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Bucharest University Faculty of Physics 2023 Meeting

1.**Atmosphere and Earth Science; Environment Protection**
Location and Time: Rm. 27, 3rd fl. *Moderators:* Lect. Dr. Gabriela IORGA, Assoc. Prof. Dr. Cristian NECULA
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Location and Time: Nuclear spectroscopy Lab *Moderators:* Assoc. Prof. Dr. Mircea BERCU, Assoc. Prof. Dr. Vasile BERCU
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Location and Time: Biophysics Lab, 3rd fl. *Moderators:* Prof. Dr. Aurel POPESCU, Assoc. Prof. Dr. Claudia CHILOM
4.**Nuclear and Elementary Particles Physics**
Location and Time: Amf. 4 *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 *Moderators:* Lect. Dr. Sanda VOINEA, CS1 Dr. Cornelia Nichita
6.**Physics Education**
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7.**Polymer Physics**
Location and Time: Rm. 47, 3rd fl. *Moderators:* Prof. Dr. Valentin BARNA, Assoc. Prof. Dr. Cătălin BERLIC
8.**Solid State Physics and Materials Science, Optics, Spectroscopy, Plasma and Lasers**
Location and Time: Rm. 22, 2nd fl. *Moderators:* Prof. Dr. Alexandru NEMNEŞ, Assoc. Prof. Dr. Vlad Antohe
9.**Theoretical Physics and Applied Mathematics**
Location and Time: Amf. 3 *Moderators:* Prof. Dr. Virgil BĂRAN, Lect. Dr. Roxana ZUS

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

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Attribution of extreme daily temperature to anthropogenic and natural factors, based on observational data

1.2 - Genica - Liliana SĂFTOIU GOLEA, Bogdan ANTONESCU, Sabina ȘTEFAN, Gabriela IORGA

A comparison between the characteristics of low clouds above two regions with different climates

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1.1 Attribution of extreme daily temperature to anthropogenic and natural factors, based on observational data

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PhD students in authors' list

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Keywords: extreme temperature, attribution, anthropogenic and natural causes

In the context of global warming, the global impact of extreme phenomena is increasing, with implications on societal systems such as health, agriculture, economy, infrastructure. Attribution of extreme events is mainly performed using model simulations, but they require large computational resources and their accuracy depends on model limitations. Complementary with model simulations, we performed a multivariate analysis of global daily extreme temperature fields extending over the period 1950-2021. Through the analysis we identified two separate components, whose properties make it possible to associate them with anthropogenic and natural factors. Whereas one is associated with a centennial trend related to increasing atmospheric CO2 concentration, of anthropogenic origin, the other is characterized by interdecadal fluctuations corresponding to the Atlantic multidecadal oscillation, a natural mode of variability. Our results make it possible to quantitatively highlight the contribution of anthropogenic and natural factors to temperature extremes in all regions of the globe. These arguments can assist government policy makers in formulating adaptation strategies to the increasing frequency and magnitude of extreme temperatures in a warming world.

1.2 A comparison between the characteristics of low clouds above two regions with different climates

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Keywords: low clouds, satellite data, albedo

Because clouds play an important role in the Earth's radiative budget and on Earth's climate, hourly satellite data from the Clouds and the Earth's Radiant Energy System (CERES) database (i.e., SYN1DEG-1Hour) were extracted for Bucharest and Cluj-Napoca, two areas under different climates, in the time frame between March 2000 and March 2022. The low clouds classification (thin, medium and tick) and their occurence were the primary goals of the study. Secondly, a comparative analysis of a series of macrophysical and microphysical cloud parameters (e.g., albedo, cover fraction, optical depth, liquid water path, and water radius) has been performed. Thin clouds proved to appear with highest frequency over both cities: 58.57 % (Bucharest) and 52.38 % (Cluj-Napoca), followed by the medium (35.85 % for Bucharest and 43.63 % for Cluj- Napoca) clouds. The thick clouds are significantly less

frequent over Cluj-Napoca (3.97%) than over Bucharest (5.57 %). The study revealed differences between the cloud properties. We observed that while median cloud optical depth is higher for thin clouds over Cluj-Napoca than for the clouds over Bucharest, this parameter has higher values for clouds over Bucharest in cases of medium and thick clouds. The relative difference of the median effective radius of cloud droplets in Cluj-Napoca versus Bucharest ranged between about 2% and 6%, showing the clouds over Cluj-Napoca have larger droplets than the more polluted clouds over Bucharest. This resulted in more reflective medium and thick clouds over Bucharest than over Cluj-Napoca. The differences in cloud characteristics for each urban area provide important information for researches targeted to the understanding of the aerosol-cloud interaction, the formation and evolution of low clouds.

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1.3 On the organization of passive shallow cumulus clouds

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Keywords:

The shallow cumulus clouds are ubiquitous in the atmosphere, populating a large part of the subtropical oceans. As a result, numerous studies investigated the organization of cumulus clouds and their interaction with the climate. However, the organization of passive shallow clouds and their impact on the atmospheric convection received very limited attention. In this work, we perform a series of large eddy simulations in order to investigate how the organization and the total cloud cover depends on the relative humidity of the environment. We show that although the active cumulus clouds size only shows a weak correlation with the relative humidity, the passive clouds size is very sensitive to it. We also show that the cloud cover of the shallow cumuli is very sensitive to the relative humidity. We explain the organization of passive shallow cumulus clouds through a conceptual picture.

1.4 Shallow convection memory might explain the transition from shallow to deep convection

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Keywords: Convection, Transition, Cumulonimbus, Dynamical model

The initiation of storm convection in a diurnal cycle is still poorly represented in the weather prediction and general circulation models. This leads to a poor forecast of severe events and large climate uncertainty. The reason for this is represented by our poor understanding of the physical mechanisms controlling the transition from shallow to deep convection. On one hand, the shallow preconditioning is too slow to explain the rapid transition, and on the other hand, the transition is too slow too be explained by a single starting plume developing in the cloud layer. In this work, we discuss the role of shallow cumuli in the initiation of deep convection. By using a simple entraining plume model, we show that the interaction between a convective plume and a passive shallow cumulus helps the former to reach higher altitudes and, in the right conditions, may initiate deep convection. A large-eddy simulation is also performed to simulate a transition from shallow to deep, and we show that indeed the interaction between the passive and active shallow clouds helps the updrafts to better preserve the buoyancy, and thus, to reach higher altitudes. In addition, although the passive cumuli only occupies a very small fraction, the new clouds prefer to develop exactly in the place of the old passive ones. This suggest that the passive clouds, due to their moisturizing effect, change the structure of the transition layer. Therefore, our results suggest that the shallow convective memory is very important in the convective cycle, and it might explain the rapid transition from shallow, non-precipitating, cumulus to deep, precipitating, storm convection. We then propose a predatory-prey dynamical model for shallow and deep convection with shallow memory and cold pools effects.

1.5 The impact of icing phenomena in aviation - study case

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Keywords:

Icing is a hazardous weather phenomenon for aviation. The effect of this phenomenon consists in an accumulation of ice that can affect an aircraft on the ground, during take-off, landing or during flight through clouds, being favored by certain weather conditions. The purpose of this study is to determine the regions in the Romanian airspace where icing situations were reported, their intensity, as well as the meteorological conditions that favored them. The study of meteorological conditions associated with icing involves a deeper knowledge of the responsible phenomena related to the phase transformations of water in the atmosphere, in general, and in clouds, in particular. The study uses the database containing the pilots' reports regarding icing situations encountered during the flight for the period 2019-2020. This database belongs to the management of ROMATSA (Romanian Air Traffic Administration), which deals with the provision of air traffic services, aeronautical meteorological services, aeronautical information services, etc. In addition, data obtained from geostationary weather satellites, international images from NOAA's National Weather Service, Eumetsat, aeronautical charts for flight planning from Sky Vector Aeronautical Charts, Windy application were also used. The obtained results show very clearly the areas where icing occurred for the planes parked on the ground in 3 of the 7 airports and those during the flight, demonstrating that the study methods used allow surveys for longer periods of time, especially during late autumn, winter and late winter.

1.6 Measurements of radon concentration in selected laboratories of the Faculty of Chemistry of the University of Bucharest

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Keywords: RADON

Indoor air quality in a public buiding is of high importance especially in homes, offices, schools or universities, where people spend more than a half of their time. Measuring the indoor radioactive noble gas radon is, therefore, crucial as both the World Health Organization and the International Agency for Research in Cancer have identified radon as a first order human carcinogen. With regard to radon exposure in workplaces, each state imposes certain reference levels. Within the European Union, the Directive No 59/EURATOM on 5 December 2013 by Council of Europe recommends a value of 300 Bq m-3 not to be exceeded. The aim of this work is to monitor the radon concentration in five laboratories of the Faculty of Chemistry of the University of Bucharest. The selected rooms for the present study are used by both professors and students, and some of them store the sources of ionizing radiation. The main source of radon indoor buildings is the soil from which radon is constantly released. Building materials are also an important source of radon. The indoor radon concentrations are measured by Airthings Wave smart detectors Measurements were made between October 2020 and April 2021 and show that radon concentrations vary between 28 Bq/m3 and 120 Bq/m3, with an average of 40 Bq/m3. The maximum imposed level of 80Bq m-3 was never exceeded. In a single laboratory the activity concentration of radon reached higher values, up to 120 Bq/m-3. The data obtained showed a low risk from the point of view of radon exposure for students, while for professors, who spend a significantly higher time inside the laboratories, it is recommended to wear a respirator mask and to limit the exposure time when handling samples subjected to irradiation with neutron irradiation More ventilation is recommended especially after the weekend.

1.7 A leap towards cultural heritage secrets

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Keywords: GPR, built cultural heritage, non-destructive investigations

This research provides an up to date overview upon the advantages and characteristics of Ground Penetrating Radar (GPR) in the documentation, survey, detection and research of cultural heritage sites and goods, presenting case studies and original developments. The paper highlights the most recent and valuable contributions in the field, performing a consistent assessment over the existing literature. Based on the study of electromagnetic waves propagation with wavelengths ranging within the radio spectrum, GPR is able to provide assessment of the structural integrity, to investigate materials compaction and nature, and to find the accurate location of buried features and structures. In terms of deliverables, GPR offers a reflection image generated by the interaction of radio waves with subsurface features (reflection, refraction), with frequencies ranging from 10 MHz up to 4 GHz, that represents a map in amplitude of what lies beyond our sight. The paper presents the recent works conducted within

the frame of heritage preservation worldwide, showing the growing need for research and development of this geophysical method. The challenges raised by the understanding and unveiling of specific features from architectural monuments, archaeological sites, artworks and other types of tangible cultural heritage, are reflected in the intelligent strategies for data extraction. By non-invasive means GPR is able to provide valuable information from a variety of casuistry, such as: revealing the state of conservation for mural paintings by mapping the distribution of cracks [1], highlighting the structural features regarding the component materials; locating with high accuracy buried tombs residing beneath ancient monasteries[2]; pointing out the level and dampness distribution in archaeological sites and buildings trough evaluation of materials dielectric properties[3] etc. Based on its response, GPR data can be visualized in 3D by taking into consideration the reflections amplitudes, this feature allowing a better understanding of what lies underneath the surface.

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1.8 Airborne and satellite-based assessment of CH4 at a regional scale in Romania

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Keywords: Methane, Satellite data, Airborne, Climate change, Atmosphere

Methane is a potent greenhouse gas with a significant impact on Earth's atmosphere and on climate. To better understand its distribution and sources, satellite data and airborne measurements have been utilized worldwide. In Romania, studies on methane have just begun and researchers are turning to use both remote and in situ measurements to gain insights into the country's contribution to the global methane budget and its impact on the local atmosphere. The present study will show a part of the results from monitoring campaigns that have been conducted over the Bucharest and Ploiesti area, during the time period 2021-2022, within the Technical Assistance for a Romanian Atmospheric Mobile Observation System (RAMOS) and Atmospheric Composition Uncertainty Field Studies (QA4EO) projects. The measurements were performed with the instrument Picarro G2401 which is based on the "cavity ring-down spectroscopy" (CRDS) technique, mounted onboard the BN-2 Islander research aircraft, operated by the National Institute for Aerospace Research “Elie Carafoli” (INCAS) in Bucharest, Romania. The importance of continued monitoring and efforts to reduce methane emissions in Romania is also emphasized, as well as the critical role that satellite data and airborne measurements can play in providing a comprehensive understanding of the methane problem. Outcomes of present research provide crucial information on the distribution and sources of methane to policymakers and stakeholders working to address this critical issue of the country's methane emissions and atmospheric concentrations, at least on a regional scale.

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This study was also supported by the RAMOS - Technical Assistance for a Romanian Atmospheric Mobile Observation System project funded by European Space Agency under grant number 4000118115/16/NL/FF/gp, by the QA4EO - Atmospheric Composition Uncertainty Field Studies project funded by European Space Agency under the grand number 4000128426/19 /NL/FF/ab. This study was made with the help of Copernicus Sentinel data for year 2021 processed by Sentinel Hub (https://s5phub.copernicus.eu/dhus/#/home).

1.9 Comprehensive analysis of air quality monitoring (PM2.5, PM10) using low-cost sensors in Bucharest and Cluj

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Keywords: air quality monitoring, particulate matter, statistical analysis, short-term prediction, ARIMA model

Air quality monitoring is essential for understanding environmental conditions and protecting public health. This study aims to comprehensively analyze air quality in Bucharest and Cluj by focusing on particulate matter (PM2.5, PM10) concentrations. The study aims to assess the levels, variability and distribution of PM2.5 and PM10 concentrations, to identify spatial and temporal patterns, and to do short-term predictions for air quality. Particulate matter data was collected using low-cost sensors located across Bucharest and Cluj. Statistical methods, including descriptive analysis and the Autoregressive Integrated Moving Average (ARIMA) model were applied to the PM data series. The

ARIMA model, a time series analysis technique, was used to make short-term predictions based on historical data. The statistical analysis revealed significant spatial and temporal variations in PM2.5 and PM10 concentrations in the two cities. Pollution hotspots were identified, highlighting areas with high pollution levels. The study demonstrates the effectiveness of statistical methods, particularly the ARIMA model, in analyzing and predicting air quality in Bucharest and Cluj. The study also emphasizes the importance of continuous monitoring and data-driven approaches for improving air quality and public health in urban areas. The study findings support the implementation of effective strategies and policies to mitigate air pollution and create healthier living environments in Bucharest and Cluj.

1.10 Observational study of major air pollutants over urban Romania from ground-based measurements

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Keywords: air quality, urban air pollution, East Europe, PM10, PM2.5, NO2, CO, SO2, O3

This study aimed to characterize urban air pollution in 33 cities across Romania in 2019 and 2020. The atmospheric main pollutant mass concentrations, particulates PM10 and PM2.5 and gaseous species NO2, CO, SO2, O3, were extracted from the database of the National Air Quality Monitoring Network from 01.012019 to 31.12.2020. The time-series were statistically analyzed for each city for the representative month of each season and then used to estimate the pollutant impact on the surrounding regions. Results show significant decreases for most pollutants in most cities especially spring of 2020. Maps of interpolated mass concentrations reveal regional significant differences with pollutant-specific hot- and cold-spots in Romania. In addition to social and traffic restrictions, the decreases are higher or lower depending on other factors (topography, climatic factors, degree of industrialization of the area, etc.). This work constitutes a good database to characterize de urban air pollution in major cities and the spatial distribution of their impact around and could help the authorities in their measures to better control pollutant emissions or to investigate the impact on population health under various future economic development scenarios.

Acknowledgement:
Research in this work received funding from the NO Grants 2014-2021, under contract no. 31/2020, EEA-RO-NO-2019-0423 project. Data regarding ground-based air pollutants and local meteorology were extracted from the public available Romanian National Air Quality Database, www.calitateaer.ro, last accessed in December 2021.

1.11 Assessment of air pollution by aerosols over a coal open-mine influenced region in southwestern Romania

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Keywords: air quality, PM10, PM2.5, PM1, TC, coal, opencast mining

Mining activity in open-pit coal sites exerts a high pressure over the surrounding environment and on the health of people working and living nearby, as higher levels of particulate matter could increase their risk to develop various diseases. The aim of this study was to capture the level of exploitation activities in the residential area close to the coal open-mine in terms of mass concentrations and total carbon fractions (TC) of ambient PM10, PM2.5 and PM1 samples. Two sampling campaigns during 10 successive days (5-14 April 2018) and during 5 successive days (12-16 January 2019) covered both working (full time, part-time and non-working days) at the coal exploitation. Additional campaigns in summer and autumn of 2019, in winter 2019-2020, and in spring of 2020 were performed to capture the seasonal variations of different fractions of PM and of TC component. Fine fraction was also analyzed based on the aerosol Angstrom exponent, determined from measurements of the aerosol scattering coefficient at 450 nm, 550 nm and 700 nm by a nephelometer which operated at 1-min resolution. The mass concentrations of PM and TC showed significant variations from full time working days to non-working days. Insights into the morphology of particles and elemental composition were obtained by scanning electron microscopy (SEM) and energy dispersive x-ray (EDX/EDS) analysis. Major elements that were identified C, O, Si, Ca, K, S, Cu, Ni, Fe, Mg, Ti have both crustal and anthropogenic origin, in various proportions.

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1.12 Temporal trend analysis of trace gases in South – Eastern Romania over the past 15 years

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Keywords: NO2, CO, SO2, O3, Romania, trend analysis

The air quality degrades due to presence in the atmosphere of high levels of atmospheric pollutants. Pollutants also affect the climate and have significant impacts on human health. As South-Eastern Romania (SERo) represents a region under the significant droughts and increasing temperatures due to climate changes, it became important to understand the spatial distributions and contributions of gaseous pollutants to the ambient pollution levels as well as the changes of pollution atmospheric loads across this area. In the present study, datasets comprising hourly concentrations of NO2, CO, SO2 and O3, collected from three monitoring stations were obtained from the National Air Quality Network (RNMCA) over 15 years (2007–2021) and trend analysis was performed. Moreover, the statistical analysis we conducted on the trace gasses showed the areas with lowest and/or with highest concentrations. These changes in the concentration levels seem to be affected by both physical geographical factors and the local economic factors (traffic, industry type, agricultural and biomass burning activities). Our present work shed light on NO2, CO, SO2 and O3 pattern and temporal variations, and the study findings help on both the identification of main pollution sources and for refinement of future pollution mitigation strategies applied to the regional scales.

Acknowledgement:
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1.13 Satellite mega constellations: operational risks and impact on astronomic ground-based observation

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Keywords: Starlink, LEO, satellite, SpaceX, mega constellations, operational risks, astronomy, ground-based observations

More than half of the active satellites currently on Low Earth Orbits (LEO) belong to the Starlink mega-constellation. Many more satellites are to come, while just 10% of the scheduled Starlink satellites have been launched on their operational orbits, and more than 40,000 slots are reserved by the Starlink owner company. This unprecedented agglomeration of LEO is just at the beginning, the scientific community prediction is that until year 2030 up to 100,000 satellites are to be deployed in low Earth orbits, clustered in several mega-constellations. This will tremendously increase the orbital maneuvers, potential collisions on orbits and consequently the number of space debris. Beside this, problems for the worldwide astronomical community regarding ground-based observations should be immediately accounted. The presentation analyzes the stage of the configuration of the Starlink mega-constellation and refers the measures taken by the operator SpaceX in regards to one of the major concerns - reducing the harmful effects of the reflection of sunlight by satellites. A synthesis of several relevant scientific articles that present different methods of evaluating the impact of these satellites on astronomical observations and also their solutions is presented. These aspects will be treated in two Deep Learning methods for automatic classification of images affected by satellites, images from the

Hubble Space Telescope archive. The presentation will focus also on the planed scientific activities on this subject in Romania and more specifically in the Astronomical Institute of the Romanian Academy.

Acknowledgement:
Astronomical Institute of the Romanian Academy

1.14 Automated photometric survey of inactive satellites (APSIS)

Mirela Mădălina TRELIA[1,2], Dan Alin NEDELCU[2,3], Mirel BIRLAN[2,3,1]
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Keywords: space debris, light-curves, photometry, rotational dynamics

The last decade is marked by a significant increase in the number of artificial space objects orbiting the Earth. The Astronomical Institute of the Romanian Academy (AIRA), as a participant in the EUSST consortium, conducts astrometric astronomical observations for artificial space objects located in orbits between 1000 and 36,000 kilometers in altitude (MEO, GEO, HEO orbits). Recently, within AIRA, an extended photometric study of inactive satellites located in graveyard orbits, where all decommissioned geosynchronous satellites reside, has been initiated. The Automated Photometric Survey of Inactive Satellites (APSIS) program, which generates quasi- real-time data, is constantly being developed, allowing the analysis of light curves and rotation periods of the objects of interest. Each set of observations consisted of acquiring 1500 images with short exposure times (0.5s - 1s) using the HARET telescope, located at the Berthelot Observatory (MPC Code: L54) in the General Berthelot commune, Hunedoara County. Differential photometry techniques were used to determine light curves and rotation periods for a sample of visible inactive satellites during the study. The obtained light curves were compared with synthetic ones generated using a typical box-wing geostationary satellite model under various illumination conditions and phase angles. The results of these comparisons will be the basis for utilizing the light curve inversion technique to extract the physical characteristics of space objects. This presentation will include the results of observations for 20 satellites, as well as their light curves. Additionally, three of these objects were observed at different moments in time during the study, allowing for the observation of their rotation period evolution.

1.15 On near-surface site characterization surveys performed with the Atom 3C seismographs using seismic methods

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Keywords: site characterization, Spatial Autocorrelation method (SPAC), microtremor array measurements (MAM), Multichannel Analysis of Surface Waves (MASW)

Geological and geotechnical surveys of a site provide all the necessary information about the quality and properties of the soil. Atom 3C are newly 3 channels wireless seismographs which can collect passive data from ambient seismic noise (ASN) for microtremor array measurements (MAM) and active data, using a sledgehammer as a seismic source for Multichannel Analysis of Surface Waves (MASW), two geophysical methods widely used for measuring shear-wave velocity distribution at depths of tens of meters. The MAM method is based on the analysis of ASN that originates from different sources including human activities, traffic, wind and ocean waves. The MAM method can be applied using different array geometries, such as linear array, circular arrays, triangle arrays. The choice of array geometry depends on the specific requirements of the study, such as the size and shape of the study area, the desired resolution, and the availability of equipment and personnel. The MASW, on the other hand, uses surface wave signals generated by a sledgehammer as a seismic source and several seismographs placed in a linear array. For the MAM technique, data processing can be performed using the Spatial Autocorrelation method (SPAC), whereas for the MASW technique, the recorded data is converted into frequency-wavenumber spectrum. MAM and MASW methods estimate the phase velocity of the ‘passive’ (ASN) or ‘active’ (generated by artificial sources) surface waves. The phase velocity is related to the subsurface shear-wave velocity (Vs) through a dispersion relation (dispersion curve). By inverting the dispersion curve, the Vs profile of the subsurface can be determined. The Vs30 parameter (average Vs to 30 m depth) is commonly used in seismic hazard assessments to account for the local site effects and has been incorporated in seismic design codes in many countries around the world. Finally, we exemplify the application of these methods on datasets obtained using different array geometries, including L-shape, triangle or linear arrays.

