina MIRON

6.1 11:15-11:30 - Călin GALERIU, Ion GRUIA, Alexandru DĂNESC
An Improved Arduino-Controlled Photogate

6.2 11:30-11:45 - Patrick-Joshua BIRO
Bridging Generations in Physics Teaching. Study Case: Lessons from the Teaching Legacy of Ludovic Schwartz

6.3 11:45-12:00 - Bogdan GHERASIM, Ovidiu TOMA, Cristina MIRON, Ştefan ANTOHE
Digital Electricity Experiments with Raspberry Pi

6.4 12:00-12:15 - Marilena COLŢ, Mihai Valerian POPESCU, Florentina Loredana DRAGOMIR, Valentin BARNA
LASER Diffraction Study: Determinig the Wavelength of Optical Radiation. Beer-Lambert's Law for Calculating the Optical Density of Air

6.5 12:15-12:30 - Fabiola CHIRIACESCU, Bogdan CHIRIACESCU, Cristina MIRON
Using Grassroots Comics to Teach Physics at Secondary School Level

6.6 12:30-12:45 - Adriana RADU, Mihai V. POPESCU, Daniela STOICA, Ionel GRIGORE, Cristina MIRON, Valentin BARNA
Study for the Motion of Bodies in the Gravitational Field using the Einstein Tablet

6.7 12:45-13:00 - Roxana DUMITRU, Bogdan CHIRIACESCU, Fabiola CHIRIACESCU, Cristina MIRON, Cătălin BERLIC, Valentin BARNA
Simple Experiment and Simulation of a Rotating Liquid's Free Surface

6.8 13:00-13:15 - Iulian ŞOMĂCESCU
Research Method of the Universal Sub-Quantum Fluid

6.9 13:15-13:30 - Maria IONESCU, Luminița DINESCU
The Use of Artificial Intelligence in Teaching and Learning Physics

6.10 13:30-13:45 - Anda CIOBANU, Cristina MIRON, Valentin BARNA
Implementation of Augmented Reality using GeoGebra Software in the Study of Mechanical, Thermal and Optical Phenomena in Pre-university Education

6.1 An Improved Arduino-Controlled Photogate

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Keywords: Arduino Uno in physics education, a measurement of gravitational acceleration

Since the development of our Arduino-controlled photogate [1], we and other physics educators have used it with excellent results in both high school and college settings. At the same time, the feedback received during the manufacturing process, during the teaching of how the photogate works, and during the actual data collection and analysis, has brought us some very valuable pedagogical insights and has allowed us to improve uppon our original photogate housing design and Arduino code. The goal of this follow-up article is to disseminate these observations.

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6.2 Bridging Generations in Physics Teaching. Study Case: Lessons from the Teaching Legacy of Ludovic Schwartz

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Keywords: physics teaching, intergenerational mentoring, Ludovic Schwartz, mentorship approach

As teachers seek to revitalize Physics education in the 21st century, the importance of intergenerational mentoring has become increasingly evident, especially in the context of STEM education [1-2]. Physics is identified as a core element in STEM education [3], and fostering such a dynamic in school would enhance the respect towards this subject and its importance. This includes the situation when a teacher chooses a constructivist approach for their lessons [4]. In this spirit, the Romanian-Jewish teacher Ludovic Schwartz (1925-1988) has demonstrated the capability of creating the aforementioned dynamic. We address the question: Which of his qualities and didactical strategies would contribute to the success of current students in understanding Physics? Through a mixed-methods approach, we intend to highlight his teaching methodologies and mentorship approach from three perspectives: (a) the influence towards his students, regardless of their future career path, as related by them [5], (b) his vision regarding Physics education, as shown in local and national publications [6-7], [8-10], and (c) the variety of the Physics problems he has proposed during his teaching years [11-13] and through the lens of the Memorial Ludovic Schwartz Contest [14]. We conducted in-depth interviews with two of his former students from different backgrounds, in order to avoid biased opinions. Furthermore, we analyzed ten documents featuring his work in Physics education, including books and speciality articles. Our preliminary findings show that a constructivist and student-centered approach, adopted by Schwartz, is also adaptable for Physics teaching in the 21st century. Granted, such an approach is subject to caution due to the recent pandemical context and the use of Artificial Intelligence. By addressing them in the debate of intergenerational mentoring in Physics, an improved mentor-mentee relationship would benefit the students of all levels of Physics understanding.

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6.3 Digital Electricity Experiments with Raspberry Pi

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Keywords: physics education, didactic experiment, Raspberry Pi, Ohm’s Law, Peltier Effect

Physics is a science with a strong experimental background and that is why didactic experiments are used in the teaching of physics. One of the challenges of the digitization of physics teaching is the digitization of didactic experiments. Raspberry Pi is a small but powerfull single-board computer. It can do all the things you’d expect from a computer, but it also has a GPIO (general-purpose input/output) header that can be used to connect various sensors and other devices. We used the Raspberry Pi connected with different sensors for some didactic experiments related to Ohm’s Law and Peltier Effect. To verify Ohm's law experimentally, we need a Raspberry Pi and two sensors: one for current and one for voltage. Both sensors are analogical and therefore, to connect them to Raspberry Pi, we used the expansion plate Explorer Hat Pro to convert the analog signal into digital signal. Another interesting effect of the electric current is the Peltier effect. In this experiment we used a Peltier element, 2 digital temperature sensors, placed on the two faces of the Peltier element, a current sensor and an analog-to-digital converter to measure the current intensity through the Peltier element. In both experiments we obtained relevant graphs to illustrate the studied phenomena. Using devices like the Raspberry Pi does not cost much and helps us to carry out relevant experiments for the teaching process, in this case experiments for Ohm's Law and the Peltier Effect.

6.4 LASER Diffraction Study: Determinig the Wavelength of Optical Radiation. Beer-Lambert’s Law for Calculating the Optical Density of Air

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Keywords: diffraction, optical density and transmittance, digital lux meter, physics education.

The paper proposes a study of the phenomenon of light diffraction at high school or introductory university level, using a lux meter. The light intensity in the diffraction table for two different wavelengths corresponding to red and green colors

will be analyzed comparatively. Using a diffraction grating with known LPI will initially determine the two wavelengths of the LASER beams. These beams will later be used in the calculation, by means of the Beer-Lambert law, of the air absorbance, respectively the air transmittance for the bright central fringe and for the following maxima. Because it is widely used in academia, OriginLab was used for data analysis and graphing.

6.5 Using Grassroots Comics to Teach Physics at Secondary School Level

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Keywords: physics education, conceptual physics, STEAM, grassroots comics

Teaching Physics at pre-universitary level implies a permanent adaptation process. Not only that the technology and tools at teacher's disposal are permanently evolving, but the students also, their way of thinking and the attitude towards the learning process are changing all the time. Given the dependency of the students on the new technologies, especially the smartphones, some new methods to make them more creative, to encourage them to think by themselves, to develop skills that needs coordination between brain and hands are needed. In the present work, the authors presents the Grassroots Comics method, adapted from solving some social and educational problems to presenting and exploring some basic notions of Physics. Grassroots Comics consist in making an A3 poster with a comic strip of four panels. The format is cheap and takes in consideration the lack of drawing skills of the students. On the other hand, encouraging them to tell a story about a physical phenomenon, makes them to research about the subject, to understand the process and the concepts and to transpose it in a short story with four stages. The analysis and discussions after exposing student's works are equally important, facilitating discussions, exchanging knowledge, correcting faults in logic or understanding the basic notions etc. The method helps the students to understand some difficult physical concepts, phenomenon and processes from the nature. At the same time, it helps to develop the creativity, critical thinking, drawing and storytelling skills, competencies very needed nowadays.

6.6 Study for the Motion of Bodies in the Gravitational Field using the Einstein Tablet

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Keywords: Einstein tablet, MILAB software, distance sensor, data analysis

In the present study we have considered the motion of a body in the gravitational field, using the Einstein tablet and a distance sensor. The distance sensor recorded the coordinate of the body in relation to time. The data was then processed using the MiLAB Software. The graph of the velocity versus time was determined, the gravitational acceleration was calculated. The graphs of the kinetic energy of the body with respect to time and the graph of the potential energy of the body in relation to the spatial coordinate were also represented. By presenting the experiment of motion in the gravitational field, studied with the Einstein Tablet, we sought to demonstrate the fact that, starting from simple experiments, it is possible to reach complex data processing facilitated by the MiLAB software.

6.7 Simple Experiment and Simulation of a Rotating Liquid's Free Surface

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Keywords: free surface of a rotating liquid, video analysis, Python script, physics education

This work explains an easy and cost-effective method to investigate the behavior of the free surface of water in a rotating container. Using a standing camera, we recorded the movement of the container and the profile of the surface of the water. In the resulting video, we initially noticed the usual parabolic shape of the free surface, characteristic to rotating liquids. The video was then analyzed by means of Tracker software and we found the rotation period of the container and the displacement of the parabola apex. From the acquired data we were able to calculate the gravitational acceleration with very good precision. In the second part of the work we created a Python script for simulating the same experiment. The user may interactively change the involved main physical parameters, observing the modification of the parabola's shape. Our work proposes a didactic alternative approach for study and simulation of a rotating liquid free surface, while the attained results can be compared with the ones obtained by traditional methods.

