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Bucharest University Faculty of Physics 2022 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
2. **Atomic and Molecular Physics. Astrophysics. Applications**
   Location and Time: Nuclear spectroscopy Lab *Moderators:* Assoc. Prof. Dr. Mircea BERCU, Assoc. Prof. Dr. Vasile BERCU
3. **Biophysics; Medical Physics**
   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. 12 *Moderators:* Lect. Dr. Sanda VOINEA, Lect. Dr. Adriana BĂLAN
6. **Physics Education**
   Location and Time: Seminar Rm. 11 *Moderators:* Prof. Dr. Ştefan ANTOHE, Assoc. Prof. Dr. Cristina MIRON
7. **Polymer Physics**
   Location and Time: Seminar Rm. 2 *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: Amf. 1 *Moderators:* Assoc. Prof. Mircea BULINSKI, Assoc. Prof. Dr. Alexandru NEMNEŞ
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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1.1 Observational study of major air pollutants over urban Romania in 2020 in comparison with 2019 as it results from ground-based measurements

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Keywords: air quality, urban air pollution, East Europe, ground-based 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 selected cities have different level of economic development, various climate and topographic conditions, and they are expected to be impacted by manifold pollution sources. Because during 2020 different levels of measures of COVID-19 pandemic prevention were taken at the country scale, measures that have led to significant reductions of the emissions of primary pollutants, the 2020 year provided us with a unique opportunity to find out what would be the possible variation range of major air pollutants in Romanian urban areas under various strengths of anthropogenic activity. The ambient pollutant mass concentrations, both particulate 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 pollution decreases for most pollutants in most cities in 2020. 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.). The lockdown period in spring of 2020 determined significant improvement of air quality in all Romanian urban areas. Maps of interpolated mass concentrations reveal regional significant differences with pollutant-specific hot- and cold-spots in Romania. 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.

1.2 Insights into spatial distribution of NO2 pollution over Bucharest using multiple instruments (satellite, aircraft, ground-based): preliminary results of selected case-studies

Sebastian IANCU[1,2], Alexis MERLAUD[3], Gabriela IORGA[1,6], Valeriu FILIP[1], Anca NEMUC[4], Alin SCARLAT[2], Alexandru TUDOR[2], Daniel CONSTANTIN[5], Adrian ROȘU[5], Denisa URLEA[7], Andreea CALCAN[2]
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Keywords: NO2 urban air pollution, satellite data, airborne measurements, ground-based measurements

Atmospheric pollution has well-known impact on the human life; therefore observing the emissions of trace gases is an important part of monitoring the atmospheric composition. In this study, we present preliminary results

obtained from measurements in Bucharest, Romania, using several platforms. The measurements are performed in the context of Sentinel 5P calibration and validation activities and the strategy is to have recurrent flights for the extent of one year, as well as ground-based measurements. The goal is to observe the variation of the city's pollution, as the sources change from one season to another. Measurements have started in the Summer of 2021 and covered so far the time-frame until Spring 2022. The region of interest is Bucharest, capital of Romania, and its metropolitan surroundings, a region with a 112 km perimeter and an area of 850 km2. The main sources of pollution are represented by the city's power and thermal plants and the car traffic. Apart from the scientific flights, there were performed ground-based measurements, both from a fixed location and a mobile platform. We report here results from three days of measurements: two late Autumn days, namely 11th and 22nd November 2021 and one Winter day, 23rd December 2021. Several instruments were used, airborne and ground-based (mobile and static) that employ teledetection as well as in-situ techniques. This multiple case-study research has shown that both airborne and satellite observations present large spatial variations of NO2 levels over the Bucharest region with significant differences even from day to day as the atmospheric conditions vary. The results also show good correlation between the airborne DOAS imaging system and the TROPOMI satellite observations, with correlation coefficients up to 0.96.

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Project "ActiveCAART", contract no. 32PFE/2021 funded by the Romanian Ministry of Research, Innovation and Digitalization through Programme 1- Development of the national research and development system, Subprogram 1.2 Institutional performance - Funding programs of excellence in RDI.

1.3 Preliminary analysis of morphologic and magnetic properties of aerosols at three sites in Romania

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Keywords: ground-based PM10, aerosol magnetic properties, East Europe, FORC, non linear Preisach maps

This study is focused on morphology and the magnetic properties of PM10 aerosol samples collected at three different sites in southern Romania: Bucharest as urban, heavy impacted by traffic in the very center of the city, Magurele as suburban, under the influence of Bucharest and of the agricultural activities in the surrounding areas and Matasari, a rural site located in south-western Romania that is heavy impacted by the industrial activities at open-pit coal mines located in the proximity. Measurement campaigns were performed in different seasons between 2019 and 2022 using low-volume samplers. Sampling times varied from 12 to 72 hours, in order to assure the enough aerosol deposits on the quartz fiber filters for the magnetic properties analyses. Morphological and compositional samples properties were determined by scanning electron microscopy (SEM) and energy dispersive x-ray spectroscopy (EDS) analysis. The magnetic properties were determined by using vibration magnetometer (VSM). This study shows first magnetic characterization (IRM aquisition curves, remanent and saturation magnetization, FORC and Preisach diagrams) of aerosol samples in Romania and identified both anthropogenic

signatures as magnetit/maghemit in all samples and natural signature by aeolian hematite from desert dust in some of the samples. This work also shows that the use of the magnetic fingerprints coupled with morphology analysis as proxies to monitor the sources of ambient particulate matter represents a powerful method for identification of anthropogenic magnetic minerals and their domain states and interactions.

Acknowledgement:
AD and GI gratefully acknowledge the funding from the NO Grants 2014-2021, under contract no. 31/2020, EEA-RO-NO-2019-0423 project.

1.4 Analysis of air pollution episodes during a four-year monitoring period in Ploiesti, Romania

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Keywords: pollution episodes, meteorological parameters, particulate matter, gaseous species

The Ploiesti city is one of the polluted cities in Romania, situated north of Bucharest, at about 60 km. Some of the most important Romanian oil refineries operate here. The city also represents an important transportation hub, linking Bucharest and the southern Romania with the northeastern (Moldavia) and western parts of the country (Transylvania). A professional meteorological station, belonging to "I. L. Caragiale" National College, was used to study the influence of weather conditions (reflected in meteorological parameters temperature, relative humidity, pressure, wind speed and direction) on the air pollution of Ploiesti during a four-year period (2018-2021). This study is focused on major air pollutants, particulate matter (PM10, PM2.5), and also gaseous species (NO2, CO, SO2, O3). The data series, that includes hourly and daily values of each pollutant mass concentrations, were extracted form National Air Quality Monitoring Network in Romania. A synthesis of the pollution episodes has been made for the investigated period, using the method proposed by Iorga et al. (2015). For each year, we identified both local and regional pollution episodes, but also episodes strongly influenced by the long-range transport of dust PM2.5 pollution. Each pollution episode was extensively characterized.

References:
Iorga G., Balaceanu C., Stefan S., Annual air pollution level of major primary pollutants in Greater Area of Bucharest, 2015, Atmos. Poll. Res. 6. 10.5094/APR.2015.091.

Acknowledgement:
The research leading to these results has 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 were extracted from the public available Romanian National Air Quality Database, www.calitateaer.ro, last accessed in December 2021. The authors thank the NOAA Air Resources Laboratory for HYSPLIT model https://www.ready.noaa.gov and the Barcelona dust forecast center for BSC-DREAM8b and NMBM/BSC-Dust models https://ess.bsc.es/bsc-dust-daily-forecast.

1.5 Air pollution by aerosols over a coal open-mine influenced region in southwestern Romania

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Keywords: PM10, PM2.5, PM1, coal, air quality, SEM, EDS analysis

The influence of anthropogenic activities on atmospheric composition, air quality and human health has become a critical issue in the context of nowadays climate changes. Present study is focused on the determination of the mass concentrations of the airborne particulate matter in a residential area close to a coal open-mine in south-western Romania. Total carbon fractions (TC) and major ions of different fractions of ambient particulate matter PM10, PM2.5 and PM1 were quantified. The sampling campaigns of 10 days were performed in all seasons between 2018 and 2020. The samples were collected at about 10 m over the ground for 12 hours per day, using two low-volume samplers (substrate: quartz fiber filter) and an eight-stage low-pressure cascade impactor (size range 0.06-16 μm diameter; substrate: aluminum foil). Morphological and compositional sample properties were determined by scanning electron microscopy (SEM) and energy dispersive x-ray spectroscopy (EDS) analysis. Results show the presence of both anthropogenic and natural origin elements in ambient samples with variations well correlated to the strength of nearby anthropogenic activities.

Acknowledgement:
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1.6 MEASUREMENT OF THE RADON CONCENTRATION IN THE AIR IN BUILDINGS AND IN THE RADIOACTIVE WASTE STORAGE FACILITY FROM IFIN-HH

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Keywords: radon concentration

This paper presents measurements of the radon specific activity in the air, in some classrooms and amphitheaters from the Faculty of Physics, in the Department of Radioactive Waste Management (DMDR) laboratory and in an intermediate storage facility for radioactive waste from DMDR-IFIN-HH. The radon concentration was measured using a professional AlphaGuard monitor and five commercial Airthings monitors. From the measurements performed it was observed that the radon concentration values are comparable, but the professional monitor has a higher speed response. The radon specific activity in the Faculty of Physics' classrooms is below the recommended level by Directive 2013/59 / Euratom and the Norms on the basic requirements of Radiological Safety, which specifies a reference level of 300 Bq / m3 for housing and jobs . Because of this, there is no need a ventilation system. In amphitheaters, was an increase of the radon level concentration during the night, close to the reference level and for this reason, these must be ventilated, for at least 15 minutes, before use. In the DMDR laboratory, the maximum level of the radon specific activity is close to 200 Bq / m3 during the night, which justifies the installation

of a fan that introduces air from outside, because the increase in radon concentration influences the measurements and analyzes performed in the laboratory. In the DMDR storage are sources of neutrons, Ra-Be, Am-Be, Am-241 and Ra-226, especially long-lived radionuclide sources, which leads to an increase the radon concentration. Therefore, in order to be able to operate safely from the point of view of radiation protection, this intermediate storage was provided with a ventilation system. Because a high radon concentration is harmful for the human health, it is recommended that all rooms, where the people live or work, should be ventilated as often as possible.

1.7 Multi-source analysis of air-mass and cloud properties over Romania during Cumbre Vieja Volcano eruption

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Keywords: airborne measurements, cloud properties, volcano, CAPS

Volcanic ash particles play an important role in climate change because they can persist in the stratosphere and they are transported on long distances, thus being involved in most of the atmospheric dynamic processes. Modifying the atmospheric composition, they have a negative impact on air quality, climate and human health, visibility and they severely disrupt the air traffic. Moreover, the cloud formation and evolution are influenced by the interactions between volcanic ash and cloud particles. This study examined the impact of volcanic ash from Cumbre Vieja Volcano eruption on 27-29 September 2021 has on the cloud microstructural properties over the areas crossed by the air mass carrying the volcanic ash. The research was performed using a synergy of measurements and modelling techniques and methods airborne measurements, satellite, synoptic and numerical modelling data. Cloud properties, including number concentration, effective diameter and liquid water content were determined in situ by performing a research campaign during 27-29 September 2021 using a Hawker Beechcraft King Air C90GTx aircraft equipped with a cloud, aerosol and precipitation spectrometer (CAPS). Clouds and the Earth's Radiant Energy System (CERES) database was used to extract additional information on cloud cover fraction, cloud types, cloud top temperature, cloud top pressure, height, and liquid water path in order to complement and compare with the airborne data. In addition, the volcanic ash transport over Romanian territory was studied using a hybrid single particle langrangian integrated trajectory model (HYSPLIT, [1]). The front characteristics, including temperature, wind direction, density and dew point were analyzed to establish the impact of volcanic ash particles on cloud properties and to characterize the air-mass containing volcanic matter.

References:
[1] Rolph, G., Stein, A., Stunder, B., 2017. Real-time environmental applications and display system: READY. Environ. Model. Software 95, 210–228.

Acknowledgement:
This research received support from NO Grants 2014-2021, under Project EEA-RO-NO-2019-0423, contract no 31/01.09.2020 and PNCDI III 1.2. Institutional performance, under Project ACTIVE-CAART, contract no 32 PFE/30.12.2021.
Cloud properties were extracted from Clouds and the Earth's Radiant Energy System (CERES) database (https://ceres.larc.nasa.gov/data/), last access on Aprilie 2022. NOAA Air Resources Laboratory is gratefully acknowledged for the use of HYSPLIT model https://www.ready.noaa.gov.

1.8 Study of macrophysical and microphysical characteristics of medium thickness clouds over Bucharest-Măgurele

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Keywords: clouds, data satellite, climatology

Because clouds play an important role in the Earth's radiative budget and on Earth's climate, the aim of this study was to understand the occurrence and characteristics of medium thickness clouds using satellite data. Partial results from a study conducted between December 2019 – February 2021 are presented. Hourly data from the Clouds and the Earth's Radiant Energy System (CERES) database (i.e., SYN1DEG-1Hour) were extracted and used for analysis of a series of macrophysical and microphysical cloud parameters (e.g., cloud cover fraction, cloud top temperature, cloud base temperature, cloud top pressure, cloud height, cloud optical depth, liquid water path, ice water path, cloud water radius and ice water radius). We studied the cloud vertical classification and their composition (water droplets or ice crystals). Măgurele Center for Atmosphere and Radiation Studies (MARS, 44.35°N, 26.03 °E), located south western Bucharest, was chosen as a study area because of the suite of remote sensing instruments (e.g., ceilometer, cloud radar, microwave radiometer) installed at this site that can be used to in-depth researches for understanding the formation and evolution of clouds.