1.16 A comprehensive seismic data catalogue for the Tg. Jiu (Romania) seismic sequence

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Keywords: earthquake catalogue, focal mechanism, magnitude, Gorj area

Seismic activity in Romania is complex and encounters a variety of tectonic domains, from crustal-depth earthquakes, to intermediate-depth. The seismicity that extends down to 200 km depth and which is limited in a small subcrustal seismogenic volume beneath the SE bend of the Carpathians arc, whereas crustal depth seismicity is distributed throughout the territory. The characterization of seismogenic processes and the assessment of seismic hazard are closely related to zonal seismicity. Earthquake catalogues should provide an in-depth understanding of the seismotectonic setting of the areas of interest and are essential to develop a reliable seismic source model. For this study the data used are ANTELOPE routine locations, for the seismic sequence which started in February 2023, close to Targu Jiu city, in the Oltenia region, extracted from the INCDFP catalogue. The strongest events, characterized as doublet earthquakes, occurred on 13th and 14th February, the first shock with ML=5.2, and respectively the second shock with ML=5.7. These main shocks were followed by specific seismicity bursts, at focal depths from 1 to 20 km, most of them being situated in the 10-20 km depth interval. The aim of this work is to show that by using the JHD technique we are able to better delimit

specific clusters in comparison with routine catalog locations. It is also important that a catalogue of earthquakes be as comprehensive as possible and provide a complex variety of seismic data. Therefore, in order to provide a more complex characterization for the Tg. Jiu seismic sequence, we also determined the source parameters (MW, M0, f0), along with the focal mechanisms for events with ML≥ 3. The results of this study are useful for assessing past and current tectonic activities and future research of the epicentral area.

Acknowledgement:
This study was carried out within the National Research Program (project MULTIRISC no PN19080102).

1.17 Investigating Rayleigh Wave Dispersions across the Carpathian Orogen

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Keywords: tomography, dispersion, group velocities, Rayleigh Wave

The Carpathians were formed by the collision between the Eurasian and the Tisza-Dacia units, pushed by the converging African continent. Several extensions of the Tethys Ocean were closed, so that the Dacia unit was folded and pushed over the edge of the East European Craton and the Moesian Platform, which are tectonic units of different ages and structures that behaved differently when they collided with the Dacia tectonic subunit. This can be observed in the Neogene-Quaternary magmatism associated with the subduction process, both in terms of age and chemical composition. Therefore, surface wave seismic tomography is a useful tool to decipher the complex tectonic evolution of the Carpathian orogen. To better understand how lithospheric structure on Romanian territory changes from the East European Craton to younger European microplates, we used earthquake data recorded at permanent broadband seismic stations of the Romanian National Seismic Network (RSN). We used the Multiple Filtering Technique (MFT) to investigate the dispersion of Rayleigh and Love wave group velocities for earthquakes that occurred within 4000 km of the epicenter and had a magnitude of mb > 4, recorded at the RSN(Romanian Seismic Network) between 2010 and 2017. For travel time tomography, we employed Fast Marching Surface Tomography (FMST) using an iterative non-linear inversion technique in spherical coordinates. Over 4000 seismic paths were included in the analysis, resulting in group velocity maps ranging from 30 to 80 seconds, which effectively captured depth variations between 40 and 200 km. The velocity maps obtained revealed the presence of a low-velocity body situated ahead of the Vrancea plate, indicating the upwelling of asthenospheric material due to plate subduction.

Acknowledgement:
This paper was carried out within EENSANE program (PN-III-P4-ID-PCE-2020-2972) and Nucleu Program SOL4RISC (PN2336020).

1.18 Investigation of polypyrrole/nano-TiO2 and poypyrrole/nano-WO3 nanocomposites as anode modifier in salt bridge based Microbial Fuel Cell using municipal wastewater

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Keywords: bioenergy; microbial fuel cell; anode modification; nanocomposite

Over the past decade, various materials have been investigated as modifier for microbial fuel cells (MFC) anodes, which is an important aspect for practical implementation of (MFC) in wastewater treatment. Compared with other modification strategies, the modification of MFC anode with nanocomposite materials provides considerable encouragements for developing of high-performance anode, required for practical implementation of MFC in a wastewater treatment system [1, 2]. Among them, nanocomposite of conducting polymers with carbon nanostructures or metal-oxide nanoparticles has been proved to be an effective strategy to enhance the performance of microbial fuel cell anodes, overcoming the limitations of conducting polymers such as relatively low electronic conductivity, poor electron transfer properties and poor stability in long term tests [2-4]. In this aim, the nanocomposite of polypyrrole with nano -WO3 and nano-TiO2 as anode modifier were used to investigate the performance of low cost, salt bridge based microbial fuel cells. FT-IR spectroscopy, X-ray diffraction and Scanning electron microscopy (SEM) were used for the characterization of nanocomposite materials. The power output of low cost, salt bridge based MFCs with modified anodes were compared in order to study the performance of MFC in terms of energy production.

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Acknowledgement:

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Section 2: Atomic and Molecular Physics. Astrophysics. Applications

Location and time: **Nuclear spectroscopy Lab**

Moderators:

Assoc. Prof. Dr. Mircea BERCU

Assoc. Prof. Dr. Vasile BERCU

2.1 - Mirela Mădălina TRELIA, Dan Alin NEDELCU, Mirel BIRLAN

Automated Photometric Survey of Inactive Satellites (APSIS)

2.2 - Ionuț SLABU, Tudor ȘUTEU, Alexandru NICULESCU, Mihaela COSINSCHI, Vasile BERCU, Leonard Constantin GEBAC

Artificial intelligence enhanced image analysis in atomic emission spectroscopy

2.3 - Florentina PÎSLAN, Laurențiu CARAMETE, Ana CARAMETE

Multimessenger astronomy as a tool for modeling unresolved cosmic sources

2.4 - Liliana DUMITRU, Octavian BLAGOI, Cristian DANESCU

A study of solar flares associated with a filament eruption

2.5 - Maxim ANDRONIC

Simulating the gravitational interactions of N bodies in 3D and modelling the orbit of the Sun and neighbouring stars in the Milky Way potential using Gaia data

2.6 - Cristian DANESCU, Liliana DUMITRU, Octavian BLAGOI

Special phenomena produced in the ascending phase of the solar cycle 25

2.7 - Octavian BLAGOI, Liliana DUMITRU, Cristian DANESCU

Solar radio bursts, characteristics and examples of radio bursts received by e-callisto network

2.1 Automated Photometric Survey of Inactive Satellites (APSIS)

Mirela Mădălina TRELIA[1,2], Dan Alin NEDELCU[2,3], Mirel BIRLAN[1,2,3]
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Keywords: space debris, light-curves, photometry, rotational dynamics

The last decade is marked by a significant increase in the number of artificial space objects orbiting the Earth. The Astronomical Institute of the Romanian Academy (AIRA), as a participant in the EUSST consortium, conducts astrometric astronomical observations for artificial space objects located in orbits between 1000 and 36,000 kilometers in altitude (MEO, GEO, HEO orbits). Recently, within AIRA, an extended photometric study of inactive satellites located in graveyard orbits, where all decommissioned geosynchronous satellites reside, has been initiated. The Automated Photometric Survey of Inactive Satellites (APSIS) program, which generates quasi-real-time data, is constantly being developed, allowing the analysis of light curves and rotation periods of the objects of interest. Each set of observations consisted of acquiring 1500 images with short exposure times (0.5s - 1s) using the HARET telescope, located at the Berthelot Observatory (MPC Code: L54) in the General Berthelot commune, Hunedoara County. Differential photometry techniques were used to determine light curves and rotation periods for a sample of visible inactive satellites during the study. The obtained light curves were compared with synthetic ones generated using a typical box-wing geostationary satellite model under various illumination conditions and phase angles. The results of these comparisons will be the basis for utilizing the light curve inversion technique to extract the physical characteristics of space objects. This presentation will include the results of observations for 20 satellites, as well as their light curves. Additionally, three of these objects were observed at different moments in time during the study, allowing for the observation of their rotation period evolution.

2.2 Artificial intelligence enhanced image analysis in atomic emission spectroscopy

Ionuț SLABU, Tudor ȘUTEU, Alexandru NICULESCU, Mihaela COSINSCHI, Vasile BERCU, Leonard Constantin GEBAC

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Keywords: atomic spectroscopy; Balmer series; artificial intelligence

The observation of the discrete nature of hydrogen's emission spectrum was of foundational importance in developing quantum theory. The atomic model proposed by Niels Bohr explained the empirical formulas developed previously by Balmer. However, in theory, Rydberg's constant, with which one can compute the emission wavelengths, can have two possible values, depending on the approximation used: an infinite mass nucleus system, or a reduced mass system. In this study, we developed an image analysis based protocol that has the sensitivity to discern between the two approximations. The spectrum’s investigation method uses an "in-house" developed software

application capable of retrieving the information from a smartphone's camera and converting it to an array of intensities instead of a matrix made of color channels. Artificial intelligence algorithms (Computer Vision and Deep Convolutional Neural Networks) are used to identify the atom which emits the light in a very efficient, precise and fast way, without any human intervention. The software is packed in a graphical user interface for optimal and easy interaction, cross-platform runtime and suitable for further updates and applications in other fields of physics, e.g., astrophysics.

2.3 Multimessenger astronomy as a tool for modeling unresolved cosmic sources

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Keywords: multi-messenger studies, gravitational waves, binary black hole systems

Recently, with the first discovery of gravitational waves (GW) by ground detectors (LIGO, VIRGO and KAGRA), the multi-messenger studies began in full with the aim of better understanding the astrophysical events that produced them. This involves observing, along the gravitational wave signal, other different messengers emerging from the same sources: photons with wavelengths spanning the whole electromagnetic spectrum and neutrinos. Here, we focused on binary black hole systems that emit GWs during their inspiraling and merging phases. The frequencies of GWs emitted by these super massive systems are below the detection limit of ground observatories and we need to go to space to detect them. We start from the electromagnetically observed objects that could qualify as inspiraling binary black hole systems and check if we can confirm their nature with GW searches. We consider different system configuration scenarios and, by analyzing both intrinsic and extrinsic parameters of the source and their effect on the shape of the GW spectrum in each case, we make a prediction of the capability of future space-based GW detectors such as LISA Mission to "hear" the GWs coming from these sources. When simulating the waveforms for different source configurations, we used the IMRPhenomD approximant and the (flat) LambdaCDM cosmological model. We conclude that future space-based GW observatories can detect counterpart signatures of previously electromagnetically observed objects and predict their evolution.

2.4 A study of solar flares associated with a filament eruption

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Keywords: active region, solar flares, filament eruptions, coronal mass ejections, nonlinear force-free field

Solar flares, filament eruptions and coronal mass ejections (CMEs) are spectacular eruptive phenomena produced in the solar atmosphere. In order to understand these phenomena, it is important to analyze their evolution over time, but also to analyze the parameters involved in these phenomena. We present a M3.7 class solar flare associated with a filament eruption observed in Active Region 13229 (AR 13229), located in the northern solar hemisphere (N29W24), on February 24, 2023. These phenomena produced a coronal mass ejection with an earth-directed component. Using a nonlinear

force-free field (NLFFF) algorithm, we calculated the magnetic flux and obtained the 3D magnetic configuration from photospheric magnetic magnetograms Spaceweather HMI Active Region Patch (SHARP) from the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO). We analyzed the evolution of the magnetic flux in the interval of 120 minutes around the eruption.

Acknowledgement:
We acknowledge SDO teams for the science data.

2.5 Simulating the gravitational interactions of N bodies in 3D and modelling the orbit of the Sun and neighbouring stars in the Milky Way potential using Gaia data

Maxim ANDRONIC

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Keywords: 3D simulation, gravitational interactions, orbital dynamics, closest stars, Gaia data, astrophysics.

In this presentation, I will discuss my progress in simulating the gravitational interactions of multiple bodies in three dimensions using Python. Additionally, I will describe my ongoing work in modelling the orbit of the Sun and neighbouring stars within the Milky Way potential by incorporating Gaia data.
I will begin by providing an overview of the principles underlying gravitational simulations and their significance in astrophysics research. I will explain the computational techniques I have employed to numerically solve the equations of motion governing celestial bodies' interactions.
Next, I will present my Python code that performs the simulation of N bodies in three-dimensional space. I will explain the implementation details, including the calculation of gravitational forces between bodies and the integration of equations of motion using scipy.solve_ivp. I will showcase the ability of my code to accurately simulate the behaviour of multiple bodies under the influence of gravity alone.
Furthermore, I will discuss my ongoing efforts to incorporate Gaia data into my simulations. By extracting relevant positional and velocity information from Gaia's database, I aim to model the orbit of the Sun and neighbouring stars within the Milky Way potential. I will outline the challenges I have encountered in incorporating a realistic potential model and real data.

Acknowledgement:
This work was conducted under the guidance of Dr. Laurențiu Caramete, SC III, at the Institute of Space Science.

2.6 Special phenomena produced in the ascending phase of the solar cycle 25

Cristian DANESCU, Liliana DUMITRU, Octavian BLAGOI

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Keywords: solar cycle, sunspots, solar activity

The 25th solar cycle, which began in December 2019, has attracted considerable attention among scientists and researchers due to the more dynamic evolution than expected. This could lead to some

major impact on various terrestrial systems. This dynamic, revealed by the number of sunspots and the magnitude of eruptive phenomena, shows an intensification of solar activity. This paper aims to provide a comprehensive analysis of the predictions made for the 25th solar cycle and compare them to the actual situation as observed so far. By examining the solar cycle's characteristics, such as sunspot activity, solar flares, and geomagnetic disturbances, we evaluate the accuracy of early forecasts and identify any deviations from expectations. To accomplish this, we review and synthesize existing literature on solar cycle predictions, taking data from solar physicists, heliophysicists, and space weather experts. These predictions were based on historical patterns, statistical models, and advancements in solar observations. We present an analysis of the current situation in the 25th solar cycle, incorporating data from ground-based and space-based observations (some of them being obtained from the AIRA solar station) - such as sunspot records, coronal mass ejections (CMEs), and solar radiation measurements. We analyze the methodologies employed and the factors considered by various research groups to assess the credibility of their forecasts. By comparing the observed solar activity to the predicted values, we evaluate the accuracy of the early forecasts and determine the extent to which they align with the actual situation. This kind of study is very useful because we can examines the implications of the 25th solar cycle on Earth's technological infrastructure.

2.7 Solar radio bursts, characteristics and examples of radio bursts received by e-callisto network

Octavian BLAGOI, Liliana DUMITRU, Cristian DANESCU

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Keywords: solar flares, solar corona, radio astronomy, radio bursts, coronal mass ejections, electron oscillations, (non)relativistic speed electron beam, bow shock, bremsstrahlung

Solar radio bursts are generated in the upper corona by oscillating electrons in the solar magnetic field and is correlated with solar flares, coronal mass ejections and other phenomena. We present the main types of radio bursts that can be received on the ground on high frequencies (HF) and very high frequencies (VHF) radio bands. We present examples of radio bursts of different types in spectrograms aquired by different stations from the e-callisto network deployed arround the world, including radio burst detected at Bucharest CALLISTO station installed at the Astronomical Institute of Romanian Academy.

References:

Section 3: Biophysics; Medical Physics

Location and time: **Biophysics Lab, 3rd fl.**

Moderators:

Prof. Dr. Aurel POPESCU

Assoc. Prof. Dr. Claudia CHILOM

3.1 - Ana-Nicoleta Bondar

RATIONAL DRUG DESIGN FOR TARGETED DRUG DELIVERY: (bio)PHYSICS MEETS SUPER-COMPUTING AND GRAPH THEORY

3.2 - Aurel I. POPESCU, Claudia Gabriela CHILOM

Teaching Biophysics II. Biophysical approach of transport through cellular membranes

3.3 - Ana-Maria IGNAT, Claudia Gabriela CHILOM, Andreea Alexandra UDREA, Alina DUMITRACHE, Mihai Th. DUMITRACHE

A comparative study of intensity - modulated radiotherapy (IMRT) treatment planning technique using different number of fields in head and neck cancer

3.4 - Alexa Teodora CREȚU, Mihai Th. DUMITRACHE, Maria VLĂSCEANU, Alina DUMITRACHE, Claudia Gabriela CHILOM

The impact of Gamma analysis on acceptability criteria in pacient specific quality assurance

3.5 - Mădălina-Georgiana CHIVU, Monica DĂESCU, Mihaela BAIBARAC, Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU

The photodegradation processes of acetyl salycilic acid

3.6 - Ionel ELISEI, Ionel LAZANU, Mihaela PÂRVU

Detection of alpha particles in indoor spaces

3.7 - Radu BĂZĂVAN

The X-ray and light beam alignment in diagnostic radiology

3.8 - Andrei-Alexandru VASILIU, Constantin Augustin Dan PISTOL, Irina OANE, Ioana MÎNDRUȚĂ, Andrei BARBORICĂ

The analysis of covert cogntion: Covert naming task

3.9 - Diana-Lavinia STAN, Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Sorina IFTIMIE, Nicoleta CAZACU, Sorina IFTIMIE, Andreea COSTAS, Adriana Elena BĂLAN, Claudia Gabriela CHILOM1Andreea COSTAS, Adriana Elena BALAN, Claudia Gabriela CHILOM

Design and characterization of albumin nanoparticles

3.10 - Francesca-Giulia GUARNERI, Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Bogdan ZORILĂ, Mina RĂILEANU, Mihaela BACALUM

Fluorescence studies on the influence of synthetic antimicrobial peptide HRWWRWWRH-NH2 on the cell membrane fluidity

3.11 - Andra-Cătălina STĂNESCU, Mariana ȘTEFAN, Vasile BERCU

Antioxidant activity of ZnO nanoparticles doped with Gd3+

3.12 - Sorina Antonia MUNTEANU, Mirabela DUMITRACHE, Daniela STROE, Marius CĂLIN

Features of computerized planning systems in 3D conformal radiotherapy

3.13 - Diana SERAFIN, P. R. VASOS, C. ZĂGREAN-TUZA, I. FIDEL, S. VASILCA, D. NEGUȚ, M. SUDITU, R. POPESCU, M. BACALUM, G. GIUBEG, L. NEAGU, P. G. BLEOTU, M. ROȘU, E. HERMANN, M. MIREA, L. NIȚĂ, M. IOVEA, O. TEȘILEANU, A. HANGANU, M. A. VODĂ, A. SADET, I. C. CHIRICUȚĂ

Magneric resonance biomarkers for timely detection of high dose-rate radiation effects in cells

3.14 - Denisa-Sonia ANDRONIC, Ana-Nicoleta BONDAR

Calcitonin receptors in hydrated lipid membranes
3.15 - Andreea IONESCU BAICAN, Ancuța Elena BACIU, Claudia Gabriela CHILOM, Amalia CONSTANTINESCU, Bogdan Cosmin TANASE
The care and management of patients with indication for intracavitary 3D brachytherapy
3.16 - Andreea Alexandra UDREA, Mihai DUMITRACHE, Alina DUMITRACHE, Maria VLĂSCEANU
Multi-center pilot studies based on IAEA end-to-end audit methodologies using anthropomorphic phantoms
3.17 - Roberta M. NEAGOE, Mihai T. DUMITRACHE, Claudia Gabriela CHILOM
IMRT dosimetric evaluation of the commissioning of treatment planning system using anthropomorphic head and shoulder phantom
3.18 - Magda-Adelina MIHALCEA, Adriana BĂLAN, Mihai DUMITRACHE
Analysis of absolute dose determination in clinical practice of linear accelerator radiotherapy according to TRS398 protocol
3.19 - Maria-Silvia STANA, Răducu POPA, Marius CĂLIN
Sparing of the hippocampus during whole brain radiation therapy: A dosimetric study using Monaco treatment planning system
3.20 - Denisa Maria BĂLESCU, Oana RISTEA, Răducu POPA
Lung cancer treatment plan and dosimetric verification using the IQM system
3.21 - Dumitru POPESCU, Dumitru Petru IGA, Alin Gabriel POPESCU, Valentin I. R. NICULESCU
Mathematical simulation of the functioning of a pulsatory liposome in a closed environment
3.22 - Daria-Andreea DRAGOTOIU-RADUȚĂ, Andrei BARBORICĂ
The analysis of SEEG data in epileptic patients using computational methods
3.23 - Anca-Ștefania ORIAN, Claudia Gabriela CHILOM, Mihai DUMITRACHE
Comparative study in intensity-modulated radiation therapy (IMRT) vs. 3D conformal planning for prostate adenoma

3.1 RATIONAL DRUG DESIGN FOR TARGETED DRUG DELIVERY: (bio)PHYSICS MEETS SUPER-COMPUTING AND GRAPH THEORY

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Cancer and inflammation may be characterized by acidic external pH, which impacts membrane reactions and provides therapeutic opportunities. To sense pH, cells may rely on biomolecules named proteins which utilize specific moieties whose protonation state changes in the relevant pH range. Changes in the protonation state and proton-transfer reactions involve electronic structure changes whereby covalent bonds to hydrogen atoms break or form. We use a broad range of computational (bio)physics techniques to study proteins involved in pH sensing, and peptides of direct interest to deliver cargo to cells and cell organelles with acidic pH. Given the fundamental role of fluctuating hydrogen-bond networks for proton reactions, we perform large-scale atomistic simulations of membrane protein systems, develop graph-based algorithms for efficient analyses of data sets arising from the simulations, and derive accurate force-field parameters for non-standard chemical compounds of interest. The talk will present our graph-based algorithms and applications on pH-dependent membrane pore formation and protonation-coupled membrane proteins.

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3.2 Teaching Biophysics II. Biophysical approach of transport through cellular membranes

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Keywords: Active transport, ionic pumps, ATP-synthase, passive transport, simple diffusion, facilitated diffusion, carriers, ionic channels, pore formers, vesicular transport

Cellular metabolism implies a permanent transport through membranes of a great diversity of particles (e.g., ions, molecules, macromolecules, protein vesicles, etc.) in and out of the cells. The transport phenomena can be classified as passive (along the concentration gradients, driven solely by thermal agitation) or active (against the concentration gradients, driven by an energy supply) and selective (i.e., through specific pathways) or non selective through membrane lipid bilayers. This paper will describe in an accessible manner and classify all the types of membrane transport from a biophysical point of view along with their crucial roles in normal cellular functioning.

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3.3 A comparative study of intensity - modulated radiotherapy (IMRT) treatment planning technique using different number of fields in head and neck cancer

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Keywords: radiotherapy, IMRT, conformity index (CI), homogeneity index (HI), dose-volume histogram (DVH), H&Ncancer

The abusive consumption of alcohol and tobacco are the most common factors leading to the appearance of tumors localized in the head and neck sphere and they can cause severe damage to the oral cavity, pharynx, and oropharynx. In order to treat these conditions, it is recommended to use radiation therapy techniques, either as a stand-alone treatment or in combination with chemotherapy [1]. There are several radiotherapy treatment planning techniques, equally used in practice, but the choice of using one instead of the other depends on both the planner and the type of complexity of the tumor. In general, the treatment of complex tumors, with concave or irregular shapes, such as those located in the head and neck (H&N) area, is carried out with the IMRT technique [2]. Intensity - modulated radiotherapy (IMRT) technique is derived from 3D-CRT and is one of the most used techniques of radiotherapy nowadays. In the treatment planning process using the IMRT, an odd number of fields (e.g., 5,7,9 or 11), equally spaced are usually used. For evaluating the quality of the treatment plan, the tools such as dose-volume histogram (DVH), conformity indices (CI), and homogeneity indices (HI) are used [3]. The aim of this study was to present the influence of the number of radiation fields on the treatment plan as well as to determine the optimal number of fields for the treatment planning process of H&N cancer. Eight radiotherapy treatment plans have been created and

compared by using DVH. To have a more comprehensive view during the evaluation process of the treatment plans, the coverage quality and the homogeneity of the dose in the target volume (PTV) were calculated and analyzed, too.