6.8 Research Method of the Universal Sub-Quantum Fluid

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Keywords: research, method, sub-quantum, fluid

Research on SQDF seeks to know the characteristics of the unobservable sub-quantum environment (SQE) and its immixture into observable quantum environment, regarding constituent sub-quantum particles (SQP), nature of gravity, electricity, heat and electrical neutrality at neutrons and photons, and the kinetic Compton waves. The employed method consists in updating anterior hypothetical theories regarding SQE, passing from the qualitative to the quantitative analysis through new equations, using data resulted from experience and natural units (kg, m, rad, s), which allow identification all party-entities implicated within these phenomena. The following results (knowledge and data) have been obtained: 'impossibility to detect individual SQP effect' (because of the dimensional incompatibility with the quantum sensorial measurement apparatus); 'pressure equalization kinetic effect' at speed c inner SQDF; the SQP's characteristics inclusive new equations for the relativistic masses, sizes, speeds, wavelengths, pressures and inner/outer energies of the quantum kinetic cluster-particles; the mass-kinetic nature of gravity, electricity and heat; 'the mass-electric equivalence' for the electrons; the 'electrical neutrality effect' at neutrons and protons; the 'diameter of the optical fibres' and optical wavelengths in telecommunications, which allowed the attenuation decrease and increase of transmission capacity and distance, from 4 km (patented fibers) to thousand km, as first application [1-5]. In Conclusion, the employed method demonstrates the possibility to know causally fundamental environment at the lowest complexity level, through an internal complete, non-contradictory description of reality [6-8]. The results can be used in the future for creating new materials and technologies in telecommunication, health and the environment control. The findings can also be included into the educational circuit trough publications, doctoral researches and optional universities courses.

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6.9 The Use of Artificial Intelligence in Teaching and Learning Physics

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Keywords: artificial intelligence, ChatGPT, teaching and learning physics, problem-solving skills

The technological revolution promoted in particular by the use of artificial intelligence had a significant impact on education as well. One of the most important contributions of artificial intelligence in teaching is the personalization of learning. One of the most advanced AI tools is ChatGPT, a language model developed by OpenAI that is capable of generating coherent text and answering questions based on existing information. ChatGPT can serve as a virtual teaching assistant, providing personalized explanations to students. Students can ask specific questions related to the physical concepts they are studying and ChatGPT provides detailed answers tailored to their level of understanding. Another advantage of using ChatGPT is its ability to provide real-time support. ChatGPT can generate personalized problems and exercises for students. Teachers can use ChatGPT to create problem sets that cover different levels of difficulty and focus on areas where students need more practice. By integrating this advanced artificial intelligence tool into the physics instruction process, teachers can create a more interactive and tailored learning environment for each student, thereby contributing to a deeper and more effective understanding of physics. Although ChatGPT is an advanced language model, it can also generate inaccurate or erroneous answers due to training data limitations, misinterpretation of questions, lack of contextual knowledge, limited numerical ability and reasoning errors. This paper presents how ChatGPT can be used in the physics training process to consolidate and reinforce physics knowledge, develop intermediate-level physics problem-solving skills, and stimulate students' critical thinking through individual and collaborative activities.

6.10 Implementation of Augmented Reality using GeoGebra Software in the Study of Mechanical, Thermal and Optical Phenomena in Pre-university Education

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Keywords: Augmented Reality, GeoGebra simulation, physics education, oscillatory motion, heat transfer, geometrical optics

Augmented reality (AR) is a technology with remarkable potential in enhancing the learning of physics in the pre-university education, having the ability to stimulate students' interest and engagement in teaching activities. Through GeoGebra software, we can exploit this technology to merge real-world elements with virtual information, providing relevance to abstract physical concepts. In this paper, we aim to present the applications developed with GeoGebra software for the implementation of augmented reality in the study of oscillatory systems (Maxwell pendulum, Mach pendulum), as well as in the analysis of heat transfer from a building to the outside environment. Additionally, we have explored the possibility of applying this technology in solving geometrical optics problems, creating attractive and interactive environments aimed at enhancing understanding of optical concepts and phenomena. The development of 3D models for studying various systems and the integration of AR experiments in investigating physical phenomena supports the digital and scientific literacy of young learners and represent a significant step in transforming how physics is perceived by students, making it more accessible and relatable to their everyday experience.

Section 7: Polymer Physics

Location and time: **Seminar Rm. 2**

Moderators:

Prof. Dr. Valentin BARNA

Assoc. Prof. Dr. Cătălin BERLIC

7.1 11:15-11:30 - Marius Iulian MIHAILESCU, Stefania Loredana NITA, Marius ROGOBETE, Valentina MARASCU, Valentin BARNA

Quantum Leap - Navigating the future of secure communication with quantum cryptography

7.2 11:30-11:45 - Marius Iulian MIHAILESCU, Stefania Loredana NITA, Marius ROGOBETE, Valentina MARASCU, Valentin BARNA

Entangled worlds: Exploring the intersection of quantum computing and cryptography

7.3 11:45-12:00 - Marius Iulian MIHAILESCU, Stefania Loredana NITA, Marius ROGOBETE, Valentina MARASCU, Valentin BARNA

Breaking the Code: The role of quantum algorithms in advancing cryptographic techniques

7.4 12:00-12:15 - Vladut GIDEA, Gabriel CALITA, Stefania Loredana NITA, Marius ROGOBETE, Marius Iulian MIHAILESCU, Valentina MARASCU

From Bungee Jumping to Rocket Motion: educational approach in the framework of computational methods for natural science domain

7.5 12:15-12:30 - Valentina MARASCU, Marius Iulian MIHAILESCU, Stefania Loredana NITA, Marius ROGOBETE, Ciprian RACUCIU

Tungsten and Titanium lab-synthesized materials: an overview in the field of military applications

7.6 12:30-12:45 - Marius Iulian Mihailescu, Valentina Marascu, Cristina Miron, Valentin Barna

Computational Integration with Simpson's 3/8 and Bode's Rules in C#, Python, and C++. An Educational Study with Applicability towards Teaching Polymers Field

7.7 12:45-13:00 - Stefan CARAMIZOIU, *, Stefan-Marian IORDACHE, *, Ana-Maria IORDACHE, Ana-Maria RADUTA, Valentin BARNA, Ileana Cristina VASILIU, Irinela CHILIBON, Cristiana Eugenia Ana GRIGORESCU

3D Printed Integrating Sphere Coated with Highly Reflective Surface Coating Using BaSO4

7.8 13:00-13:15 - Valentin BARNA

From Spontaneous Emission to LASER Capabilities in Innovative Dye-Embedded Organic Systems

7.9 13:15-13:30 - Valentin BARNA, Catalin BERLIC, Lucian Dragos FILIP

Designing New Photonic BandGap Tunnable Micro-Structures

7.10 13:30-13:45 - Nichita GHEREG, Robert-Antonio IVANESCU, Alexandru-Catalin MACOVEI, Andrada-Maria PUISOR, Andrei TURTICA, Catalin BERLIC

Exploring Phase Transitions: A Monte Carlo Simulation Approach to the Ising Model

7.11 13:45-14:00 - Adrian BERLIC, Catalin BERLIC

Machine Learning Assisted Calibration of the Lebwohl-Lasher Model for Liquid Crystal Simulations

7.12 14:00-14:15 - Catalin BERLIC, Valentin BARNA, Daciana ZMARANDACHE, Adrian BERLIC, Eduard GATIN

Predictive Modeling of Polymer Crystallization: Integrating the Avrami Equation in Computational Simulations

7.1 Quantum Leap - Navigating the future of secure communication with quantum cryptography

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Keywords: quantum cryptography; quantum key distribution (QKD); secure communication; cryptographic security

The paper explores the changing field of secure communication, focusing on the significant impact of quantum cryptography. The talk begins by discussing the current issues in digital security, focusing on the weaknesses of traditional cryptographic techniques when faced with the capabilities of quantum computing. This talk aims to examine and emphasize the importance of quantum cryptography as a reliable method for ensuring secure communications in the future. The authors present a detailed summary of the fundamental principles of quantum cryptography, covering quantum key distribution (QKD) and important concepts of quantum mechanics such as superposition and entanglement that form the basis of this technology. We will examine possible uses of quantum cryptography, focusing on its importance in safeguarding vital infrastructure, government communications, and financial transactions. They also examine the future potential of quantum cryptography, particularly its incorporation with upcoming technologies such as blockchain and the Internet of Things (IoT). The article offers a comprehensive and futuristic examination of how quantum cryptography will revolutionize safe communication in a society that is becoming more interconnected and quantum-conscious.

7.2 Entangled worlds: Exploring the intersection of quantum computing and cryptography

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Keywords: quantum cryptography; post-quantum cryptography (PQC); cryptography

The book thoroughly examines the interaction between quantum computing and encryption, two advanced domains in current technology. This study explores the specific ways in which progress in quantum computing affects cryptographic security. This research aims to examine the impact of advancements in quantum computing on cryptographic methods and to investigate the necessary adaptations in cryptography to tackle these new difficulties. The study begins by explaining the basic principles of quantum computing, emphasizing its distinct features like superposition and entanglement, which allow quantum computers to do certain calculations more rapidly than classical computers. The paper also analyzes practical obstacles in creating quantum-resistant cryptography systems and their real-world applications. This involves conversations about scalability, infrastructure integration, and the necessity for global standards and policies. The paper stresses the importance of the cryptographic community taking proactive steps to adjust to the quantum computing age. The study advocates for further research and cooperation between quantum physicists and cryptographers to create secure cryptographic systems that are immune to quantum attacks, thus guaranteeing the ongoing security of sensitive data in the quantum era.