Acknowledgement:
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1.9 Severe weather: tornadoes in Romania

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Keywords: severe weather, tornadoes, atmospheric instability

In the past years, the tornadoes in Europe have been an underestimated threat. Tornado Alley is not the only place in the world where tornadoes form. Although these severe weather phenomena can negatively impact the population, infrastructure, and agricultural lands, and sometimes they even produce significant damage and life losses, many things about their formation are not understood yet. There were about 150 reported tornadoes in Romania between 1955 and 2019, but there might have been much more unreported. We used vertical soundings of the atmosphere (obtained from thundeR Era 5 sigma levels for Europe) of these meteorological events in order to analyze and identify the parameters that are most important for tornadoes especially for the ones in our country. Then we synthesized the range of values for eight specific parameters acquired in three different ways and also

compared them with the range of values in other countries in Europe and the USA. From the available data existing in Romania, it resulted that the majority of evaluated tornadoes on the Fujita scale produce light to moderate damage (F0, F1), some produce considerable damage (F2), and there are very few cases of F3 tornadoes that produce severe damage (only one is evaluated as an F3 in the database I used). Therefore, one of the next steps is to find more pieces of information (like damage imagery, witness testimonies, and media reports) about the tornadoes that unfortunately are not evaluated so far and evaluate them on the Fujita scale to verify the results on a more extensive data set.

1.10 Improving location parameters for earthquakes in Romania using joint hypocenter determination method (JHD)

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Keywords: seismicity, joint hypocenter determination method, earthquake catalog, ANTELOPE

The seismic activity in Romania is rather complex, with earthquakes occurring preferentially along Carpathians and in the adjacent areas. According to their specific properties, they can be included in different seismogenic zones, defined as areas with clustered seismicity where seismic activity and the orientation of the stress field are considered relatively uniform. The characterization of seismogenic processes and the assessment of seismic hazard are closely related to zonal seismicity. The determination of the specific characteristics of the seismogenic process is of particular importance for seismic hazard assessment and seismotectonics analysis. Scaling relationships of source parameters and local effects are directly related to seismic hazard prediction and assessment. 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 and revised locations extracted from the INCDFP catalogue, which are furthermore relocated using joint hypocenter determination method (JHD). The basic idea behind this technique is to simultaneously determine an optimum 1-D structural model for the target area, to relocate the events and to fix a common set of station corrections. Under appropriate conditions, the station corrections reproduce the unmodeled velocity variations, and thus can significantly improve the location of events. These corrections are related to local effects characterizing the station site. The relocated earthquakes and quarry blasts using JHD better delimit specific clusters in comparison with routine catalog locations.

1.11 Seismic noise analysis in the microseismic and high-frequency domain at the Romanian seismic stations

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Keywords: ambient seismic noise, wind speed, single and double frequency peak, seasonal variations

In the absence of earthquakes, seismic stations continuously record the Earth's vibrations, called ambient seismic noise (ASN). The main concern coming from the ASN records is improving the seismic data quality using different tools developed especially for this purpose. Power Spectral Densities (PSD) and their corresponding Probability

Density Functions (PDF) are tools used to evaluate the station performance and show the noise level at the station's site. For high frequencies (>1Hz), the noise sources are from cultural activities and show diurnal variation, while for low frequencies (<1Hz), the noise is generated by natural sources and shows seasonal variation. In this study, we analyzed the vertical components of the Romanian seismic stations to characterize the noise levels at the stations and investigate noise variations in space and time. We found similar features related to the single and double-frequency peaks for several stations in eastern Romania. These peaks have a natural origin and are related to oceanic waves. We examined the relationship between noise levels and weather parameters (e.g., wind speed) for the stations where seismic sensors are collocated with weather sensors. We show that an increase in wind speed leads to an increase in the noise level at high frequencies (> 2 Hz). Also, we computed four-year spectrograms for some stations that revealed an increase of ASN in the 2-5 Hz frequency range during the warmer seasons, contrary to the colder months. On the other hand, at lower frequencies (0,5-1 Hz), the power of seismic noise increases during the colder months of the year.

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1.12 A reanalysis of the ROMPLUS seismic events located in the northeast of Romania

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Keywords: ROMPLUS catalogue, seismic events, statistical discrimination, waveforms cross-correlation, earthquakes relocation

In this study, we reanalyse seismic events recorded between 2005 and 2021 in the updated Romanian seismic catalogue (ROMPLUS) and located in the north-eastern part of Romania i.e., Bucovina region. As several quarries are currently active in this region, two types of sources, tectonic and anthropogenic, are mixed in ROMPLUS catalogue, causing errors when estimating the seismicity.
Multiple methods were taken into account to achieve the objective of this research. The statistical methods were firstly applied, indicating the presence of anthropogenic events in the ROMPLUS catalogue for the Bucovina region. To increase the accuracy of the preceding analysis the waveforms cross-correlation technique was applied on the vertical seismograms recorded by BUR31, the broadband station of the Bucovina (BURAR) seismic array. Moreover, three events that showed significant depth errors were relocated by reviewing the onsets of the seismic phases and applying the LOCSAT algorithm embedded in the Antelope software environment. The events were relocated based on a 1-D velocity model which is commonly used to determine the earthquakes parameters reported in the catalogue.
The results emphasize that proposed discrimination techniques are able to distinguish between tectonic and anthropogenic events. In addition, three seismic sequences and a swarm of earthquakes were identified in 2011, 2013 and 2017, delimiting two active seismic areas in Bucovina. The present analysis could be extended to other areas to enhance the data in the ROMPLUS catalogue contributing significantly to the future seismicity and seismic hazard studies.

1.13 A dedicated tool for co-seismic interferogram generation and displacements

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Keywords: SAR data, DInSAR, earthquakes, ground deformations

Earthquakes are one of the most devastating natural hazards on Earth, which captivate scientists' interest, and governments, as it is one of the most challenging hazards to assess. Many tools and technology have been developed in the last decades to investigate these events and better understand them. These tools are deployed on the ground or space to monitor the most critical seismic areas. Interferometry is a sophisticated remote sensing technique that relies on the microwave signal's properties to detect Earth surface changes with millimeter accuracy. However, it got a lot of interest in the last three decades due to the specifically designed missions in the SAR domain to permanently orbit the Earth. In simple words, this technique needs two images acquired in the same track direction to measure the phase changes that might occur due to earthquake-related deformations. In this case, the difference in phase signal between those two SAR images results in a co-seismic interferogram. Further, surface displacements related to earthquake hazards are determined based on the interferogram fringes. In this aspect, we aim to develop an easy-to-use web module, integrated into a platform called SETTING (Integrated thematic services in the field of Earth observation: a national platform for innovation), for the unspecialized public users who will be getting the final products. The module will automatically perform the interferogram generation process and calculate the spatial deformations. The results this module deliver is trivial, allowing a non-expert to get an idea about the impact of an earthquake. Moreover, these results can be easily used by other professionals and experts from different fields as prior information for planning and development policies and related studies or the damage assessment caused by a specific event.

1.14 identification of quarry blasts in the dobrogea area based on seismological data

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Keywords: seismology, quarry blasts, discrimination methods

The most important products of the seismological network are the complete and reliable earthquake catalogues. Data affected by errors and quarry blasts recorded as seismic events in the Romanian earthquake catalogue (ROMPLUS), will distort the seismicity model that characterizes a certain region, being a critical issue in many studies, such as earthquake statistics, seismic source and seismic hazard. The main objective of this study was to identify the quarry blasts recorded as seismic events in the ROMPLUS catalogue (Popa et al., 2022). We used seismic recordings from the Dobrogea area, Romania, which occurred between 2012 and 2016 Approximatively 74 quarries were identified in the study region, all these representing controlled sources of explosions. According to the events recorded by the Romanian Seismic Network (RSN) stations, in the Dobrogea region we have both anthropic and tectonic events, and the correct discrimination and association of the type of event is crucial for an accurate and reliable catalogue of earthquakes. We first applied multiple statistical discrimination methods (Dinescu R. et al, 2018). Almost 90% of the data set analyzed results may be due to human activities. These events can be considered as templates for the automatic detection of events with the same type of source in the cross-correlation technique (Goldstein, P. et al.,2003). We applied the cross-correlation technique using six `template` waveforms. Only for four of the events with a correlation coefficient (CC) of 0.850 representing a similarity of 85% with the waveform used

as a template were identified. By applying the statistical methods and the cross-correlation technique a significant number of events were detected during the working days and hours and with a very high correlation coefficient. These events will be considered as quarry blasts in the catalogue. The study will be continued by extending the data set to the entire instrumental period of the catalogue data for this area and later for other areas in the country.

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1.15 X-ray microtomographic investigation of Dobrudja Green Schists: A preliminary analysis

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Analytical and chemical methods based on the interaction of X rays with material are widely considered and applied in geology. X-ray Computed Microtomography (MCT) is of particular interest due to its capability to emphasize complex internal structures such as voids, inclusions or any other type of inhomogeneities. The present study reports a preliminary analysis of several greenschist samples from the Topolog area, Dobrudja (Romania), in order to investigate the internal structure and of the probes, with the aim to identify features of transformation during metamorphism. The images acquired using X ray MCT emphasize the presence of microstructures related to shearing, oriented voids, parallel and oblique fractures, which might be related to faulting and inclusions. One of the investigated samples, the SV 4 one is of particular interest due to the presence of euhedral/framboidal pyrite crystals [1]. Future analyses are planned to include the determination of the Dobrudja greenschists chemical and mineralogical composition extended the pyrite crystals.

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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 - Alexandru-Ionut NICULESCU, Mihaela-Alina MUNTEANU, Leonard GEBAC
The encapsulation of Ne inside dodecahedrane molecular cage

2.2 - Leonard Constantin GEBAC, Mircea BERCU, Valeriu FILIP
Formation mechanism of endohedral He@C20H20

2.3 - Liliana DUMITRU, Cristian DANESCU, Octavian BLAGOI
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Energies and Dipole Interactions of the Dynamic Endo-Exohedral Dodecahedrane complex He@C20H18-Be2C2O

2.5 - Ana LUPOAE, Marcel POPESCU, Daniel Nicolae BERTEȘTEANU, Radu Mihai GHERASE, Marian H. NAIMAN, Remus Andrei PĂUN
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2.6 - Sorin-Theodor BRĂTESCU, Mihaela-Alina MUNTEANU, Leonard Constantin GEBAC
Study of Helium dimer in C20H20 molecular cage

2.7 - Vlad-Andrei BÂSCEANU, Laurențiu-Ioan CARAMETE, Ana CARAMETE, Maria Cătălina IȘFAN, Alexandru JIPA
Deep Learning Techniques for Gravitational Waves Analysis

2.8 - Leonard Constantin GEBAC, Mircea BERCU, Valeriu FILIP
Encapsulation of He inside C20H20 in the presence of static electric field

2.9 - Mihaela-Alina MUNTEANU, Leonard-Constantin GEBAC
Study of stability of He@C20H20 in the presence of an electric field

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PIXE Method Applied on Cucuteni Ceramics

2.11 - Gabriel CHIRITOI, Eugeniu Mihnea POPESCU, Florin Adrian POPESCU
Preliminary analysis of the Mini-EUSO Telescope data taken in D3 offline trigger mode

2.1 The encapsulation of Ne inside dodecahedrane molecular cage

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Keywords: molecular cage; dodecahedrane; molecular dynamics; ab initio

A fulleren is a molecule that presens mutiple special caracteristics, such as a hight degree of symmetry and a sphere like structure. The property that holds the most value for us, regarding the conducted simulations, is the cage like structure thus, these molecules may be found in capsule like roles for various other smaller element for various amount of time. For our simulation C20H20 was used as a capsule and the neon atom as a projectile. For this investigation, multiple programs for molecular dynamics and various types of calculus where used. For our simulations the ab initio molecular dynamic simulation type was used as well as the STO-3G function base set. The fist task was to determine a static potential. 37 position where chosen for the neon atom, inside and outside the cage, in order to find the hight of the potential barrier the neon aton needed to pass in order to enter inside the cage. By knowing the value of the potential barrier we can determin the aproximative cinetic energy needed the penetration to happen. The obtained reference speed is aprox 217 A/ps. It is now possible to search for the incapsulation speed interval using dynamic simulations. This interval was found to be between 227A/ps and 280 A/ps. Following this, we picked a value for the speed to further our investigation; the value 250 A/ps was thus chosen. A 10000 step long simulation was runned, in which the neon oscillates many times insede the cage, thus, the total energy of the sistem can be analized. This value varies within asmall interval and such we can deduce that the sistem is stable for the chosen time frame. Up next, multiple other aspects where investigated such as the rotational energy, the electric dipol or the translational energy of the cage, all with respect to time.

2.2 Formation mechanism of endohedral He@C20H20

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Keywords: molecular dynamics, dodecahedrane, encapsulation, atom oscillator

The highest symmetry collision between He and dodecahedrane C20H20 is analyzed in the framework of ab initio Unrestricted Hartree-Fock, 6-31G basis set, molecular dynamics simulations at different initial kinetic energies of the incident helium atom, ranging in between 14 and 28 eV. The interaction between He and the cage-like molecule is described by the static and the dynamic potential energies. It is observed that the dynamic potential barrier height is variable and is a function of the initial kinetic energy of the He atom. At the threshold of the reactive collision, that is, perpendicular through the center of a carbon pentagon ring, the barrier for the encapsulation is found to be very close to that reported by experiments and also by higher level approximation methods. Geometric and energetic parameters are being monitored at each time-step of 0.1 fs of the simulations in order to describe the encapsulation process in great detail. The dependence of the geometric parameters (radius of the cyclopentane ring, distance between first and second order neighbors and CH bond length) versus the position relative to the collision site, reveal a flower-like opening of the cage, followed by a swallowing of the incident atom. Furthermore, the distribution of He kinetic energy on to cage translation, vibration and deformation is being observed as a function of the initial kinetic energy of He and also of position. At threshold, and also at higher incident energies of helium, the dependence of the kinetic energy of He shows the absorption of the projectile inside the cage. The stability of this quantum oscillator revealed by almost stable frequencies in the THz range, makes it suitable for advanced applications.