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3.4 The impact of Gamma analysis on acceptability criteria in pacient specific quality assurance

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Keywords: IMRT, Gamma analysis, acceptability criteria, action limits, γ index, passing rates

Intensity Modulated Radiation Therapy (IMRT) is a precise and effective treatment technique used in cancer therapy, in terms of conforming high doses of radiation to the target volume, while the organs at risk receive a much smaller dose. The beam delivery system used to irradiate patients generally provides a dose distribution that includes regions of high gradient and must be verified before the treatment. For this reason, every designed treatment plan using the IMRT technique should be verified before the first fraction will be delivered to the patient. During the specific verification of the treatment plan, the ability of the treatment equipment to properly deliver the plan is analyzed. Over time, a large number of quality assurance methods have been developed, including Gamma analysis [1]. Gamma analysis mathematically compares the dose distribution generated by the computerized planning system to that measured by a two-dimensional detector array, in terms of spatial resolution and dose. This method combines the dose difference test with the distance to agreement criteria. The gamma (γ) index, calculated independently for each reference point, is the minimum distance in the renormalized multidimensional space between the evaluated distribution and the reference point. If the value of the γ index is less or equal to 1, the evaluated point passes the test. The aim of this study was to establish the action limits based on the Gamma test’s passing rates, for various acceptability criteria (3%/3mm G, 3%/3mm L, 2%/2mm G, 2%/2mm L, 3%/2mm G). The action limits are defined as the amount the quality measures are allowed to deviate to maintain the quality of treatment delivery as well as defining the action levels for various anatomical sites [2]. For each tumor localization (ORL, lung, prostate), the Gamma test was performed on 50 treatment plans. Based on the results, the confidence and action limits were calculated for each criterion.

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3.5 The photodegradation processes of acetyl salycilic acid

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Keywords: acetyl salycilic acid, photodegradation, UV irradiation, spectral investigation

This research work presents the spectral investigation (Raman, FTIR, fotoluminescence and UV-VIS spectroscopy) of the photodegradation process of acetyl salycilic acid (ASA) in the presence of H2O2. This study has a high importance in the biomedical field, because ASA contains a reactive acetyl group which can oxidize easily, and also carboxylic and ester functional groups which are highly vulnerable to hydrolysis under various hydrolytic conditions. The purpose of this study is to determine the ASA behaviour in the absence and in the presence of excipients in aqueous solutions containing H2O2. According to the UV-VIS spectra, after 130 minutes of irradiation of ASA in the presence of H2O2, a bathochromic shift of the maximum absorption band from 290 nm to 298 nm was observed. The photoluminescence spectra show that the irradiation of ASA in the presence of H2O2 leads to a decrease in the maximum intensity of the ASA band from 2.75 ·10^3 counts/sec to 2.65·10^3 counts/sec, simultaneously with the shift of the maximum of the PL band from 366 nm to 369 nm. Exposure to UV light of ASA solutions containing H2O2 resulted in an additional shift of the maximum of the PL band to 331 nm, simultaneously with the increase in intensity of the PL band situated at 397 nm from 2.25·10^3 counts/sec to 3.00 ·10^3 counts/sec.

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3.6 Detection of alpha particles in indoor spaces

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According to scientific research over the last hundred years, natural radioactivity is represented mainly by alpha particles coming from Radon decay (a progenitor of Uranium, Thorium and Actinium decay chains). Because of the very long half-life of these elements, Radon emission is present permanently in our dayly life. In 1988 the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO) declared that Radon is one of the carcinogenic substances for humans. In addition, it identifies Radon as a carcinogen in Group 1 and places it at the second place, after smoking, as a cause of lung cancer [1], [2]. During 18.12.2022 – 20-03.2023 we conducted a study regarding the detection of alpha particles emitted by natural sources in indoor spaces. Our purpose was to detect levels of alpha particles using a solid-state nuclear detector (SSND) named CR-39 (Columbia resin). After an exposure of 90 days, the detectors were etched in a solution of NaOH (6.5 M) at 80 ºC for 6 hours. The traces left by the alpha particles that interacted with the plastic track detectors were visualized using an optical microscope and the interaction rates were obtained. The results showed a significant number of alpha particles detected on the ground floor, proving the emanation of 222Rn from the basement. Additionally, almost a constant number of alpha particles were detected at each level of the building (11 levels for one building and 5 levels for the second one), suggesting that the main contribution of alpha particles is due to the construction materials.

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3.7 The X-ray and light beam alignment in diagnostic radiology

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Keywords: X-ray and light beam alignment, Light beam and bucky centering, Image fields on X-ray exposure

The alignment of X-ray, light and detector fields is a crucial acceptability criterion for a radiological system to perform exposure with all correct geometrical projections, thus ensuring an adequately limited and predictable irradiation dose for the patient. However, collimation, according to the investigated tissue performed by the medical staff over misaligned fields, can cause overexposure of the patient due to the larger radiation area than the visible area that was taken into account. Furthermore, as a result of this exposure, a clinically relevant image is not obtained, and the radiological investigation procedure needs to be repeated, which attracts another dose of radiation to be sent to the patient. Therefore, for the radiological equipment, a seemingly simple but, in practice, comprehensive check can significantly reduce the delivered dose, including the unwanted effects of ionizing radiation on human tissue. This paper exhibits and explains the delicate aspects that can negatively affect the work process associated with handling activity and applying the acceptability criteria for using radiological systems in the diagnostic radiology department. There is also mentioned one of the primary causative sources that can lead to this field alignment errors and the overexposure consequence to avoid its occurrence. The last part of this work gives a step-by-step example as guidance to check the alignment and centring of the radiological image fields along with the acceptable obtained values.

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3.8 The analysis of covert cogntion: Covert naming task

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The brain is a complex organ that controls important processes such as thought, memory, emotion and every process that regulates our bodies. Cognitive, sensory or motor stimulation produces a change in the brain's existing electrical activity, called evoked potentials. In order to analyse the evoked potentials produced by stimulation in the brain, certain stimulation paradigms are used. An example of such a paradigm is the Covert Naming paradigm which is based on a visual-auditory task carried out in the E-Prime program. It has a simple structure composed of 3 conditions (listening to stimuli, visualising and associating pairs of nonverbal stimuli and visualising and associating pairs of verbal stimuli). Following stimulation with the paradigm, evoked potential analysis (ERP) was performed using Matlab software, the aim being to observe specific responses in certain brain regions. Following the analysis, specific activations were observed on intracranial contacts located in brain regions such as: cingulate cortex, amygdala, insula and temporal gyrus. These activations were observed in approximately 70% of the recordings, with potentials located within 400-500 ms after stimulus onset. These regions are brain areas with major activity in processes underlying the inner awareness of language processing. The signal from the intracranial recording contacts was compared between all three conditions to observe the significant obtained differences. Thus, it is possible to observe or not the existence of activations in brain regions specific to language and cognitive processes.

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3.9 Design and characterization of albumin nanoparticles

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The use of albumin nanoparticles as precisely targeted drug delivery systems is one of the directions increasingly addressed in nanomedicine. These nanoparticles offer the advantage of biocompatibility and biodegradability, making them suitable for the delivery of drugs or molecules with antioxidant or anticancer activity. In this study, the desolvation method was used to prepare bovine serum albumin nanoparticles (BSA NPs). Their morphology and dimensions were examined by scanning electron microscopy (SEM) and atomic force microscopy (AFM), and their stability over time was evaluated using UV-Visible absorption spectroscopy. The experimental results showed that BSA NPs have a spherical shape, with a smooth surface. Their average diameter is around 200 nm, and the stability over time is relatively good. Such large NPs may have limited ability to passively diffuse into tissues, but they may still be able to actively target specific cells or tissues. For example, BSA NPs could be designed to remain at the site of administration, rather than needing to travel into the body.

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3.10 Fluorescence studies on the influence of synthetic antimicrobial peptide HRWWRWWRH-NH2 on the cell membrane fluidity

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Keywords: Antimicrobial peptides, Laurdan, GP, membrane fluidity, model membranes, methyl-β-cyclodextrin, cholesterol

Antimicrobial peptides (AMPs) are short peptides found in humans, animals, and plants with a wide spectrum of bio-activities (antibacterial, antifungal, antiparasitic, and antiviral properties) [1], [2]. In this study, the Laurdan fluorescence with key-parameter GP (Generalized Polarization), was used to

investigate the changes in the membrane fluidity of two cell lines (normal human skin cells-BJ and melanoma murine cells-B16), at two different temperatures (20°C and 37°C), induced by the gradual addition of the synthetic antimicrobial peptide P8 (HRWWRWWRH-NH2). Additionally, as a positive control test, we used the compound methyl-β-cyclodextrin (MβCD) in the same conditions to further verify the results obtained for P8. Due to the existence of its hydrophobic core, MβCD has a strong affinity to cholesterol and is used to deplete the cholesterol from the cells [3], [4]. Extending the study, we tested the effects of MβCD on LUV model membranes made from phosphatidylcholine and cholesterol at relevant temperatures for the experiment and at different concentrations of this compound, ranging from 0.33 mM to 1.66 mM. The results showed that the synthetic antimicrobial peptide P8 increased the membrane fluidity of both cell lines at both temperatures. This was also confirmed by the addition of MβCD on LUV model membranes at the same two temperatures, resulting in the decreasing of the GP values. The evaluation of the LUV model membranes between 10°C and 40°C with MβCD showed a decrease in GP values with the temperature for all four experimental conditions that have been tested, corresponding to 0, 0.33, 1 and 1.66 mM MβCD. However, adding the MβCD on cells, particularly on the B16 cell line, resulted in the increasing of the GP values at 20°C, therefore a more rigid condition of the membrane. At 37°C, GP values were observed to increase slightly (at 0.33 mM MβCD), immediately followed by decreasing values, indicating a more fluid cell membrane. This effect can be associated with the presence of cholesterol in the eukaryotic cell membrane and its complex role in maintaining the fluidity of the cell membrane.

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3.11 Antioxidant activity of ZnO nanoparticles doped with Gd3+

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Zinc oxide nanoparticles (ZnO) are among the most investigated metal oxide nanoparticles and have emerged as a promising material in the fields of optical, electrical, food packaging, and biomedical applications due to their biocompatibility, low toxicity, and low cost. These nanoparticles possess strong biological activity and are in use for various biological applications in several industries

(as antimicrobial, antioxidant, antidiabetic, anticancer, anti-inflammatory, photocatalytic, wound healing and drug delivery agent). This study evaluates the free radical scavenging properties of the ZnO nanoparticles doped with different concentrations of Gd3+. For the analysis of the antioxidant activity we have used the Electron Paramagnetic Resonance (EPR) spectroscopy to perform a 2,2–diphenyl-1-picrylhydrazyl hydrate (DPPH) assay, on four samples of ZnO nanoparticles, pure and doped with Gd3+. The ZnO scavenging activity was determined to be stronger at lower Gd3+ concentrations.

3.12 Features of computerized planning systems in 3D conformal radiotherapy

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Keywords: Radiotherapy, Oncentra Masterplan 3D-technique and Monaco v5.11 3D-technique, pelvic cancers

This study presents the particularities of the choice of the treatment plan for pelvic cancers for 30 patients with pelvic cancers in the Radiotherapy Clinic of Colțea Clinical Hospital Bucharest. After the acquisition of imaging data, treatment plans were made in parallel, with the same prescription in tumor volume using the Oncentra Masterplan 3D-technique and Monaco v5.11 3D-technique planning systems. The optimal dose distributions and the constraints set on the organs at risk were evaluated, highlighting the differences with a major impact on the choice of treatment plans.

3.13 Magneric resonance biomarkers for timely detection of high dose-rate radiation effects in cells

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Keywords:

In the recent use of radiotherapy to treat and control various types of cancer, dose-rates are explored to minimize radiation toxicity. Molecular biomarkers evaluated via in-cell studies have the potential of monitoring the radiation dose and dose-rate response within a biologically relevant time-window of up to tens of hours. We investigate the metabolic changes induced by radiation in cells via Magnetic Resonance Spectroscopy. The presentation will detail procedures used for metabolic imaging of radiation effects in glioblastoma U251 MG cell cultures. The specific investigation of metabolic pathways using carbon-13 isotopically-enriched glucose will be discussed.
When it comes to profiling metabolites using nuclear magnetic resonance (NMR) spectroscopy, there are typically two significant challenges that need to be addressed: the requirement to mitigate interference caused by the substantial concentration of large molecules and the need for the identification and quantification of individual metabolites. This presentation will contain two methods for the alleviation of interference from proteins and other molecules, using magnetic resonance size-dependent parameters and, respectively, filters.

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3.14 Calcitonin receptors in hydrated lipid membranes

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Keywords: G protein-coupled receptors, calcitonin, computational biomedicine, MD simulations

G Protein-Coupled Receptors (GPCRs) are the largest family of membrane receptors with a great functional diversity. They mediate the biological effects of hormones, neurotransmitters, odorants, as well as of visual stimuli. Therefore, GPCRs turn into essential drug targets and every year approximately one third of the approved and marketed drugs are in fact modulating the activity of a GPCR [1]. Involving the great power of computers helps us get insight into the high specificity of GPCRs, study their conformational dynamics and make predictions about their signaling pathways. One peptide hormone that binds to a class B GPCR is calcitonin. It has a key role in regulating the calcium concentration in blood and it is used as a therapeutic drug for hypercalcemia, osteoporosis and Paget's disease [2, 3]. This work presents the main steps of preparing a protein – membrane system that is suitable for undergoing Molecular Dynamics (MD) simulations. It covers the study of the architecture of both calcitonin and the calcitonin receptor starting from an initial set of Cartesian coordinates, the prediction of the 3D structure of the whole receptor – G protein complex using Artificial Intelligence and the insertion of the receptor into a POPC bilayer that is hydrated on both sides.

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3.15 The care and management of patients with indication for intracavitary 3D brachytherapy

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Keywords: 3D brachytherapy, cervix carcinoma, intracavitary

Our work assesses the strategy of designing intracavitary 3D brachytherapy treatment plans for cervical malignant lesions with ganglionic infiltration, using the Miami applicator and the vaginal applicator. Specifically, external radiotherapy was applied to the patient, in a total dose of 45 Gy with 1.8 Gy per fraction, 25 sessions, 5 days a week, over a period of 5 weeks. Immediately after the completion of the treatment, intracavitary irradiation is continued, in 3 sessions with the fractionation of 7.5 Gy per session. The first irradiation is a Miami-type application followed by two vaginal applications with a vaginal applicator. We show that is possible to deliver the highest possible dose of radiation to a tumor while affecting as little as possible the surrounding healthy tissues. A number of three plans were made, one plan for the Miami application and two plans with the same isodoses for the vaginal applications, and evaluated in terms of computerized dosimetry parameters such as dose-volume histograms, with regards for the organs at risk (OAR) like bladder and rectum. In order to examine the quality and extent to which the treatment plans agree with the general rules prescribing the radiation exposure of surrounding organs to radiological risk, we compared the results against the EMBRACE II recommendations concerning the values of the dose constraints for OARs. In most cases, all prescribed doses were delivered appropriately while protecting the adjacent organs as much as possible. However, in a certain case, the values obtained for the bladder and for the rectum exceeded the benchmarks due to the fact that these organs were anatomically too close to the target volume. In such circumstances, according to the ALARA principle (As Low As Reasonable Achievable), an optimization was performed to reduce the exposure without adversely affecting the dose distribution.

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3.16 Multi-center pilot studies based on IAEA end-to-end audit methodologies using anthropomorphic phantoms

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Keywords: Dosimetry audit, 3D-CRT, IMRT/VMAT

Dosimetry audit is widely recognized being a very important component of quality management program in radiotherapy (RT). At an institutional level, the external dosimetry audit provides an independent verification of the local approaches thus supporting the safe implementation of new and complex RT techniques. The International Atomic Energy Agency (IAEA) has developed two methodologies for on-site "end-to-end" audits [1, 2] simulating the essential parts of 3D-Conformal Radiation Therapy (3D-CRT) and Intensity Modulated Radiation Therapy (IMRT)/Volumetric Modulated Arc Therapy (VMAT) RT workflows. The anthropomorphic phantoms are treated following the pathway similar to that of the patient and the doses verified by independent auditors. Both methodologies were applied in different nationwide RT centers which helped to evaluate the implementation of these RT techniques in the clinical practice.

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3.17 IMRT dosimetric evaluation of the commissioning of treatment planning system using anthropomorphic head and shoulder phantom

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Keywords: Intensity modulated radiation therapy, end-to-end test, point dose measurements, patient-specific quality assurance.

In the present study, an accurate dosimetric evaluation of the intensity modulated radiation therapy (IMRT) workflow using the "end-to-end" test is considered. This approach follows, with the aid of an anthropomorphic head and shoulder phantom, the pathway of a real head and neck cancer patient, from imaging to dose delivery. The treatment plan was done by IMRT delivery technique with simultaneous integrated boost, using Eclipse treatment planning system (TPS) for medical linear accelerator Varian Unique. The patient-specific quality assurance (PSQA) was performed using MapCHECK device to compare measured to planned doses by Gamma analysis. Further, point dose measurements were performed using a PTW Semiflex ionization chamber in different locations into the phantom: the planning target volume (PTV) and organs at risk (OARs). The dose differences between ion chamber measurements and calculated dose from TPS are within the tolerance limits. Therefore, the results obtained in this study confirm the accuracy of local current practice of dose delivery by IMRT technique.

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3.18 Analysis of absolute dose determination in clinical practice of linear accelerator radiotherapy according to TRS398 protocol

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Keywords: Radiotherapy, absolute dose, TRS398 protocol, treating patients

Analysis of absolute dose determination in clinical practice of linear accelerator radiotherapy according to the TRS 398 protocol of the International Atomic Energy Agency (IAEA) is an essential method to ensure accurate and safe delivery of radiation treatment to patients. The IAEA's TRS 398 Protocol provides detailed guidelines and recommendations for the measurement and calibration of radiation doses in linear accelerator treatment. This analysis is based on the use of physical dosimetry and reference standards to verify and validate the performance of the radiation delivery system. During the analysis process, specialized detectors and measuring equipment are used to record and quantify the radiation dose administered to patients. These measurements are compared to planned doses and standard values established in the TRS 398 protocol. Any significant deviation from the desired dose may indicate unwanted problems in the radiation delivery system and require corrective interventions. Absolute dose determination analysis is important to ensure that patients receive the appropriate radiation dose during treatment. This helps minimize the risks of under dosing or overdosing, which can affect the effectiveness of the treatment and cause unwanted side effects. Also, the analysis of determining the absolute dose contributes to maintaining the quality of the radiation delivery system over time, by identifying possible deviations or malfunctions and taking the necessary corrective measures. This can ensure consistency and reliability in the delivery of radiation treatment, essential for optimal therapeutic outcomes. In conclusion, the analysis of absolute dose determination in clinical practice of linear accelerator radiotherapy according to the IAEA TRS 398 protocol is an essential process for ensuring accurate and safe delivery of radiation treatment to patients. This analysis helps to verify and validate the performance of the radiation delivery system and to maintain quality over time, thus ensuring treatment efficacy and safety.

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3.19 Sparing of the hippocampus during whole brain radiation therapy: A dosimetric study using Monaco treatment planning system

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Keywords: Magnetic resonance imaging, computed tomography, radiotherapy, medical physicist

High energy X-rays radiotherapy is a common treatment for brain tumours. There are different types of external radiotherapy. The most common type used is called volumetric modulated arc therapy (VMAT). The goal of this treatment was to perform whole brain irradiation (WBI) with hippocampus sparing and dose escalation on multiple brain metastases because the irradiation of the hippocampus is the most important cause of neurocognitive decline after cerebral radiotherapy. The treatment plan for brain cancer patients is a complex and customized process that aims to provide the best therapeutic options based on the characteristics of each patient. The goals of the radiation treatment planning were homogeneous whole brain dose distribution, maximal hippocampus sparing, highly conformal dose escalation to brain metastases, and protection of predefined organs at risk (OAR) like brainstem, optical chiasm and optical nerves, eyes, inner ears, and lenses. For radiation treatment planning, patients underwent computed tomography (CT) in thermoplastic mask immobilization. Contrast-enhanced T1-weighted magnetic resonance imaging scans for treatment planning and CT images were rigidly coregistered based on mutual information in the contouring system (Monaco version 6.1, Elekta) and served for target volume and OAR delineation and dose calculation. The hippocampus sparing plan was considered clinically acceptable per RTOG 0933 dosimetry compliance criteria. VMAT planning provided highly conformal and homogenous dose distributions for the whole brain with lower doses to OAR such as the hippocampus. These results suggest that HS-WBRT with SIB is a clinically feasible, fast, and effective treatment option for patients with a relatively large number of m-BM lesions.

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3.20 Lung cancer treatment plan and dosimetric verification using the IQM system

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Keywords: Radiotherapy, lung cancer, IQM system

This study presents the dosimetric verification using the IQM (Integral Quality Monitor) system of a treatment plan performed for lung cancer. The IQM system is a radiotherapy verification system that uses new generation technology to ensure accurate verification of treatment plans before being

delivered to the patient. Using the Monaco planning system we have produced the treatment plan used in the study for the Elekta Versa HD linear accelerator and verified in the IQM system. The quality assurance system started being developed in 2002 and the first prototype was installed in 2014.

3.21 Mathematical simulation of the functioning of a pulsatory liposome in a closed environment

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Keywords: Osmotic gradient, stretched vesicle, pulsatory vesicle, drug releasing biocontroller

In this paper we consider a liposome filled with an osmotic solution included in a water enclosure. Due to the process of osmosis, the liposome swells until it reaches a critical size, when a pore appears in its membrane. The appearance of the pore causes a change in the evolution of the liposome. The contents of vesicles are partially removed through the pore and induce a decrease in the volume of the vesicle to the initial size. A new cycle can start. Liposome evolves as a two-stroke cycle engine. After each cycle, the concentration of osmotic solvit inside the liposome decreases. After performing a number of cycles, the liposome activity will stop. The swelling of the liposome is described by a differential equation. All the processes which contribute to the vesicle relaxing and its come back to the initial size are described by three differential equations.The activity of a pulsatory liposome can be characterized by the following parameters: a) number of cycles, the length time of each cycle and liposome activity life; b) the length time of the swelling stage and of the relaxation stage for each cycle; c) the quantitie of solute leaked out through the pore in each cycle.

3.22 The analysis of SEEG data in epileptic patients using computational methods

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Keywords: SEEG data, Epileptic activity, Empirical mode decomposition, Hilbert transform

Epilepsy, a neurological disorder characterized by recurrent seizures, necessitates thorough analysis of intracranial electroencephalography (SEEG) data to comprehend underlying mechanisms and guide therapeutic interventions.In this study, we propose a novel approach that combines Empirical Mode Decomposition (EMD) and Hilbert transform for the analysis of SEEG data in an epileptic patient. EMD has been proven to be a powerful tool for analyzing nonlinear and non-stationary signals. It is a data-driven technique that decomposes signals into intrinsic mode functions (IMFs) of different timescales. By adaptively extracting oscillatory components, EMD enables identification of frequency

bands within SEEG data, crucial for characterizing epileptic activity. Hilbert transform complements this by analyzing instantaneous amplitude and phase. We apply EMD to decompose SEEG data into IMFs, effectively separating frequency components. Subsequently, we utilize Hilbert transform on each IMF to extract instantaneous amplitude and phase, enabling identification and tracking of transient events and temporal dynamics within each frequency band.