7.3 Breaking the Code: The role of quantum algorithms in advancing cryptographic techniques

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Keywords: quantum cryptography; post-quantum cryptography (PQC); Shor’s Algorithm; Grover Algorithm

This research is crucial as it explores the significant influence of quantum algorithms on cryptography. This work thoroughly analyzes the relationship between the advancing skills of quantum computing and the development of cryptography techniques. This work aims to comprehensively evaluate the impact of quantum algorithms on cryptographic techniques, including their role in introducing weaknesses in current systems and facilitating the development of more secure, quantum-resistant solutions. The study commences by outlining the basic principles of quantum computing, highlighting the unique characteristics of quantum algorithms that set them apart from classical algorithms. The text offers an in-depth analysis of important quantum algorithms, including Shor's algorithm and Grover's algorithm, which have substantial impacts on cryptographic security. The study examines the weaknesses that quantum algorithms bring to conventional cryptography systems like RSA and ECC. The rapid progress in quantum computing emphasizes the need for the cryptographic community to tackle these vulnerabilities promptly. Ultimately, the paper provides a thorough examination of how quantum algorithms affect cryptography. It highlights how quantum computing can both threaten the security of present cryptography systems and stimulate the development of stronger, quantum-resistant cryptographic solutions.

7.4 From Bungee Jumping to Rocket Motion: educational approach in the framework of computational methods for natural science domain

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Keywords: computational methods; python models; educational approaches

The process of computational modeling in bungee jumping entails the utilization of differential equations to predict the velocity of the jumper. This is achieved by examining the interplay of gravitational, elastic, and air resistance forces. This model serves the dual purpose of elucidating the mechanics of bungee jumping and serving as an educational instrument for illustrating complex dynamics in a user-friendly environment. Conversely, rocket motion, an essential component of aeronautical engineering, involves an intricate interplay between forces and alterations in mass. For example, computational models of rocket motion clarify the fundamental principles of propulsion, conservation of mass, and conversion of energy, offering students a deep understanding of the intricacies of space travel and rocket engineering. Our work utilized a range of physics models, which were generated using the Python programming language, to emphasize the underlying physics principles. The performed simulations can bridge the gap between theoretical physics and practical, real-life applications, making them both unique and helpful for educational reasons. Incorporating computational physics into the teaching of bungee leaping, rocket motion, and scuba diving not only improves the learning process but also greatly boosts safety and operational efficiency in these fields. This exemplifies the symbiotic relationship between physics education and its pragmatic application in specialized domains.

7.5 Tungsten and Titanium lab-synthesized materials: an overview in the field of military applications

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Keywords: lab-synthesized materials; tungsten; titanium; particles;

The present paper investigates in depth tungsten and titanium compounds developed for military use in laboratories. Our primary focus is the utilization of these materials in a multitude of applications. These include the fabrication of aircraft exterior components using tungsten dust in the shape of cauliflower, the development of dependable betavoltaic batteries with titanium coatings to provide enhanced long-term energy solutions in challenging environments, and more. The paper elucidates the experimental laboratory enhancements implemented on these metals to augment their inherent properties, thereby expanding their application in contemporary military technology. The areas of emphasis encompass improvements in the longevity of materials, cost-effectiveness, and strategic benefits for military operations.

7.6 Computational Integration with Simpson’s 3/8 and Bode’s Rules in C#, Python, and C++. An Educational Study with Applicability towards Teaching Polymers Field

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Keywords: computation; C#, Python, C++ languages; polymers teaching; Simpson’s 3/8 and Bode’s formula

Computational methods improve the quality of the educational process. In the present day, fields such as the Internet of Things and blockchain offer significant advantages for students' learning, by incorporating computational language, to solve diverse mathematical problems from various physics domains, including the polymers teaching field. Our research presents a novel approach to integrating mathematics and computer science for educational objectives, with applicability towards the polymers teaching field. In this study, we have employed Bode's and Simpson's 3/8 formulae to solve the problem. The implementation was done using three programming languages often used in computer science: C++, Python, and C#. A diligent mathematical problem was successfully solved and comprehensively described, to augment the pupils' understanding. This strategy was devised to foster the student's inquisitiveness in the realms of mathematics and computer science.

7.7 3D Printed Integrating Sphere Coated with Highly Reflective Surface Coating Using BaSO4

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Keywords: integrating sphere, barium sulfate, high reflective surface, 3D printing.

The integrating spheres, known also as Ulbricht spheres, are essential tools, and they are widely used in fields like optics, spectroscopy and photometry, where they serve to evaluate and characterize the properties of light in detail. Constructed of high-cost specialized materials, the accessibility of these devices is restricted to a broad spectrum of researchers. To overcome these restrictions, an innovative methodology is suggested, consisting of the development of an integration sphere

fabricated by 3D printing technology, using white polylactic acid (PLA) and finished with a layer of highly reflective and diffusive material such as BaSO4. This approach brings multiple benefits: cost efficiency is significantly improved by eliminating the need for expensive equipment and machinery, the rapid prototyping process is facilitated by allowing prompt adjustments of the sphere design according to specific experimental requirements, and it is possible to make in a few hours using a standard 3D printer. Furthermore, the scalability of this model allows easy adaptation of the sphere dimensions to conform to different sample sizes and measurement needs. Thus, the 3D-printed and BaSO4-coated integration sphere stands out as an advantageous alternative to traditional models, offering superior solutions in terms of cost, accessibility, customization and efficiency in the application of optical measurements.

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7.8 From Spontaneous Emission to LASER Capabilities in Innovative Dye-Embedded Organic Systems

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Keywords: Random Light Generation, Fluorescence, Light Scattering, Optical Amplification, Micro-Lasers

Systems employed for light generation and amplification are extensively studied nowadays both theoretically and experimentally. Random Lasers (RLs) serve as fascinating examples of devices that combine the scattering of light and optical amplification. The combination of light localization and random lasing is particularly intriguing due to the unique characteristics of each lasing source and the distinct emission properties of localized modes. In this study, we present laser emission from small-scale systems doped with fluorescent dye, whether confined or boundary-less. Various optical emission characteristics, such as spectral analysis, behavior below and above the lasing energy threshold, emission efficiency, intensity profiling of far-field spatial lasing modes, and temporal emission behavior, validate the light amplification and the occurrence of laser emission from our true mirrorless devices. The proposed micro-lasers stand out for sub-nanometer emission peak wavelength, their low lasing threshold, high efficiency, long-term stability, ease of fabrication and diverse design possibilities. These systems are ideal for producing small-scale flexible laser systems and are anticipated to find applications in modern biomedical fields, optics, photonics and material science.

7.9 Designing New Photonic BandGap Tunnable Micro-Structures

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Keywords: Photonic BandGap Structures, Soft Materials, Periodic Structures, Optical Amplification

We present the initial findings about simulating the potential formation of PBG (Photonic BandGap) structures in systems composed of periodic or aperiodic layers made from different materials (including Nematics, Polymers, air etc) for use as adjustable compact light amplification systems or optical reflectors in the visible and NIR-IR spectra. Our study includes simulations for various potential periodic systems of micrometer size length, made from sandwiched materials having refractive optical indices in the range 1 - 1.8. By selecting appropriate slice lengths and material combinations we can achieve customizable high-quality optical amplifiers and laser devices for specific wavelengths, but also highly personalized bandpass and notch optical filters. Employing birefringent materials (such as liquid crystals) enables us to actively adjust and fine-tune these PBG devices in real-time, offering a wider range of applications and increased versatility in the fields of optics, photonics and nanotechnologies.

7.10 Exploring Phase Transitions: A Monte Carlo Simulation Approach to the Ising Model

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Keywords: Monte Carlo simulation, Ising model, square lattice, phase transition, magnetization, susceptibility

The study presents an investigation of the Ising model using Monte Carlo simulations to reveal the peculiarities of the phase transition behaviors in both one-dimensional (1D) and two-dimensional (2D) systems. Initially, the Ising model parameters, including interaction strength and magnetic field effects, are outlined, setting the groundwork for simulation scenarios. The Monte Carlo method, particularly the Metropolis algorithm, is employed to simulate the spin interactions and to calculate properties such as energy, magnetization, susceptibility, and heat capacity. In the 1D case, our simulations confirm the absence of a phase transition at finite temperatures, aligning with theoretical predictions. Conversely, the 2D model, simulated on a square lattice, clearly exhibits a phase transition, characterized by a spontaneous magnetization as temperature decreases below the critical value. The critical temperature is estimated and compared with the known exact solution of the 2D Ising model. This work not only reinforces the utility of Monte Carlo simulations in studying statistical physics models but also provides insights into the critical behaviors of low-dimensional systems, potentially guiding future experimental and theoretical research in critical phenomena.

7.11 Machine Learning Assisted Calibration of the Lebwohl-Lasher Model for Liquid Crystal Simulations

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Keywords: liquid crystals, computer simulation, Lebwohl-Lasher, machine learning, neural network

The accurate simulation of liquid crystal behaviors is important for advancing materials science and engineering applications. Traditional computational models, while robust, often require extensive calibration to align with experimental data, a process that can be both time-consuming and computationally expensive. These include the scenarios where the characteristics of the surface, confined geometries, the size, location, and quantity of inclusions, as well as temperature, electric or magnetic fields cand lead to complicated behaviors. This study introduces a novel approach that employs machine learning techniques to enhance the calibration of the Lebwohl-Lasher model, which may become important for simulating nematic liquid crystals. We developed a hybrid framework combining the Lebwohl-Lasher model with supervised learning algorithms to adjust model parameters based on previous simulations or experiment. The initial phase involves training a neural network on a dataset derived from high-fidelity simulations under varied conditions. The trained models predicted model parameters that optimize the alignment of simulation outputs with observed data, significantly reducing the manual parameters adjusting traditionally required.