2.3 Study of the first productive active region from the ascending phase of the solar cycle 25

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We studied the evolution of the active region (AR) 12975 since it was the first productive active region from the ascending phase of the solar cycle 25. The active region was observed between March 24 and April 4, 2022. During this period 80 solar flares (67 C-class, 12 M-class and one X-class) were detected. Following the M4.0 class solar flare on March 28 (with max at 11:28 UTC), a radio burst type II and an Earth direction Coronal Mass Ejection (CME) followed. The type II radio burst was detected by the CALLISTO radio spectrometer installed at Solar Observatory from Astronomical Institute of the Romanian Academy, a custom device for this kind of radio observations, developed by Christian Monstein (IRSOL, Switzerland). Using an nonlinear force-free field (NLFFF) method, we calculated the unsigned magnetic flux and extrapolated the configuration of the 3D coronal magnetic field using the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamic Observatory (SDO).

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2.4 Energies and Dipole Interactions of the Dynamic Endo-Exohedral Dodecahedrane complex He@C20H18-Be2C2O

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Keywords: ab-initio, molecular dynamics, dodecahedrane, dipole moment, frequency spectrum, energy transfer

The discovery of fullerenes, carbon-based molecules that take the form of cage- or tube-like structures, represented a great feat of the 20th century, with applications ranging from nanoscience to medicine and various industries. Fullerenes can be used by themselves for their structural or spectroscopic properties, but their capability of hosting other atomic or molecular species within their cavities is of most interest. The object of this paper is the behavioural study of a fullerene-derivate complex, consisting of a moving helium atom, encapsulated within a dodecahedrane cage radical (He@C20H18) that is covalently bonded to the exohedral group -Be2C2O. This extension aligns linearly with the sphere-like structure, defining an axis and a plane of symmetry, that will be referenced to impose “parallel”, respectively “perpendicular” velocities of the He atom in molecular dynamics simulations, starting from the equilibrium position, near the centre of the cage. Computational calculations are conducted using an ab-initio method, the Hartree-Fock approximation, operated on the minimal STO-3G basis set,

in order to determine how this system would evolve in time. It has been observed that the dipole moment is affected in different ways by the direction and the magnitude of the velocity: the dipolar amplitude would reach much higher values when the movement is parallel to the main axis, than that from perpendicular movement, phenomenon best observed at low kinetic energies. There is little correlation between the dipole variation and the spatial position. The dipole spectrum of frequencies, on the other hand, will become richer the higher the velocity, indicating an increase in the number of molecular vibrational modes. Furthermore, the kinetic energy of the helium atom decays much faster for greater velocities, a significant energy transfer that manifests as slight deformations in the array of other atoms and translational, respectively, rotational movement of the whole system.

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2.5 Spectroscopic follow-up of the red supergiant star Betelgeuse

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Keywords: Betelgeuse, spectral analysis

In December 2019, astronomers reported a significant dim in the magnitude of Betelgeuse (alpha Ori, a red supergiant star located in the constellation Orion). By mid-February 2020, the star plummeted to about 35% of its typical brightness before recovering over the next few months. This phenomenon caught the attention of the scientific community around the world, having them consider the possibility of a supernova explosion. The spectral data analysis represents a key technique for understanding the processes that took place. Because Betelgeuse is one of the brightest stars in the night sky, it can be monitored with small aperture telescopes. In this context, we proceeded to obtain it's spectra by using an Alpy 600 spectrograph, mounted on a 9.25" Schmidt-Cassegrain telescope.

We present the data reduction methods and the results on observations that were performed on the nights of 13 and 18 of February 2020, in the midst of its dimming. For calibration purposes, we used two well-known stars, (13 Mon, and 61 Ori), for calibrating the wavelength scale and for finding the transmittance of the setup. The process was followed by the identification of characteristic spectral lines of compound molecules, TiO (titanium monoxide) and CaH2 (calcium hydride), that reveal the late stage evolution of the star. Our investigations were complemented by fitting the spectrum of Betelgeuse with a Planck function in order to estimate the temperature. The best fit for the spectral continue was obtained for T = 3500 K.

2.6 Study of Helium dimer in C20H20 molecular cage

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Keywords: molecular cage; dodecahedrane; molecular dynamics; ab initio

Dodecahedrane is a chemical compound, a hydrocarbon with formula C20H20, whose carbon atoms are arranged as the vertices (corners) of a regular dodecahedron. Each carbon is bound to three neighbouring carbon atoms and to

a hydrogen atom. The most useful thing about these large molecules is the capacity to encapsulate other atoms or clusters of atoms and transport them or force them to interact in different ways then they naturally do. Two Helium atoms and there interactions are investigated in these research. The system is studied at STO-3G aproximation and is using the ab inito set of function of molecular dynamics. These simulation were completed using computers and the programs used the Self Consistent Field of Hartree-Fock method to perform the calculus. The dimer proprietes of Helium molecule are confirmed by calculating the distances between them and the distances from them to the cage center of mass, the angles and also the kinetic energy. There is a dependece of movement in the dimer and it is best shown by ploting the frequency function of distance and angle opening (Fourier transformation).

2.7 Deep Learning Techniques for Gravitational Waves Analysis

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Keywords: Time-Domain Astrophysics, Deep Learning, Gravitational Waves

In the past years, Deep Learning (DL) has become more and more popular, partially due to the technological development of deep learning specific GPUs (Graphics Processing Unit) but more importantly due to the broad range of uses such as image processing, medical diagnoses and market forecasting. Recently, Deep Learning Convolutional Neural Networks (DL-CNN) were used to detect Gravitational Wave (GW) signals which proved the potential of these algorithms in the context of time-domain astrophysics. In this work we present the preliminary results using different deep learning techniques used in the analysis of GW signals emitted by Massive Black Hole Binaries (MBHB), with component mass ratios in the range of 1-1501. The data consists of simulated GW signals, both clean and injected into Gaussian Random Noise and also randomly generated Gaussian Noise. These results have direct implications in sending early alerts in the context of multi-messenger astronomy.

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2.8 Encapsulation of He inside C20H20 in the presence of static electric field

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Keywords: molecular dynamics, dodecahedrane, encapsulation, electric field

This work is concerned with the study of the effect that a static electric field has on the encapsulation process of helium inside dodecahedrane. The simulations use the framework of ab initio molecular dynamics, with 6-31G basis set and Unrestricted Hartree-Fock approximation. The threshold energy, at the highest symmetry collision, is determined in a previous work [Formation mechanism of endohedral He@C20H20] and is used here as a reference point for the "no field" case. The same collisional scenario is adopted here, but this time with static electric field applied on the direction of propagation of the projectile (oZ axis). We study the modifications of geometric and energetic parameters [Formation mechanism of endohedral He@C20H20] brought by different amplitudes of the

applied field in both positive and negative of oZ direction. Just before encapsulation, when He is in the proximity of the cyclopentane ring, a dynamic effect of pulling still exists, and is proportional with the applied field. If the direction of the field is oriented from the projectile towards the cage (by convention, negative field) one sees an enhancement of the acceleration of the incident atom towards the cage. This is due to the depolarization of the HeC20H20 system, effect that, on one hand, minimizes the coulombic repulsion between the nuclei of the collision partners and on the other hand, increases the electron exchange from the cage to He. This study could be used to develop new experiments in which the probability of encapsulation of an outside atom to increase.

2.9 Study of stability of He@C20H20 in the presence of an electric field

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Keywords: molecular cage; dodecahedrane; molecular dynamics; ab initio; electric field;

This present work investigates the effects of an electric field applied on the endohedral molecule He@C20H20 and the time stability of the structure. The simulations use ab initio molecular dynamics, Unrestricted Hartree-Fock approximation with 6-31G basis set. The electric field is implemented in different directions, along the Ox and Oz axis, and has different intensities. Parameters were considered at each time-step of 0.1 fs in multiple situations in order to analyze changes in the behavior of the He atom or the cage-like molecule. During these simulations, the He atom encapsulated in the molecule oscillates with a certain frequency, and the cage-like structure does the same. One could observe that when an electric field is applied, there are some changes in these frequencies, that depend on the intensity of the electric field. Moreover, this work analyzes the difference in the frequency of oscillation of the dipole moment.

2.10 PIXE Method Applied on Cucuteni Ceramics

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The aim of the present work is to highlight the benefits of applying PIXE (Particle-Induced X-ray Emission) technique on several dozen samples. As a case study we choose ceramic artefacts originating from several historical periods in the steppe and sylvosteppe regions between the Nistru and Prut rivers [1]. In order to determine the elemental composition a 2.9 MeV proton beam generated by the 3 MV Tandetron accelerator from IFIN-HH was used [2]. The experiment was performed with low beam current, in the range of nA and data acquisition was set at 300 s per sample. Recorded spectra post-processing was carried out with GUPIX software tuned with NIST 679 standard [3,4]. Principal Component Analysis (PCA) suggested the presence of multiple clusters, which most probably indicates different manufacturing techniques developed within the 5 000 years time range.

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2.11 Preliminary analysis of the Mini-EUSO Telescope data taken in D3 offline trigger mode

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In the last few years, the traditional detection of the UV fluorescence yield of Extended Air Showers (EAS) produced by Ultra-High Energy Cosmic Rays (UHECR) by ground observatories, is completed by using of space-based UV telescopes. As such, the Mini-EUSO telescope is operating onboard ISS (International Space Station) from 2019, mounted on the nadir-looking UV transparent window of the Zvezda module at assigned time slots called 'sessions'. During its operation, for short periods of time, Mini-EUSO was switched in the D3 mode which is used for the studies for even slower events such as meteor and strange quark matter search. In the present contribution, we report the preliminary analysis of the data taken in D3 offline trigger mode.

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Section 3: Biophysics; Medical Physics

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

Moderators:

Prof. Dr. Aurel POPESCU

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3.1 - Claudia G. CHILOM, Aurel I. POPESCU
Bionics: some outstanding applications in medicine

3.2 - Diana L. STAN, Raluca TÎRCĂ, Daria FLOREA, Georgiana CHIRA, Nicoleta CAZACU, Claudia G. CHILOM
Effect of flavonoids on physico-chemical properties of aldehyde dehidrogenase

3.3 - Elif SELIM, Claudia CHILOM, Lucia ENCIU
Dose-volume parameters in prostate radiotherapy. Comparison between 3D and VMAT Techniques.

3.4 - Francesca-Giulia GUARNERI, Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Mihaela BACALUM
The influence of synthetic antimicrobial peptide P8 on the membrane fluidity using laurdan fluorescence

3.5 - Andreea UDREA, Mihai DUMITRACHE, Alina DUMITRACHE, Maria VLĂSCEANU
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Protein-based particles for biomedical applications

3.9 - Rahela CIOBANU, Mirabela DUMITRACHE, Daniela STROE, Claudia Gabriela CHILOM
Planning and evaluation of head and neck cancers

3.10 - Dumitru POPESCU*, Dumitru Petru IGA, Alin Gabriel POPESCU, Valentin I. R. NICULESCU
Pulsatory liposome – a two-stroke bionic biomicroengine

3.11 - Ilie Andrei NECSOIU, Cristina PETROIU, Alexandru JIPA
Quality control in quantitative SPECT/CT imaging: concepts, requirements, methodes

3.12 - Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Claudia CHILOM, Rafaela COCOSI-VARTOPEANU, Sorina IFTIMIE, Cornelia NICHITA, Irina ZGURA, Viorel IFTIMIE, Sanja PETROVIC
Effect of "green" silver nanoparticles on urease activity

3.13 - Bianca-Alexandra IORDAN, Claudia CHILOM, Raducu POPA
External radiotherapy and afterloading brachytherapy in genital cancers

3.14 - Marius-Valentin COSTACHE, Tia POPESCU, Ionuț DUMITRU, Vasile BERCU, Leonard GEBAC
The effect of the CT calibration curve on patient dose distributions

3.15 - Gratiela NITESCU, Madalina CROITORIU, Andrei BARBORICA
The benefits of CT Simulation with Deep Inspiration Breath Hold tehnique for breast cancer radiotherapy

3.1 Bionics: some outstanding applications in medicine

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Keywords: bionics, medicine, bacteriorhodopsin, spider fibres, artificial blood, retina and ear prostheses

In the first definitions of Bionics, it was stipulated its main goal: the transfer of solutions experimented by the living matter to the techniques in order to realize cheaper, efficient and ecological technologies and devices. In the meantime, the area of Bionics applications was successfully extended to other activity fields: agriculture, sports, entertainment and, especially, medicine. This work presents some outstanding examples of surprising biological solutions adopted by the living beings and their transfer to medicine, in order to help the diseased people to be cured or to be endowed with performant prostheses offering them a quasi-normal life.

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Faculty of Physics, University of Bucharest, June 18, 2021

3.2 Effect of flavonoids on physico-chemical properties of aldehyde dehidrogenase

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Flavonoids are a class of molecules identified in many natural plants with promising biological activities such as antioxidant, anti-inflammatory, and anti-cancer effects. This study aims to investigate the interaction between flavonoids apigenin, quercetin, and fisetin with aldehyde dehydrogenase. This is an enzyme that contributes to the acetaldehyde detoxification by oxidizing it to acetate, and also is involved in lipid peroxidation, and metabolism of amino acids, biogenic amines, corticosteroids, retinoids, and protein deglycation. Aldehyde dehydrogenase stability under the action of heat was also investigated and the changes induced by three flavonoids on the conformational stability of the protein were monitored. Spectroscopic studies showed that apigenin, fisetin, and quercetin quenched aldehyde dehydrogenase fluorescence by a dynamic mechanism. Calculating the values of the thermodynamic parameters, it was noticed that the interaction processes between flavonoids and aldehyde dehydrogenase were driven by hydrophobic forces. At the same time, the interaction was enthalpically driven for apigenin, entropically driven for quercetin, and with the same contribution of the enthalpy and entropy for fisetin. The distance between the Trp residues and flavonoids and also the efficiency of the energy transfer between the aldehyde dehydrogenase and flavonoids were evaluated based on FRET. Molecular docking confirmed the results obtained by fluorimetry. Denaturation process of aldehyde dehydrogenase and aldehyde dehydrogenase-flavonoids complexes was investigated. It was observed that apigenin has stabilized protein structure against denaturation, while fisetin and quercetin have a destabilizing effect.