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3.23 Comparative study in intensity-modulated radiation therapy (IMRT) vs. 3D conformal planning for prostate adenoma

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Keywords: Radiotherapy, intensity modulated radiation therapy, 3D conformal radiation therapy, dose-volume histograms

The main objective of the study is to highlight the differences between two treatment techniques in radiation therapy for prostate adenoma: Intensity-Modulated Radiation Therapy and 3D Conformal Radiation Therapy. Radiation therapy evolved following the discovery of X-rays by W.C. Röntgen in 1895, the discovery of radioactivity in 1896, and the discovery of the radioactive elements radium and polonium by the Curie couple starting from 1898. IMRT utilizes a radiation delivery system that allows for the adjustment of radiation beam intensity during treatment. This enables a more precise distribution of radiation dose to the target, allowing higher doses to be delivered to the tumor while sparing the surrounding healthy tissues. IMRT can be used in the treatment of complex tumors located near sensitive organs and enables a more precise conformation of the radiation beam to the shape of the target. 3D-CRT uses three-dimensional images of the tumor and surrounding healthy tissues to plan the treatment. The radiation beam is shaped according to the shape of the target and delivered in multiple beams to ensure uniform coverage of the target area. This technique is effective in treating tumors with regular shapes and can deliver precise radiation doses to the target while minimizing exposure to healthy tissues. In comparison, 3D-CRT is more suitable for tumors with more regular shapes, such as convex ones, while IMRT can be used in the treatment of both convex and concave tumors, thanks to

its ability to modulate the intensity of the radiation beam. The primary objective of the study is to analyze dose-volume histograms, which are essential tools for obtaining a detailed evaluation of the treatment plan and optimizing the balance between tumor destruction and protection of healthy tissues. These histograms allow radiation therapists to evaluate and adjust the treatment to maximize effectiveness and minimize side effects.

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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 - Alexandru JIPA

75 years of relativistic heavy ion collisions

4.2 - Daniel DOROBANȚU, Mariana PETRIȘ, Mihai PETROVICI

An innovative architecture of Multi-Strip Multi-Gap Resistive Plate Counters (MSMGRPCs) for the inner zone of the Time-of-Flight system of the CBM experiment

4.3 - Mircea PENTIA, Chivuta BADITA, Dana DUMITRIU, Amilcar IONESCU, Horia PETRASCU

Studies of Strong Field QED Processes at ELI-NP

4.4 - Mihaela PÂRVU, Denis BARBU, Ionel LAZANU

Non-collider searches for micro-black holes, strangelets and A(anti)QN: general discussion

4.5 - D. GURAU, D. STANGA, L. DONE, O. SIMA, E. IONESCU

Computational Characterization of Coaxial HPGe detectors using Monte Carlo Simulation and Nonlinear Least Squares Optimization

4.6 - Denis BARBU, Mihaela PÂRVU, Ionel LAZANU

Proton decay searches using neutrino and DM detectors

4.7 - Flavius-Andrei MOTI, Mihaela PARVU

Neutron Induced Reactions of Interest for Rare Event Physics Experiments

4.8 - Ioan Paul PÂRLEA, Mihaela SIN, Yi XU

Theoretical predictions for radiative capture cross-sections of interest for astrophysics in the fast neutron region

4.9 - Oana SÎRBU, Dimiter BALABANSKI, Mikolaj CWIOK, Wojciech DOMINIK, Magdalena KUICH, Ștefan NICULAE, Adrian ROTARU

TPC - A tool of discovery

4.10 - Murat ABLAI, Dănuț ARGINTARU, Marius CĂLIN, Tiberiu EȘANU, Alexandru JIPA1a, Ionel LAZANU, Oana RISTEA, Cătălin RISTEA, Nicolae George ȚUȚURAȘ

The influence of the resonance matter on the apparition of the mixed phase in nuclear matter formed in nucleus-nucleus collisions at FAIR-GSI energies

4.11 - Diana DEARA, Oana RISTEA, Catalin RISTEA

The study of the mean transverse momentum of strange hadrons produced in relativistic nuclear collisions

4.12 - E. Ionescu, D. Gurau, M. Sima, D. Stanga

Radiological characterization to demonstrate the end stage for the VVR-S nuclear reactor building

4.13 - Paula-Gina Isar

Origin and sources of ultra-high-energy cosmic rays

4.14 - Murat ABLAI1a, Dănuț ARGINTARU, Marius CĂLIN, Tiberiu EȘANU, Alexandru JIPA1b, Ionel LAZANU, Oana RISTEA, Cătălin RISTEA, Nicolae George ȚUȚURAȘ

New aspects on the entropy in relativistic and ultrarelativistic nuclear collisions

4.15 - Murat ABLAI, Dan ARGINTARU, Florin BEREVOIANU, Marius CALIN, Tiberiu ESANU, Ioana KUNCSER, Alexandru JIPA*, Ionel LAZANU, Luca MINZINA, Andrei NECSOIU, Claudia OLARU, Cristian OMAT, Oana RISTEA, Cătălin RISTEA, Liviu STOICA, Nicolae George ȚUȚURAS

Some predictions on behaviour of the nuclear matter in nuclear collisions at FAIR-GSI energies

4.1 75 years of relativistic heavy ion collisions

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Keywords: cosmic radiations, accelerator systems, heavy ion collisions, collisions dynamics, nuclear matter phases and phase transitions

In 1948, Dr. Phyllis Freier group discovered the heavy ion component of the cosmic radiations and a new era in the study of the structure of matter, origin and evolution of the Universe was opened. After the cosmic rays period, the era of the accelerator systems begun in 1970. This new era has 3 interesting stages. This work is dedicated to the presentation of the major results obtained in the field on bulk properties of the nuclear matter, collision dynamics, nuclear matter phases and phase transitions in hot and dense nuclear matter formed in relativistic and ultrarelativistic heavy ion collisions. The important results obtained in this field by the staff members of the Faculty of Physics will be stressed.

4.2 An innovative architecture of Multi-Strip Multi-Gap Resistive Plate Counters (MSMGRPCs) for the inner zone of the Time-of-Flight system of the CBM experiment

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Studying the phase diagram of strongly interacting matter predicted by Quantum Chromodynamics (QCD), understanding its phase transitions and searching for its critical points represents the fundamental motivation behind all the heavy-ion experiments at relativistic and ultra-relativistic energies. While ALICE (A Large Ion Collider Experiment) experiment using the highest energy accessible at LHC (Large Hadron Collider) studies the phase diagram of QCD at very high temperatures and vanishing baryonic chemical potential, trying to probe cosmological scenarios for the expanding Universe, a few microseconds after Big Bang, understanding the phase diagram at high baryonic chemical potential and moderate temperature, characteristic for the inner core of the neutron stars requires a new generation of heavy-ion experiments. At the future fixed target Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt using Au-Au collisions at centre of mass energies √(s_NN)=4.9 GeV at SIS100 accelerator, nuclear baryonic matter at densities of 5-7 times higher than the normal nuclei is produced. Multi-differential analysis of the rare diagnostic probes requires huge statistics. Therefore, the CBM experiment is designed to run at interaction rates up to 10 MHz for Au-Au collisions and at 8 meters from the target, at the low polar angles covered by the experiment, high particle densities with rates up to 4·10^4 particles/sec·cm2 are expected. Charged hadrons identification will be provided by the Time-of-Flight (ToF) system based on Multi-gap Resistive Plate Counters (MRPC) and also using the momentum information of the particles measured with a tracking system placed inside the magnetic field. In order to cope with such an unprecedented counting rate without deteriorating their performance over the whole lifetime of the experiment which is foreseen to run for 2 months a year for

10 years, a new generation of detectors has to be developed. Completely new architectures of the MSMGRPCs with different granularities for the inner zone of the CBM-ToF system will be presented.

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4.3 Studies of Strong Field QED Processes at ELI-NP

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Keywords: Strong Field QED, Multi-photon interactions, Feynman amplitudes for QED processes, Schwinger effect, Breit-Wheeler process, Bethe–Heitler process, ELI-NP.

In high energy particle physics the production of massive particles is a common local process. On the other hand the low energy laser photon – electron interaction has a larger range (λc - electron Compton wavelength) that allows a multi-photon interaction with a single electron. This can produce matter by transforming virtual e+e- pairs of the physical vacuum into real ones.
Particle production from the EM field, one of the amazing predictions of QED, is possible exploiting the physical vacuum properties in some settings: - an intense static electric field: Schwinger effect [1-6]. - a photon field: Breit – Wheeler process [7]. - a combination of the two: Bethe – Heitler process [8]. In the regime of Strong Field QED (SFQED) the photon-electron interactions (charge-field coupling parameter ξ>>1) are treated non-perturbatively. The diagrams with a given order in α (fine-structure constant), depend on all terms in ξ expansion.
Until now the Schwinger limit ~1018 V/m of static electric field, has not been reached experimentally. But in the context of HPLS (High Power Laser System) [9,10] combining high intense electric field interacting with relativistic electrons, the particle production by Schwinger effect can be observed.
In the ELI-NP environment, the e+e- pairs production can be considered by two types of processes: Breit - Wheeler: γR + n γL --> e+ + e- or Bethe – Heitler: γR + γV --> e+ + e- The GeV γR real photons can be obtained using laser wakefield accelerated electrons by "bremsstrahlung" or "inverse Compton scattering". The study of SFQED processes involves the cross sections evaluation with Feynman diagrams and constructing characteristic distributions on the available phase space. A specific setup at ELI-NP can be prepared.

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4.4 Non-collider searches for micro-black holes, strangelets and A(anti)QN: general discussion

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Currently, the existence of dark matter is strongly supported, but its nature remains elusive. There exist various theories of dark matter involving heavy particles and/or new states of matter. The Standard Model (SM) was probed with a great precision by collider experiments at the TeV scale. However, there is a number of reasons to suppose that unobserved particles exist at or above the TeV scale. Non-collider experiments offer promising ways to explore mass regions beyond the SM, not available at colliders. This short communication is focused on a specific class of hypothetical stable massive particles predicted by the SM or by BSM theories or supported by these and which can be directly observed via their interactions in a detector.

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4.5 Computational Characterization of Coaxial HPGe detectors using Monte Carlo Simulation and Nonlinear Least Squares Optimization

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Monte Carlo (MC) simulation models, implemented as computer codes, are widely used for computing the full-energy peak (FEP) efficiency of gamma spectrometry (GS) systems because the relative method of measurement has severe restrictions. The input variables of these computer models consist of model variables and model parameters. The geometric model of the detector is the key component of MC simulation models because it defines the parameters on which the FEP efficiency of the detector depends. Because computer models are always imperfect, there always exists a

discrepancy (discrepancy function) between the true and computed values of the FEP efficiency. The goal of the model calibration is to estimate the optimal values of the model parameters and the discrepancy function. The calibration of MC simulation models for computing the FEP efficiency is known as detector characterization. MC simulation codes are computationally expensive and this can be alleviated via the use of surrogate models. A nonlinear surrogate model was developed, which well approximates the FEP efficiency provided by MC simulation codes using grid-based interpolation. A simple methodology for computational characterization of coaxial HPGe detectors using GESPECOR software and nonlinear least squares is described and applied in practice using a GS system equipped with a Canberra p-type coaxial HPGe detector model GC3018. The geometrical model of the detector contains fifteen parameters but many of them are known accurately. Consequently, five parameters (crystal radius and length, dead-layer face and side and distance holder-endcap) were optimized using the surrogate model mentioned above, lsqnonlin function from Matlab software and a set of reference values of the FEP efficiency. The optimal model for the p-type HPGe detector GC3018 was verified in the energy range of 60-2000 keV. The discrepancies between measured and computed values were smaller than 4 % for point sources and 3 % for cylindrical sources.

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4.6 Proton decay searches using neutrino and DM detectors

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In this communication we present a preliminary and comparative discussion associated with the possibility of proton decay detection using two different detector technologies – water Cherenkov detectors and LAr/LXe TPCs. The components of the radioactive background have been identified and the aspects related to the ambiguities in particle identification are discussed. Aspects of the contribution of the nuclear dynamics are also considered.

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4.7 Neutron Induced Reactions of Interest for Rare Event Physics Experiments

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Currently, many experiments trying to detect and understand the nature of dark matter and to study neutrino's properties are being developed. Given the low interaction rate of these particles with matter, these experiments are affected by backgrounds that can be induced by all sorts of nuclear reactions, leading to false signals in the detection system. We have studied the cosmic neutron flux and the nuclear reactions induced by this component of the cosmic rays on 3 different elements (Al-27, Fe-56, Si-28) with 4 different outcomes for each: (n,2n), (n,α), (n,γ) and (n,p). We investigated the interaction cross sections as a function of the incident energy of the neutrons and the results are presented. Also, the experimental values are compared to the evaluated cross sections, and a discussion on the importance of the uncertainty on the interaction rate is done.

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4.8 Theoretical predictions for radiative capture cross-sections of interest for astrophysics in the fast neutron region

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Keywords: Nuclear reactions, r-process, astrophysics, EMPIRE, TALYS

The radiative capture reaction plays a key role in the nucleosynthesis process. The applications of nuclear astrophysics involve thousands of unstable nuclei for which no experimental data are available, therefore theoretical predictions of the reaction data are needed. The present study intents to establish if and at what extent the reaction models with empirical parameters implemented in the evaluation codes could be used for the estimation of the reaction cross sections of the nuclei away from the stability valley at energies above the resonance region. For this purpose, the EMPIRE code was used to provide an overall description for the cross sections of the neutron induced reactions on the isotopic chain of Molybdenum ranging in atomic mass from 83 to 115, in the incident energy range 0.01-20 MeV. The results of the calculations for the stable isotopes are compared with the TALYS code predictions from TENDL, with evaluations from major libraries and with the existing experimental data. The behavior of the input parameters and of the calculated cross sections from dripline to dripline is analyzed and discussed.

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4.9 TPC - A tool of discovery

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The mini-eTPC detector, located at ELI-NP, is a 4-π gas-based time-projection chamber, used to study photonuclear reactions at astrophysical energies. The main feature of this detector system is that the gas inside of it functions as both the target of interest and also as detection medium. It uses an electronic read-out system, based on GEM (Gas Electron Multipliers, developed at CERN) and a segmented anode with 256 channels. Its main purpose is to study how 12C and 16O isotopes are produced in stellar environments. The detector is designed to work with transparent primary beams (neutrons or gamma) to perform inverse reactions (neutrons on 12C, resulting in triple alpha disintegration) and measure the production cross-sections of the direct reaction, triple alpha to 12C. This system was jointly developed in collaboration with Faculty of Physics, University of Warsaw and the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH). In the current work, we present the commissioning experiment that took place at the 3MV Tandetron Accelerator at IFIN-HH, using a primary neutron beam on CO2 as gas target. We will show the kinematic reconstruction of the resultant events, a method for particle identification using stopping power analysis and the relevant polar and azimuthal distributions of the reactants, in the detector reference frame.

4.10 The influence of the resonance matter on the apparition of the mixed phase in nuclear matter formed in nucleus-nucleus collisions at FAIR-GSI energies

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The Facility for Antiproton and Ion Research (FAIR) from GSI Darmstadt (Germany) will offer, since 2027, beams of high intensity and very high repetition rate. The Compressed Baryonic Matter (CBM) Experiment was built to perform measurements at these very high repetition rates. Therefore, interesting laboratory results on the specific phases of the nuclear matter in different temperature and baryonic density conditions could be obtained, including possible phase transitions. Fundamental results on the connections with the Universe formation and evolution could be obtained, too (see, P.Senger – Particles 4(2)(2021)214-226). One of the possible phase of the very dense matter formed in nuclear collisions with high mass numbers is the so-called mixed phase, in agreement with the Gorenstein and Gadzinski hypothesis. As the other possible phases, the specific experimental signals of this nuclear matter phase could be „shadowed" by the formation of the resonance matter, in agreement with V. Metag hypothesis. Therefore, in this work we analyse the conditions for resonance matter formation in nucleus-nucleus collisions at FAIR-GSI. The disscusions consider energy beam, collision geometry, as well as other aspects. Comparisons with experimental results obtained by HADES Collaboration, at SIS 18, and SKM 200 Collaboration, at Synchrophasotron will be done.

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4.11 The study of the mean transverse momentum of strange hadrons produced in relativistic nuclear collisions

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Heavy-ion collisions at high energies create extreme conditions of temperature and density, where the nuclear matter undergoes unique phase transitions. One of these phases is Quark-Gluon Plasma(QGP), a state of matter in which quarks and gluons are deconfined. The study of this phase of nuclear matter provides insights into the early Universe. After the collision, due to multiple interactions between the constituents, quarks and gluons, the produced system reaches thermal equilibrium and the deconfined matter develops a hydrodynamic flow behaviour. During this process, the system's volume increases and it starts to cool down leading to the confinement of matter. The produced hadrons undergo multiple elastic and inelastic collisions until the system reaches the kinetic freeze-out stage, when all the interactions between them cease and their transverse momentum distributions become fixed. The collective flow velocity of the fireball will affect the transverse momentum spectra of the produced particles. The shape of the pT spectra modifies due to this collective motion of the system, with a stronger influence on heavier particles. Based on the pT spectra of strange hadrons, the mean

transverse momentum of the ⟦ K⟧^0 s, Λ, (Λ)¯, Ξ^-, (Ξ)¯^+, Ω^-, Ω¯^+, was obtained. The analyzed data were obtained in Au+Au collisions at RHIC-BES energies (√(s_NN) = 7.7 GeV, 11.5 GeV, 19.6 GeV, 27 GeV and 39 GeV). The results will be compared with ⟨pT ⟩ of non-strange hadrons. The dependence of the mean transverse momentum ⟨pT ⟩ on particle species and event centrality at various incident energies will be presented and discussed. Special emphasis will be given on particles containing one or more strange quarks, strangeness being an important observable in the search for deconfined state of matter.

4.12 Radiological characterization to demonstrate the end stage for the VVR-S nuclear reactor building

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The VVR-S nuclear research reactor in Magurele, Romania, operated for 40 years before being closed in 1997. After 6 years of conservation, the Romanian government took the decision to permanently shut down the reactor and an immediate dismantling strategy was implemented. The decommissioning process involved dismantling of the reactor components and decontamination of the working areas. As part of the final step of decommissioning, a radiological survey was conducted to assess the level of residual radioactivity on the site. This paper focuses on the methodology employed for the radiological characterization of the reactor building and presents the methods and techniques utilized. The goal was to ensure that the building met the release criteria, thus allowing for its potential restricted reuse in the future. The study also showcases the results obtained for representative areas within the VVR-S nuclear research reactor. In compliance with national legislation, the authorization holder submitted a request to the regulatory body for approval of the restricted reuse of the building. This request was supported by a thorough comparison of the radiological characterization results with the levels stipulated in both national and international standards. By conducting a comprehensive radiological survey and employing appropriate methods and techniques, the study provides valuable insights into the state of the VVR-S nuclear research reactor and its potential for future use. The findings, in conjunction with compliance to regulatory standards, contribute to informed decision-making regarding the building's future.

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4.13 Origin and sources of ultra-high-energy cosmic rays

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Although cosmic rays have been discovered more than a century ago, the sources of ultra-high-energy cosmic rays (UHECRs) remain a mystery for scientists nowadays. The flux of UHECRs drops with increased energy, from one particle per km^2 per year, at about 10^18 eV, to one particle per km^2 per century, at about 10^20 eV. Moreover, charged particle cosmic rays are deflected in the their way through the other space by the powerful magnetic fields, therefore the origin of arrival directions are hard to estimate precisely. Evidence that UHECRs are of extra-galactic origin has been reported extensively in the scientific literature by large-scale cosmic ray experiments, like the Pierre Auger Observatory observing the southern sky, or the Telescope Array observing the northern sky, which are nowadays struggling to increase the event measurement statistics at the highest energies with improved detectors. The highest-energy cosmic ray events recorded so far will be introduced. Potential source candidates of UHECRs will be discussed.

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4.14 New aspects on the entropy in relativistic and ultrarelativistic nuclear collisions

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In the efforts made for identification of the basic phases of nuclear matter and possible phase transitions, in deep correlations with the thermodynamic and hydrodynamic conditions, many ways and approaches have been considered. Considering the dependence on the thermodynamic equilibrium type for these transitions, many works proposed the entropy evaluation in each relativistic nuclear collisions, as well as the evolution of the entropy from the initial state, with maximum compression and highest temperature, to the final freeze-out state. Therefore, in the present work, authors analyse the situation and propose an analysis of the entropy evolution in a nucleus-nucleus collision at high energy, as well as a method for such analysis based on genetic algorithms and mix structure. The results have been separated in agreement with system types, non-linearity, optimization techniques, taking into account the possible influences of the different mathematical and processing operations. All these could influence the execution time and the presence of some false minima during the simulation. The main results obtained during these efforts are related to the necessity to consider a larger number of generations and introduction of some heuristic components to prevent the local minima. The study is still in work.

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4.15 Some predictions on behaviour of the nuclear matter in nuclear collisions at FAIR-GSI energies

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Keywords: FAIR, CBM, nucleus-nucleus collisions, predictions on interesting physical quantities

Using YaPT (Yet another Physics Tool) computing system [1], we simulated data, using versions of UrQMD and AMPT codes [2,3], for a few nucleus-nucleus collisions at available energies at FAIR. These data were analyzed both for global description of the collision dynamics, as well as for possible phase transitions in hot and very dense nuclear matter formed in the overlapping region of the two colliding nuclei. We investigated, too, some aspects of the hydrodynamic behaviour of the nuclear matter and the possibility to investigate some phase transitions using Reynolds number [4]. The interesting results for the nucleus-nucleus collisions considered in this work indicate, once again, the importance of the correct selection of the collision centrality for collision dynamics. In the investigation of the asymmetric collisions between 4He and 40Ca at 2 A GeV, using the model based on the collision geometry [5], we used the estimated date to evaluate the proton participant number, the nucleon participant number, and the size of the participant region. As in the case of other asymmetric collisions at a few A GeV, the size of the participant region is in proximity to the incident nucleus size [5-7].

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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

CS1 Dr. Cornelia Nichita

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5.2 - Cristian ISTRATE, Alexandra TREFILOV, Adriana BĂLAN
Atomic force microscopy investigation of advanced carbon nanowall structures
5.3 - Vlad TUDORACHE-PROHNITCHI, Sanda VOINEA
Heat Pump Assisted Binary Cycle Geothermal Power Plant
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Technical solution for installing the photovoltaic plant on the roof of a building
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Free radical scavenging properties of N-acetylcysteine (NAC)
5.13 - Cornelia DIAC, Tom Matei IACOB, Bogdan Ciprian MITREA, Adriana BĂLAN, Ioan STAMATIN, Serban STAMATIN
Gold Dissolution In Electrochemical Systems: Exploring Eco-Friendly Methods For Sustainable Applications
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5.15 - Matei-Tom IACOB, Cornelia DIAC, Bogdan Ciprian MITREA, Adriana BĂLAN, Ioan STAMATIN
Photosensitivity activation of copper foam by cold plasma treatment

5.1 Teaching renewable energy sources in preuniversity education

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Keywords: renewable energy sources, teaching resources, preuniversity education

Teaching renewable energy sources in preuniversity education is crucial for raising awareness and promoting sustainable practices among young students. Here are some methods we can use to effectively teach: -Interactive Presentations: Using multimedia presentations to introduce students to the concepts, such as solar, wind, hydro, geothermal, and biomass energy. Include images, videos, and interactive elements. -Hands-on Experiments: Conduct hands-on experiments to demonstrate the principles behind renewable energy sources. -Field Trips: Organize field trips to renewable energy installations such as solar farms, wind farms, or hydroelectric power plants. -Guest Speakers: Invite experts from the renewable energy industry or local environmental organizations to give talks and share their experiences. -Project-Based Learning: Assign projects that require students to research and present on different renewable energy sources. -Debates and Discussions: Organizing debates and discussions. Divide the class into groups and assign them different perspectives, such as the advantages and disadvantages of specific renewable energy sources. -Gamification: Incorporating educational games and quizzes. You can create online quizzes or use interactive applications to test their knowledge. -Hands-on Projects: Encouraging students to undertake hands-on projects, such as designing and building a solar-powered device or conducting energy audits in their school. -Discussion of Real-World Examples: Discussing current events and news. Explore success stories of communities or countries transitioning to renewable energy sources and the challenges they face. Both knowledge and awareness are very important for students to understand at an early age. It is our duty as teachers in the pre-university system to train the young generation in the wise use of natural resources.