7.12 Predictive Modeling of Polymer Crystallization: Integrating the Avrami Equation in Computational Simulations

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Keywords: polymer crystallization, Avrami equation, instantaneous nucleation, sporadic nucleation, computer simulation

Polymer crystallization is a fundamental process influencing the mechanical and thermal properties of polymer-based materials. Accurate modeling of this process is essential for optimizing manufacturing techniques and improving material performance. This study presents a computational framework that integrates the Avrami equation to predict the crystallization kinetics in polymers. We present simulation models that adapts the classical Avrami equation to various cooling rates and crystallization conditions, providing a versatile tool for predicting polymer behavior under different processing scenarios for both sporadic and instantaneous nucleation.

Section 8: Solid State Physics and Materials Science

Location and time: **Amf. 1**

Moderators:

Prof. Dr. Alexandru NEMNEŞ

Prof. Dr. Vlad-Andrei ANTOHE

8.1 11:15-11:30 - Stefan DOBRESCU, Mihaela FILIPESCU, Stefan ANTOHE

Advancements in gas detection: metal oxide semiconductors deposited by pulsed laser deposition

8.2 11:30-11:45 - Ana-Maria POPA, Andrei STOCHIOIU, Luiza-Izabela TODERAŞCU, Vlad-Andrei ANTOHE, Gabriel SOCOL, Iulia ANTOHE

Methane detection at room temperature using a chemiresistive polyaniline-based sensor

8.3 11:45-12:00 - Maria-Iulia ZAI, George Alexandru NEMNEȘ, Lucian ION, Ștefan ANTOHE, Victor LECA

Computational and experimental studies of metallic hydrides

8.4 12:00-12:15 - Elena-Isabela BANCU, Maria-Luiza Stingescu, Florin Andrei, Mihai-Robert ZAMFIR, Valentin ION, Sorina IFTIMIE, Nicu Doinel SCĂRIȘOREANU, Stefan ANTOHE

Physical properties of AZO thin films prepared by Pulsed Laser Deposition (PLD) technique

8.5 12:15-12:30 - Bianca-Georgiana ȘOLOMONEA, George-Alexandru NEMNEȘ, Călin-Andrei PANTIȘ-SIMUȚ, Paul DINCA, Corneliu STAICU, Corneliu POROȘNICU

Investigation of boron-based compounds for hydrogen isotopes retention and release: experimental and theoretical insights

8.6 12:30-12:45 - CEZAR COMANESCU, GABRIEL SCHINTEIE, ANY SERGENTU, ANDREI KUNCSER, NICUSOR IACOB, VICTOR KUNCSER

Advancements in Functionalized Magnetic Nanoparticles for Targeted Biomedical Applications

8.7 12:45-13:00 - Maria-Cristina BALASIN, Maria Luiza STINGESCU, Elena-Isabela BANCU, Felicia IACOB, Vlad Andrei ANTOHE, Sorina IFTIMIE, Stefan ANTOHE

THE INFLUENCE OF CUPC NOPARTICLES ADDING ON THE PERFORMANCES OF THE PHOTOVOLTAIC CELLS BASED ON P3HT:PC71BM (1:1) POLYMERIC BLEND

8.8 13:00-13:15 - Oana Daniela CALANCEA, Corina Anca SIMION, Adina BORONEANȚ

Computed tomography and heritage studies: the inner view of prehistoric pottery

8.9 13:15-13:30 - Andrei Alexandru-Dinu, Petre Badica, Victor Kuncser

Coupling mechanisms in MnBi-FeSiB nanocomposites obtained by spark plasma sintering

8.10 13:30-13:45 - Claudiu Caraiani, Lucian Ion

Loss function in a three layer graphene structure at zero temperature

8.11 13:45-14:00 - Teodora BURLANESCU, Mihaela BAIBARAC

Synthesis and physico-electrochemical properties of the POT/RGO and POT/WS2 composites

8.12 14:00-14:15 - Raluca IVAN, Stefan ANTOHE, Vlad Andrei ANTOHE, Angel PÉREZ DEL PINO, Eniko GYÖRGY

Visible-light active photocatalytic layers for antibiotics removal from wastewater

8.13 14:15-14:30 - Esmaeil Jalali LAVASANI, ALI AL SHAREA, Sarah Al MASOODI

Enhancement of Thermoelectric Properties of Sodium Cobalt Oxide via Magnetic Field Application

8.14 14:30-14:45 - Alexandra Karina Gheorghe, Andreea Costas, Nicoleta Preda, Ionut Enculescu

ZnO nanowires: preparation, characterization and application in electronic devices

8.15 14:45-15:00 - Rovena Veronica Pascu, Ana Maria Niculescu Banici, Bogdan Bita, Iuliana Urzica

DEVICES FOR LOW AND INTERMEDIATED OPERATING TEMPERATURE FABRICATION BY PLD OF 20%Sm-DOPED CERIA/ 20%NISDC THIN FILMS SUBANSABLY

8.16 15:00-15:15 - Buzatu George, Ana-Maria Iordache, Stefan Caramizoiu, Irina Negut, Ana-Maria Raduta, Stefan-Marian Iordache, Bogdan Biță

Comparison of different types of semiconducting polymers as sensors for kidney failure

8.1 Advancements in gas detection: metal oxide semiconductors deposited by pulsed laser deposition

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Keywords: semiconductors, PLD, metal oxide, sensor

Metal oxide semiconductors (MOS) deposited via pulsed laser deposition (PLD) have emerged as highly effective materials for gas detection due to their unique structural, electrical, and chemical properties. PLD is a versatile technique that enables the precise control of film thickness, composition, and crystallinity, which are crucial for optimizing the sensitivity and selectivity of gas sensors. This deposition method allows for the fabrication of MOS films with tailored nanostructures, including nanoparticles, nanowires, and thin films, which enhance surface area and facilitate gas adsorption and reaction processes. The sensitivity of MOS sensors to various gases, such as nitrogen dioxide (NO_2), carbon monoxide (CO), ammonia (NH3), and volatile organic compounds, is significantly influenced by the material's microstructure and the presence of surface defects, which can be finely tuned through PLD parameters. For instance, zinc oxide (ZnO), tungsten trioxide (WO3), tin dioxide (SnO2), and titanium dioxide (TiO2) are commonly used MOS materials in gas sensors due to their high surface reactivity and stability. PLD enables the incorporation of dopants and the creation of heterostructures, further enhancing the sensor performance by modifying the electronic properties and facilitating charge transfer during gas interactions. Studies have demonstrated that MOS sensors deposited by PLD exhibit rapid response times, high sensitivity, and good stability at various operating temperatures. The deposition process also allows for the integration of these sensors onto flexible and rigid substrates, broadening their application scope in portable and wearable devices. Moreover, the ability to deposit thin films with uniform thickness and minimal defects contributes to the reproducibility and reliability of the sensors.

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8.2 Methane detection at room temperature using a chemiresistive polyaniline-based sensor

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Keywords: polyaniline, conductive polymers, chemiresistive gas sensors, methane sensing

Gas monitoring technology is crucial for many industries, including the healthcare sector, industrial safety and environmental monitoring. Given the purpose of identifying potential risks, maintaining work safety and controlling emissions, it is essential to quickly and accurately detect a variety of toxic gases, including methane. [1] Chemiresistive sensors based on conductive polymers (i.e. polyaniline, polypyrrole) exhibit great sensitivity, quick response time and versatility, making them highly attractive devices for gas detection in ambient conditions [2-4]. In this study, the conductive polymer named polyaniline (PANi) was chosen for its ability to adapt to a vast variety of gases, including ammonia, methane and hydrogen. [5] This polymer was synthesized by chemically polymerizing its monomer directly on interdigitated gold electrodes. Employing investigative methods such as X-ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM), further information about the sensor’s morphological and chemical characteristics

was obtained. Additionally, an in-house gas testing equipment was used to electrically characterize the developed sensor. Using a source-meter, the electrical characteristics of the sensor inside the gas chamber were examined while it was subjected to different methane concentrations ranging from 1 to 50 ppm. In conclusion, the data acquired showed that the suggested sensor demonstrates a noticeable change in electrical resistance upon exposure to the gas, indicating its high sensitivity to detect small concentrations of methane, as low as 1 ppm.

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8.3 Computational and experimental studies of metallic hydrides

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Keywords: Density Functional Theory; chromium hydride; palladium hydride; superconductivity; ELK code; SIESTA code; phonon density of states.

Metallic hydrides (Me-Hx) have a long history of drawing significant interest from the scientific community for their potential as room-temperature superconductors. Due to a controllable composition of heavy and light elements, they are also attractive for the fabrication of high-power laser targets. One such promising candidate is palladium hydride (Pd-H), which can readily embed significant amounts of hydrogen in the metallic interstitial sites even at ambient pressure and at room temperature. In the present work, computational methods were used to perform structural studies and identification of the physical properties of several stoichiometries of the Pd-H and Cr-H systems, using Density Functional Theory (DFT). This ab initio approach allowed us to examine how the hydrogen embedded in metallic interstitial sites gives rise to superconductivity from the ensuing electron-phonon coupling. To this end, the formation enthalpy of the candidate hydrides presented herein, studied as a function of stoichiometry and pressure, was investigated using an efficient structure prediction software (CALYPSO). Their physical properties were then determined using an all electron linearized augmented plane wave code (ELK), which also served to predict their critical temperatures (TC). We were able to computationally determine that a majority of the studied hydrides feature hydrogen-filled interstitial sites within their closely-packed metal lattices and our electron-phonon coupling calculations showed that they are phonon-mediated superconductors. Ultimately, we compared our computational results with experimental ones derived from hydride films deposited via RF sputtering, including epitaxial PdH thin films, which were for the first time obtained using a physical deposition method.