3.3 Dose-volume parameters in prostate radiotherapy. Comparison between 3D and VMAT Techniques.

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Keywords: prostate neoplasm, volumetric modulated arc therapy (VMAT), 3D radiotherapy

The aim of this work is the comparison between 3D and VMAT techniques applied to the prostate neoplasm irradiation. The dose-volume parameters were analyzed to highlight the importance of the irradiation technique and of the doses collected in radiotherapy by the tumor volume and by the organs at risk. The most important organs at risk in the case of prostate neoplasm are bladder and rectum. The study analyzes the doses collected by the bladder and rectum and the coverage of the tumor volume by these two techniques. The analysis was made on 18 patients, for each patient in part being made 3D and VMAT plans. The prescribed dose was 78 Gy in 39 fractions with 2 Gy per day. The images necessary for the planning were purchased with Computer Tomography by Siemens. Then they were exported in Monaco Treatment Planning System for dose distribution calculation. Using Microsoft Excel software, we determined the average dose delivered at the tumor volume and processed in Excel all the doses obtained in DVH for the 18 patients through the two irradiation techniques.

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3.4 The influence of synthetic antimicrobial peptide P8 on the membrane fluidity using laurdan fluorescence

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Antimicrobial peptides (AMPs) are an important class of short peptides that can be found in humans, animals, and plants with a wide spectrum of antibacterial, antifungal, antiparasitic, and antiviral properties [1], [2]. We conducted a study regarding the influence of the synthetic antimicrobial peptide P8 (HRWWRWWRH-NH2) on the membrane fluidity of two different cell lines (BJ and B16) using the General Polarization (GP) values, a key parameter to obtain important information on the behaviour of the mentioned membranes. Laurdan, which is known to sense the polarity changes in the environment, was used as a fluorescent membrane probe to label the BJ and B16 cells, the first being healthy skin cells and the second the melanoma cell line. P8 was added in varying concentrations. The temperature was increased from 20°C to 37°C to further investigate the peptide's effect on the cells. The results showed significant changes induced by the AMPS on the membrane fluidity of both cell lines,

confirming that the experimental protocol was efficient in assessing the desired parameter. This protocol will be further developed to better understand the complex interactions that occur between AMPs and the cellular membranes.

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3.5 A multi-institutional pilot study using a CIRS SHANE phantome

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Keywords: Dosimetry audit, IMRT, VMAT

External dosimetry audit is a tool for quality improvement in radiotherapy (RT), being widely recognised to ensure patient dosimetry accuracy and consistency. Large scale audits have provided data which helped to increase the confidence in dose delivey and allowed RT institutions to benchmark themselves against others with similar equipment and thus find out if they have got the best out of a system [1]. In order to review the physics aspects of the overall clinical Intensity Modulated Radiation Therapy (IMRT) performance, a multi-institutional pilot study was carried out in five RT institutions nationwide, with six medical linear accelerators being involved. The International Atomic Energy Agency (IAEA) "end-to-end" audit methodology for on-site verification of IMRT dose delivery, which simulates all the steps of an IMRT treatment, in an ‘end-to-end’ approach (i.e., following the pathway similar to that of the patient, from imaging, through treatment planning to the dose delivery) using an anthropomorphic CIRS Shoulder, Head&Neck End-to-End (SHANE) phantom was followed [2]. Overall, the multi-institutional pilot study results showed that an accurate treatment delivery, within the recommended agreement criteria, is achieved in the centers, thus showing a high quality of IMRT/volumetric modulated arc therapy (VMAT) clinical implementation for Head&Neck treatments.

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3.6 Orthogonal decomposition of transient response in optogenetic data

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Keywords: keywords: optogenetics, prefrontal cortex, empirical mode decomposition, cocaine

Gamma oscillations in the brain's prefrontal area show strong coherence during associative learning [1], and their duration is proportional to the decision time in behavioral tests. Gamma rhythm involves the reciprocal interaction between parvalbumin fast-spiking interneurons (Pv-FSI) and principal cells to ensure fine-tuned excitation-inhibition balance in the brain [2]. We used optogenetic tools to investigate the response of the local network in the medial prefrontal cortex (mPFC) of mice [3]. The Pv-FSI [4] were infected with the viral vector Channelrhodopsin-2 (ChR2) [5], a transmembrane protein that rapidly forms a nonselective cation channel leading to membrane depolarization when activated by blue light [6]. Briefly, 10 ms laser pulses were delivered with an optrode that allowed the recording of the local field potential (LFP) response for 2 seconds [7]. Each procedure was repeated 100 times, and only data from stable couplings were reported for control and systemic cocaine administration [8,9]. Given the transient nature of the response, we used the empirical mode decomposition (EMD) for data analysis [10]. The orthogonal decomposition of the original LFP into intrinsic mode functions (IMFs) allows clear identification of the frequency bands and the corresponding energy distributions. The orthogonality indices show a certain amount of leakage among the IMFs, most likely due to noise contaminating all frequency bands. The IMFs show distinct relaxation coefficients for cocaine versus control that allow rapid data screening.

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3.7 Adaptive radiotherapy in cervical cancer

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Cervical cancer is a diagnosis present in more than half a million women each year (by 2020, ~ 600,000 women have been reported). This disease leads to over 300,000 deaths each year, staying in the top 4 ranking of women cancer. In most cases, the cause of the disease is human papilloma virus (HPV), smoking, or immune system dysfunction. 90 % of this disease occurs in low-income and middle countries, while in developed countries the incidence and mortality of cervical cancer has been significantly reduced. Adaptive radiotherapy helps cancer treatment, with the primary goal being to deliver individualized radiation therapy, based on the inclusion of feedback on anatomical and biological changes during treatment planning and optimization. ART is trying to change the initial parameters of the treatment plan so that it can compensate for changes during treatment. The changes can be anatomical, due to migration or movement of the tumor, but also the weight loss of the patient. This type of radiotherapy uses multimodal imaging and plan optimization in order to compensate for the above changes. ART radiotherapy can be used at different times of treatment, in order to increase dependence on automatic processes. This type of therapy offers a major advantage for cervical cancer due to the complex and varied movement of the target of the cervix during radiotherapy. In this study, the difference between dose delivered at the beginning of the treatment and the way it modifies during the radiotherapy therapy is explained. Also, this study contains the way the planning evolved during the therapy and what would happen if the treatment planning had not been improved.

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3.8 Protein-based particles for biomedical applications

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Keywords: bovine serum albumin nanoparticles; nanoprecipitation; ascorbic acid

Protein-based particles are one of the most important research topics in nanomedicine, being used especially as drug delivery systems. From the wide variety of proteins, albumins offer several advantages in biomedical applications, due to their availability, water solubility, innocuous degradation metabolites, biodegradability, biocompatibility, nontoxicity, they being components of the human and animal blood. In this work, various types of bovine serum albumin nanoparticles (BSA-NPs), with or without ascorbic acid, were prepared via different nanoprecipitation methods. The obtained BSA-NPs were characterized by UV-Vis absorption and fluorescence spectroscopy. Their size and morphology were studied by Scanning Electron Microscopy (SEM). The stability in

time of the synthesized BSA-NPs was spectrally monitored.These results could be exploited in the development of novel drug carrier systems to be used in biomedical field.

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3.9 Planning and evaluation of head and neck cancers

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This study presents the dosimetric evaluation of the treatment plan for 60 patients with head and neck cancers (HNC) from the Radiotherapy Clinic of the Coltea Clinical Hospital in Bucharest using the VMAT (Volumetric Modulated Arc Therapy) irradiation technique. For all 60 treatment plans were used a 360 degree long dynamic arc beam, respectively two dynamic arc beams, using the MONACO 5.11 planning system. In modulated intensity radiotherapy, additional quality assurance is required because the complexity of the technology can lead to systematic and random errors in dose administration. Therefore, the gamma index analysis was used to compare the gamma index for the agreement distance of 3 mm and the dose difference of 3 %. Gamma analysis was applied for 20 treatment plans with the 1 arc VMAT technique, with the criterion of 3 mm/4 % according to TG 119, developed by the AAPM.

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3.10 Pulsatory liposome – a two-stroke bionic biomicroengine

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

In this work, we have considered the problem of a pulsatory lipid vesicle. Under positive osmotic stress a giant lipid vesicle swells up to a critical diameter, when suddenly a transbilayer pore appears if the swelling process is slowly enough. A part of the intracellular material comes out of the cell through this transmembrane pore and the

liposome membrane relaxes and finally, it recovers. The pore increases in the first part of its evolution, then decreases, and finally it closes. The both simultaneous dynamics processes described above start again and so on. The vesicle evolution is a cyclic process and the vesicle becomes a pulsatory one. Here we will obtain the differential equations of both the vesicle and the pore dynamics. Also, we will analyse the characteristic parameters of the periodic process (swelling time, pore lifetime, number of cycles, the duration of vesicle activity, material quantity leaked out during a cycle). Also, we present the conditions to programme a n-cycles working vesicle.

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3.11 Quality control in quantitative SPECT/CT imaging: concepts, requirements, methodes

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Nuclear medicine imaging is an exquisitely sensitive method of assessing and quantifying physiological processes in vivo. Historically, nuclear medicine quantification has progressed from simple thyroid uptake measurements to present kinetic and standard uptake value (SUV) analysis using PET. More recently, single photon emission computed tomography (SPECT) quantification in terms of kBq/mL has become more common - predominantly because of the needs of internal dosimetry for radionuclide therapy. Quantitative SPECT/CT imaging allows the usage of a extensive range of radiopharmaceuticals in various cancer studies and other clinical applications. While the concept of quantitative SPECT/CT has existed for years, SPECT/CT systems are not intrinsically quantitative; their means for measuring activity concentration are limited without additional efforts such as complex manual calibrations. Performing acquisitions using SPECT/CT systems that meet the requirements of periodic quality control tests and properly calibrated, according to NEMA/IAEA/AAPM international guidelines, are essential for obtaining accurate quantitative results. In quantitative SPECT imaging, conversion of pixel values from counts to radioactivity concentration per unit volume (for example, Bq/mL) requires measuring a conversion factor, often referred to as system sensitivity. This factor should be measured for each combination of collimator and radioisotope, in a cross calibration procedure (cps/MBq) units. We also tested the quantitative accuracy of the SPECT/CT system for 99mTc in a simple configuration (phantom - NEMA NU-2), evaluating background calibration factor, recovery coefficient, the accuracy of measurements, coefficient of variation for image noise, total activity deviation, and contrast recovery.

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3.12 Effect of “green” silver nanoparticles on urease activity

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Keywords: “green” silver nanoparticles; antioxidant activity; urease

Recent progress in “green” nanotechnology is trying to fight against many diseases, a special interest being given to silver nanoparticles. Urease, a nickel-containing enzyme, has been reported to contribute to the pathogenesis of hepatic coma, encephalopathy, gastritis and gastric ulcer, and other diseases. In this study, biogenic silver nanoparticles (bio-AgNPs) were “green” synthesized by using an aqueous extract of Mentha piperita L. leaves, and then examined against urease activity. The obtained AgNPs presented good physical stability (checked by zeta potential measurements) and high antioxidant activity (evaluated by chemiluminescence technique). Their size was estimated by DLS measurements. UV-Vis absorption and fluorescence emission spectroscopy were used to study the impact of bio-AgNPs on urease. The synthesized bio-AgNPs exhibited good urease inhibitory activity. These findings could be exploited in the development of novel inhibitors of urease for biomedical applications.

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3.13 External radiotherapy and afterloading brachytherapy in genital cancers

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Keywords: external radiotherapy, brahihterapy, treatment plan

There are two types of radiotherapy according to the position of radiation source in relation to the patient body: external radiotherapy, when the radiation source is located outside the patient and internal radiotherapy or brachytherapy, when the radiation source is placed inside the tumor or in direct contact with it. A female patient with a cervix tumor was chosen to underwent the two types of treatment. In the case of external radiotherapy, the first step is a CT scan to create the treatment plan. The female patient is positioned by restraint systems, armrest,

knee bracket and leg brace with bar bracket, mattress for back and sitting. The second step is to center and scan the patient, and the last step is to mark the tattoo spots on her skin. After completing the CT scans, the data are inserted into the Monaco system where the physician outlines the risk organs and the tumor. After contouring the tumor, the physician prescribes the dose, and the medical physicist will prepare the plan according to the indications of the radiotherapist. The CBCT system (CONEBEAM CT) is used which makes a complete rotation around the patient and acquires the CT scan with the actual position of the patient and the treatment position. After this stage, one can start irradiation of the patient with the prescribed treatment. In the case of afterloading brachytherapy, two or three brachytherapy sessions are performed depending on the doses received by the primary critical organs (rectum, bladder and intestines) in external radiation therapy, but also on the stage of the disease. The cylindrical applicator is mounted to the patient and, for a better view of the bladder, a contrast substance is introduced by means of a urinary catheter. The next step is to move the patient to the CT scanner, in order to scan her and record the images needed to perform the treatment plan. The patient is scanned in the pelvic area so that the vaginal applicator can be fully visualized. The images are transmitted to the Monaco treatment plan system, in order to delimit the target volume and the critical organs. The set of images with the completed contours are sent further to the Oncenta treatment plan system, specially designed for the development of a treatment plan in brachytherapy. After the treatment plan is performed the patient's irradiation can begin.

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3.14 The effect of the CT calibration curve on patient dose distributions

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Keywords: Computed tomography, dose distributions, Hounsfield units, TPS

X-ray computed tomography (CT) is the most common source of information about the exact locations of tumor sites. Many factors, such as inhomogeneity and overlapping of patient’s body tissues, can have a major effect on dose distributions. In order to achieve accurate dose distributions in image-based treatment planning for patients undergoing external-beam radiotherapy, it is necessary to obtain the relationship between the CT numbers and electron densities, as the input for the treatment planning system (TPS). The CT number, expressed in Hounsfield units, is a normalized value of the linear attenuation coefficient of each voxel (pixel volume) of a CT image. The corrections of tissue inhomogeneity are obtained by establishing a calibration curve from CT images of an electron density phantom that has various tissue equivalent materials with known physical properties and densities in the range of those of real human tissues. Multiple calibration curves were obtained in order to observe the influence of tube voltages (kVp) and currents (mA) on the measurement of Hounsfield units and the quality of the images. Hence, the Hounsfield units of all the rods with different known electron densities were determined experimentally using a defined region of interest (ROI) for all the measurements. Each ROI was considered in the middle of each material, away from the edges to avoid partial volume effects that could influence the outcome. The results indicated that in low densities, such as lungs and soft tissues, there was no observable difference between the curves, but by increasing the densities and approaching the bone densities, the differences in HU units were revealed.