5.2 Atomic force microscopy investigation of advanced carbon nanowall structures

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Keywords: carbon nanowalls, atomic force microscopy

Carbon nanowalls (CNWs), vertically aligned graphene sheets, are very attractive materials in various fields due to their high conductivity, mechanical robustness, optical and other remarkable properties. In the present work, we investigate advanced CNW structures obtained by plasma assisted chemical vapour deposition technique using atomic force microscopy (AFM). The surface features are imaged in a non-contact mode. 3D profiles from the topography images are analysed and the distances between the sheets are evaluated. The electrical charge distribution on the sample surface is also

studied. Current-voltage curves obtained by AFM spectroscopy are measured at selected points of interest on the sample surface. By combining all these techniques enabled by AFM, valuable information on surface properties can be retrieved, leading to a deeper understanding of conduction mechanisms, optical absorption, hydrofobicity, etc.

5.3 Heat Pump Assisted Binary Cycle Geothermal Power Plant

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Keywords: geothermal power plant, binary cycle, heat pumps, efficiency

The biggest drawback that renewable energy power plants have over their fossil fuel counterparts is the dependance on geological and geographical location. Binary Cycle Geothermal power plants can produce electricity from geological sources with temperatures as low as 170o F (approx. 77oC). Ground source heat pumps have output temperatures of approx. 50oC. Perhaps a sequential heat pump system can provide sufficient thermal mass at adequate temperatures for a Binary type Geothermal power plant to operate, effectively eliminating the need of a naturally occurring geothermal source, and enabling the implementation of a renewable energy power plant with constant output, irrespective of geological location. The aim of this study is to analyze the efficiency of a Binary Cycle Geothermal Power Plant whose “hot” reservoir is provided by heat pumps.

5.4 Technical solution for installing the photovoltaic plant on the roof of a building

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Keywords: photovoltaic panels, inverter, installation and analysis

This study presents a technical solution for producing electric energy specifically designed for the Faculty of Physics building. The proposed solution aims to harness renewable energy sources and promote sustainable electricity generation within the facility. The Faculty of Physics building requires a reliable and sustainable source of electric energy to meet its operational needs. To address this requirement, a technical solution leveraging renewable energy technologies is proposed. The proposed solution is the installation of a photovoltaic (PV) system on the building's rooftop, utilizing solar energy to generate electricity. The design phase of the solution involves a comprehensive evaluation of the building's rooftop to assess its suitability for PV installation. Factors such as structural integrity, orientation, shading analysis, and available space are considered to ensure optimal system performance. The installation process: mounting solar panels onto the rooftop using appropriate support structures or racks, ensuring a secure and weather-resistant installation. The electrical wiring is integrating the PV system with the building's electrical infrastructure and incorporating an inverter to convert the generated solar energy into usable electricity. Adherence to safety protocols and compliance with local electrical codes are paramount throughout the installation. After installation, comprehensive testing and commissioning are conducted to verify its functionality and performance: rigorous checks of electrical connections, power output validation, and assessment of monitoring systems. Routine maintenance and

periodic cleaning are essential to optimize the system's efficiency and maximize its lifespan. Implementing this technical solution offers several benefits for the Faculty of Physics building. By utilizing solar energy, the building can significantly reduce its reliance on conventional fossil fuel-based electricity sources, thereby lowering its environmental impact. The PV system enables the building to generate electricity on-site, potentially resulting in cost savings and promoting energy independence. Furthermore, the longevity of PV systems and their compatibility with energy storage technologies make them a sustainable choice for long-term energy production. In conclusion, the proposed technical solution involving the installation of a photovoltaic system on the rooftop of the Faculty of Physics building presents a sustainable approach to meet the facility's electric energy requirements. Through careful design, installation, and maintenance, this solution can contribute to the building's energy efficiency goals, reduce environmental footprint, and foster a commitment to renewable energy within the academic institution.

5.5 Sun-tracking photovoltaic system for educational and training activities

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Keywords: photovoltaics, sun-tracking system

The sun is part of our life and has an important role because it warms the earth, the water in the oceans evaporates thanks to it, the clouds are directed by air currents determining the rains and maintaining the flow of the rivers. Fortunately, solar energy can be converted into electricity in an environmentally friendly process. Photovoltaic panels are a clean and environmentally friendly source of electricity. Obtaining this energy, however, poses a number of challenges for device and equipment designers. The amount of energy produced by the panel strongly depends on the angle of incidence and the intensity of the light falling on the surface of the cells. This, in turn, leads to instability of the output power parameters, since even shading of a small part of the panel can cause a drastic reduction in efficiency. The elegant solution would be a system of photovoltaic panels that can track the position of the sun for optimized electricity production. In this context, our aim is to design and build a sun tracking system. The experimental photovoltaic system contains the following components: solar panel, panel fixing system, inverter, connectors and cables, the sun-tracking system, mega jade development boards, current measurement and regulation equipment, batteries, etc. Stepper motors, different types of wheels for panel orientation made on ender and Prusa 3D printers, bearings for rotating the rods were used for the sun tracking system. After the experimental device was built, it was tested under relevant conditions. The data provided by the inverter was analyzed in terms of energy produced in relation to weather conditions.

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This project is carried out together with the Ercast robotics team of the Energetic Technological High School "Elie Radu", Ploiesti, under the supervision of prof. Dana Constantinescu.

5.6 Ecological technologies for the removal of pharmaceutical pollutants from contaminated water

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Keywords: ecological technologies, pharmaceutical pollutants, water decontamination

Pharmaceutical pollutants represent a class of emergent contaminants that require the implementation of ecological decontamination technologies to ensure the treatment of wastewater and the elimination of pharmaceuticals before the discharge of water into the environment. Considering the high demand of the market in the field of medicines and implicitly their increasing production, pharmaceutical pollution has become a global and worldwide problem. The conventional removal of pharmaceutical pollutants methods has many limitations with low efficiency, a fact that led to the development of new ecological systems. In this sense, the present work aims to implement ecological technologies for water decontamination, based on natural filteters such as montmorillonite clay, micronized activated zeolite, activated carbon and combinations thereof. The removal effect from water of of the pharmaceutical compound N-acetylcysteine (NAC) and the absorption capacity (CA%) of filter materials was evaluated by UV-VIS spectroscopy (Jasco, Japan, V-570 spectrophotometer). Spectra of the samples before and after filtering, were acquired in the range of 200-800 nm and their monitoring highlighted the decreasing of the absorbance value at the wavelengths corresponding to the pharmaceutical compound N- acetylcysteine (NAC). By employing eco-technologies based on natural filter materials, it was found that activated carbon is the most effective filter material (CA = 40.86%), followed by montmorillonite clay (CA = 36.90%) and micronized activated zeolite (25.04%). In addition, the morphological characteristics of the filter materials were investigated with a Digital Mobile Microscope (1X-544X, TC-006, Digital Mobile Microscope, China) and highlighted their specific micro structures.

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5.7 Influence of the microporous layer on the performance of proton exchange membrane fuel cell

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Keywords: microporous layer, proton exchange membrane fuel cell

Fuel cells are electrochemical generators that convert energy from chemical reactions into electricity, with heat and water (in the case of hydrogen and air fuel cells) as by-products. Proton exchange membrane fuel cells are electrochemical devices powered by hydrogen oxidised at the anode and oxygen reduced at the cathode (redox reaction). The resulting protons in the anode area pass through the proton exchange membrane to the cathode. As the membrane is not electrically conductive, the electrons generated by the hydrogen reaction pass through the external circuit and generate an electric current. The gas diffusion layer plays a key role in the operation of fuel cells, ensuring both the efficient diffusion of reactants to the catalyst layer and the transport of electrons to and from the catalyst layer. We propose an improved microporous layer consisting of carbon nanowalls, i.e. vertical walls of graphene, deposited using high frequency plasma assisted chemical vapour deposition. Such materials with improved properties over the usual carbonaceous materials, high porosity, stability, considerable durability or high hydrophobicity, open new approaches in the evolution of electrochemical devices. Single cell tests of the fabricated membrane-electrode assembly with carbon nanowalls as microporous layers have indicated improved performance comparable to industrial quality membrane assemblies, 500 mW cm-2 mg-1 cathodic Pt load at 80 ◦C and 80% RH. Furthermore, degradation processes in terms of catalyst electrochemical active area and fuel-hydrogen crossover are addressed.

5.8 Design and Performance Analysis of a PV- Electrolyser System Simulation Using a Buck-Boost Converter for Enhanced Hydrogen Production.

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Keywords: Hydrogen Production, Buck-Boost Converter, PEM electrolyser.

The coupling of solar photovoltaics (PV) and electrolysers represents a promising technology for the production of hydrogen in a way that is both ethical and sustainable for the environment. While PV and electrolyser technologies are well-established, the efficiency of such systems still poses great challenges due to the high variability of solar radiation. These fluctuations directly impact the power output of solar PVs, affecting the electrolyser's performance. In order to overcome the challenges associated with solar radiation variability, an efficient coupling between the solar PV and the electrolyser is essential to ensure optimal hydrogen production. The coupling of this system entails the use of suitable power conversion devices, such as DC-DC converters, which can help to regulate both the current and the voltage that is being supplied to the electrolyser. Depending on the size of the system, there are different converters that can be used, such as a buck-boost converter. Its operation involves the conversion of the input voltage to either a higher or lower output voltage, depending on the requirements of the electrolyser. By adjusting the duty cycle of the converter, the buck-boost converter can efficiently manage the power flow and stabilize the voltage and current levels, enhancing the performance of the electrolyser. In this paper we undertake a comprehensive analysis of a solar PV-electrolyser system by utilizing MATLAB/Simulink. The main objective of this study is to evaluate the efficiency of this system, particularly in relation to hydrogen production. To achieve this, a buck-boost converter within the simulation model was included. Through the simulation, we analyze the efficiency

of the system under varying case scenarios. The simulation offers a comprehensive understanding of the solar PV-electrolyser system's performance and its potential for efficient hydrogen production.

5.9 Bioelectrochemical Activity of Probiotics: A Case Study for Potential Use in Biobatteries

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Keywords: Probiotics, Biobatteries, Potențial Redox, MFC

Probiotics, known for their beneficial health effects, have attracted attention as potential electricity producers in biobattery applications. This dissertation aims to demonstrate that probiotics can generate an electrical potential and to evaluate their possible use in biobatteries and medical devices.
In the first part of the paper there were introduced the basic concepts of microbial fuel cells (MFC). Here we outlined the working principle of microbial cells, the components of a cell, its configurations and the electron transfer mechanism, as well as the redox potential in microbial fuel cells.
To test the potential of probiotics we chose three probiotics on the market which have Lactobacillus bacteria in their composition.
The first part of the experiment consisted of measuring the redox potential of probiotics. The result of the measurements determining which probiotic will be used in the microbial fuel cell.
The second part of the experiment consisted of measuring the potential of the probiotic studied in a microbial fuel cell. For both experiments the followed procedure, methods and used materials were presented.
At the end of the study, the data obtained were represented, commented and an evaluation was made regarding the use of these results in a possible use of probiotics in devices such as biobatteries.

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5.10 Design and construction of a natural gas-fired heat supply system

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Keywords: heat supply system, natural gas, renewable energy

The heat supply system includes all installations and equipment in the entire chain of production, transport, distribution and consumption of heat. Natural gas covers 24% of the world's energy needs. Estimated global gas reserves are around 170,000 billion m3, which covers the energy needs for 67 years. Romania has proven natural gas reserves of 100 billion m3. Currently, Romania has the third largest gas reserves in the European Union, after the Netherlands and the United Kingdom. In this paper we have presented the design and execution of the technical chamber that supplies thermal

energy to a research institute. The standards, calculations, schemes and materials used for this installation are presented. The paper also presents solutions for converting the existing installation to use renewable solar energy as a source of heat energy supplied to the building. This type of conversion of the heat supply system in the building would lead to lower costs and reduced pollution.

5.11 Hydrogen Vehicles – Opportunity for a Sustainable Future?

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Keywords: hydrogen technology, fuel, vehicles, renewable energy, sustainability

This study provides a comprehensive analysis of the sustainability of hydrogen vehicle technology in Europe. The assessment considers several dimensions, including economic, social and environmental sustainability. The results show that hydrogen technology does not meet all points of sustainability. Social sustainability is considered to be achieved, as the technology enjoys broad acceptance among the population and is expected to create new jobs. Policy guidelines, such as the European Hydrogen Road, further support the integration of hydrogen technology. Furthermore, it is necessary to address the issue of critical raw materials, in order to reduce dependence on authoritarian states and to meet sustainability. Environmental sustainability is not achieved yet, as the production of green hydrogen is still limited. The transformation to renewable electricity production is crucial to achieve environmental advantages. Economic sustainability is the biggest challenge. Battery electric vehicle technology is developing rapidly and offers low operating costs, and rapid development suggests that trucks could also be battery-powered in the future. As there is a cheap alternative to hydrogen technology for vehicles, hydrogen technology will not be economical sustainable. Taking into account a strong and stable power grid in Europe, electrification by battery-powered vehicles is the more likely scenario. In summary, hydrogen technology offers an opportunity for a sustainable future in vehicles. However, its application in conventional passenger transport is questionable. Even while social and environmental sustainability are justified, there are still questions about economic sustainability, particularly in Europe. The hydrogen technology is likely to become mainstream in certain transportation and industry application areas. In addition, new technologies such as artificial intelligence, autonomous vehicles and high speed transport systems could influence the future role of hydrogen in vehicles.

5.12 Free radical scavenging properties of N-acetylcysteine (NAC)

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Keywords: N-acetylcysteine, radical scavenging, antioxidant activity, chemiluminescence technique

N-acetylcysteine (NAC) is a derivative of the amino acid cysteine and is a precursor to glutathione, an important antioxidant in the body. NAC has been shown to have free radical scavenging properties, which means it can help protect cells from damage caused by reactive oxygen species (ROS) and other harmful molecules. The complex pharmacological action of N-acetylcysteine (NAC) allows its use in the treatment of various diseases such as liver failure, inflammatory processes but also nephropathy and brain disorders. N-acetylcysteine (NAC) presents a therapeutic efficacy due to its ability to reduce extracellular cystine to cysteine, and as a source of sulfhydryl groups. NAC stimulates glutathione synthesis, enhances glutathione-S-transferase activity, promotes liver detoxification by inhibiting xenobiotic biotransformation, and is a powerful nucleophile capable of scavenging free radicals. Starting from these considerations, the present paper aims to evaluate the scavenger effect of N-acetylcysteine by three distinct methods. Thus, the scavenger effect of free radicals was assessed by employing in vitro non cellular assays using the chemiluminescence technique in aminophthalhydrazide-hydrogen peroxide system at pH=8.6, DPPH(2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay and ABTS (2,2′azinobis-(3-ethylbenzthiazoline-6- sulfonic acid) methods. The results confirmed a significant value of antioxidant activity but also a good correlation between the three techniques approached.

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5.13 Gold Dissolution In Electrochemical Systems: Exploring Eco-Friendly Methods For Sustainable Applications

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Keywords: recovery, electrochemistry, gold dissolution, circular economy

Gold is a highly valued precious metal that finds extensive use in various applications such as electronic devices, jewelry and currency reserves. This is primarily due to its exceptional chemical resistance, stability at high temperatures and reliable electrical properties.y. However, the available resources of gold are gradually diminishing. In order to meet future demands and preserve these finite resources, it becomes imperative to recycle gold-containing materials, such as electronic scraps and used equipment. By employing these spent materials, we can both satisfy the growing demand for gold and conserve the Earth's scarce resources. Various methods are available for the recovery and recycling of gold. These methods include mechanical separation, pyrometallurgical and hydrometallurgical which have been extensively used to extract gold from gold-containing materials. However, these methods pose environmental challenges due to emissions of gases and concerns over the stable supply of metal-rich ores suitable for smelting in the future. In recent years, there has been a shift towards more environmentally friendly and sustainable methods, including electrochemical processes. These approaches aim to minimize the environmental impact associated with traditional methods and ensure a stable supply of gold while conserving resources. The electrochemical dissolution of gold is a complex subject that has been the focus of study for over five decades [1,2]. Despite significant research efforts, our understanding of this process remains somewhat limited. By enhancing our understanding of gold

dissolution, we can unlock new possibilities for optimizing gold recovery processes and developing more efficient and sustainable electrochemical technologies. In this work, we will focus on the electrochemical oxidation and dissolution of gold which hold significant importance in the field of electrochemistry. Understanding the mechanisms behind this phenomena is crucial for comprehending the behavior of noble metals in electrochemical systems.

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5.14 Cu Nanoparticles Influence on Polyphenol Content in Ocimum Basilicum Plants

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Keywords: Cu NPs, Polyphenol

Polyphenolic compounds constitute one of the complex mechanisms that, depending on their atomic structure, participate simultaneously in plant development by regulating physiological processes and in defence against various pathogens[1]. The quantity of these compounds found in plants is influenced by the degree of exposure to oxidative stress, and their ability to interact with different enzymes, proteins, and molecules plays a significant role in human nutrition due to their antioxidant, anti-inflammatory, and preventive effects against cardiovascular diseases[2]. In light of these findings, the present study aims to verify the hypothesis of artificially stimulating the increase of polyphenolic compounds quantity in Ocimum Basilicum plants through the injection of copper nanoparticles. The study was conducted over a span of 30 days in an artificially illuminated greenhouse and involved two groups of plants: one treated with copper nanoparticles and the other serving as a reference. The variation in the quantity of polyphenols over time was determined by analyzing the plant extract. The morphological characterization of copper nanoparticles took place using UV-visible spectroscopy and dynamic light scattering (DLS) techniques.

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5.15 Photosensitivity activation of copper foam by cold plasma treatment

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Keywords: photo-catalysts, light sensitivity

Photosensitive materials have the capacity to react in a physical or chemical way when interacting with photons. This property is used in photo-catalysts to mediate chemical reactions. Copper is known to have a special selectivity for CO2 reduction and treating this material surface in plasma, makes its sensitivity to light increase, this fact opens a way for potential photo catalyst applications. The present study shows the photoelectric activity of a copper foam with a high-surface-active-area treated in a cold plasma jet that created surface oxides resulting in modified light sensitivity performance. Evaluation was done by chronoamperometric testing this material in a photo-electrochemical cell using a UV lamp, emitting at 380nm. The results showed an incident photon-to-current efficiency of more than 50%. This is a reasonable value for a photo active material and it suggests that can be used in photo electro-catalytic CO2 reduction.

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Section 6: Physics Education

Location and time: **Seminar Rm. 12**

Moderators:

Prof. Dr. Ştefan ANTOHE

Assoc. Prof. Dr. Cristina MIRON

6.1 - Anda CIOBANU, Cristina MIRON, Cătălin BERLIC, Valentin BARNA
Experimental and theoretical approach of simple oscillatory systems using Tracker and GeoGebra software

6.2 - Călin GALERIU, Geoffrey ESPER, Cristina MIRON
Nuclear physics with MightyOhm: evidence of inelastic scattering

6.3 - Adriana RADU, Daniela STOICA, Mihai V. POPESCU, Cătălin BERLIC, Cristina MIRON, Valentin BARNA
The study of elastic hysteresis using Einstein tablet

6.4 - Bogdan CHIRIACESCU, Fabiola CHIRIACESCU, Cristina MIRON, Valentin BARNA, Cătălin BERLIC
Visual instruments employed for introducing seismology notions at preuniversitary level

6.5 - Adriana RADU, Ionel GRIGORE, Valentin BARNA
Mathcad work documents for the study of the simple gravitational pendulum

6.6 - Corina RADU
Review of articles regarding teaching about photovoltaic cells in high school

6.7 - Anda CIOBANU, Cristina MIRON, Cătălin BERLIC, Valentin BARNA
Interactive exploration of heat transfer processes. Practical applications in pre-university physics education

6.8 - Andreea GOIA, Cayuss Andrei MIHĂIȚOAIA Tiberius O. CHECHE
Modeling electrostatically actuated MEMS cantilever beam

6.9 - Mihai DRAGOMIR
An analytical approach to Kepler's problem

6.10 - Andrei-Cristian OPINCĂ, Diana-Ştefania CATANĂ, Tiberius O. CHECHE
Euler’s laws and Lagrange’s equations for a particle sliding inside a cylinder

6.11 - Iulian STANCU
Microbarometers - infrasound sensors

6.12 - Constantin PISĂU
The role of computers in enhancing students’ physics problem-solving abilities

6.1 Experimental and theoretical approach of simple oscillatory systems using Tracker and GeoGebra software

Anda CIOBANU[1,2],Cristina MIRON[1], Cătălin BERLIC[1], Valentin BARNA[1]
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Keywords: Mach pendulum, Maxwell pendulum, Tracker, GeoGebra, physics education

In this paper, we present an approach for the experimental and theoretical study of systems that have oscillatory motions, such as the Mach pendulum and the Maxwell pendulum, by means of free software tools. The experimental investigation, data collection and processing are performed using the video analysis software-Tracker. For modelling the proposed systems and simulating the studied phenomena, we employed the GeoGebra mathematical software. This type of methodology, which combines real experiments with the simulation of the phenomenon, is useful and highly efficient in understanding the specific characteristics of the systems while involving students in building their own knowledge base. Another aspect is related to the possibility of using the three-dimensional models of these systems, created with GeoGebra, in augmented reality mode, which stimulates the students' interest, as well as motivation for study.

6.2 Nuclear physics with MightyOhm: evidence of inelastic scattering

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Keywords: dead time, Compton scattering, bremsstrahlung, Poisson distribution

Great physicists like Arthur Compton [1] were able to design and build new scientific instruments, which many times opened the door to new physics discoveries. Our students as well should get more involved with this creative method of doing science. One way of promoting this type of experimental research skills is to teach them how to make measurements using the very popular and affordable Arduino Uno microcontroller board and its compatible sensors. With this physics teaching philosophy in mind, and with the help of a MightyOhm Geiger counter, we have investigated the natural background radiation [2]. Smartphones and tablet PCs can also be used to measure radioactivity [3, 4]. Here we present another very accessible and safe nuclear physics experiment, which again does not require any commercial radioactive sources or expensive instrumentation. This time, with the help of a MightyOhm Geiger counter, an Arduino Uno board, and some thoriated tungsten welding electrodes, we have revealed evidence of inelastic scattering.

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6.3 The study of elastic hysteresis using Einstein tablet

Adriana RADU[1,2], Daniela STOICA[3], Mihai V. POPESCU[3], Cătălin BERLIC[1], Cristina MIRON[1], Valentin BARNA[1]
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Keywords: elastic hysteresis, ImageJ software, Einstein Tablet, physics education

The elastic properties of suitable materials are employed to dampen vibrations on the components of devices, installations, etc. Materials presenting large elastic hysteresis are used as absorbing materials of the vibration energies in various mechanical parts. For this reason, the study of the hysteresis properties is important for students in the process of learning physics. This paper describes the way the deformation of a rubber band can be studied by using the distance and force sensors attached to an Einstein tablet. By means of the MILAB software we obtain the dependence graph for the deformation of a rubber band versus the deforming force. We observed that the return of the band to its initial shape was not carried out in the same way as during the initial elongation, contrary to what happens in the case of a spring deformed within the limit of elasticity, the process presenting hysteresis. The area between the two plotted curves represents the energy dissipated in the elastic material and is determined via ImageJ processing software. It can be concluded that the deformation of the rubber band does not respect Hooke's law and the system loses energy in the process. The method proposed for the study of elastic hysteresis by employing the Einstein tablet and Image J provides very good results, comparable to other methods and can be considered interesting and attractive for students studying the elastic properties of various materials.