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8.4 Physical properties of AZO thin films prepared by Pulsed Laser Deposition (PLD) technique

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Keywords: Transparent conductive oxides (TCO), AZO Thin Films, PLD

This study focuses on preparation and characterization of transparent conductive films (TCO) based on Al doped zinc oxide (AZO). This material is suitable as a TCO due to its specific properties, such as relatively low cost and low toxicity, compared with other TCOs, such as Indium-Tin Oxide (ITO) [1-2]. The study aims to enhance the physical characteristics of AZO films fabricated through pulsed laser deposition (PLD) using a solid-state Nd: YAG laser (266 nm). The AZO layers were deposited using a ceramic ZnO: Al2O3 (98:2 wt%) target onto silicon and glass substrates at a temperature of 300°C both in vacuum and oxygen atmosphere. After deposition, the structural properties of AZO films were analyzed using X-ray diffraction (XRD) measurements. The optical characterization of the samples was carried out using spectroscopic ellipsometry (SE) and UV-VIS-NIR spectrophotometry in the spectral range of 300-1700 nm. Additionally, the morphology of the films was studied using an atomic force microscope (AFM). Finally, the electrical characterization was assessed using a four-point measurement technique. The structural analysis revealed that all AZO films exhibited characteristic (002) diffraction peaks associated with the wurtzite structure. Furthermore, the transmission coefficient of a single layer of AZO across the entire visible spectrum exceeded 80%.

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8.5 Investigation of boron-based compounds for hydrogen isotopes retention and release: experimental and theoretical insights

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Keywords:

Boron and its compounds represent a novel material that will be implemented in the fusion nuclear reactor proposed at the International Thermonuclear Experimental Reactor (ITER). As boron has a high affinity for certain elements, such as nitrogen, carbon, or oxygen [1], a boronization process is needed in order to reduce the impurities from residual gas and to lower the energy required for plasma ignition. Here, the boron structures are studied from both the experimental and theoretical points of view. Electronic properties and the activation energies of hydrogen isotopes in boron-crystalline structures are determined for certain reactions, such as: diffusion, trapping, and detrapping. Here we employ ab-initio calculations, in the framework of density functional theory (DFT), molecular dynamics (MD), and nudged elastic method (NEB). The study also shows the high affinity of boron to hydrogen, given by the large activation energies, meaning that a lot of energy is necessary in the process for an H atom to leave the structure. From the experimental results, a high temperature of desorption is observed in the thermal desorption spectra.
To confirm the obtained theoretical results, boron, and gaseous-intrusions boron layers were produced using high impulse power magnetron sputtering (HiPIMS), as this deposition method can provide ions energy with similar values to the ones obtained in ITER. The samples were deposited on tungsten substrates, as it is desired to simulate as good as possible the fusion reactor conditions. The deposited samples are being studied from a morphological and structural point of view, while the deuterium retention in the co-deposited layers is analyzed. The results are consistent and the experimental confirmation of the activation energies will be further investigated.

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8.6 Advancements in Functionalized Magnetic Nanoparticles for Targeted Biomedical Applications

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Keywords: magnetic nanoparticles, hyperthermia, morphology, XRD, cancer

surface functionalization of magnetic nanoparticles (MNPs) has revolutionized their utility in multimodal imaging, drug delivery, and catalysis [1,2]. A systematic study on the synthesis and characterization of magnetic nanoparticles (MNPs) has afforded by thermal decomposition of organometallic precursors hydrophobic and hydrophilic magnetite nanoparticles with average size in the range 10 – 50 nm. The shape of the resulting NPs was tuned with respect to size and shape, the synthesis being versatile enough to afford various morphologies from cubic, hexagonal, tetragonal to spherical. Notably, the MNPs exhibited narrow size distribution and high magnetizations approaching the theoretical value for magnetite. The influence of the synthesis conditions (concentration, type of iron precursor, molar ration, type of surfactant, temperature and time of thermal treatment) on the morphology, size and properties of the resulting MNPs were investigated by XRD, TEM, Mossbauer Spectroscopy and SQUID magnetometry. Using varying ratios of surfactants (oleic acid: oleyl amine), we established a clear correlation between MNP morphology and the nature of the surfactant system utilized. The synthesized MNPs were investigated regarding their cytotoxic effect by in vitro studies against cancer cells. In this respect, complementary hyperthermia studies were undertaken in order to establish the SAR value for as-synthesized magnetite NPs, the study being extended on the cancer cell culture for gaining further insights on the influence of magnetic properties and morphology on the cytotoxic potential.

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8.7 THE INFLUENCE OF CUPC NOPARTICLES ADDING ON THE PERFORMANCES OF THE PHOTOVOLTAIC CELLS BASED ON P3HT:PC71BM (1:1) POLYMERIC BLEND

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Keywords: Keywords: P3HT, PC71BM, CuPC, PEDOT:PSS, organic photovoltaic cells

In this study, we report the fabrication and characterization of an innovative photovoltaic cells prepared by adding small molecules of copper phthalocyanine (CuPC) either into holes transporter layer (HTL) or to the active layer. The active layer of the conventional photovoltaic cell was grown as a 1:1 ratio mixture between a conductive polymer, poly(3-hexylthiophene-2,5-diyl (P3HT) as donor, and a fullerene derivative, [6,6]-phenyl-C71-butyric acid methyl ester (PC71BM) as acceptor. The contribution of the CuPC adding was investigated by its participaton to photogeneration into the ternary absorber layer P3HT:PC71BM + CuPC or by the improvement of the hole transport properties as blending with the (3,4-etylenedioxylenethiophene):polystyrene sulphonic acid (PEDOT:PSS), used frequently as conventional hole transport layer (HTL). The individual layers PEDOT:PSS, P3HT:PC71BM and customized layers PEDOT:PSS + CuPC (75:25, wt%), P3HT:PC71BM + CuPC at three different concentrations: 75:25, 50:50, 25:75 wt%, were deposited by spin-coating, at room temperature. The top electrode of the cell into superstrate structures, was indium tin oxide (ITO) coated optical glass, and the back contact (cathode), was an aluminum thin film, deposited by thermal vacuum evaporation. The electrical and photo-electrical properties of the prepared structures were investigate by the measurements of the Current-Voltage characteristics in dark and at illumination, in AM 1.5 conditions (100 mW/cm2), respectively. The typical parameters measured as photoelement such as: external quantum efficiency (EQE), short-circuit current (ISC), open circuit photovoltage (UOC), fill factor (FF), and power conversion efficiency (PCE) were calculated and discussed in terms of a conventional ITO/PEDOT:PSS/P3HT:PC71BM(1:1)/Al structure. The main conclusion of this study is that the adding of nanoparticles of CuPC have a significant contribution to the absorption and photogeneration processes, broadening the absorption spectrum to shorter wavelengths and accentuating the characteristic peaks of P3HT around 600 nm.

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8.8 Computed tomography and heritage studies: the inner view of prehistoric pottery

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Keywords: archaeology, computed tomography, ceramics, radiocarbon dating, heritage objects

The understanding and conservation of cultural heritage and archaeological material culture are significantly impacted today by the use of archaeometric studies. Our presentation focuses on the use of computed tomography to understand the manufacturing techniques and pottery fabrics from the Cuina Turcului rockshelter archaeological site in the Romanian Iron

Gates of the Danube. Studies relating to pottery primary forming techniques are relatively scarce in the field of prehistoric ceramic studies although isolated attempts exist for ancient pottery (Classical Greek and Roman periods). As a non-destructive methodology, CT allows the precise visual and computable detection of clay fabric microstructures and inclusions, which are determinant in classifying prehistoric pottery. Our CT images (on an assemblage of over 150 pot sherds and various other clay objects, so far) clearly indicate forming techniques in the specific texture of the ceramic matrix, as suggested by the orientation of the voids and the inclusions in the clay. Also, by comparing experimentally manufactured pots to archaeological samples we were able to determine the nature, density and size of the various types of clay inclusions used by the prehistoric potters. We determined that clay recipes varied greatly during the ages, from the Early Neolithic to the Bronze Age. as indicated by our studies. A significant number of 14C obtained at the AMS facility at IFIN-HH allowed us to precisely link pottery types to the archaeological cultural layers. Our results clearly show the invaluable potential of micro-CT in the study of pottery forming techniques of archaeological vessels. As prehistoric vessels and figurines are heritage objects, the method is also invaluable in assisting restoration and conservation techniques. Our project reinforces the importance of interdisciplinary studies in academic and museum research.