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3.15 The benefits of CT Simulation with Deep Inspiration Breath Hold tehnique for breast cancer radiotherapy

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Keywords: CT simulation, DIBH, IMRT, radiotherapy, breast cancer

Radiation revolutionized medicine when it was first used to treat cancer in 1901. Its use, however, has only been able to evolve as far as technical innovation has allowed. Now, thanks to progress in physics, technology and computing, radiation therapy is entering a new era of precision, effectiveness and safety. The goal of radiotherapy is to safely maximize the treatment of a tumour using radiation, while minimizing harm to the patient's nearby normal tissue and critical organs. This work describes a CT simulation technique that significantly reduces cardiac toxicity associated with decreased average dose in the heart but also in the lungs: Deep Inspiration Breath Hold (DIBH). The Intensity Modulated Radiation Therapy (IMRT) treatment technique is also captured and described. DIBH is useful in situations where radiotherapy is needed in the thoracic region and comes with advantages over free breathing treatment: better accuracy of treatment delivered (as respiratory movement is removed), reduction of lung toxicity and especially reduction of heart toxicity, thus decreasing risk of cardiac mortality and acute coronary events. The work is based on a comparison between the two treatment methods (Free Breathing and Deep Inspiration Breath Hold) following the analysis of treatment plans for a sample of breast cancer patients. The obstacle of the method is that not all patients will be able to hold their breath for (30-40) s, the time required for the CT simulation but also for the delivery of the treatment at each radiotherapy session. Patients are encouraged and guided to practice deep-inspiring exercises, and the benefits of this simulation and treatment technique have been seen in dosimetric analysis.

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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 - Murat ABLAI, Dan ARGINTARU, Călin BEȘLIU, Marius CĂLIN, Tiberiu EȘANU, Alexandru JIPA, Ionel LAZANU, Cătălin RISTEA, Oana RISTEA, Nicolae George ȚUȚURAȘ

New ways in the investigation of the phase transitions in nuclear matter

4.2 - Elena STROICI, Mihaela PĂRVU, Ionel LAZANU

Antineutrinos fluxes from reactors as background in experiments for proton decay

4.3 - Daniel DOROBANȚU, Mariana PETRIȘ, Mihai PETROVICI

An innovative architecture of MSMGRPCs based on low resistivity glass

4.4 - Raluca-Andreea MIRON, Oana RISTEA

Study of Bragg curve characteristics of proton and ion beams in different biological tissues using SRIM code

4.5 - Radu DOBRE, Elena FIRU, Titi PREDA

Momentum analysis for particles produced in p+W interactions at 400 GeV/c in a nuclear emulsion detector

4.6 - Denis BARBU, Mihaela PĂRVU, Ionel LAZANU

Relic neutrinos from the Early Universe and the use of heavy nuclei in their detection

4.7 - Alexandru-FLorin BEREVOIANU, Larisa GANEA, Andrei APOSTOL, Doina STANCIU

Applications of non-destructive analysis techniques for characterisation of materials found outside the regulatory control

4.8 - Mihaela Gabriela BESOIU

Anisotropic flow of identified particles in Xe–Xe collisions at √s_NN = 5.44 TeV

4.9 - Alice PĂUN, Gabriela PĂVĂLAȘ, Vlad POPA

Search for nuclearites with neutrino telescopes

4.10 - Claudia OLARU

GEANT4 simulation of radioluminescence light induced by an alpha emitting radioactive source in air

4.11 - Andreea-Cristina POPA, Andi CUCOANES, Oana RISTEA

Geant4 Simulations of Markus Ionization Chambers required in Laser–Based Accelaration Experiments

4.12 - Cristiana OPREA, Alexandru MIHUL*, Ioan Alexandru OPREA

Hauser-Feshbach statistical modeling of 233U(n,f)

4.13 - Liviu NIȚĂ

SOFTWARE APPLICATION TO INVESTIGATE COINCIDENCES OF THE MUONIC RADIATION WHEN PASSING THROUGH THE MULTI PIXEL PHOTON COUNTER (MPPC) UNDERGROUND DETECTOR

4.14 - C. OPREA,*, A. MIHUL**, I. OPREA, S. ZGURA, M. POTLOG, A. NEAGU

Nuclear production of Tin isotopes in the Universe and related processes

4.15 - Ștefan GALIN, Andrei NEACȘU

Reliability of Shell Model Hamiltonians in Double-Beta Decay

4.16 - Diana COCIOABĂ, Radu LEONTE, Roxana CORNOIU, Alexandra FONSECA, Ivanna HRYNCHAK, Dana NICULAE

Overview on the ICNAS/UC internship: results and discussions

4.17 - Cristian OMAT, Mirel BIRLAN

Characterization of Potential Hazardous Asteroids in terms of Planetary Defence concept

4.18 - Iuliana BACIOIU
Study of the cosmic rays in atmosphere

4.19 - Paula Gina ISAR
Radio signals from highly energetic extensive air showers: status and new prospective

4.20 - Ciprian COSAR
Simulation and measurement of gamma-ray activity for U-Ore & Th-Ore samples at various ages

4.1 New ways in the investigation of the phase transitions in nuclear matter

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Keywords: relativistic and ultra-relativistic nuclear collisions, phases of the nuclear matter, phase transitions

Nuclear matter formed in relativistic and ultrarelativistic nuclear collisions offer conditions for existence of different phase of this type of matter. Many of them could be associated with different cosmological phenomena, from the beginning of our Universe, to the extreme evolution of some type of stars. In the present work, we discuse a few nuclear matter phases, possibile phase transitions, as well as experimental methods for investigation of these complexe processes.

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4.2 Antineutrinos fluxes from reactors as background in experiments for proton decay

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Keywords: antineutrinos fluxes, background, LAr experiments, proton decay

Scientific goals of the DUNE project encompass a broad range of activities. These searches answers to neutrino oscillation studies combined with determining the neutrino mass ordering and to the measurements of CP violating phase, but in the same time new phenomena associated with theories beyond Standard Model are searched (the unification of the three fundamental forces, the matter - antimatter asymmetry of the Universe, proton decay or new particles as candidates for dark matter). LAr experiments are particularly sensitive to proton decay modes, key mode of interest in this case is $p \rightarrow (K+)+anti(\nu)$. Antineutrinos produced at nuclear reactors constitute a major source of background for searches of this decay channel. Considering the fluxes of antineutrinos produces by nuclear plants existent in this moment on the terrestrial globe, we estimated their hypothetical contributions to background fluxes in DUNE experiment for proton decays.

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4.3 An innovative architecture of MSMGRPCs based on low resistivity glass

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Keywords: Gaseous detectors, Muti-Strip, Multi-Gap RPCs, ageing, high irradiation dose

Understanding the phase diagram of strongly interacting matter predicted by Quantum Chromodynamics (QCD), its phase transitions and potential critical points, using heavy ion collisions is a challenging task in our days. While at Relativistic Heavy Ion Collider (RHIC) and Large Hadron Collider(LHC) energies, the studies are concentrated on the properties of very high energy density and temperature of produced fireballs, expected to be characteristic for the expanding Universe, a few microseconds after Big Bang, at lower collision energies, nuclear baryonic matter at densities of 5-7 times higher than the normal nuclei is produced, characteristic for the inner core of the neutron stars. An experiment where detailed studies on the properties and dynamics of highly compressed baryonic object will be performed is the fixed target Compressed Baryonic Matter (CBM) experiment at Facility for Anti-proton and Ion Research (FAIR) in Darmstadt, Germany. Multi-differential analysis and high precision measurements of rare probes require unprecedented high statistics. Therefore, CBM experiment is designed to run at interaction rates up to 10 MHz for Au-Au collisions at centre of mass energies$\sqrt{(s_NN}$)=4.7 GeV at SIS100 accelerator. At this interaction rate, the low polar angles of the experiment are exposed to high particle densities with rates up to 4·10^4 particles/sec·cm2. A new generation of detectors has to be developed in order to cope with such unprecedented counting rate without deteriorating their performance. Charged hadrons identification will be provided by the Time-of-Flight (ToF) system based on Resistive Plate Counters (RPC) and tracking in a dipolar magnetic field based on silicon detectors and out of magnetic field by Transition Radiation Detectors (TRD). For maintaining its performance over the whole lifetime of the experiment, expected to be at least 10 years, with about 2 months/year of data taking, the ageing effects due to high irradiation dose have to be reduced at maximum. An innovative architecture of Multi-Strip Multi-Gap RPC (MSMGRPC) which fulfils all these requirements will be presented.

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4.4 Study of Bragg curve characteristics of proton and ion beams in different biological tissues using SRIM code

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Keywords: Hadrontherapy, SRIM, simulation

Hadron therapy is a form of radiotherapy in which the irradiating beams are made of heavy charged particles, such as protons and heavy ions. These particles, due to their characteristic interaction mechanisms, have a substantial potential to deposit a higher dose in a particular area with a minimum effect on the surrounding healthy tissues. In this study, SRIM (Stopping and Range of Ions in Matter) code was used to obtain Bragg curves using ions such as Hydrogen, Helium, Lithium, Carbon and Neon of energies of 10, 20, 40, 80 and 160 MeV/nucleon in bone, adipose tissue, spleen and pancreas. The dependence of the stopping power, the Bragg peak position and range on the incident energy, type of projectile and type of tissue will be presented and discussed. By using a simulated multilayer target, we have irradiated with different proton beam energies the thyroid tissue and found the most suitable proton energy interval for this specific geometry to obtain the Spread Out Bragg Peak (SOBP).

4.5 Momentum analysis for particles produced in p+W interactions at 400 GeV/c in a nuclear emulsion detector

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Keywords: tau-neutrino, cross-section, nuclear emulsions, Multiple Coulomb Scattering

The DsTau experiment at CERN-SPS has been proposed to measure an inclusive differential cross-section of a Ds production with a consecutive decay to tau lepton in p-A interactions. A precise measurement of the tau neutrino cross section would enable a search for new physics effects such as testing the Lepton Universality (LU) of Standard Model in neutrino interactions. The detector is based on nuclear emulsion providing a sub-micron spatial resolution for the detection of short length and small "kink" decays. Therefore, it is very suitable to search for peculiar decay topologies ("double kink") of $Ds \rightarrow \tau \rightarrow X$. The physics run in 2021 was successfully done and the emulsion films are ready for scanning and analysis. In this presentation, the momentum measurement of charged particles through MCS, as well as a comparison between Monte Carlo momentum and momentum estimated with follow down track analysis for simulated particles are presented.

4.6 Relic neutrinos from the Early Universe and the use of heavy nuclei in their detection

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Keywords: neutrino relics, Big Bang Model, neutrino capture

Analyzing the Big Bang Model, one can predict the existence of a cosmic neutrino background, as in the case of the Cosmic Microwave Background. However, unlike photons, neutrinos barely interact with the matter, making their detection very difficult. By studying the theory of β decay of some heavy nuclei with very low decaying energy, we might achieve the energy resolution required to detect the cosmic neutrino background through neutrino capture on β-decaying heavy nuclei. We can also predict the average relic neutrino density with the Big Bang Model, which makes it possible to calculate the capture rate of relic neutrinos on β-active nuclei. If we consider the contribution of the over density caused by the gravitational attraction of the Milky Way this might improve the rate by a factor close to 2.

4.7 Applications of non-destructive analysis techniques for characterisation of materials found outside the regulatory control

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Keywords: Nuclear Forensics, Gamma Spectrometry, Ion Beam Analysis, Depleted Uranium

When responding to nuclear security events, nuclear foreniscs characterisation of seized evidence represents an important component of the criminal investigation process. The aim of this research is to apply High Resolution Gamma Spectrometry (HRGS), X-Ray Fluorescence (XRF) and Ion Beam Analysis (IBA) to determine the isotopic and elemental composition of radioactive exhibits for nuclear forensics purposes. The results of this work have direct implications for criminal investigations and prosecution as well as state nuclear security. Four types of industrial gamma radiography devices made of depleted uranium were analyzed using a HPGe detector. A computer software PC/FRAM v5.1 was used to estimate the isotopic composition of the uranium bearing materials. Moreover, all the four types of samples were analyzed using a portable XRF device and its analysis software. In order to increase confidence in nuclear forensics findigns, all four samples were also analyzed using Particle Induced X-ray Emission (PIXE) and Particle Induce Gamma-ray Emission (PIGE) methods. The samples of interest were irradiated by 3 MeV protons at the 3 MV Tandetron™ of the Horia Hulubei National Institute for Physics and Nuclear Engineering. All the measurements were done using an external beam set-up, using a HPGe detector for measuring gamma rays and a silicon drift detector (SDD) for measuring characteristic X-rays. The GUPIX software was applied for processing the PIXE spectra.

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4.8 Anisotropic flow of identified particles in Xe–Xe collisions at √s_NN = 5.44 TeV

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Keywords: heavy-ion collisions, anisotropic flow, flow coefficients

Heavy-ion collisions produce asymmetric pressure gradients which convert the initial spatial asymmetry into an anisotropy in final state momentum space via multiple interactions, a phenomenon referred to as anisotropic flow. The magnitude of anisotropic flow is characterized using the harmonic coefficients v_n in a Fourier decomposition of the azimuthal distribution of produced particles relative to the symmetry plane in a collision. In this talk we

present the elliptic and triangular flow coefficients of identified particles (π^±, K^± and p+$\overline{p}$) measured in Xe-Xe collisions at $\sqrt{s}$_NN = 5.44 TeV recorded by the ALICE detector. The results obtained using the scala r product method are reported as a function of transverse momentum, p_T, within the rapidity range |y|<0.5 for various centrality classes. The flow coefficients exhibit a particle mass dependence for p_T < 3 GeV/c and type grouping (i.e., mesons and baryons) at intermediate transverse momenta (3 < p_T < 8 GeV/c). The centrality dependence of the shape evolution of the p_T- differential v_2 is also shown for various particles.