6.4 Visual instruments employed for introducing seismology notions at preuniversitary level

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Keywords: seismology concepts, visual instruments, Tupitube animation, Whiteboard animation

In the beginning of 2023, an intensification of seismic activities was observed in South-Eastern Europe. A strong earthquake in Turkey (06.02.2023) followed by multiple replicas as well as some

unusual seismic activity in the South-Western part of Romania, brought back to the public's attention these potential catastrophic hazards. Since we cannot control these phenomena, to protect ourselves from the devastating effects of earthquakes, it's clear that it is highly necessary to be informed and to know the measures to be taken for our safety. This type of education should start already at school level. It is well known that visual materials have a big impact on students. Herein, three short videos realized by two different techniques are presented: an animation made with TupiTube application, and two animations made in the Whiteboard animation technique. The Tupitube animation shows in what manner the P and S seismic waves travel and also the effects they produce. The first Whiteboard animation is related to the Richter and Mercalli scales and, while the second one is about safety measures we have to take in case of an earthquake for our own protection. In the presented materials there is easy to understand information and the videos can be useful instruments for the teachers to introduce seismology concepts.

6.5 Mathcad work documents for the study of the simple gravitational pendulum

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Keywords: Mathcad, didactic tool, gravitational pendulum, oscillation period, elliptic integral, physics education

This paper presents a didactic tool designed with Mathcad work documents for the study of the simple gravitational pendulum in oscillation mode. For a certain value of the initial angular amplitude, entered in the input data, the period of the pendulum is calculated and compared with the approximations of order zero, one and two from the expansion series. For the calculation of the period, it is shown how the full elliptic integral of the first kind can be evaluated in Mathcad with the initial angular amplitude of the pendulum as a parameter. On the same graph are superimposed the curves that reproduce the dependence of the period and the approximations of the zero, first and second order on the initial angular amplitude. The facilities of the Mathcad program can be explored to quickly calculate the values of an indexed quantity by an index. Thus, we have generated the table with the values of the oscillation period depending on the values of the initial angular amplitude. Also, on the same graph, the errors relative to the calculation of the period in the zero, one and two orders were graphically represented for comparison. By using the tool in class, students can calculate the period of the gravitational pendulum at any value of the initial angular amplitude and clarify under which conditions the movement of the pendulum can be approximated in zero, one and two orders depending on practical needs.

6.6 Review of articles regarding teaching about photovoltaic cells in high school

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Keywords: review, surveys, photovoltaic cells

As technology continues to evolve, it is becoming of increasing importance for high school students to have a very strong foundation in physics, which would provide them with a fundamental understanding of how the physical world works. An integrated curriculum that blends physics with engineering can provide students with a deeper understanding of complex topics, which is critical to many emerging technologies, including renewable energy technologies such as photovoltaic cells. In this article are reviewed surveys testing interest in higher complexity high school physics courses, that were conducted among high school students and graduates from technological universities, and, also, are reviewed approches of high school physics courses on photovoltaic cells as renewable, sustainable energy sources, essential to combat climate change.

6.7 Interactive exploration of heat transfer processes. Practical applications in pre-university physics education

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Keywords: heat transfer, Google Colab, GeoGebra, physics education

This paper focuses on presenting two practical applications that allow students to explore heat transfer processes in an interactive and engaging manner, suitable for pre-university physics education. The first application aims to determine the thermal equilibrium state of a water-ice mixture through a Python application developed on the Google Colab platform. Problem analysis and the necessary steps for solving it are included in a mind map created by means of Cmap Tools software. The second application centers on calculating the heat requirements for a building. For this purpose, GeoGebra software is used to construct a 3D model of the building and then calculate heat exchanges through conduction, convection and radiation. This approach enables students to explore theoretical concepts in a practical and interactive manner, contributing to an in-depth understanding of this subject. By applying the heat transfer concepts in real-life situations and by employing modern technologies in their study we contribute to the development of the students' analytical and critical thinking skills in an interdisciplinary, efficient and creative manner.

6.8 Modeling electrostatically actuated MEMS cantilever beam

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Keywords: MEMS, actuation voltage, cantilever beam

The cantilever beam for micro-electromechanical systems (MEMS) switch is basically a switch controlled by electrostatic forces acting on two plates of a capacitor. The top moving plate is an elastic beam with a certain polarity, while the bottom fixed plate has opposite polarity. At the actuation voltage the beam becomes unstable and collapses to the down state closing the switch. The elastic deformation is described by the Euler–Bernoulli beam equations. The orientation of the top moving plate is taken into account. The theoretical model is compared with experimental results.

6.9 An analytical approach to Kepler's problem

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Keywords: analytical mechanics, Kepler's problem, simulations

In this presentation I shall do a compared study of the four methods used in Analytical Mechanics - Lagrangian, Hamiltonian, Routh's Method and Poisson Brackets - by solving a classic example in Newtonian Mechanics: Kepler's Problem. After a short introduction into the problem itself, we discuss each formalism and consider numerical simulations of well-known orbital systems.

6.10 Euler’s laws and Lagrange’s equations for a particle sliding inside a cylinder

Andrei-Cristian OPINCĂ[1], Diana-Ștefania CATANĂ[1], Tiberius O.CHECHE[1]

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Keywords: Euler’s laws, Lagrange’s equations, relative rotation motion

Euler’s laws and Lagrange’s equations are applied to simulate the relative motion of a particle sliding inside a cylinder placed on a horizontal surface. The motion is described from the simplest to the most complex case as a function of the friction coefficients between the in-contact surfaces. Differential equations and their solutions for the rotation and translation motion of the particle-cylinder system are provided.

6.11 Microbarometers - infrasound sensors

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Keywords: infrasound, atmospheric pressure, hysteresis, physics education

Infrasound measurements are achieved through a dedicated set of equipment, called "infrasound measurement chain". Most modern ones consist of an infra sensor, the acquisition unit and, when necessary, a reducing wind noise filter. The sensor measures atmospheric pressure changes over a broad range of values and offers a dynamic signal recorder. The fact that nuclear explosions generate infrasound stimulated an increased interest in infrasound sensors and led to their application also in other areas. Infrasound sensor aneroid capsule consists of an aneroid capsule and an linear variable differential transducer that measures the variable air pressure changes within a defined cavity. A magnet and coil velocity transducer can be employed as a detector aneroid capsule. Such sensor is robust, has very low noise and provides a response in accordance with the characteristics of the background noise. Some infrasound sensors use precision quartz crystal resonators to reduce the stress induced by pressure changes. The resonance frequency varies depending on the pressure generated by stress. They are described as transducers with remarkable repeatability, low hysteresis, and excellent stability.

6.12 The role of computers in enhancing students’ physics problem-solving abilities

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Keywords: problem solving techniques, computer assisted learning, software applications, physics education

With the rapid advancements in technology, computers have emerged as valuable tools that can enhance students' learning experiences and problem-solving abilities. This work explores the integration of computers in physics education to enable students to effectively solve physics problems. Using various software applications and interactive learning platforms, students can engage in exploration, visualization, facilitating a deeper understanding of physics concepts. These applications can help students to obtain improved results thorough methods of problem-solving techniques employed in physics education. Computer-assisted learning offers personalized feedback and adaptive assessments, tailoring the learning experience to individual student needs, enhancing engagement and promoting self-directed learning. By integrating technology in physics classes, teachers can enhance the learning experience, promote active participation and equip students with the necessary skills to excel in their physics studies.

Section 7: Polymer Physics

Location and time: **Rm. 47, 3rd fl.**

Moderators:

Prof. Dr. Valentin BARNA

Assoc. Prof. Dr. Cătălin BERLIC

7.1 - Catalin BERLIC, Cristina MIRON, Valentin BARNA

On the Effect of External Fields on Liquid Crystal Alignment at Liquid-Solid Interfaces: A Monte Carlo Approach

7.2 - Catalin BERLIC, Eduard GATIN, Daciana ZMARANDACHE, Adrian BERLIC, Diana-Lavinia STAN

Investigating the Effect of Chain Length on Polymer Conformation Using Monte Carlo Simulation

7.3 - Adrian BERLIC, Catalin BERLIC

Exploring the Potential of Artificial Intelligence Language Models in Monte Carlo Simulations in Polymer Physics

7.4 - Valentin BARNA

Particular Characteristics of Controllable Dye-Doped Nematic Liquid Crystal Optical Micro-Emitters

7.5 - Valentina MARASCU, Anca BONCIU, Valentin BARNA

Automatic vs. Manual Algorithm Approaches for Image Processing

7.6 - Valentin BARNA, Lucian Dragos FILIP, Catalin BERLIC

Optically Tunable Photonic BandGap Soft Matter Systems

7.7 - Bogdan BUTOI, Andreea GROZA, Paul DINCA, Cornel STAICU, Oana POMPILIAN, Cristian LUNGU, Valentin BARNA

Electro-optical switching of plasma deposited PANI layered liquid crystal cells

7.8 - Bogdan BUTOI, Cornel STAICU, Oana G. POMPILIAN, Paul DINCA, Corneliu POROSNICU, Andreea GROZA

Deposition of Fe2O3 Doped PANI Thin Films by DC Plasma Polymerization

7.9 - Stéphanie NKÉMONE, Simona-Liliana ICONARU, Steluta Carmen CIOBANU, Peter Teke NDIFON, Linda Dyorisse Nyamen, Daniela PREDOI

Synthesis and Characterization of Undoped/ Eggshells-Doped Ternary Metallic Oxide Nanocomposite NiZnCr-O2

7.10 - Stéphanie NKÉMONE, Simona-Liliana ICONARU, Steluta Carmen CIOBANU, Peter Teke NDIFON, Linda Dyorisse NYAMEN, Liliana GHEGOIU, Monica Luminita BADEA, Daniela PREDOI

Synthesis and Characterization of Ternary Triple Hydroxide NiZnCr-Th

7.11 - Valentina MARASCU, Anca BONCIU, Valentin BARNA

Image Processing Algorithms for Educational Purposes

7.12 - Madalina ICRIVERZI, Paula FLORIAN, Anca BONCIU, Nicoleta DUMITRESCU, Laurentiu RUSEN, Anca ROSEANU, Valentina MARASCU, Valentina DINCA

MAPLE Modified Polydimethylsiloxane (PDMS) Interfaces Characteristics Influence on Cell Behavior

7.1 On the Effect of External Fields on Liquid Crystal Alignment at Liquid-Solid Interfaces: A Monte Carlo Approach

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Keywords: liquid crystal alignment, liquid-solid interfaces, Monte Carlo simulation, surface anchoring, director orientation, light transmission

We employ Monte Carlo simulations to investigate the effect of external fields on liquid crystal alignment at liquid-solid interfaces. Our simulation methodology incorporates realistic intermolecular potentials and considers the presence of an electric field. We focus on the interactions between liquid crystal molecules, the substrate surface, and the external field, aiming to unravel the underlying mechanisms governing liquid crystal alignment. By systematically varying the strength and orientation of the external field, we examine the resulting changes in liquid crystal ordering, anchoring behavior, and alignment structures at the liquid-solid interface. We analyze various alignment metrics, including surface anchoring strength, director orientation, and layering properties, to characterize the alignment response of liquid crystals under the influence of external fields. Our simulation methodology combines the Monte Carlo simulation technique with a light propagation model, incorporating the interaction of light with liquid crystal molecules. We consider the optical anisotropy of liquid crystals and the influence of alignment at liquid-solid interfaces on light transmission. By systematically varying the parameters such as liquid crystal alignment, external field strength and orientation, and incident light properties, we examine the impact on light transmission characteristics, including transmission intensity, polarization, and spatial distribution. We analyze the influence of alignment-induced birefringence, surface anchoring, and field-induced reorientation on the optical behavior of liquid crystal systems.

7.2 Investigating the Effect of Chain Length on Polymer Conformation Using Monte Carlo Simulation

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Keywords: polymer configuration, chain length, Monte Carlo simulation, radius of gyration, end-to-end distance, spatial organization

In this study, we use Monte Carlo simulation to investigate the effect of chain length on the configuration of polymers. By systematically varying the chain length parameter, we explore how changes in polymer length influence key structural properties, including the radius of gyration, end-to-end distance, and spatial organization. Our Monte Carlo simulation methodology incorporates realistic interatomic potentials and considers factors such as temperature and solvent interactions. Starting with

an extended polymer chain, we implement a range of simulation protocols to explore the configurational space and sample various conformations. The simulation results reveal trends in polymer configuration as chain length is varied. Shorter chains tend to adopt more compact conformations with smaller radii of gyration and end-to-end distances. As the chain length increases, polymers exhibit a greater degree of chain stiffness and extended conformations become more prevalent. Additionally, we investigate the influence of chain length on the occurrence of entanglements, chain entropies, and conformational transitions.

7.3 Exploring the Potential of Artificial Intelligence Language Models in Monte Carlo Simulations in Polymer Physics

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Keywords: artificial intelligence, Monte Carlo simulations, polymer physics, machine learning, conformational sampling, property prediction

The application of artificial intelligence (AI) techniques in Monte Carlo simulations of polymer physics holds significant promise for enhancing the understanding of polymer behavior and accelerating the discovery of novel materials with tailored properties. In this work, we explore the potential of AI in Monte Carlo simulations of polymer physics, aiming to unlock new ways for predictive modeling and efficient exploration of polymer systems. First of all, AI can assists in developing novel algorithms or improving existing ones used in Monte Carlo simulations. It may be also involved in designing efficient sampling techniques, optimizing simulation parameters, or developing intelligent strategies for enhanced conformational sampling. By training machine learning models on large datasets of simulated polymer systems, it can help estimate physical properties of polymers, enabling researchers to gain insights without performing extensive simulations. Large language models can provide guidance and recommendations during the simulation process. We asked specific questions, and we seek advice on selecting appropriate simulation parameters, optimizing sampling strategies, or exploring specific aspects of polymer physics. We note that while AI can assist us in various aspects of Monte Carlo simulations, the actual implementation and execution of the simulations would typically be performed using specialized software and computational resources. The main role of AI is to provide guidance, support, and insights based on the information and knowledge available to it.

7.4 Particular Characteristics of Controllable Dye-Doped Nematic Liquid Crystal Optical Micro-Emitters

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Keywords: Optical Micro Lasers, Liquid Crystals, Phase Trasition

Random laser effect in a confined, partially ordered, dye doped nematic liquid crystals with long-range dielectric tensor fluctuations are presented. Coherent backscattering of light waves in

orientationally ordered nematic liquid crystals shows a weak localization of light which strongly supports diffusive laser action, when in presence of a gain medium (dye molecules). Beyond a certain optical pumping energy value, sequences of brilliant small lights appear on the background screen, emerging from our sample. A strongly fluctuating spatio-temporal random laser emission pattern (spectral width ca. 0.5 nm FWHM) is then measured. Experimental data disclose a high temperature dependency of the lasing properties in the nematic phase and in close vicinity of the nematic-isotropic (N-I) phase transition. The surprising reoccurrence of random lasing at higher temperatures, near the N-I transition is explained to be related to a different scattering mechanism, due to the micro-droplet phase nucleation.

7.5 Automatic vs. Manual Algorithm Approaches for Image Processing

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Keywords: Matlab; Hough Transform; automatic vs. manual detection.

An effective tool for information extraction, algorithm-based approaches also provide a fresh viewpoint on the outcomes. In order to explore the consequence of several physics' scenarios, concerning particle detection, we gave an overview of the utilized manual and automatic algorithm-based methodologies in our work. In short, the pictures were subjected to Hough Transform, Canny edge detection, and circularity analysis.

7.6 Optically Tunable Photonic BandGap Soft Matter Systems

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Keywords: Polymers, Liquid Crystals, Photonic BandGaps, Refraction Index, Periodic Nanometric Soft Matter Systems

Herein we present some computational simulations, new design and fabrication methods for special Photonic BandGap (PBGs) systems built from various soft materials (polymers, liquid crystals) to be employed as tunable compact light amplification systems in the visible and NIR optical range. Potential periodic structures with micrometric size, fabricated from materials with refraction indices in the interval 1 – 1.7 are discussed. The selection of suitable arrangements, geometries and material mixtures can lead to obtaining tunable high quality optical amplifiers and even lasing devices for certain designated wavelengths, as well as personalized pass band optical filters. By employing birefringent liquid materials (i.e. liquid crystals) in the configuration we can achieve real time spectral tuning for

these types of devices, an important feature that allows for a broad application range and higher versatility in the field of optics, photonics and nanotechnologies.

7.7 Electro-optical switching of plasma deposited PANI layered liquid crystal cells

Bogdan BUTOI[1], Andreea GROZA[1], Paul DINCA[1], Cornel STAICU[1,2,3], Oana POMPILIAN[1], Cristian LUNGU[1] and Valentin BARNA[3]
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Keywords: plasma, plasma polymerization, polymers, liquid crystal, response time

The most common application of liquid crystals is in the manufacture of displays,industry that exceeds several billion dollars.Currently, liquid crystal display manufacturing techniques and technology are low in price and high in reliability, so hundreds of millions devices are made, especially in the Far East and Japan. This technology has had a resounding success especially due to the "passive" nature of the operation, low energy consumption and good clarity in strong lighting. For displays to be effective, the refresh rate of a display must be greater that the refresh rate of the human eye (30-60Hz). These refresh rates are easily obtained with colesteric liquid crystals but are more expensive than nematic liquid crystals most commonly used. In this work, by means of a DC plasma polymerization reactor, we depositedpolyaniline (PANI) thin films on top of ITO coated glass, at different plasma and geometrical parameters, to obtain different topologies in order to condition nematic liquid crystals to behave like colesteric ones. Morphological measurements were performed by AFM and SEM imaging, while structural proprieties were investigated by FT-IR. 6 of the coated samples was used to obtain liquid crystal cells(LCC) and filled with nematic crystals. The refresh rate of each LCC was measured using an electro-optical setup in two different configurations (ground switch-off from polymer side / ITO side) and at different polarization voltages and frequencies.

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7.8 Deposition of Fe2O3 Doped PANI Thin Films by DC Plasma Polymerization

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Keywords: Polyaniline, thin films, iron oxide, nanoparticles, plasma polymerization

Polyaniline (PANI) thin films have been shown an increased interest by the scientific community for their impressive proprieties such as conductivity, adhesion, chemical stability and ease of use. The use of iron oxide doped polyaniline (PANI) has numerous applications as anticorrosive layers, sensor sensitivity boost, or in biomedical applications such as hyperthermia cancer treatments, imaging or drug delivery. This work is focused on analysing proprieties of Fe2O3 doped PANI films obtained by DC plasma polymerization in a vacuum device called reactor. As described in some of our earlier work [1], the plasma polymerization reactor consists of a vacuum chamber, two inner electrodes and a sample holder. After achieving a base-pressure of 10-2torr, aniline mixed with Fe2O3 nanoparticles is injected inside the reactor through a hole in the anode (upper electrode) and a DC plasma is ignited. The polymerization process starts and a polyaniline film starts to grown on the substrate surface, embedding the iron oxide particles. The resulting thin films were viewed from a morphological point of view by SEM (Scanning Electron Microscope) and AFM (Atomic Force Microscopy). These analysis have shown a uniform distribution of particles on the surface and imbedded in the film, claims that are also supported by EDS (Electron Dispersion Spectroscopy) measurements. Furthermore, size distribution of Fe2O3particles range between 200nm and 3µm. FT-IR (Fourier Transform Infrared Spectroscopy) present some modification in the PANI spectra from obtaining a core-shell conformation.

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7.9 Synthesis and Characterization of Undoped/ Eggshells-Doped Ternary Metallic Oxide Nanocomposite NiZnCr-O2

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Keywords: doped eggshells, nanocomposites, X-Ray Diffraction, Scanning Electron Microscopy, Energy-dispersive X-ray spectroscopy

We report here the synthesis of eggshells (ES) doped ternary metallic oxide (NiZnCr-O2) nanocomposite where the ES concentration was xES= 0 and xES = 0.05. The final samples was obtained after the calcination of ternary triple hydroxide (NiZnCr-TH) nanocomposite at 650°C. Thephysico-chemical properties of finalNiZnCr-TH nanocomposite were characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM) and Fourier Transform Infrared (FTIR) spectroscopy. Energy-dispersive X-ray spectroscopy (EDS) was used for the chemical analysis of synthesized samples. The preliminary results obtained in this study highlight the importance of NiZnCr-TH treated at 650oC in improving the properties of soft magnetic composites (SMC) that could be used in the development of electromagnetic devices, especially electric motors.

7.10 Synthesis and Characterization of Ternary Triple Hydroxide NiZnCr-Th

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Keywords: metal salts, co-precipitation method, soft magnetic composites

Ternary triple hydroxide (NiZnCr-TH) was prepared using corresponding metal salts in the ratio (1 :1 :1), using co-precipitation method[1].The ternary triple oxide was then doped with eggshell (ES) where xES was 0 and 0.05. The structure and morphology of synthesized materials were characterized by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM)and Atomic Force Microscopy (AFM). The elemental analysis of obtained materials was carried out by Energy-dispersive X-ray spectroscopy (EDS). The chemical properties of the obtained samples were observed by Fourier Transform Infrared (FTIR) spectroscopy. The structural properties of the materials obtained in this study highlighted their importance in the improvement of soft magnetic composites (SMC).

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7.11 Image Processing Algorithms for Educational Purposes

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Keywords: image processing; Python; K-means method.

The realm of applied physics serves as a link between theory and real-world applications. Computer science is important in this field because of its broad and complicated ability to mimic and forecast physical processes. As a result, in our work, we will emphasize the significance of analyzing using computer-based methodologies, to analyze images by using the K-mean algorithm. Combined with the optimization protocol, the final results may accomplish the scientific rigor.

7.12 MAPLE Modified Polydimethylsiloxane (PDMS) Interfaces Characteristics Influence on Cell Behavior

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One strategy to develop new and more efficient biodevices used as implants is based on surface physical-chemical modifications in order to prevent undesired biological responses [1, 2]. The physical-chemical characteristics of the newly proposed Poly(2-methacryloyloxyethyl phosphorylcholine) (pMPC) functionalized scaffold obtained by Matrix-Assisted Laser Evaporation (MAPLE) method [3] were evaluated by Scanning Electron Microscopy, Atomic Force Microscopy, Contact angle, Surface energy, Fourier Transform Infrared Spectroscopy and X-ray Photoelectron Spectroscopy. The assessment of adhesion, proliferation and morphology of cells grown on the functionalized Polydimethylsiloxane (PDMS) surfaces was performed in vitro, using human macrophages and fibroblasts, cells involved in foreign body reaction. The results obtained after evaluation of the physical–chemical properties of the new coatings revealed that the MAPLE technique proposed has the advantage of achieving homogeneous, stable and moderate hydrophilic thin layers onto hydrophobic PDMS. Moreover, this approach does not require any pre-treatment, therefore avoiding the major disadvantage of hydrophobicity recovery. Biological investigation evidenced the reduction of the adhesion and proliferation of human macrophages by ~50% and of human fibroblast by ~40% on the modified surfaces of PDMS compared to unmodified scaffold, thus circumventing undesired cell responses such as inflammation and fibrosis. All these highlighted the potential for the new PDMS interfaces obtained by MAPLE to be used in the biomedical field to design PDMS-based implants exhibiting long-term hydrophilic profile stability and better mitigating foreign body response.