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8.9 Coupling mechanisms in MnBi-FeSiB nanocomposites obtained by spark plasma sintering

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Keywords: exchange-spring; RE-free permanent magnets; nanocomposites

This study focuses on the development of RE-free permanent magnets, particularly Mn-based ones, with MnBi as a key compound due to its high magneto-crystalline anisotropy and positive temperature coefficient of coercivity [1,2]. The research proposes composites of MnBi-FeSiB, aiming to understand the intricate relationship between microstructural details and magnetic exchange coupling to achieve exchange-spring magnets [3]. These nanocomposites, comprising hard (MnBi) and soft (FeSiB) magnetic phases with strong exchange interactions, offer promising paths for advanced permanent magnet applications, allowing for enhanced maximum energy products ((BH)max) and novel functional characteristics compared to individual constituents [4,5]. Samples with varying compositions (Mn55Bi45 + x·Fe70Si10B20, where x = 0, 3, 5, 10, 20 wt. %) were prepared via spark plasma sintering (SPS). Comprehensive characterization techniques, including X-ray diffraction, electron microscopy, magnetometry, and Mössbauer spectroscopy, were employed. The study revealed complex correlations between starting compositions, fabrication processes, and functional magnetic characteristics, uncovering unexpected relations between microstructure and magnetic coupling mechanisms. Exchange spring effects were observed, displaying sensitivity to morpho-structural and compositional features controlled by processing conditions. Overall, the results are showing the potential of powder metallurgy routes combined with SPS in designing and optimizing

permanent magnet materials. This research paves the way for the development of tunable magnetic properties in bulk magnets, offering alternatives to rare-earth-based equivalents for various applications.

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8.10 Loss function in a three layer graphene structure at zero temperature

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Keywords: Plasmons, Loss Function, Heterostructure, Graphene

We compute theoretically the loss function in a three layer graphene structure within random phase approximation (RPA) at zero temperature. In the long wave approximation we obtain analytical expressions for the loss function restricted to the acoustic and optical plasmon branches. We study both the homogenous as well as the inhomogenous case. Numerical simulations show that the plasmonic spectral weight of the loss function associated with undamped plasmonic branches is dominated by the acoustic plasmons. The loss function displays the usual broadened peaks for damped plasmons and we observe that these peaks start to merge as we increase the interlayer distance between the graphene layers.

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8.11 Synthesis and physico-electrochemical properties of the POT/RGO and POT/WS2 composites

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Keywords: conducting polymer, functionalization, reduced graphene oxide, transition metal dichalcogenide, exfoliation, poly(o-toluidine), composites

Three methods were used to prepare the poly(o-toluidine)/reduced graphene oxide (POT/RGO) composites and the poly(o-toluidine)/WS2 (POT/WS2) composites: i) the interaction in solid state of the two constituents (POT with RGO and POT with WS2), ii) the chemical polymerization of o-toluidine (OT) in the presence of the RGO layers or WS2 nanoparticles and iii) the electrochemical polymerization of OT assisted by the RGO or WS2 sheets. Using correlated studies of Raman scattering, FTIR spectroscopy and X-ray photoelectron spectroscopy, we demonstrated that: i) the interaction in solid state of POT with RGO leads to a non-covalently functionalization of RGO with POT; ii) the chemical polymerization of OT in the presence of RGO results in a covalently functionalization of RGO with POT in emeraldine base (EB) state and leucoemeraldine salt (LS) state and iii) the electrochemical polymerization of OT in the presence of RGO sheets leads to a covalently functionalization of RGO with POT-LS and POT-emeraldine salt (ES). Moreover, the WS2 sheets were obtained using the ball milling method on WS2 nanoparticles, followed by an ultrasonication process in N,N'-dimethyl formamide. Thus, using X-ray diffraction, the exfoliation process of the WS2 nanoparticles was highlighted. Correlated studies of Raman scattering, FTIR spectroscopy and X-ray photoelectron spectroscopy (XPS) have demonstrated that: a) the chemical polymerization of OT in the presence of WS2 nanoparticles leads to the POT/WS2 composites, which contain repeating units of POT in LS state; while ii) the electrochemical polymerization of OT in the presence of WS2 sheets leads to POT/WS2 composites, containing repeating units of POT in ES state.

8.12 Visible-light active photocatalytic layers for antibiotics removal from wastewater

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Semiconductor photocatalysts have been the subject of significant attention as a simple time and energy-efficient technology to convert organic pollutants into eco-friendly mineralized byproducts under solar irradiation. Several semiconductor photocatalysts, including transition metal oxides, hydroxides, sulfides, phosphates, and dimensional (2D) materials were widely investigated for wastewater treatment by degrading organic molecules under light irradiation. However, most of these materials present a wide band gap, and thus optical absorption is limited to the UV spectral range leading to low photodegradation efficiency, a main drawback for practical applications. Many efforts have been focused on finding photocatalyst materials that could overcome the drawback of the wide band gap photocatalysts. Lower band gap metal oxides, such as iron oxides and hydroxides are currently considered for photocatalytic applications, owing to their favourable properties such as high chemical stability, wide abundance, and low toxicity. This study was focused on the growth of photocatalytic nanostructures based on iron oxides and graphene-like reduced and nitrogen-doped graphene oxide, aiming to increase the lifetime of photogenerated electron-hole pairs and thus to enhance the photocatalytic efficiency in the visible spectral region. These nanostructures were grown on a solid substrate in one single step using a laser technique called ,,Matrix-Assisted Pulsed Laser Evaporation" (MAPLE), without any post-processing treatments. The prepared layers were used for the decomposition of chloramphenicol molecules, one of the most used antibiotics, by irradiation in the visible range of the solar spectrum.

8.13 Enhancement of Thermoelectric Properties of Sodium Cobalt Oxide via Magnetic Field Application

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Keywords: Sodium cobalt oxide, Thermoelectric materials, Magnetic field enhancement, Seebeck coefficient, Energy conversion efficiency

Sodium cobalt oxide ($NaCo_2O_4$) is an extensively studied thermoelectric material[1]. It is prized for its robust electrical conductivity and substantial Seebeck coefficient, which are critical for efficient energy conversion[2]. This research focuses on the novel application of a magnetic field to enhance these inherent thermoelectric properties of sodium cobalt oxide. In this study, the powder of $NaCo_2O_4$ was synthesized by the sol-gel method. A cylinder tablet with a 2.5 cm diameter and 3 mm height was made of this powder to measure the thermoelectric material. A 0.3 Tesla magnetic field was applied perpendicular to the temperature gradient on both the hot and cold sides of the pellet to explore the potential enhancement of its thermoelectric properties. This experimental setup was designed to assess the impact of magnetic influence on the charge carrier mobility and scattering mechanisms, which are pivotal in the thermoelectric power generation process. The results indicated a marked increase in the output voltage upon applying the magnetic field, suggesting an enhanced Seebeck coefficient. The significant improvement in the output voltage and Seebeck coefficient under the magnetic field suggests that magnetic alignment influences the electronic transport properties of $NaCo_2O_4$. This study not only deepens the understanding of magneto-thermoelectric effects in sodium cobalt oxide but also opens up promising avenues for utilizing magnetic fields to boost the performance of cobalt oxide thermoelectric materials, offering a compelling strategy for optimizing energy harvesting technologies.

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8.14 ZnO nanowires: preparation, characterization and application in electronic devices

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Keywords: ZnO nanowires, thermal oxidation in air, lithographic techniques, electronic devices

Lately, an increased research interest was focused on the preparation of metal oxide nanowire arrays due to their potential use in the development of innovative and miniaturized electronic devices with novel properties and functionalities

determined by their one-dimensional morphology [1-3]. In order to optimize the electronic device performance and reliability there is still a significant need for the investigation of the semiconductor material used. One of the most popular semiconductor nanowires, ZnO nanowires have received extensive attention due to their unique electrical, optical, piezoelectric and thermoelectric properties and multiple wet and dry preparation routes, making them the perfect candidates for integration in optoelectronic devices, energy harvesting, sensors, etc. In this work, ZnO nanowire arrays were obtained using a cost-effective straightforward route, thermal oxidation in air. The structural, morphological, compositional and optical properties of the ZnO nanowire arrays were analyzed and discussed in detail using X-ray diffraction, field emission scanning electron microscopy, energy dispersive X-ray spectroscopy, and reflectance. Additionally, current-voltage measurements were performed to assess their potential use in optoelectronic applications.

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8.15 DEVICES FOR LOW AND INTERMEDIATED OPERATING TEMPERATURE FABRICATION BY PLD OF 20%Sm-DOPED CERIA/ 20%NISDC THIN FILMS SUBANSABLY

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Keywords: Ceramic thin films, 20%Ni-SDC/ 20%SDC/Si(100), PLD, Low and Intermediate Temperature, Electrochemical devices

Ceramics solid oxide fuel cells (μSOFC) and potentiometric oxygen sensor with low and intermediary operating temperatures will be developed in thin films technology by Pulsed Laser Deposition (PLD) on Si (100) using the importance of 20% SDC [1,2,3,4]. 20%Ni-SDC [5] is deposed on SDC at 100.000 pulses compared with 27.000 for SDC. The microstructure of this bilayer is characterized by XRD, SEM, AFM, XPS; optical characterization is made by variable spectroelipsometry. The temperatures of substrates are fixed at 500˚C and 600˚C. Crystalline cubic structure with good uniformity will assure further developments in these fields.

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8.16 Comparison of different types of semiconducting polymers as sensors for kidney failure

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Keywords: sensors, urea, electrochemical investigations, graphene nanoplatelets, semiconducting polymers

n this paper, we report the development of a new urea electrochemical sensor based on semiconducting polymers and graphene nanoplatelets. Pyrrole, aniline, and thiophene each underwent electropolymerization, both simple and in the presence of graphene nanoplatelets on screen-printed substrates. Electropolymerisation of semiconducting polymers in the presence of graphene nanoplatelets was successful, except for aniline. Following the polymerisation process, the sensors underwent a washing and drying procedure before being tested with eight varying concentrations of urea. The artificial saliva system, including dispersed urea, consists of the following components: NaCl, KCl, $CaCl_2 \cdot 2H_2O$, $NaH_2PO_4 \cdot 2H_2O$, and $Na_2S \cdot 9H_2O$, as specified by the Fusayama formulation. We conducted scanning electron microscopy (SEM) analysis on the electropolymerised samples, revealing the uniformity of the polymeric sheets. The electrochemical investigation demonstrated that the sensors utilising polythiophene and graphene, as well as polypyrrole and graphene, could detect urea in samples with a limit of detection (LOD) of 19.99 mg/mL and 13.58 mg/mL, respectively. The sensors are suitable for identifying kidney failure in patients during triage based on their electrochemical response to urea.