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ALICE Collaboration

4.9 Search for nuclearites with neutrino telescopes

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Keywords: neutrino telescopes, nuclearites, strange quark matter, Monte Carlo simulation

Over the past decades, theories have predicted the existence of heavy compact objects containing an extremely dense form of exotic matter named Strange Quark Matter (SQM). This type of hypothetical matter is composed of nearly equal quantities of up, down and strange quarks and is supposed to be the ground state of Quantum Chromodynamics. Nuclearites are the massive component of SQM particles. Some studies show that nuclearites heavier than 10^{13} GeV with velocities of approximately 250 km/s could reach the Earth and could be observed by neutrino telescopes. KM3NeT is a network of deep-sea neutrino telescopes located in the Mediterranean Sea, dedicated to the search for high-energy cosmic neutrinos and the study of neutrino properties. The KM3NeT detector is currently under construction and is already taking data with the first installed lines. Nuclearites can be detected by the instrumented area through the visible blackbody radiation generated along their path. In this work, nuclearites were simulated using a dedicated Monte Carlo program, then they were processed using the existent KM3NeT triggers. Simulated atmospheric muons were also added in this study, as downgoing muons represent the main contributor to the background. A preliminary comparison between simulated nuclearites and atmospheric muons will be presented, as well as an evaluation of the KM3NeT detector response to the signal of nuclearites.

4.10 GEANT4 simulation of radioluminescence light induced by an alpha emitting radioactive source in air

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Keywords: Monte Carlo simulations, radioluminescence, optical detection, alpha particles

For this work, Monte Carlo simulations using Geant4 were used to study the characteristics of the ultraviolet light emitted at the surface of an Am-241 radioactive source placed in air. This phenomenon is known as radioluminescence emission and occurs from the ionization of air molecules, induced by alpha particles. The simulation results were obtained within the 19ENV02 RemoteALPHA EMPIR project, which is currently in progress. Its main objective is to develop new optical systems that can be used for stand-off detection and quantification of environmental contaminations with alpha particle emitters, via air radioluminescence. The need for this type of detectors arises from the context of a nuclear emergency event, such as the failure of a nuclear installation, a terroristic attack, transportation accidents, or any events that may cause the contamination of the environment with alpha emitting radionuclides. To safely and efficiently investigate such an event, the traditional detection methods could be replaced by employing remotely controlled detectors to scan the contaminated areas, thus reducing the risks to emergency personnel, and providing real-time information about the radiological event. The emission of radioluminescence photons in air has been formerly studied in the literature and is based on the excitations of air molecules induced by secondary electrons released in ionizations. The excited molecules undergo radiative transitions to lower energy states, releasing UV-light photons. The simulation of radioluminescence photons was performed using data available in the literature, as well as experimental results from project activities. Finally, the ultraviolet image of a simulated Am-241 source was obtained.

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4.11 Geant4 Simulations of Markus Ionization Chambers required in Laser–Based Accelaration Experiments

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Keywords: ionization chamber, Geant4, simulation, laser acceleration, Monte Carlo

An ionization chamber creates an electric field by placing two electrodes within an enclosed volume of gas or air. Under the influence of this field, ion pairs formed along the path of a particle that hit the detector, begin to drift. The ionization chamber is operated in current mode in its most basic form by detecting the average current corresponding to drifting ions and electrons within its active volume [1].The Advanced Markus chamber is a special case of ionization chamber, having a plane-parallel design of the electrodes and a vented sensitive volume of 0.02 cm3, filled with air. Such detector is used in connection to precision electrometers for measurements in high energy electron beams, as a reference in absolute dosimetry, i.e., for measuremenet of dose and dose rate in radiation therapy [2]. We implemented the geometry of this ionization chamber in GEANT4 [3] and we analysed the range of energies for both electrons and protons in relation to laser-based acceleration experiments. In this context, we

examined the detector response to nominal ranges of energies (2-45 MeV for electrons and 50-270 MeV for protons) and beyond these values, analysing the deposited energy given by multiple Monte Carlo simulations, each containing 10^7 events.

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4.12 Hauser-Feshbach statistical modeling of 233U(n,f)

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Keywords: 233U(n,f) process, Hauser-Feshbach modeling, cross-sections, mass distribution, fission yields

Nuclear data obtained in the research of 233Uranium fission are of great importance for nuclear reactors based on the Th-U fuel cycle. Fission cross-sections, mass and charge distributions, prompt emission in fission including neutron multiplicities, yields of some isotopes of interest as - 232Uranium, and associated uncertainties were obtained. This paper presents the theoretical predictions and the first results on 233U(n,f) by applying Talys and the author's computer codes, dedicated to nuclear reaction mechanisms and the structure of nuclei calculations. First, the fission mass distributions and product yields were simulated using the Brosa model. For some cases, the fission yield isomeric ratios were calculated using different gamma and neutron source models. Uncertainties induced by nuclear data were quantified using preliminary, energy-dependent relative covariance matrices evaluated with ENDF nuclear data and processed for the studied fission process. Theoretical evaluations obtained here are compared with existing experimental data. The present research on 233U(n,f) reaction is realized in the frame of the nuclear data program running at JINR Dubna basic facilities IREN and MT-25 Microtron.

4.13 SOFTWARE APPLICATION TO INVESTIGATE COINCIDENCES OF THE MUONIC RADIATION WHEN PASSING THROUGH THE MULTI PIXEL PHOTON COUNTER (MPPC) UNDERGROUND DETECTOR

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This software application can be successfully used in a quick calculation of the spatial distribution of muonic radiation passing through the detector. The software provides multiple sets of already processed data for various graphical representations.

4.14 Nuclear production of Tin isotopes in the Universe and related processes

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Keywords: Sn isotopes, nuclear astrophysics, cross-sections, astrochemical yields, uncertainties

Nuclear astrophysics processes play a key role in the yields of the astrochemical elements of Big Bang Nucleosynthesis for standard cosmology. The interaction of fast protons with natural indium and the production of tin isotopes for nuclear astrophysics have been investigated. Cross-sections of processes 113In(p,gamma)114Sn, 113In(p,2n)112Sn and 115In(p,n)115Sn were evaluated for threshold protons and up to 35 MeV. The contribution of nuclear reaction mechanisms related to the discrete and continuum states of the residual nuclei have been obtained. A good agreement was reached between theoretical calculus and experimental data in the literature. The results obtained in the computer simulation showed that the concentrations of Tin isotopes depend on the cross-section and the natural abundance of the target nuclei. Astrophysical rates were determined for Tin isotopes in p + 113,115In. The uncertainties of the cross-section, related to the variation of the optical potential parameters, were analyzed.

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4.15 Reliability of Shell Model Hamiltonians in Double-Beta Decay

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Keywords: Neutrinoless double beta decay, interacting shell model, effective Hamiltonians

The literature distinguishes between two types of double beta decay: two-neutrino double beta decay ($2\nu\beta\beta$) that has been measured in a dozen isotopes and neutrinoless double beta decay ($0\nu\beta\beta$) that has not yet been observed, but

experimental limits on its half-life are available. In the 0νββ mode, the only leptons present in the final states would be the outgoing two electrons, thus violating the lepton number conservation. We make a statistical analysis of the 48Ca 0νββ nuclear matrix elements (NME) using the interacting shell model. Producing random variations in the limits of ±10% for the matrix elements of three effective Hamiltonian, we perform the calculations for several observables that can be obtained from the existing nuclear data. In the end, we search for the correlations between the 0νββ NME and these observables. To make a more general prediction for the 0νββ NME, we combine the probability distribution functions of all three Hamiltonians with equal weights, obtaining a range between 0.45 and 0.95 at 90% confidence level and a mean value of 0.68.

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4.16 Overview on the ICNAS/UC internship: results and discussions

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Keywords: nuclear physics, cyclotron, nuclear medicine

The visit to the Institute for Nuclear Sciences of the University of Coimbra (ICNAS / UC) within the IFIN-HH institutional program aimed at observing and understanding the methods of obtaining medical radioisotopes used within ICNAS / UC. As a nuclear physicist, I will be able to make a comparison with the methods used for the TR-19 cyclotron in IFIN-HH, taking into account the methods used for the 2 ICNAS cyclotrons for the production of medical radioisotopes. We performed experiments to obtain and purify 64Cu and 89Zr, followed by peptide and antibody labeling. Given that only liquid targets are used in ICNAS, the irradiation parameters are adapted to the system present there. The purpose of the trip has been achieved. Following the visit and the development of all the experiments, 2 comparative articles will be written.

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4.17 Characterization of Potential Hazardous Asteroids in terms of Planetary Defence concept

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Keywords: Potential Hazardous Asteroids, Planetary Defence, photometry, lightcurve

The Main Asteroid Belt is an area not yet fully explored and the source of Near Earth Asteroids. A special category are the Potential Hazardous Asteroids (PHA) which poses a threat to life on our planet. Even if the impact with a massive asteroid is almost impossible in the next years, the small and medium sized rocks are far more

common in the inner Solar System and can do serious damage on interior planets, inclusive Earth. In recent years, more precisely after the Chelyabinsk event (February 15th, 2013) when an undetected medium sized asteroid (17-20 m) exploded at 30 km above the ground and caused significant human injuries and property damage, humanity has become much more aware of the potential threats that could come from space. The Planetary Defense concept is a worldwide mechanism which monitors the risky asteroids and develops some space programs to deviate them from their dangerous trajectory.In terms of asteroid monitoring, Romania is represented by the Astronomical Institute of the Romanian Academy, a highly appreciated research institute which provided support for the elaboration of this work. Based on the documentation provided and the logistical support (a professional telescope and a high resolution CCD camera), has been performed the monitorization of 4 NEA's in a few observation nights. The applied procedure: the analyzing the images with the Tycho Tracker, a modern astronomical software based on Synthetic Tracking method with which could be performed the photometry, then determination the lightcurve for each observation night and finally the calculation of the rotation period for each asteroid. The results were conclusive by comparison with the values from Small-Body Database Lookup (NASA).

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4.18 Study of the cosmic rays in atmosphere

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Keywords: cosmic rays, radiation dosimetry, energy spectrum

When primary cosmic ray particles come into the atmosphere of the Earth, the secondary particles generated through nuclear reactions with atomic nuclei reach the low altitudes of the atmosphere. The distribution in energy of cosmic ray nucleons from 10 GeV up to the energy characteristic of the knee region of the energy spectrum of the cosmic rays and radiation dosimetry are presented here. The theoretical interpretations of the elemental composition of the primary cosmic radiation suggested that the cosmic ray protons are the main component of the primary cosmic radiation in the terrestrial and space environments. Conclusion is that, the calculated flux of cosmic ray particles decreases with increasing energies as shows the primary proton and nucleon spectra presented in this study.

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4.19 Radio signals from highly energetic extensive air showers: status and new prospective

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Keywords: cosmic rays, inclined air showers, radio detection, Monte Carlo simulations, Pierre Auger Observatory

Over the last decade, radio detection of extensive air showers has matured from small prototype arrays, like LOPES [1, 2], to large-scale cosmic-ray experiments, like the Pierre Auger Observatory [3]. The technique relies on the measurement of coherent radio emission dominantly arising from secondary charge particles deflected in the Earth's magnetic field, with secondary radiation arising from negative charge excess present in air showers [4]. In contrast to vertical air showers (with zenith angles below 60 degrees), the inclined ones illuminate large ground areas of several km2, with radio signals detectable in the 30 to 80 MHz band [5]. Since the area illuminated by radio signals grows with the shower's zenith angle, the radio detector needs to cover large arrays, as it is the case of AugerPrime, i.e. the upgrade of Auger, which facilitates the installation of radio antennas on top of each surface particle detector, covering thus the entire Auger array of 3000 km2 with complementary detectors (water tanks, scintillators, radio stations), of 100% duty cycle each, at the same place. This is particularly attractive for radio detection on energy estimation of cosmic rays [6] and observation of inclined air showers. In this paper we look at the response of a model hexagonal detector [7], by using a sample of CoREAS simulations [8, 9] of 37 events for two primaries (proton and iron), two energies (1018 and 1019 eV), three zenith angles (60, 70, 80 degrees) and respectively eight azimuth angles (0, 45, 90, 135, 180, 225, 360 degrees). This study comes in the support to the world's largest cosmic ray experiment, the Pierre Auger Observatory, which currently is in the upgrade phase, aiming to improve its detectors and consequently rise statistics, in order to elucidate mysteries of the most energetic cosmic rays.

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4.20 Simulation and measurement of gamma-ray activity for U-Ore & Th-Ore samples at various ages

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Keywords: Uranium, Thorium, MCNP, Fitzpeaks

We investigate the natural occurring of daughter nuclei of two nuclear families (U-234, U-235, U-238 & Th-232 sample isotopes taken into account), we taken into consideration a periods of 1, 5, 10, 25, 50 years for the secular equilibriums. We intended to develop a new and better way for characterization of uranium and thorium ore samples. Gamma-ray activity measurement of pure Thorium & Uranium natural occurring ore samples at different ages, combined with efficiency, coincidence summing correction. Samples of both U and Th have been placed at 5 cm and all initial activity have been set for 100.000 Bq. Total counting of spectra has been taken into account in order to compare between ages of the ores. MCNP a Monte Carlo simulation code was employed in simulating the data, then EFFTRAN code was employed for coincidence gamma correction, Fitzpeaks was used to analyze the photopeaks present and obtain the activity of each principal photopeak. The method can be used in conjunction with other methods to accurately determine the age of samples based on the activity of daughter nuclides and possible to determine the amount of Uranium or Thorium present. Fitzpeaks is of great addition for gamma-ray spectroscopy and metrology as a tool, its easy to manipulate gamma-ray spectra. The advantage of MC simulations are that you can simulate U-234 which in real samples are very difficult to trace. Based on the U-234 activity detected we can obtain clear data about how enriched is the sample, providing a tool for nuclear forensics.