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Section 8: Solid State Physics and Materials Science, Optics, Spectroscopy, Plasma and Lasers

Location and time: **Rm. 22, 2nd fl.**

Moderators:

Prof. Dr. Alexandru NEMNEŞ

Assoc. Prof. Dr. Vlad Antohe

8.1 - Nicolae FILIPOIU, Amanda Teodora PREDA, Dragos-Victor ANGHEL, Roxana PATRU, Rachel Elizabeth BROPHY, Movaffaq KATEB, C. BESLEAGA, Andrei Gabriel Tomulescu, Ioana PINTILIE, Andrei MANOLESCU, George Alexandru NEMNES
Capacitive and inductive effects in perovskite solar cells

8.2 - Ana-Maria POPA, Andrei STOCHIOIU, Luiza-Izabela TODERAŞCU, Vlad-Andrei ANTOHE, Gabriel SOCOL, Iulia ANTOHE
Highly-sensitive detection of ammonia using polymer based chemiresistive sensors

8.3 - Stefan DOBRESCU, Adrian BERCEA, Simona BRAJNICOV, Iulian BOERASU, Anca BONCIU, Cristina CRACIUN, Mihaela FILIPESCU, Maria DINESCU
Nanocomposite layers based on tungsten oxide/polymer processed by laser methods

8.4 - Angel Theodor BURUIANA, Mohamed Yassine ZAKI, Florinel SAVA, Alin VELEA, Maria MARIN, Elena ISPAS, Alexandru Razvan PETRE, Corina Anca SIMION, Anca LUCA
Efflorescence Formation and Interactions with Lithic Material: Insights from the Exterior Wall of the Episcopal Church – Curtea de Argeş

8.5 - Brahim YDIR, Iulia ANTOHE, Gabriel SOCOL, Mohamed BOUSSETTA, Houda LAHLOU
Effects of withdrawal speed on the properties of ZnO thin films deposited by an automated SILAR technique

8.6 - Teodora BURLANESCU, Mihaela BAIBARAC
Synthesis, Optical Properties and Electrodes Used for the Evaluation of Curcumin's Concentration

8.7 - Daniela STAN, Corina Anca SIMION, Cristian MANAILESCU, Maria Valentina ILIE, Alexandru Razvan PETRE, Andrei BALARIE, Dan STEFAN, Adrian IONITA
XRF and AMS: a simple and minimally invasive strategy to find answers to questions regarding the spatio-temporal origin of some construction materials

8.8 - R. EL OTMANI, A. ALMAGGOUSSI, A. RAJIRA, M. LABRINI, A. ABOUNADI, A. EL MANOUNI, M. E. KHADIRI, J. BENZAKOUR, J. EL HASKOURI, S. MURCIA MASCAROS
TOWARDS A STOICHIOMETRIC ELECTRODEPOSITION OF SnS

8.9 - Maria-Adela TANASE, Cristina BESLEAGA, Lucian ION
Fabrication and charactherisation of micro-transistors

8.10 - Diana-Ştefania CATANA, Ciprian Augustin PARLOAGA, Mohamed Yassine ZAKI, Daniel SIMAMDAN, Florinel SAVA, Angel Theodor BURUIANA, Alin VELEA
Formation and detection of Secondary Crystalline Phases in Cu2SnS3 Thin Films for Photovoltaic Applications

8.11 - Felicia IACOB, Maria BĂLĂŞIN, Ştefan ANTOHE, Sorina IFTIMIE, Vlad-Andrei ANTOHE
The effect of CuPc nanoparticles adding on the optical and photo-electrical behavior of the bulk heterojunction photovoltaic cells based on P3HT:PC71BM (1:1) polymeric blend

8.12 - Ana-Maria PANAITESCU, Vlad-Andrei ANTOHE, Ştefan ANTOHE
Study of Optical and Electrical Properties of RF-Sputtered ZnSe/ZnTe Heterojunctions for UV detecting applications

8.13 - Tudor ȘUTEU, Iuliana M. CHIRICA, Anca G. MIREA, Ștefan NEAȚU, Michel W. BARSOUM, Mihaela FLOREA, Florentina NEAȚU
Titanium Carbide MXenes functionalization for Heterogeneous catalysis in PET hydrolysis
8.14 - R. Pascu, G. Epurescu, R. Birjega, B. Mitu, S. Somacescu
STRUCTURAL AND ELECTRICAL INFLUENCE OF VARIABLE Ni-8YSZ THIN FILMS OBTAINED by RADIO FREQUENCY-PULSED LASER DEPOSITION
8.15 - Doina Bejan
Influence of pressure and temperature on the magneto-optical properties and Aharonov-Bohm oscillations of a quantum ring
8.16 - Radu L. CARAGEA, Dan MATEI, Marian C. BĂZĂVAN, Daniel URSESCU
Material characterization for energy measurement of laser pulses
8.17 - Andreea-Maria Pătrașcu, Monica Dinu
Laser Doppler Vibrometry Applications in Cultural Heritage
8.18 - Septimiu BALASCUTA, Viorel NASTASA
Measurements of the absorption and transmission coefficient of the optical cleaning tissues in visible and near infrared.
8.19 - Mirela PARASCHIV, Ion SMARANDA, Irina ZGURA, Paul GANEA, Madalina CHIVU, Bogdan CHIRICUTA, Mihaela BAIBARAC
Degradation of losartan potassium highlighted by correlated studies of photoluminescence and infrared absorption spectroscopy

8.1 Capacitive and inductive effects in perovskite solar cells

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Keywords:

The perovskite solar cells (PSCs) witnessed an impressive development in terms of power conversion efficiencies, reaching 25.7%, becoming one of most rapidly advancing technologies. However, one problematic issue, which still hinders the commercialization, concerns the stability of the PSCs. Of critical importance is the detection and mitigation of ion migration, which is evidenced in the hysteretic effects (large signal analysis) and also in the huge apparent capacitive and inductive effects (small-signal analysis / impedance spectroscopy).
We introduce an equivalent circuit, which consistently explains the features in the dynamic J-V characteristics [1], like the normal and inverted hysteresis, as well as the peculiar capacitive and inductive effects visible in the impedance spectroscopy. Our model is based on the key assumption that the recombination current is ion-modulated. Here, we discuss the different roles of ionic charge accumulation and ionic charge current in reproducing capacitive and inductive effects, in close connection with the physical processes leading to photo-generated carrier recombination. The simulations are backed by experimental impedance spectroscopy data. Our approach also outlines a possible investigation route of ion migration, which aims to a more robust design of the PSCs.
In addition, we provide a comprehensive overview on the hysteretic phenomena in perovskite solar cells and the importance of proper measurement protocols [2,3].

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8.2 Highly-sensitive detection of ammonia using polymer based chemiresistive sensors

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Keywords: polyaniline, polypyrrole, conductive polymers, chemiresistive gas sensors, ammonia detection

Ammonia is a gas present everywhere in our surroundings, being produced even by our own bodies. However, at high concentrations, it can have harmful effects on our health, which highlights the crucial importance of detecting and monitoring its presence [1]. In this context, the chemiresistive sensors based on conductive polymers have been successfully proven to be advantageous gas sensing devices, since they present in general very good sensitivity, they have the ability to work at room temperature and they have a short response time [2].
In this work, polyaniline (PANi) and polypyrrole (PPy) conductive polymers were selected due to their affinity for ammonia detection [3, 4]. Both polymers were synthesized via chemical polymerization of their monomers directly on the interdigitated gold electrodes and have been further characterized by scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). Moreover, the prepared sensors were electrically characterized in an in-house built gas testing setup. The electrical properties of the sensor inside the gas chamber were investigated using a source-meter while were direct exposed to ammonia concentrations varying from 1 to 1000 ppm.
A comparison study was performed between the both developed PANi and PPy based chemiresistive sensors in terms of stability, repeatability and sensitivity for ammonia.

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8.3 Nanocomposite layers based on tungsten oxide/polymer processed by laser methods

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Nanostructured composites based on tungsten oxide (WO3) and polymer (polyaniline or polypyrrole) were obtained as active membranes (thin films) for gas sensor applications. Pulsed laser deposition (PLD) and/or matrix-assisted pulsed laser evaporation (MAPLE) techniques were used to fabricate these membranes. Morphological and chemical characterizations were carried out on the resulting thin films. In the case of WO3/PPy and WO3/PANI composites obtained as thin films by MAPLE, it was observed that an increase of WO3 concentration in the polymeric matrix induced an increase in the density and roughness of the surface. Another way to obtain these composites as films was to grow WO3 thin films using PLD, which were “decorated” with polymer using MAPLE. The morphological investigations on WO3 thin films obtained by PLD revealed a “cloudlike” mesoporous surface with a relatively large specific surface area. After decoration of WO3 with polymers by MAPLE, the morphological investigations showed that PPy completely covered the mesoporous surface, leaving the “cloudlike” WO3 relatively intact. When PANI was deposited on the WO3 structures, a “crushing” of the WO3 structures was observed at the nanoscale. The “decoration” of the “cloudlike” structures of WO3 was not observed like in the case of PPy. At a micrometric level, the surface of the WO3/PANI films exhibited a porosity which induced a high specific surface area.

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8.4 Efflorescence Formation and Interactions with Lithic Material: Insights from the Exterior Wall of the Episcopal Church – Curtea de Argeș

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Keywords: Efflorescence, SEM-EDX, XRD, Raman spectroscopy, FTIR

Efflorescence, a phenomenon defined by the loss of water molecules from crystalline salts, has been studied on samples collected from an exterior wall of the Episcopal Church – Curtea de Argeș, during current restorations. The research aimed to: characterize the efflorescence and the lithic material using SEM-EDX (Scanning Electron Microscopy coupled with Energy Dispersive X-ray), XRD (X-Ray Diffraction), Raman and FTIR (Fourier Transform Infrared) spectroscopy analyses, but also estimate the impact of the efflorescence on the exterior walls preservation of the historical monument by radiocarbon determinations using AMS method. The efflorescence sample has two different zones, being predominantly composed of sodium carbonate crystallized with a minimum number of water molecules, a sign of the efflorescence phenomenon, and of calcium carbonate, respectively, indicating a mixture with recarbonated calcite arising from the interaction with lithic material. The lithic sample obtained by scraping the surface of limestone after discarding the efflorescence contains only calcium carbonate and rehydrated calcite, with no sodium compounds. To solve the interaction mechanisms between the wall, the efflorescence and the environment, a unique answer came from AMS method. As hypothesis to be tested, supposing that for treating of external walls between 2006 and 2017 a dietary sodium bicarbonate solution has been used, and knowing that the covering stone is quarry limestone, we can verify carbon-14 levels in both samples. Freshly cut limestone from the quarry has a geological origin and radiocarbon age at the lower limits of AMS dating. Dietary sodium bicarbonate has also been shown to have a geological age. Thus, Background levels were expected. Instead of, apparent ages were: 30,000 years and 10,000 years, respectively, as a result of succesive-layers combination with carbon dioxide from atmosphere. Radiocarbon dating and FTIR results demonstrates the occurrence of decarbonation/recarbonation at the interface between efflorescence and lithic material, further research being required.

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8.5 Effects of withdrawal speed on the properties of ZnO thin films deposited by an automated SILAR technique

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Keywords: ZnO thin film, withdrawal speed, immersion speed, SILAR, nanomaterials

Nanotechnology is a field of science found in various areas of our lives since it allows the creation of materials with unique structures and properties [1]. These nanomaterials with interesting features can be prepared by various physical, chemical, and/or biological methods, and they vary according to the employed synthesis approach [2]. Successive ionic layer adsorption and reaction (SILAR) is one of the most widely used method to deposit thin films of various materials because of its simplicity, efficiency and versatility[3]. The growth of thin films using the SILAR technique is influenced by various factors, including the concentration of precursor solutions, pH, number of cycles, temperature, dipping time, speed of substrate immersion and withdrawal, respectively [4]. The latter parameter is the most difficult to control, affecting the final thin film properties, such as thickness, size, uniformity and adhesion. The traditional manual control of this mechanical parameter leads to restrictions and problems in reproducibility and coating quality. In this context, the in-house developed SILAR automated system [5] allows precise controlling of all the deposition parameters, including the immersion and the withdrawal speed of the substrate. In this work, the variation of the substrate withdrawal speeds was studied to see its effect on the structural, morphological and optical properties of the obtained zinc oxide (ZnO) thin films. The crystallinity, as well as the phase purity of the ZnO coated by immersion, was confirmed by X-ray diffraction (XRD) and demonstrates that the crystallite size decreases with increasing withdrawal speed, i.e., decreasing film thickness. The surface morphology of the films characterized by scanning electron microscopy (SEM) revealed a change in the function of the withdrawal rate variation. The optical band gap of the dip-coated ZnO films was estimated in the range of 3.14 to 3.21 eV from the UV-VIS transmission data, and it shows an increase with increasing withdrawal speed.

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8.6 Synthesis, Optical Properties and Electrodes Used for the Evaluation of Curcumin's Concentration

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Keywords: UV-VIS spectroscopy, Raman spectroscopy, detection of curcumin

This work presents the synthesis, optical properties, and principal electrodes employed for the evaluation of curcumin's concentration. Curcumin (CM) is a natural pigment, possessing a crystalline structure and is the most significant curcuminoid in turmeric. CM is effective in treating a wide array of diseases, particularly cancers, due to its antioxidant, antiproliferative, antibacterial, and anti-inflammatory properties [1,2]. In terms of its optical properties, curcumin has been characterized in previous studies by: a) an absorption band with a maximum located at 429 nm assigned to π-π* electronic transitions [3]; b) a photoluminescence band situated in the spectral range of 450-650 nm [4]; c) a Raman spectrum displaying peaks at 962, 1150, 1184, 1249, 1318, 1431, 1626 and 1601 cm-1, with the most prominent Raman bands located at 1601 and 1626 cm-1 attributed to the stretching vibrational mode of the C-C bond in the benzene ring and the C=O vibrational bond, respectively [5]; and d) an IR spectrum showing bands located at 1024, 1278, 1428, 1509, 1597, 1628 and 3508 cm-1 [6]. Electrochemical techniques are extensively utilized to provide valuable information about electrochemical systems. The electrodes used for quantifying curcumin concentration have been modified with carbon nanoparticles, nanocomposites, polymers, inorganic nanowires, and ionic liquid [1]. Understanding curcumin's behaviour in mediums with pH ranging from acidic to neutral and to basic is crucial for accurately quantifying curcumin concentration in biological samples. An example of curcumin's behaviour in a basic medium is demonstrated by UV-VIS spectroscopy. Preliminary data indicate a decrease in absorbance at 462-468 nm when curcumin interacts with NaOH and the sample is exposed to UV light.

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8.7 XRF and AMS: a simple and minimally invasive strategy to find answers to questions regarding the spatio-temporal origin of some construction materials

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Keywords: XRF technique, AMS method, archaeometry, construction materials, archaeological findings

The study tries to give a comparative look on construction materials, such as bricks and mortars/plasters, from different geographical places and historical periods. Although not enough to characterize these materials complexly, the XRF technique aims to provide quick answers to simple questions regarding some aspects related to the composition of construction materials, the pigments used, and to give rise some clues on the sources of raw materials. Radiocarbon dating using AMS method establishes the origin of the calcite: mechanically processed quarry limestone (giving no information about the “antropization time”) or mechanically and thermally processed (giving some suggestions on the real time of construction), providing information on hystorical periods, related to site-specific techniques. The studied cases involve samples from the territory of the current states of Kyrgyzstan and Romania. The geographical barriers of the past are much more flexible than we’re thinking, from an historical point of view, and the results/interpretation offer an interesting overview on the constructive choices and architectural vision, the sources of pigments and the "stylistic trends". Our choice for case studies was oriented on samples from archaeological excavations of the last years at Kök Tash Mausoleum (an underground mausoleum located in the Kochkor Valley of north-eastern Kyrgyzstan, XI – XIII century AD or earlier), from the Roman Fort Pietroasele Buzău (built by Emperor Constantine the Great during the campaign of 332 AD against the Goths from north of the Danube), from the Documaci Funerary Complex in Mangalia (built in the Greco-Roman period and reused for housing in the X-XII centuries AD), and from the Lecca-Micşuneşti Manor in Ilfov Romania (post XVIII century AD). In some situations, the interpretations were also supported by radiocarbon results obtained at the RoAMS laboratory in IFIN-HH on other types of materials.

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8.8 TOWARDS A STOICHIOMETRIC ELECTRODEPOSITION OF SnS

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Keywords: SnS, Electrodeposition, TEA, EDTA, RAMAN, Optical properties.

Abstract: SnS films have been grown at room temperature by electrochemical deposition technique on to ITO (indium-tin-oxide) coated glass substrates. Tin chloride (SnCl2) and sodium thiosulphate (Na2S2O3) were used in aqueous solution as precursors and ethylenediamine tetraacetic acid (C10H16N2O8, EDTA) or triethanolamine (C6H15NO3, TEA) was added to slow the deposition rate of Sn. The pH of each solution was adjusted to 1.8. The deposition time was 60 min and the potential was maintained to -1 V vs Ag/AgCl electrode. The structural, morphological and optical properties of the electrodeposited films were investigated. X-ray diffraction patterns confirm the polycrystalline samples' nature as the α-SnS orthorhombic structure. A clear change in the preferential growth direction was observed when adding TEA. Raman spectroscopy spectra exhibit five bands belonging to both transversal and longitudinal optical phonons modes that match with the α-SnS prototype ones. Scanning electron microscopy images show that the films morphology was highly influenced by the complexing agent. The addition of EDTA leads to significant decrease in particle size, while that of TEA results in a mixture of both small and large particles. Energy-dispersive X-ray spectroscopy measurements demonstrate that the addition of complexing agent, TEA or EDTA, leads to a close stoichiometry with better crystallographic properties for TEA addition. The optical characterization shows that the addition of EDTA results in a blue shift of the band gap energy, while the addition of TEA rather causes its red shift.

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8.9 Fabrication and charactherisation of micro-transistors

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Keywords: PDMS, strechable, humidity sensor, thin film transistor, transparent

As technology advanced, the requirement for smaller functional devices (high device density) that meet the needs of contemporary life became mandatory. This is how the micro-transistor was brought to life [1].
Further upgrade of the transistors towards fully transparent and flexible is essential for a wider range of applications [2] like electronic skins or wearable sensors.
In our study, we developed the incipient phase of a strechable thin film transistor (TFT) based on a PDMS (Polydimethylsiloxane) membrane and also fabricated transistors on rigid substrate [2],[3]. The fabrication techniques used were magnetron sputtering, spin-coating, and photolitography. Atomic force microscopy (AFM) was used to analyze the devices.
The electrical response of the obtained transistors was assessed in normal atmospheric conditions and also in various humidity level to check its functionality as humidity sensor.
In the future, we intend to fully develop an utilizable stretchable and transparent transistor.

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8.10 Formation and detection of Secondary Crystalline Phases in Cu2SnS3 Thin Films for Photovoltaic Applications

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Cu2SnS3 (CTS) thin films have emerged as promising materials for sustainable photovoltaics due to their earth-abundant constituents and high-topping optoelectronic properties. However, the formation of secondary phases during the film synthesis poses challenges to achieving efficient and stable device performance. This study investigates the occurrence and impact of secondary phases in CTS thin films, shedding light on their formation mechanisms and their influence on the material's structural, optical, morphological and compositional properties. Through a systematic experimental approach, we have synthesized CTS films by magnetron sputtering and we have explored various annealing treatments to understand the factors influencing secondary phase formation. Characterization techniques including X-ray diffraction, scanning electron microscopy, and energy-dispersive X-ray spectroscopy are employed to identify and analyze the secondary phases present in the films. Additionally, we investigate the influence of these secondary phases on the optical properties of the films, SnxSy and Cu2-xS exhibiting a significant impact. These results reveal that the formation of secondary phases in CTS thin films is strongly dependent on the synthesis conditions, such as the elemental precursor ratios and annealing processes. Some theorethical implications on secondary phase formation tackling in-situ parameters during post – annealing and XRD measurements are to be discussed. Understanding the formation and effects of secondary phases in CTS thin films is crucial for minimizing their occurrence and mitigating their detrimental effects. Therefore, this study provides valuable insights into the optimization of manufacturing processes and the enhancement in the performance of CTS-based photovoltaic devices.

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8.11 The effect of CuPc nanoparticles adding on the optical and photo-electrical behavior of the bulk heterojunction photovoltaic cells based on P3HT:PC71BM (1:1) polymeric blend

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Keywords: Organic photovoltaic cells (OPCs), P3HT:PC71BM, CuPc nanoparticles

Photovoltaic cells based on P3HT:PC71BM (1:1) mixed with copper phthalocyanine (CuPc) nanoparticles (25:75) were deposited by spin-coating onto substrates made of optical glass, further covered with ITO and PEDOT:PSS. The aim of the present study was to compare the as-prepared solar cells with the “conventional” ones, free of CuPc molecules, in order to investigate if the presence in the active layer of these nanoparticles has any influence on the performance of photovoltaic structures. In this context, we measured the current-voltage characteristics in the dark and under illumination in AM 1.5 conditions (100 mW/cm2), determining the typical parameters in regime of photoelement for both prepared samples. Although the values obtained for the structures containing CuPc nanoparticles are not as promising as expected, when compared to the “conventional” architectures prepared in the same conditions, the OPV cells with P3HT:PC71BM:CuPc nanoparticles composite as photoactive layer still produced few interesting changes intended to improve the performances of the cells acting as photoelement.

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8.12 Study of Optical and Electrical Properties of RF-Sputtered ZnSe/ZnTe Heterojunctions for UV detecting applications

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Keywords: zinc selenide/zinc telluride (ZnSe/ZnTe) heterojunctions; radio-frequency magnetron sputtering (RF-MS); photoelectrical measurements; photodiodes; ultraviolet (UV) photodetectors.

Cadmium (Cd) – free photodiodes based on n-type Zinc Selenide / p-type Zinc Telluride (n-ZnSe/p-ZnTe) heterojunctions were prepared by Radio Frequency-Magnetron Sputtering (RF-MS) technique, and their detailed optical and electrical characterization was performed. Onto an optical glass substrate, 100 nm gold (Au) thin film was deposited by Thermal Vacuum Evaporation (TVE) representing the back-contact, followed by the successive RF-MS deposition of ZnTe, ZnSe, Zinc Oxide (ZnO) and Indium Tin Oxide (ITO) thin films, finally resulting in the Au/ZnTe/ZnSe/ZnO/ITO sub-micrometric "substrate"-type configuration. Next, the optical characterization by Ultraviolet-Visible (UV-VIS) spectroscopy was performed on the component thin films, and their optical band gap values were determined. The electrical measurements in the dark and under illumination at different light intensities were subsequently performed. The Current-Voltage (I-V) characteristics in the dark are nonlinear with a relatively high asymmetry, following the modified Shockley-Read equation. From their analysis, the series resistance, shunt resistance, the ideality factor and saturation current were determined with high accuracy. It is worth noting that the action spectrum of the structure is shifted to short wavelengths. A sensibility test for the 420-500 nm range was performed while changing the intensity of the incident light from 100 mW/cm2 down to 10 mW/cm2 and measuring the photocurrent. The obtained results provided sufficient information to consider the present sub-micrometric photodiodes based on n-ZnSe/p-ZnTe heterojunctions to be more suitable for the UV domain, demonstrating their potential for integration within UV photodetectors relying onto environmentally friendly materials.