Section 9: Theoretical and Computational Physics, High-Energy Physics, Applied Mathematics

Location and time: **Amf. 3**

Moderators:

Lect. Dr. Roxana ZUS

CS I Dr. Călin ALEXA

Assoc. Prof. Dr. Radu Slobodeanu

9.1 11:15-11:30 - Adrian STOICA
On the derivation of three singular integral equations arising in lifting wing theory

9.2 11:30-11:45 - Stefan Domokos
Method for computing the energy of H2, HF, BH, H2O, CH4, H2SO4, diamond with the valence bond and molecular orbital theories using MATLAB R2014a and obtaining the monotone increase of the total energy of the electrons when the internuclear distance increase

9.3 11:45-12:00 - Vladimir Ungureanu, Madalina Boca
Elements of Chaos Theory; Applications in Biological Systems

9.4 12:00-12:15 - Rădoacă-Dogaru Andrei-Ioan
Brane Gas Cosmology with Compact Time

9.5 12:15-12:30 - Dana Maria IOAN, Mihai DRAGOMIR, Florin Vlad IANCU, Roxana ZUS, Mihai MARCIU, Virgil BARAN
The space-time acceleration and the interplay between matter and geometry

9.6 12:30-12:45 - Dana Maria IOAN, Mihai Dragomir, Florin Vlad IANCU, Roxana ZUS, Mihai MARCIU, Virgil BARAN
Observational effects in extended cubic gravity theories

9.7 12:45-13:00 - Mihai DRAGOMIR, Mihai MARCIU, Dana Maria IOAN, Virgil BARAN, Roxana ZUS
Cubic gravity theory based on third order contractions of the Riemann tensor-Observational constraints

9.8 13:00-13:15 - Florin Vlad IANCU, Dana Maria IOAN, Mihai DRAGOMIR, Roxana ZUS, Mihai MARCIU, Virgil BARAN
Cosmological aspects of new scalar tensor models - theory and observations

9.9 13:15-13:30 - Cristian IORGA
Interference between discrete quasi-bound and free electron states in the angular distribution of photoelectrons

9.10 13:30-13:45 - Andrei Constantin, Madalina Boca
Interaction of atomic systems with helical beams

9.11 13:45-14:00 - Ligia-Maria POMÂRJANSCHI, Dragos Iustin PALADE
Analysis of turbulent transport in tokamak plasmas through test-particle simulations and neural network predictions

9.12 14:15-14:30 - Ioan M. DINU, Ioana DUMINICA, Adam JINARU, Bogdan DOBRESCU, Calin ALEXA
Resonant production of vectorlike quarks at the HL-LHC

9.13 14:30-14:45 - Hammad Rasheed
Phenomenological Minimal Supersymmetry Scan using Run 2 ATLAS searches

9.14 14:45-15:00 - Petre-Constantin Boboc
Latest results from precision measurements at the NA62 experiment

9.15 15:00-15:15 - Matei-Stefan Filip, Otilia Ducu, Julien Maurer
Rate of Fake Tracks in Dense Environments Using Run3 Data in the ATLAS Experiment

9.16 15:15-15:30 - Daniel-Cristian COSTACHE, Dorel PIETREANU
Simulation of a plastic scintillating detector using the GEANT4 framework

9.17 15:30-15:45 - Eduard George STAN, Andrei GHEAȚĂ
GPU-friendly boundary representation geometry model for simulation

9.18 15:45-16:00 - Murat ABLAI
Revisiting Shannon Information Theory in Particle Physics and Nuclear Interactions

9.1 On the derivation of three singular integral equations arising in lifting wing theory

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Keywords: Singular integral equations, Calderón-Zygmund operator, Holder functions

Singular integral operators play a significant role in the field of aerodynamics, particularly in the theory of lifting wings. They are of the type of integral operators where the kernel is singular and the sometimes the integrand becomes unbounded at some points within the domain of integration, which typically correspond to points of physical significance such as leading edge or trailing edge.
Singular integral operators arise when applying boundary conditions, such as the no-penetration condition on the surface of an airfoil or wing, which leads to integral equations with singular kernels. This step, of evaluating the limit, is usually carried out more or less formally. In this paper, we deal with three examples from theory of lifting wing where we shall proof rigurously these limit evaluations.

9.2 Method for computing the energy of H2, HF, BH, H2O, CH4, H2SO4, diamond with the valence bond and molecular orbital theories using MATLAB R2014a and obtaining the monotone increase of the total energy of the electrons when the internuclear distance increase

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Keywords: Computation; Valence bond; Molecular orbital

With the wave function c(ab+ba)+aa+bb [1], using MATLAB, we computed all the integrals for the H2 molecule, by variation of the internuclear distance and the shielding constant [2], and we obtained the energy -31,4511 eV, the internuclear distance 1,46 a0, the percent of the Heitler-London wave function 2,8688, the shielding constant 1,193, and monotone increase of the total energy of the electrons when the internuclear distance increase, that lead to the minimum of the energy as the sum of two monotone energies, the electrons energy and the internuclear energy, and by quadratic fit of the total energy of the H2 molecule with MATLAB we obtained y=6,1*x^2-18*x-18 eV, and computation of many integrals for the energy of the HF molecule [3], and all the integrals of BH molecule [4], we obtained the results from these papers, and if we will compute the integrals for the energy for the H2O molecule [5], [6], for the CH4 molecule [5], for the H2SO4 molecule [7], and for the diamond [8], we will show that the total energy of the electrons has monotone increase when the internuclear distance increase and the angle between the bonds is resulting by adding the electrons energy to the internuclear Coulomb energy.

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9.3 Elements of Chaos Theory; Applications in Biological Systems

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Keywords: logistic map, classical chaos, neural bursting

We start with some simple simulations of biological systems such as spreading of a virus or prey-predators models, based on several variants of the logistic map. In each case we study the properties of the temporal evolution of our model systems in their dependence on the parameters of the logistic map. We define and study the attractors and the bifurcations, and then extend our analysis to the theoretical Henon-Heiles system.

Next, we study one of the currently available neuron models: the Morris–Lecar model. We start with a simple presentation of the main characteristics, we define the phenomenon of neural bursting and spiking, and study the bursting behaviors of the Morris-Lecar model.
All the numerical results in presented in our work were obtained with simulation codes written in Python.

9.4 Brane Gas Cosmology with Compact Time

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Keywords: cosmology, branes, T-duality

Brane Gas Cosmology (BGC) is a well-known proposal to explain the dimensionality of spacetime and resolve the initial singularity of the Big Bang Model, among other features, starting from a compact (9+1)-dimensional universe populated by strings and membranes of various dimensions, in thermodynamic equilibrium. The main mechanism for the decompactification of only 3 dimensions is brane-antibrane annihilation. Simulations by Easther et al (2004) have shown that indeed the corresponding Einstein-Boltzmann equation tends to favor 3 large dimensions, but the other 6 still decompactify too fast. Based on an observation by Gibbons on branes on toric spaces, we attempt to balance the Einstein-Boltzmann equation by allowing branes to wrap a compact temporal dimension as well. We discuss cosmological implications of such a model of BGC.

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9.5 The space-time acceleration and the interplay between matter and geometry

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We discuss the possible emergence of the dark energy phenomenon due to the specific relation between matter and geometry, considering a viable theoretical model based on the interplay between the Einstein tensor and the Energy-momentum tensor. In this unorthodox theory the geometry and matter are considered on equal footing, leading to the matter cre-

ation or annihilation at the background level. For the linear decomposition, the present model represents an unusual step towards a more tangible gravity theory.

9.6 Observational effects in extended cubic gravity theories

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Keywords: cosmology, dark energy, expansion

In this presentation we shall discuss various physical effects associated to the expansion of our Universe, considering a theoretical model based on specific couplings with a cubic invariant. Analyzing data from cosmic chronometers, baryon acoustic oscillations, supernovae, and quasi-stellar objects (QSOs) we study the physical implications and the possible constraints of several constant parameters. The presentation extends our recent paper [1].

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9.7 Cubic gravity theory based on third order contractions of the Riemann tensor-Observational constraints

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The paper [1] studies different observational features in the case of a specific cubic gravity theory, based on third order contractions of the Riemann tensor. Considering viable cosmic chronometers data, baryon acoustic oscillations, and supernovae, we analyze the viability of such a theoretical model, obtaining specific constraints for different parameters in the current scenario. It is shown that the present extension of the ΛCDM cosmological model is compatible with recent data sets. The results indicate that the dark energy equation of state is exhibiting a phantom regime in the near past in the case of the best fitted values, a behavior which is in agreement with various phenomenological studies.

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9.8 Cosmological aspects of new scalar tensor models - theory and observations

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In this presentation we shall discuss the emergence of the gravitational interaction in recent cosmological theories based on scalar fields. After a short overview of the speculative domain, we plunge into recent theories, analyzing the possible influence of the background expansion due to the appearance of scalar fields in the corresponding action. Lastly, we confront our cosmological theory with recent data from cosmic chronometers, baryon acoustic oscillations, and supernovae.