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

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

Moderators:

Lect. Dr. Sanda VOINEA

Lect. Dr. Adriana BĂLAN

5.1 - Cornelia NICHITA, Mustafa K. H. ALHUSSAINY
Bionanostructured systems based on chitosan and selective polyphenolic extract

5.2 - Razvan BALICA, Cornelia DIAC, Matei Tom IACOB, Bogdan Ciprian MITREA, Adriana BĂLAN, Ioan STAMATIN
A more environmentally friendly method of recovering precious metals from printed circuit boards

5.3 - Anda CIOBANU, Sanda VOINEA
Software application for the fuel cells study

5.4 - Florin-Lucian COMAN, Sanda VOINEA
Increasing the efficiency of energy consumption for a dwelling house using ecological insulating materials

5.5 - Carmen MĂRUNȚIȘ, Sanda VOINEA
Experimental study of the horizontal axis wind turbine

5.6 - Cristina HUMA, Sanda VOINEA
The study of Romania's energy potential from the perspective of houses power supply

5.7 - Ana Lăcrămioara APETREI, Cornelia DIAC, Sanda VOINEA, Cornelia NICHITA
Antioxidant potential of Hippophae rhamnoides L. extracts

5.8 - Florian POMPIERU
Automotive propulsion efficiency study

5.9 - Ana-Maria CONSTANTIN, Sanda VOINEA
Methods for optimizing energy efficiency for the traditional house

5.10 - Ioana Diana SOMOIAG, Sanda VOINEA, Cornelia NICHITA
Removal of pharmaceutical compounds from water using natural filtering materials

5.11 - Claudia BURLACU, Sanda VOINEA
Passive building optimization methodology considering energy demand, thermal comfort and cost

5.12 - Roxana Iozefina DUMITRACHE, Adriana Elena BALAN
Case study of an on-grid solar system with monocrystalline silicon photovoltaic panels for residential applications

5.13 - Bogdan Ciprian MITREA, Cornelia NICHITA, Cornelia DIAC, Tom Matei IACOB, Bogdan DOBRICA, Ioan STAMATIN
The Influence of Cu and TiO2 Nanoparticles on Plants Photosynthesis Process

5.14 - Daniel Tiberiu SILISTE, Sanda VOINEA
Fuel cells used to power the electrical vehicles

5.15 - Marc TORFEH, Adriana Elena BALAN
Graphene microporous layer for proton exchange membrane fuel cells

5.16 - Matei-Tom IACOB, Cornelia DIAC, Bogdan Ciprian MITREA, Adriana BALAN, Ioan STAMATIN
Bio-construction of electro-active layers

5.1 Bionanostructured systems based on chitosan and selective polyphenolic extract

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Keywords: Bionanostructured systems, Curcuma longa L. extract, antioxidant activity, encapsulation efficiency

Bionanostructured systems offer a number of features and benefits such as enhancement of solubility, bioavailability and pharmacological activity, protection from toxicity, sustained delivery and protection from physical and chemical degradation. The involvement of chitosan in obtaining the bionanostructured represent an option for controlled drug delivery. On the other hand, the application of nanotechnology in the use of plant extracts has revealed an advantageous strategy for herbal drugs, considering the benefits of nano encapsulation. This study focuses on a new bionanaostructure based on architectures of nano biopolymers, respectively chitosan and Curcuma longa L. extract, synthesized by ionotropic gelation with TPP crosslinking agent. In order to achieve this study were investigated by UV-VIS spectroscopy (Jasco, Japan, V-570 spectrophotometer) the total phenolic contents (TPC) expressed as gallic acid equivalent/g (mg/GAE g-1) using the Folin-Ciocalteu reagent, total flavonoid contents (TFC) expressed as rutin equivalent/g (mg/RE g-1), by aluminum chloride colorimetric assay and the caffeic acid derivatives content (CADC) expressed as mg caffeic acid equivalent/g dry extract (mg/CAg-1) by using Arnows' reagent. Antioxidant activity of samples (Curcuma longa L. extract and bionanostructured systems) were evaluated by in vitro non cellular assays using the chemiluminescence technique, DPPH(2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay and ABTS (2,2'-azinobis -(3-ethylbenzthiazoline-6- sulfonic acid) methods. The study included the evaluation of the encapsulation efficiency (EE%), as well as the investigation by dynamic light scattering technique for measuring the hydrodynamic size, the polydispersity index and the zeta potential.

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5.2 A more environmentally friendly method of recovering precious metals from printed circuit boards

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Keywords: electrochemical recycling, recovering of electronic waste, circular economy, electrochemistry, gold,

Electronic waste is considered one of the largest and most harmful waste sources. Currently, precious metals are recovered from electronic components through burning, which releases toxic pollutants such as phthalates and dioxins into the environment [1]. These traditional metal recovery processes tend to create serious environmental and health problems. The currently used pyrometallurgical processes require very high temperatures to melt the components, releasing hazardous gases into the atmosphere, have high operating costs and require large amounts of

energy. Hydrometallurgical techniques are more cost-effective, have more predictable results and can be easily controlled, but have the disadvantage of generating secondary wastes, most of which have serious health and environmental problems. Electrochemical processes can be used as an alternative technique for the recovery and recycling of precious metals from e-waste, being a more environmentally friendly and lower cost solution. This helps mitigate climate change by significantly reducing greenhouse gas emissions from the production of new materials, especially metals. Recovering and recycling precious metals from e-waste can bring significant economic benefits and reduce demand for raw materials, thereby also reducing dependence on imports. In this study, our attention is on the recovery of precious metals from printed circuit boards (PCBs). PCBs have a remarkably high content of precious metals and are the main component of most electronics [2]. The state of the art shows us that precious metals can be electrochemically dissolved (3), but this method is not currently used in recycling of gold or palladium from PCBs. This work focus to develop a protocol for the electrochemical recycling of Au/Pd from PCBs, with testing of the relevant parameters: the electrolyte solutions, applied potentials, electrochemical methods, scan rate, number of cycles etc. The main purpose of the present work is to improve the understanding of the electrochemical processes which have place in dissolution of precious metals.

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5.3 Software application for the fuel cells study

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Keywords: Fuel cell, theoretical parameters, modelling, Colaboratory software, Python

In the current economic and political context, the role of renewable energy is becoming significant due to the continuous increase in energy demand, the instability of fossil fuel prices and the socio-political and environmental problems. Fuel cells can be important contributors to renewable energy due to their high efficiency and their clean nature. The detailed study of these systems, the analysis of the operating characteristics and the factors that influence them, the optimization of the operating points, are useful in order to obtain high powers and efficiencies in the practical operation. In this paper we present how to employ Colaboratory software, an application developed on the Google Colab platform, which allows writing and executing Python code in browser, for the study of different types of fuel cells. We used this application in order to calculate the parameters of their operation from the laboratory measurements of characteristic current-voltage curves and power diagrams. Understanding how fuel cells work, the factors that influence the characteristics of the fuel-oxidant couple, provide the necessary data to describe the behavior of these systems in their real operation. Also, the obtained parameters by modeling help us to optimize the design of fuel cells in order to achieve maximum performance in practical applications.

5.4 Increasing the efficiency of energy consumption for a dwelling house using ecological insulating materials

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Keywords: ecological insulating materials, energy efficiency, CO2 emissions, thermal resistance

In today's buildings most of the total primary energy consumed is used for heating, ventilation and air conditioning. Conventional heating and cooling systems have a fairly large impact on operating costs, energy requirements and carbon dioxide emissions. In this paper we have calculated the heat demand for heating the house in the winter months. For this we estimated the amount of heat loss through the envelope of house, the heat input from the solar radiation input, heat loss related to the production, distribution, heat release and adjustment of the heating system, energy input to the system, including energy recovered. An excel application was created in order to compute all these values for different geographical area in Romania and different types of house envelope. Going from the results of energy demand in a traditional house, we also simulated an improvement of the insulation of the exterior walls by applying a layer of 15 cm thick wool as insulating material on the inside. For the study house a 10% reduction of energy consumption was obtained and also a 10% reduction of CO2 emissions.

5.5 Experimental study of the horizontal axis wind turbine

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Keywords: renewable energy, wind energy, horizontal axis wind turbine, electric power coefficient

This paper on the horizontal axis wind turbine is a study of a current issue in the field of energy and especially renewable energy. Wind energy is a green and sustainable source of energy to meet the needs and requirements of the current generation without affecting future generations in any way. A deep analysis of wind energy was made from several perspectives in terms of need, potential, technological capacity and resources. In the laboratory study we tested horizontal axis wind turbines with different types of blades, in order to determine the factors that influence the output power of a wind turbine, such as the number of blades, the angle of inclination of the blades, the multiplication system. The results showed the optimal configurations for reaching the maximum power depending on the wind speed, through the electric power coefficient that we determined for each configuration. The study shows the importance of these factors in determining the construction parameters of a turbine depending on the location where it should be located to extract maximum power from the wind.

5.6 The study of Romania's energy potential from the perspective of houses power supply

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Keywords: green energy, Romania, electricity,energetic potential

At the moment, billions of people are accessing the Internet, and billions more are turning on the lights in their homes. In Romania today, almost 100,000 homes are not connected to electricity, which is both a social and a legal issue. This paper discusses Romania's energy potential, how green energy is managed and why some people choose not to be connected to electricity. This study is based on data from the National Institute of Statistics. Finally, possible long-term and short-term solutions to this problem are discussed. The solutions are based on the energy potential of the targeted area, certain laws, economic rights and opportunities.

5.7 Antioxidant potential of Hippophae rhamnoides L. extracts

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Keywords: Hippophae rhamnoides L. extracts, phenolic compounds, antioxidant potential

Hippophae rhamnoides L. belongs to the Elaeagnaceae family and is an extremely valuable plant source with a complex chemical composition rich in multiple vitamins (A, B1 , B12, C, E, K, and P) carotenoids (lutein, B-carotene, zeaxanthin and lycopene) organic acids and micro-macro nutrients , phytosterols, fatty acids, such as gamma-linolenic acid (omega-6) and palmitooleic acid (omega-7), proteins, carbohydrates, trace elements (Fe, Zn, Ca, Mg, Se) and phenolic compounds (flavonoids, polyphenolic acids). Various parts of Hippophae rhamnoides L , particularly berries possess various pharmacological activities, such as antimicrobial, anti-inflammatory, immunomodulatory, antioxidant, and dermatological effects, generated by the complexity of the chemical composition mentioned above. In present study, the aim is to explore the influence of the concentration of the extraction solvent (used in the Soxhlet method) on the content of phenolic compounds and the antioxidant potential, as well as the relationship between them. By UV-VIS (Jasco, Japan, V-570 spectrophotometer) spectrometric method were determined: total polyphenolic contents (TPC) expressed as gallic acid equivalent/g (mg/GAE g-1) using the Folin-Ciocalteu reagent, total flavonoid contents (TFC) expressed as rutin equivalent/g (mg/RE g-1), by aluminum chloride colorimetric assay, caffeic acid derivatives content (CADC) expressed as mg caffeic acid equivalent/g dry extract (mg/CAg-1) by using Arnows' reagent in according to the procedure described in European Pharmacopoeia 6th edition. The antioxidant potential were investigated in vitro non cellular assays, by DPPH(2,2-diphenyl-1-picrylhydrazyl) free radical scavenging, and chemiluminescence technıque. All methods of investigation highlighted that: i) increasing the concentration of the extraction solvent leads to a higher amount of extracted phenolic compounds ii) the antioxidant potential and the content of phenolic compounds are linear correlated.

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5.8 Automotive propulsion efficiency study

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Keywords: energy efficiency, automotive propulsion, greenhouse gas emission

Controversial and longtime-studied, internal combustion and compression ignition engines were introduced by German engineer Rudolf Diesel in the years leading up to World War I in response to the need for higher efficiency than period steam engines. Due mainly to the increased compression ratio (approx. 20: 1) and the injection of fuel directly into the combustion chamber, the engine designed by him produced two or three times more energy per cylinder capacity using peanut oil (diesel fuel did not yet exist). More than a hundred years apart, the diesel engine has changed its characteristics very little. Although now powered by powerful oil and its derivatives, at impressive injection pressures of up to 2000 bar, supercharged without the need for a pre-combustion antechamber to avoid uncontrolled detonations and fully computerized management, Carnot cycle efficiency for ignition engines by compression remained practically the same as in the case of the first prototype. In this case, the maximum theoretical efficiency for modern diesel engines is, which may seem reasonable, but in the following, we will show that the real efficiency of the engine in terms of mobility is significantly lower, in reality, heat losses reach up to 80-95%. We will study the causes that lead to such low efficiency and propose solutions to streamline the propulsion system by augmenting with the efficiency devices required to be able to use the positive aspects of diesel engines in advanced hybridization with heat recovery and more modern propulsion. , such as the electric one, not before undergoing the study of plug-in hybrid propulsion systems and electric cars. On the issue of emissions, in the case of greenhouse gases (CO2) CI engines have the advantage of high efficiency over those with spark ignition, due to almost double compression, although the combustion model, the layered one, slightly reduces this advantage. Lower fuel consumption means reduced CO2, but the specificity of excess oxygen combustion in the case of CI favors the emergence of other compounds, especially NO and NO2, also known as NOx. These emissions are amplified by the inherent load and speed variations of the wheel-coupled CI engines.

5.9 Methods for optimizing energy efficiency for the traditional house

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Keywords: energy efficiency, passive house, thermal comfort, CO2 emissions.

There is an increasing emphasis on raising the energy efficiency of housing, within the EU member states, but also at national level. Buildings are among the largest consumers of energy, so an increase in energy efficiency will lead to a reduction in energy bills, a very important issue in today's global context. In recent years, passive houses have begun to rise the interest of Romanians both in terms of health and reducing the cost of maintenance, even 10 times lower compared the conventional house. According to the Passive House Institute, the passive house is the house with high thermal comfort and minimum energy consumption. The annual energy consumption for heating such a building is around 15 kWh/m2 year. A passive house has a small environmental footprint, by using non-polluting materials. With denser insulation and active ventilation, an almost constant temperature can be maintained throughout the year. Although the cost of building such a house is higher than that of a traditional house, living in such a house is significantly cheaper. On the other hand, in a traditional house, a significant amount of energy is lost during heating. The heat is dissipated through walls, windows, roofs, floors, precisely because this type of house is not well sealed, does not have very good insulation and ventilation. This paper deals with energy performance,

comparing the conventional house and the passive house, as well as upgrading the traditional house by using passive methods, essential for creating performance in order to reduce the need for energy and CO2 emissions.