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8.13 Titanium Carbide MXenes functionalization for Heterogeneous catalysis in PET hydrolysis

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Keywords: heterogeneous catalysis, 2D nanomaterials, PET recycling, depolymerization, terephthalic acid

Heterogeneous catalysis has been a cornerstone of our industrial society for hundreds of years, taking part in reactions such as the Ostwald process for nitric acid production or pollutant decomposition inside automobile catalytic reactors. Traditionally, metals and metal oxides have been primarily used as catalysts, but new economic and environmental challenges demand a shift towards novel materials which can be cheaper and have specialized properties. One such example are MXenes, a relatively new class of 2D materials that are recommended by their thermal stability and resistance to oxidation to fill the role of catalysts in all sorts of reactions. In order to obtain the material, we started from the Ti3AlC2 MAX phase and etched it with LiF and HCl to form in situ HF. The resulting Titanium Carbide MXene (Ti3C2) was activated with acidic groups by reaction with the diazonium salt of sulfanilic acid. Surface morphology and successful functionalization was verified by SEM, XRD and IR spectroscopy methods. The reaction of interest was the neutral hydrolytic depolymerization of polyethylene terephthalate (PET), one of the most produced plastics in history and one of the biggest pollutants of our environment. The products of this catalytic reaction are the constituent monomers, terephthalic acid (TPA) and ethylene glycol. During the experiments, three types of functionalized MXenes (different concentrations of sulfonic acid groups) were tested at temperatures varying from 160 to 180 °C with three commercially available sources of PET: transparent flask, green flask and synthetic T-shirt (polyester). The reactions resulted in outstanding yields (70% TPA) at temperature below 180°C.

8.14 STRUCTURAL AND ELECTRICAL INFLUENCE OF VARIABLE Ni-8YSZ THIN FILMS OBTAINED by RADIO FREQUENCY-PULSED LASER DEPOSITION

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Keywords: Variable Ni-YSZ thin films, μSOFC, Planar l Oxygen Sensor, RF – PLD Techniques, Optical and Structural Characterization, Dielectric Spectroscopy Measurements

Future generation of micro solid oxide fuel cells (μSOFC) and micro planar ceramic oxygen sensor (l sensor) have to operate at lower temperature (350 - 450°C) due to application of thin film technologies. Thin films of Ni-YSZ anodes or reference electrodes were fabricated by Pulsed Laser Deposition – Radio Frequency (PLD-RF) by variation the level of doped Ni between 0-50%. The structural, optical and electrical characterization of 10%, 15%, 20% and 50% where made with X-ray Diffraction (XRD), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), X-ray photoelectron spectroscopy (XPS), Variable Spectroscopic Ellipsometry (VVASE) and Dielectric Spectroscopy (EIS). Ni-8YSZ thin films show a well- defined porous network and electrical conductivity; at high level Ni doping it shows metallic behavior.

8.15 Influence of pressure and temperature on the magneto-optical properties and Aharonov-Bohm oscillations of a quantum ring

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We theoretically investigated the influence of pressure and temperature on the electronic and optical properties of a GaAs /Al0.3Ga0.7As quantum ring, described by a combination of a parabolic potential and an inverse square one, in the presence of the magnetic field. The results reveal a variation with pressure and temperature of the ring radiuses but also of the period of Aharonov-Bohm oscillations appearing in the electronic spectra in magnetic field. This period varies nonlinearly with pressure and temperature, increasing with pressure but decreasing with temperature raise while the ring radiuses decrease unevenly with pressure and increase with temperature. In the paper we also studied the variation of absorption and refractive index with pressure at three values of magnetic field. We found that with the increment of the magnetic field or of the pressure more transitions are allowed. When no external pressure is applied, the absorption maxima shift to lower energies at increasing magnetic field, but with increasing pressure, the absorption maxima red-shift at intermediate magnetic fields and blue-shift at high fields.

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8.16 Material characterization for energy measurement of laser pulses

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Keywords:

The development of powerful laser systems, like the one currently in use at Extreme Light Infrastructure – Nuclear Physics, capable of generating 10 PW power [1], [2], poses unique challenges in terms of measuring the laser pulses. These challenges can potentially affect their application in experiments. To address these issues, it becomes crucial to closely monitor and assess the laser beam parameters. One of the most important parameters is the beam energy, which is not directly measurable at such power. Any attempt to measure it with the currently existing energy meters results in its destruction. Building a special device, similar to currently existing ones, that can measure the energy by capturing the entire beam without getting damaged is both complex and expensive. The aim here is to develop a different type of energy meter based on partial absorption of the beam, using an absorptive filter/attenuator and to estimate the absorbed energy by measuring the temperature of the filter. Based on this, the total beam energy can be calculated, together with the shot-to-shot energy stability. The experimental setup includes a small-scale version of this energy meter. The thermal behavior of various materials was investigated considering the absorptive, transmissive, and reflective properties at different laser pulse energies. The specific thermodynamic parameters were extracted using ordinary differential equation model. Those parameters can be used towards the development of an energy meter for laser pulses with meter-sized aperture.

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8.17 Laser Doppler Vibrometry Applications in Cultural Heritage

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Keywords: LDV, built cultural heritage, non-destructive investigations

Laser Doppler vibrometer (LDV) is a non-destructive and non-contact technique based on recording the answer of materials to different sound waves in order to determine surface deformations, cracks, blisters, detachments and many other defects.[1] The current study reports developments of the method for volume monitoring of structural flaws present in mural paintings. Several tests were made on murals mock-ups with known defects, using different excitation signals: Burst Chirp, Burst Random, Periodic Chirp, Periodic Random, Sine, Square, Triangle, Sweep, Ramp and White Noise. The best results were obtained for the excitation signals Burst Chirp, Burst Random, Periodic Chirp and Periodic Random, that due to their waveform, have the highest power of penetration into the surface. Signals with a lower penetration level, Sine, Square, Triangle, Ramp and White Noise, couldn't provide conclusive results, but the Sweep function worked. Base on the type of casuistic, relevant signals can obtained using different frequencies and functions of the LDV.

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Acknowledgement:
This research was funded by the Romanian Ministry of Research, Innovation and Digitalization, under Program 1 - Development of the National Research-Development System, Subprogram 1.2 - Institutional performance - Projects to finance the excellence in RDI, SUPECONEX grant nr. 18PFE/30.12.2021 and under PNCDI 2022-2027 - Core Programme 11N/03.01.2023, project nr. PN 23 05.

8.18 Measurements of the absorption and transmission coefficient of the optical cleaning tissues in visible and near infrared.

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Keywords: spectroscopy, photometry, scattering, absorption, transmission, interpolation

The transmission and the optical density of a stack of paper lens tissues were measured at four wavelengths (405 nm, 535 nm, 632 nm and 830 nm) using four laser diodes and a standard photodiode power sensor connected to an optical power meter console. The measurements were performed for 10

distances between the stack of paper tissues and the photodiode. A nonlinear fitting model of the logarithm of the radiation power on the number of paper tissues was computed for each distance. The wavelength dependence of the absorption coefficient was extracted from the spectra recorded with a spectrophotometer between 300 nm and 1000 nm.

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8.19 Degradation of losartan potassium highlighted by correlated studies of photoluminescence and infrared absorption spectroscopy

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Keywords: Photoluminescence, FTIR spectroscopy, Degradation of Losartan Potassium

In this communication, the results reported by correlated studies of FTIR spectroscopy and photoluminescence present the degradation of losartan potassium (LP), in absence and in presence of the excipients, induced by the UV light, the acid character of tampon phosphate (TP) and the alkaline medium. The photoluminescence (PL) spectra of LP of the drug marked under the name Lorista (LO) is characterized by intense emission bands, peaked at 378 nm and 380 nm, respectively, accompanied by low intensity bands having maxima at 450-460 nm [1]. The photodegradation process of LO in solid state is highlighted by a decrease in the intensity of the PL band located at 380 nm, variation which origins both in the adsorption of water vapors from air and the interaction of LP with the excipients [1, 2, 3, 4]. The influence of acide and alkaline medium, respectively, on the LO degradation is analyzed using tampon phosphate (TP) and NaOH solutions. The intensity diminution of the PL spectra of NaOH-reacted LP and LO is the result of the formation of the photodegradation product C16H15N5O2 [1]. With the help of FTIR spectroscopy we have highlighted the appearance of the IR band at 1740 cm-1 [1, 5, 6] and the absorbance increase of the IR band at 1423 cm-1 [1, 7, 8]. In our opinion, the photodegradation product contains the C=O and C-OH functional groups.

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Section 9: Theoretical Physics and Applied Mathematics

Location and time: **Amf. 3**

Moderators:

Prof. Dr. Virgil BĂRAN

Lect. Dr. Roxana ZUS

9.1 - Renata BUNOIU, Claudia TIMOFTE
Homogenization Results for Fiber Composites with Imperfect Interfaces
9.2 - Eduard George STAN, Dan Andrei CIUBOTARU, Michele RENDA, Calin ALEXA
A new advance on dimensional-aware scalar, vector and matrix operations in c++
9.3 - Calin Andrei PANTIS-SIMUT, Amanda Teodora PREDA, Lucian ION, Andrei MANOLESCU4 George Alexandru NEMNES
Mapping confinement potentials and charge densities of interacting quantum systems using conditional generative adversarial networks
9.4 - Ioana DUMINICA, Calin ALEXA, Ioan-Mihail DINU, Adam JINARU, Bogdan DOBRESCU
A Phenomenological Study of the Diquark Scalar Production
9.5 - Adrian STOICA
On a generalized Prandtl type equation for curved and swept wing
9.6 - Florin Vlad IANCU, Dana Maria IOAN, Mihai MARCIU, Roxana ZUS, Virgil BARAN
Dynamical aspects for cosmological models with a machine learning approach
9.7 - Dana Maria IOAN, Florin Vlad IANCU, Mihai MARCIU, Roxana ZUS, Virgil BARAN
Physical properties of the interplay between matter and geometry in cosmological theories
9.8 - Andrei Borsos, Mihai Marciu
Numerical simulations in different gravity theories on local scales
9.9 - Maria-Catalina ISFAN, Laurentiu CARAMETE, Ana CARAMETE
Decoherece in Gaussian Initial Walker State Quantum Walks With Application in Solving The Three Body Problem
9.10 - Drd. TATAIANA MIHAESCU, Prof. Dr. AURELIAN ISAR
Entanglement and steering witnesses for unknown Gaussian states
9.11 - ROBERT POENARU
New Data on Wobbling Motion for $Aapprox130$ Mass Region
9.12 - Cristian-Valer VRACIU, Andrei MARIN
The evolution of turbulent plumes towards cross sections and the 'Constructal Law'
9.13 - Mihai DRAGOMIR, Radu SLOBODEANU, Mihai MARCIU
Interstellar Travel Through Wormholes
9.14 - Bogdan SAVA
Collective modes of Fermi Liquids
9.15 - Dragos Iustin PALADE, Ligia Maria POMÂRJANSCHI
Metallic nanoparticles interacting with twisted photons
9.16 - Petru-Vlad Toma, Virgil Baran, Sebastian Micluța-Câmpeanu, Madalina Boca
Angular Momentum of Classical Particles Interacting with A Laguerre-Gauss Laser Pulse
9.17 - Cristian Iorga, Virgil Băran
Asymmetry parameters for the photoionization of atoms and molecules using twisted light

9.1 Homogenization Results for Fiber Composites with Imperfect Interfaces

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The goal of this talk is to present some recent homogenization results for a class of diffusion problems in periodic fiber composites made up of two heterogeneous materials with high contrasting properties, separated by imperfect interfaces. Various forms for the functions describing the discontinuities involved in our microscopic problem are considered. Via the periodic unfolding method, several models are derived at the macroscale.

9.2 A new advance on dimensional-aware scalar, vector and matrix operations in c++

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Keywords: C++ Units Scalar Vector Matrix

We review the dimensional check problem of the high-level programming languages, discuss the existing solutions, and come up with a new solution, suited for scientific and engineering computations. Then, we introduce Univec, our C++ library designed to make scalar, vector, and matrix operations using units of measurement. Moreover, Univec supports dimensional-aware operations for complex numbers, quaternions, octonions, and sedenions. Finally, we provide tables of the relevant functions and operators implemented, and we present our future plans for improving the current implementation.

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9.3 Mapping confinement potentials and charge densities of interacting quantum systems using conditional generative adversarial networks

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Keywords: Many-Body, Exact Diagonalization, Machine Learning, GANs

An efficient and accurate description of the many-body states lays the foundation for nanoelectronic devices and applications in quantum information. These require a description beyond mean-field approximation, using methods such as exact diagonalization. The procedure is computationally demanding and for a large number of electrons in the system, it may become impractical. New techniques, based on machine learning, may provide a powerful improvement in the computational time reduction, while providing good accuracy. In our study, a general-purpose image-to-image translation method, namely pix2pix[1] is engaged. This is an Ansatz free technique, based on conditional generative adversarial network (cGAN), used to predict the ground state densities of the interacting system from randomly generated confinement potentials. Additional mappings were performed, from confinement potential to non-interacting densities and from non-interacting densities to the interacting ones. The inverse problem, namely mapping the interacting charge density to a confinement potential, can be solved by the pix2pix method. Still, not every given charge density is a ground state one or has a corresponding potential, but this inverse problem can provide near-optimal solutions. The technique optimization was performed by varying Generator, Discriminator architectures, and other parameters.

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9.4 A Phenomenological Study of the Diquark Scalar Production

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Keywords: ultraheavy particle, Monte Carlo, LHC

We study the phenomenological implications of the Suu diquark scalar production at the LHC. We introduce a hypothetical ultraheavy particle emerging from the direct collision of two up quarks. Suu is decaying into two vectorlike quarks, which are subsequently decaying only into Standard Model particles. Starting from the theoretical model that is built using the FeynRules package in Mathematica, then generating the Monte Carlo samples in MadGraph5 and implementing the appropriate machine learning techniques to discriminate the signal from the background, we analyze the feasibility of searching for ultraheavy scalars at the 13-13.6 TeV LHC.

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9.5 On a generalized Prandtl type equation for curved and swept wing

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Keywords: Lifting Line Theory, Swept Wing, Prandtl's Singular Integral Equation

The classical Prandtl's lifting line theory for straight wings of high aspect ratio was extended in [1] to curved and swept wings. In the present paper the lifting line is placed such that in any cross-section, the moment about a point located on the lifting line is zero. For a wing of constant angle of attack, the lifting line is placed at the quarter-chord point, i.e. where it is also placed by Weissinger [4]. Unlike Weissinger's equation, the singular integral equation obtained by us captures both the curvature and the swept of the wing. It is proposed a numerical scheme of solving, based on the approximation of the spanwise circulation distribution with the Lagrange interpolation of the Chebyshev nodes of the second kind. The numerical method was applied for the oblique wing, V-shape wing and for the parabolic wing. In the case of the oblique wing, the numerical results show a good agreement with Guermond's asymptotic solution.

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9.6 Dynamical aspects for cosmological models with a machine learning approach

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Keywords: cosmology, dark energy, neural networks

The evolution of the Hubble parameter is studied by considering a novel approach based on a neural network architecture. The fundamental properties of the background expansion are investigated in a nonparametric technique, obtaining the redshift dependence of the Hubble parameter at low redshifts. For low redshifts we have applied various reconstruction methods, obtaining the possible evolution of the effective equation of state in different cosmological theories.

9.7 Physical properties of the interplay between matter and geometry in cosmological theories

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Keywords: cosmology, dark energy, expansion

In this work we shall explore the interplay between matter and geometry in modern cosmological theories, by considering a specific model which takes into account the coupling between the Einstein tensor and the energy-momentum tensor, extending the fundamental Einstein-Hilbert action in a non-trivial manner. After deducing the field equations the physical features of the phase space structure are explored for various coupling functions, establishing specific constraints from a theoretic point of view.

9.8 Numerical simulations in different gravity theories on local scales

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Keywords: dark matter, expansion, collapse

In the present work we discuss various aspects related to the matter dynamics on local scales, corresponding to galactic systems. After a brief introduction into Modified Newtonian Dynamics (MOND), we investigate various properties related to the ordinary matter dynamics. The simulations

have been performed in an autonomous manner, establishing different specific computational approaches which can be further generalized by adopting a mean field perspective.

9.9 Decoherece in Gaussian Initial Walker State Quantum Walks With Application in Solving The Three Body Problem

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In this paper, we propose a new method to approach the Three-Body Problem, using the quantum walk algorithm that we modify by initiating the walker state with a Gaussian distribution and introducing decoherence through asymmetric depolarizing noise and amplitude damping noise. For robust statistical analysis and statistical tests, we compute the one-body energy probability distribution for a large number (10 000) of initial conditions sets and build a collection of probability densities of decoherent discrete-time Gaussian initial walker state quantum walk, with specific parameters. We show that 70% of one-body energy probability distributions are equated with the collection of our modified quantum walk probability densities. This signifies that the modified quantum walk algorithm reproduces the energy probability distributions of a body that interacts gravitationally with other two bodies, leading to a new view of solving the Three Body Problem.

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9.10 Entanglement and steering witnesses for unknown Gaussian states

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Keywords: entanglement witnesses, steering witnesses, Gaussian states, covariance matrices

We define and fully characterize the witnesses based on second moments detecting steering in Gaussian states by means of Gaussian measurements. All such tests, which arise from linear combination of variances or second moments of canonical operators, are easily implemented in experiments. We propose also a set of linear constraints fully characterizing steering witnesses when the steered party has one bosonic mode, while in the general case the constraints restrict the set of tests detecting steering. Given an unknown quantum state we implement a semidefinite program providing the appropriate steering test with respect to the number of random measurements performed. Thus, it is a ”repeat-until-success” method allowing for steering detection with less measurements than in full tomography. We study the efficiency of steering detection for two-mode squeezed vacuum states, for two-mode general unknown states, and for three-mode continuous variable GHZ states. In addition, we discuss the robustness of this method to statistical errors.

9.11 New Data on Wobbling Motion for $Aapprox130$ Mass Region

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Keywords: wobbling, fusion evaporation, nuclear structure, collective motion

The wobbling motion is a collective phenomena, specific to triaxial nuclei. Recent measurements on the odd-mass ^{135}Pr nucleus are briefly presented in the context of experimental data on the energy spectrum of the wobbling bands. The reasoning behind repeating experiments for this nucleus are presented, while other wobblers near the same mass regions will be presented. The magnitude of the physical quantities such as deformation parameters and moments of inertia are compared with heavier nuclei in which wobbling motion occurs.

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Myself

9.12 The evolution of turbulent plumes towards cross sections and the 'Constructal Law'

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Keywords: Constructal Law, Convection, Evolution, Jets/Plumes, Self-similarity

The turbulent buoyant plumes are fundamental turbulent and convective elements that are responsible for the heat transfer by convection in numerous complex systems. Many of these plumes have an elliptic cross section evolving towards a round cross section in the far-field. In this work, we investigate the convective flow of turbulent buoyant plumes with elliptic cross sections to see if the 'Constructal Law' can be used to explain the transition of these plumes to round cross sections. In order to create an energy-consistent plume model for the elliptic turbulent plumes, we take into account the mixing length theory. Using both the numerical and self-similar solutions of our integral model, we investigate how the flow, buoyancy, and entrainment vary on the eccentricity of the plume. In both unstratisfied and unstable situations, we demonstrate that the vertical (longitudinal) flow is optimum for round cross sections, which suggests that the 'Constructal Law' may well be able to explain the transition. Moreover, we examine the entropy production of turbulent plumes with elliptical cross sections, and demonstrate that the development of the plumes to round cross sections cannot be explained by the principal of minimization/maximization of entropy generation.

9.13 Interstellar Travel Through Wormholes

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In this presentation we shall investigate various numerical applications for a wormhole model proposed early in the 1970s by Homer Ellis [2]. This specific model has been used in the making of Christopher Nolan's motion picture, "Interstellar" (2014), a notable recent Sci-Fi movie. After a short introduction into general relativity, we consider various numerical simulations, discussing different theoretical aspects associated to wormholes. In the end of the presentation, we briefly discuss the obtained results, displaying a specific sequence from the picture itself.

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9.14 Collective modes of Fermi Liquids

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In this paper, we aim to give a brief description of the Landau model of the Fermi liquid. The way this subject will be approached will be partly microscopic, partly phenomenological. This theory starts from the case of the Fermi gas, a system whose constituents do not interact with each other. What is different, however, from the Fermi gas model, is the fact that, for liquid, the interaction between particles can no longer be neglected. In the first part, we will briefly describe the Fermi gas, studying some of its characteristics, considering that this model is the basis from which we will start. Further, the changes in physical properties when considering an interaction between fermions will be analyzed. This is introduced based on the phenomenological hypothesis, proposed by Landau, that the energy of the system is a functional of the Fermi-Dirac distribution function, which characterizes the quasiparticles of the Fermi liquid. It will allow us to express static and thermodynamic properties such as: effective mass, compressibility modulus, heat capacity, in terms of the Landau parameters, which encode the interaction properties. Next, we will study the transport equation in the Fermi liquid and use it to infer the existence of zero sound, a phenomenon of collective motion of fermions near absolute zero. This sound, which differs from the normal sound, also called the first sound, was predicted in Landau's theory and later verified experimentally. The zero sound was one of the biggest successes of this model. Although fermions theoretically cannot collide with each other at absolute zero temperatures, perturbations can propagate through a different mechanism in the Fermi liquid. This mechanism is characteristic, as we shall see, of the zero sound. By this, this mode is fundamentally different from the first sound, which is based precisely on collisions between particles.

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9.15 Metallic nanoparticles interacting with twisted photons

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Keywords: Nanoparticle, twisted photon, plasmon

We consider the interaction of metallic nanoparticles with electromagnetic fields carrying orbital angular momentum. The latter are known as "twisted photons". The ground-state and the dynamics of nanoparticles in such conditions is described in the framework of a non-linear Schrodinger equation derived within Density Functional Theory approximations. The density, current and multipolar responses of the system are computed for various spherical components of a twisted wave.

9.16 Angular Momentum of Classical Particles Interacting with A Laguerre-Gauss Laser Pulse

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We have investigated the evolution of an ensemble of classical charged particles interacting with a Laguerre-Gauss laser pulse. We have integrated numerically the relativistic equations of motion for the particles which at the initial moment (before the arrival of the laser pulse) are at rest, distributed uniformly in a disk in the focal plane of the laser.
We have studied the evolution in time of the angular momentum of the particles, and its dependence on the laser parameters (radial and azimuthal indices of the LG mode, waist, duration, and intensity) and also on the initial position of the particle in the focal plane. We have identified scaling laws obeyed by the net transfer of angular momentum to the particles as a function of the field intensity.
Finally, we present briefly the relativistic ponderomotive force approximation approach for calculating the final state of the particles, and study the influence of the laser pulse waist and duration on its validity.

9.17 Asymmetry parameters for the photoionization of atoms and molecules using twisted light

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The twisted photon-ionization differential cross section is calculated within independent particle model. Both the field and photoelectron states are expanded into spherical waves in order to extract information regarding the rotational symmetries of the emitted electrons. The differential cross section has been described using asymmetry parameters and absolute cross sections readily determined in plane wave calculations, allowing a more rapid conversion to twisted light. The orbital angular momentum of the twisted field can heavily restrict electric and magnetic interactions in atoms or molecules while also enhancing certain azimuthal symmetries within the angular distribution of emitted photoelectrons. Present calculations also predict a spatial transversal shift induced by the interference term between neighbouring electromagnetic multipoles allowing a more in-depth investigation of the structural symmetries of atoms and molecules.