9.9 Interference between discrete quasi-bound and free electron states in the angular distribution of photoelectrons

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The quasi-bound states are incorporated in the photoionization cross section by means of discrete-continuum perturbation theory [1]. The corresponding angular distribution of photoelectrons is determined within the density matrix formalism [2]. This treatment provides an efficient method of incorporating the configuration interaction between discrete and continuum states for any microscopic model of choice in conjunction with Born or distorted wave approach for free states, showcasing net improvement over the isolated-resonance and independent-processes approximation [3-5]. This model is directly applicable to central field systems, such as small molecules, atoms or nuclei, for modeling the angular distribution of ejected particles after the interaction with plane or twisted wave projectiles, and is easily amendable to account for more complex systems.

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9.10 Interaction of atomic systems with helical beams

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Keywords: helical beams, orbital angular momentum, bound-bound transitions

We present a study of the interaction of helical modes of the electromagnetic field with hydrogen-like atoms. Helical modes of the electromagnetic field [1] are particular solutions of the Maxwell equations, carrying orbital angular momentum (OAM). After the publication of the theoretical paper of Allen, OAM carrying laser fields were demonstrated experimentally and currently are used in many applications. In our work we compared two theoretical descriptions presented in the literature for helical beams: Bessel (B) and Laguerre-Gauss (LG). For each, we studied the spatial distribution of the intensity in its dependence on the beam parameters, and then calculated the bound-bound transition probability of a hydrogen-like atom interacting with such a field. We present numerical results for the transition cross section corresponding to (B), respectively (LG) beams for different parameters and asses the possibility to observe in an experiment the difference between the two cases.

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9.11 Analysis of turbulent transport in tokamak plasmas through test-particle simulations and neural network predictions

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Keywords: tokamak fusion plasma, turbulent transport, test-particle simulations, neural networks

In this work, we detail the methodology for using neural networks (NNs) to predict turbulent transport. The study focuses on magnetized fusion plasmas in tokamak devices, where the radial transport is driven through electrostatic microturbulence. This transport is quantified through macroscopic transport coefficients, i.e. convection and diffusion, which are obtained using test-particle simulations, or direct numerical simulations (DNS) [1]. At a statistical level, DNS simulates the motion of charged particle guiding centers in stochastically generated random fields associated with turbulence. Using the DNS numerical code, we created a database of plasma parameters and transport coefficients, on which we trained and tested the NN model [2]. Our results show that the NNs are orders-of-magnitude faster than traditional test-particle simulations, with a validation error below 2% and excellent agreement between predictions and real data [3]. Additionally, in terms of extrapolation and prediction, the neural network outperforms spline interpolation.

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9.12 Resonant production of vectorlike quarks at the HL-LHC

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Keywords: Diquark Scalar, Monte Carlo, Machine Learning, HL-LHC

We investigate the potentially observable consequences of resonant production of vectorlike quarks through a diquark scalar, Suu, in proton-proton collisions at the LHC energy. For this study, we consider the vectorlike quark decay into a W+ boson and a b quark, leading to a 6-jet final state. We focus on studying the 7 and 8.5 TeV mass Suu, for 13 and 13.6 TeV LHC, analyzing its signature particularly through the ATLAS and CMS detectors. Based on comprehensive Monte Carlo (MC) simulations, we developed a dedicated Machine Learning (ML) algorithm for separating signal events from the associated background. Three different models are described (Boosted Decision Tree, Random Forest and Neural Networks), choosing the most efficient one. We show that the background can be reduced to a negligible level by choosing high-purity working points. A signal-background discriminant is defined based on all variables used in the ML algorithm.

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9.13 Phenomenological Minimal Supersymmetry Scan using Run 2 ATLAS searches

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Supersymmetry (SUSY) provides elegant solutions to several problems in the Standard Model (SM), and searches for SUSY particles (sparticles) are an important component of the Large Hadron Collider (LHC) physics program. The most considered SUSY model is the minimal supersymmetric Standard Model (MSSM), which is the minimal possible extension of the SM. The MSSM contains 120 free parameters, which are large enough to handle and can be reduced to the phenomenological MSSM (pMSSM), which has 19 free parameters. This talk aims to present the latest studies for the SUSY-inclusive searches within the pMSSM framework. The study is performed using the 13 TeV RUN 2 data collected with the ATLAS experiment, which corresponds to an integrated luminosity of 139 fb-1. The study aims to quantify the exclusion strength of the Run 2 searches. Full 19 pMSSM scanning parameters generate the models to encapsulate the rich phenomenology of SUSY. It covers the R-parity-conserving SUSY models. The sparticles must be produced in pairs. The lightest supersymmetric particle (LSP) is stable through strictly enforcing R-parity conservation and weakly interacting. The LSP may be considered a viable candidate for the dark matter particle. The main targets are gluinos and squark(light flavor) in strong production and charginos and sleptons in electroweak production.

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9.14 Latest results from precision measurements at the NA62 experiment

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The NA62 experiment at CERN collected the world's largest dataset of charged kaon decays in 2016-2018, leading to the first measurement of the branching ratio of the ultra-rare $K^+ ightarrow pi^+ u ar{ u}$ decay, based on 20 candidates. In this talk two NA62 analyses are reported using the data samples collected in 2017 and 2018. $K^+ ightarrow pi^+ gamma gamma$ decay is analysed, decay collected using a minimum-bias trigger and the results include measurement of the branching ratio and study of the di-photon mass spectrum. Also, the first search of production and prompt decay of an ALP with gluon coupling in the $K^+ ightarrow pi^+ A, A ightarrow gamma gamma$ process is performed. A sample of $pi^0 ightarrow e^+ e^-$ decay candidates was collected and preliminary results of the branching ratio measurement is presented.

9.15 Rate of Fake Tracks in Dense Environments Using Run3 Data in the ATLAS Experiment

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The Large Hadron Collider (LHC) along with its upcoming High Luminosity upgrade, will continue to drive particle physics research in the next decade, probing fundamental properties of matter and interactions at unprecedented energies. This study focuses on understanding charged particle trajectories within hadronic jets, crucial for unraveling complex quantum chromodynamics processes. Jets, collimated streams of hadrons, are reconstructed from calorimetric data, augmented by trajectory information from the Inner Detector. Additionally, "particle flow" [1] methods are employed in order to enhance jet reconstruction efficiency by leveraging data from the entire detector system. However, reconstructing trajectories within high-momentum jets presents challenges, including increased misreconstruction rates due to overlapping tracks and experimental noise [2, 3]. Fake tracks, originating from nearly collinear tracks within jet cores and random overlapping tracks, contribute significantly to misreconstruction rates, especially in highdensity environments. To estimate the rate of fake tracks in real data, we rely on the agreement between Monte Carlo (MC) simulation results and physical data acquired by the ATLAS detector in Run3 in order to employ a fitting approach utilized in a control region enriched with fake tracks. This is further aided by dedicated studies utilizing MC simulations to discern variables capable of discriminating fake tracks such as the number of Semiconductor tracker hits and holes. The choice is guided by the quality of the modelling of such variables when compared with collision data. These fit results are then extrapolated to the pre-selection region in order for us to present the final uncertainty value in the rate of fake tracks.

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9.16 Simulation of a plastic scintillating detector using the GEANT4 framework

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GEANT4 is a C++ Monte Carlo simulation framework, developed primarily at CERN to aid in modelling the passage and interactions of particles through different media. GEANT4 allows the user to customize the experimental setup and permits complex geometries to be utilized in the simulation. The framework provides the tracks of the particles and the deposited energy, allowing the output of data so it can further be used in analysis. GEANT4 can also be used for the visualization of said tracks. In this study, GEANT4 was used to simulate a setup based on a plastic scintillating detector and to test its response when exposed to incident radiation. The setup was successfully simulated and the results have been plotted using the ROOT framework.

9.17 GPU-friendly boundary representation geometry model for simulation

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The SFT simulation R&D group is working on optimizing the performance of the Geant4 particle transport simulation toolkit. This includes porting the simulation software to accelerator hardware such as graphics processing units (GPUs), which often implies major rewrites of simulation components. One of the current projects targets developing a surface-based geometry model within the VecGeom library, to mitigate the geometry performance overhead observed in GPU simulations with the current 3D-solid modeling approach. The project is in a phase where the base required functionality is implemented, but several areas are still incomplete, in particular providing surface support for the full set of supported 3D-solid primitives. This project targets extending the set of supported 3D solids to be meshed, including the unit test coverage, and integration with the GPU particle transport framework.

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9.18 Revisiting Shannon Information Theory in Particle Physics and Nuclear Interactions

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Shannon information theory, a key concept from communication and data science, offers new insights when applied to particle physics and nuclear interactions. This approach measures the information content and randomness in complex quantum systems, connecting mathematical concepts with physical phenomena. Revisiting Shannon's framework, we explore its ability to reveal patterns and connections in the behavior of subatomic particles.
By viewing particles as carriers of information, we use entropy and information theory concepts to better understand particle collisions, decay processes, and nuclear reactions. Our framework employs Shannon entropy to examine the distribution of states in particle physics experiments, providing a fresh perspective on experimental data. This method can help identify hidden patterns and anomalies that traditional approaches might miss. For example, in high-energy collisions, information-theoretic measures can quantify the randomness and complexity of particle production, revealing the mechanisms behind these events.
By combining information theory with particle physics and nuclear science, we can open the door to more accurate and insightful interpretations of quantum phenomena. This multidisciplinary approach has the potential to advance both fields, leading to innovations in experimental techniques and theoretical models, further enhancing our understanding of the world.

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