5.10 Removal of pharmaceutical compounds from water using natural filtering materials

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Keywords: pharmaceutical pollution, water environment, natural filtering

The pharmaceutical industry is in continuous development both due to the high demand of the consumer market and due to the scientific progress, which has led to the very rapid development of new therapeutic molecules, generating as a side effect, the acceleration of environmental pollution. The environment and health are directly or indirectly affected by pharmaceuticals in water, especially in the vicinity of industrial pharmaceutical areas. Furthermore, it has been found that active substances (drugs) and metabolites from residential and hospital areas as well as improper disposal of expired products have a detrimental effect on the aquatic environment. Once in the environment, natural transformation processes act on drugs and produce degradation compounds that create difficulties in both environmental analysis and decontamination processes. In the present paper, the removal effect from water of some pharmaceutical's diclofenac sodium, paracetamol and spaverin (drotaverine hydrochloride) using filter materials was evaluated by UV-VIS spectroscopy (Jasco, Japan, V-570 spectrophotometer). Spectra of the samples 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 analysed pollutants. Also, the absorption capacity (CA%) of some natural filtering materials: montmorillonite clay, micronized activated zeolite and activated carbon was also evaluated. Following the application of the removal methods, it was found that montmorillonite clay is the most efficient filter material (CA = 51%), followed by micronized activated zeolite (CA = 43%) and activated carbon (41%). The study also included testing the combinations between these materials and found that the combination of the three is the most effective, having a value of absorption capacity, CA = 81%.

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5.11 Passive building optimization methodology considering energy demand, thermal comfort and cost

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In the context of a global economy affected by the global energy crisis, the energy efficiency of buildings no longer necessarily means new materials or technologies, but a careful and lengthy research to make energy

consumption and efficiency of existing building materials as we proposed in this paper. It is known that 10% of the carbon emissions caused by human activity are due to buildings, so a greater concern for the efficiency of the construction sector is legitimate and relevant. This paper aims to combine an innovative idea in the field of construction and rigorous calculation from the perspective of thermal efficiency of the design of a building. Another important aspect considered for the construction of this house is the use of ecological materials that have a very small impact on the environment. The house to be studied is built in accordance with the standards in force regarding the construction of buildings, although it includes a great proportion of ecological materials. In this sense, it was decided to use clay in plaster, a cheap, ecological material that can be found everywhere, but which also has a reasonable thermal coefficient, which recommends it as an optimal material for our project. Another material we propose for the construction of the ecological house is hemp. All hemp products are natural, environmentally friendly, biodegradable and carbon-positive (meaning they absorb more carbon dioxide than they emit). Whole houses can be built only from materials derived from hemp. Hemp materials have excellent thermal insulation properties compared to standard materials, which means low energy bill costs. Hempcrete (concrete hemp) is a mixture of chopped hemp (waste) and lime (which may include natural hydraulic lime, sand, pozzolans or cement), used as a building and insulation material. With Hempcrete it is easier to work with than many other types of traditional mortars and acts as an insulator and moisture regulator. It does not have the fragility of concrete and therefore does not need expansion joints. Like other plant products, the hemp crop absorbs carbon dioxide while growing, retains carbon dioxide and releases oxygen. Theoretically, one cube meter wall made of Hempcrete can absorb and retain 165 kg of CO2. When hemp is mixed with lime, the two react and begin a long process of mineralization. Thus, over time the wall becomes stronger, stronger and reaches the hardness of limestone. From the calculations presented in the paper it is clear that in similar conditions, respectively the same plaster, the floor of doors and windows, the house built using ecological materials such as hemp can be twice as efficient compared to the brick one. In the case of the eco house, in terms of costs, they can be up to 58% lower than the similar brick and concrete house. In order to obtain the energy independence of the house studied in the paper, we designed an installation of photovoltaic panels for power supply and a kit of solar thermal panels for hot water.

5.12 Case study of an on-grid solar system with monocrystalline silicon photovoltaic panels for residential applications

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Keywords: solar energy, photovoltaics, grid-connected photovoltaic, monocrystalline silicon photovoltaic panels

Reducing greenhouse gas emissions can be achieved by switching to renewable energy systems, such as photovoltaic panels. The use of renewable energy sources offers the advantage of sustainability in all aspects related to the development of the energy sector. Photovoltaic technology has become a major player in the global electricity generation sector and is currently one of the most developed renewable energy sources being scalable from residential to commercial applications. The aim of the study is to analyze the performance of an on-grid system coupled with the national electricity supplier using monocrystalline silicon photovoltaic panels. The 5.27 kW system is installed on the roof of the house, with a tilt angle of 26o inclination to the horizontal, in the SV-NE direction, in Măgurele, Ilfov County. Data were collected between September 2021 and February 2022, thus covering the autumn-winter seasons, a critical period because of the low solar potential. The collected data were analyzed in relevant, real operating conditions and correlated with the weather conditions: cloudy sky, the amount of radiated solar energy, and temperature. A protocol has been established for interpreting the data collected in relation to the theoretical values.

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5.13 The Influence of Cu and TiO2 Nanoparticles on Plants Photosynthesis Process

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Keywords: CO2rr, Nanoparticles, Photosynthesis

The agriculture field, according to greenhouse gas emissions data from 2020, had a contribution of 11% of the total greenhouse gas emissions in the Earth's atmosphere [1]. Nanoparticles can be used as a solution for this problem since Cu and Cu-oxides, and TiO2 (anatase crystalline phase) has a dual role, acting both in improving the photosynthesis process and also as nanopesticides. As an example, the Cu-based nanostructures are known for their fungicide and insecticide effect [2], and TiO2 nanoparticlescan act as a nutrient for plant and improves the photosynthetic activity [3]. Unlike conventional pesticides, which are highly toxic both for humans, animals and the environment, nanopesticides have the advantage of presenting a large active surface area - which allows them, even used in small quantities, to interact with pathogens and also have a low production cost [3]. There are no scientific reports to date that have evaluated the potential effects of nanoparticles inserted directly into the plant roots and exploited in the growth cycle, and in this respect, we report the effect of TiO2 and Cu-oxides NPs on the photosynthesis in several types of plants, measuring CO2 consuming by mass spectrometry techniques and appropriate sensors. As an experimental setup we use a small chamber, like a greenhouse, artificially illuminated and irrigated. In addition, the plant health level is evaluated when the NPs are inside the roots. The NPs used in the current paper are made by electrochemical oxidation and green synthesis with plant extract and analyzed by the following methods: UV-Vis, FTIR, and Raman. The photocatalytic activity has been evaluated via cyclic voltammetry and chlorophyll fluorescence.

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5.14 Fuel cells used to power the electrical vehicles

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Keywords: renewable energy, fuel cell, electric vehicles

The greenhouse effect, emissions of harmful gases such as CO and CO2, fires or explosions are all the effects of the continued use of fossil fuels mainly for electricity and heating. Considered the main fuel consumer, the vehicle has also become reliable for many people no matter how polluting it is or how expensive it is to maintain. For these reasons, over time, other means have been sought to power a vehicle, at the moment, the most used version being

that of an electric vehicle. The elimination of fossil fuels from human life cannot be done immediately, it takes years or maybe decades of work to replace or modify power plants, factories to become cleaner, and at the moment the efficiencies and the cost of implementing the fuel cells are not attracting enough attention from the public. This paper comes with alternative solutions to reduce as much as possible the burning of natural gas, coal or oil fuels. Also this study presents a different mechanism based on fuel cells, in which the fuel loading is faster, the emissions are still zero, and the fuel is accessible. Fuel cells are devices that produce electricity through oxidation-reduction reactions, the reaction products being very few or not at all harmful. Experimental analysis of different fuel cells highlighted the optimal parameters for obtained the maximum electric power.

5.15 Graphene microporous layer for proton exchange membrane fuel cells

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Keywords: Graphene, Microporous layer, PEM fuel cell

Fuel cells are considered to be part of the sustainable energy production strategy. Researchers are making progress in improving the technical performance of fuel cells by optimizing each component. One such component is the microporous layer (MPL). MPL in a fuel cell is influencing the water management- membrane humidification and removal of excess water from the cathode- and also fuel feeding to the catalyst layer, temperature, and contact resistance. In this work, we tested the overall performance of a proton exchange membrane fuel cell with commercial graphene as MPL. The membrane-electrode assembly (MEA) of the fuel cells was made from a Nafion electrolyte with Pt/C (60%) nanoparticles as a catalyst. The gas diffusion layer was obtained by spraying graphene and 10% Teflon solution as MPL onto carbon paper. Catalyst electrochemical active area was evaluated in the fuel cell testing configuration by cyclic voltammetry. Graphene MPL- MEA performances were studied at different values of humidity and temperature and compared to a similar MEA with carbon black as MPL. The reference MEA was prepared and tested under the same experimental conditions. Enhanced performances under a wide range of humidity conditions and temperatures prove that graphene is a potential MPL material in fuel cells, due to its high electrical and thermal conductivity.

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5.16 Bio-construction of electro-active layers

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Keywords: catalyst, microorganisms, bio-electrodes

Chemical reactions are at the foundation of the physical world. Understanding the chemical interactions gives us better knowledge about the world around us. One way of doing this is by simulating natural occurring reactions with the help of catalysts in electrochemistry. Catalyst can be materials that favor different reactions, depending on their

nature and the potential applied at their surfaces. One of the most important aspect that you take into consideration in constructing a catalyst is the active surface, the place near were the interactions take place. A lot of studies have been made in researching different materials with different structures. Sometimes, realizing thin active layers of materials can become difficult and quite expensive. This study is aiming to show a more eco and cheap way that can be used to construct an electroactive layer on a base material with the help of metal reducing microorganisms. This kind of bacteria are versatile microorganisms that can reduce different types of metals and they can be used to do this on the surfaces of electric conductive materials presenting a possible new way of building electrocatalysts.

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Section 6: Physics Education

Location and time: **Seminar Rm. 11**

Moderators:

Prof. Dr. Ştefan ANTOHE

Assoc. Prof. Dr. Cristina MIRON

6.1 - Iulian STANCU
Modular scheme for educating students fatigue

6.2 - Dragos TATARU, Ilie-Eduard NASTASE, Bogdan ZAHARIA, Alina COMAN, Raluca DINESCU, Andreea TOLEA
Schools Tune Into Mars - a framework for delivering Earth and Space Science activities in and out of the classroom

6.3 - Alexandru DĂNESC, Iulia GHIU
Psychological mechanisms of stimulating and energizing the learning process of quantum random walk

6.4 - Corina RADU, Ovidiu TOMA, Ștefan ANTOHE, Vlad-Andrei ANTOHE, Cristina MIRON
Physics classes enhanced by smartphone experiments

6.5 - Călin GALERIU
Nuclear physics with MightyOhm: the natural background radiation

6.6 - Andrei MARIN, Octavian IANC, Tiberius O. CHECHE
Polarization energy of charged spherical dielectric layers

6.7 - Octavian IANC, Andrei MARIN, Tiberius O. CHECHE
Two-body motion in conservative force fields

6.8 - Marin OPREA, Sebastian Emanuel CĂLIN
Green energy in schools. From solar cells to photovoltaic panel systems

6.9 - Anda CIOBANU, Cristina MIRON, Cătălin BERLIC, Valentin BARNA
Teaching geometrical optics by means of GeoGebra software

6.10 - Marilena COLT, Valentin BARNA
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Employing IMAGEJ software for improving physics lessons

6.15 - Adriana RADU, Mihai V. POPESCU, Daniela STOICA, Cătălin BERLIC, Cristina MIRON, Valentin BARNA
The study of capillary phenomena by means of ImageJ software

6.16 - Adriana RADU, Ionel GRIGORE, Valentin BARNA
Excel didactic tools for the study of the circular motion

6.17 - Adriana RADU, Ionel GRIGORE, Valentin BARNA
An Excel didactic tool to simulate the composition of the perpendicular harmonic oscillations

6.1 Modular scheme for educating students fatigue

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Keywords: modular schedule, study of duration

The modular schedule is a rearrangement of the hours allocated to each subject so that the weekly number of subjects a student studies decreases from 14 subjects / week to 8 or 9 subjects / week. The hours allocated to each discipline are grouped into periods of 6, 12, 18, 24, or 36 weeks depending on the number of hours in the framework plans. For the 12th grade, the second half of the school year will be held with physical presence only for the subjects for baccalaureate and admission, the modular schedule facilitates this. The fundamental principle is the continuity for the whole school year of the profile subjects, the subjects that are not specific to the profile being assigned periods of 6, 12 or 18 weeks. The grouping periods of the subjects do not overlap with the interrupted holiday modules of the school year. The benefits for students are obvious: the decrease of the number of subjects studied weekly, the intensive study for the subjects not specific to the profile, or for the secondary ones, the study of duration (intensified) for the specific subjects of the profile.

6.2 Schools Tune Into Mars - a framework for delivering Earth and Space Science activities in and out of the classroom

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To support teachers in developing future STEM skills for students, the Schools Tune Into Mars (STIM) project aimed to improve the effectiveness and quality of teaching science, technology, engineering, and mathematics (STEM) disciplines at the secondary level. By providing pedagogical materials with high-quality inspirational lessons related to planetary seismology as well as adequate guidance we aim to increase young students knowledge and interest in STEM education. STIM is a project that brings together a network of schools and organizations with an interest in Earth and Space education and studies related to the planet Mars. To achieve all these goals several complementary blocks of activities have been developed: a programmatic document elaborated based on the STIM resources supported by a study aiming to assess the need and opportunity of STIM resources for teachers; a pedagogical guide to support the use of resources from space missions in classrooms; a Massive Open Online Course (MOOC) entitled “bring Mars missions into the classroom” which provides online training to teachers in order to use innovative teaching materials related to Mars space missions in classrooms and a report with recommendations for the creation of a Mars-Edu network to set the scene for an innovative and long-term collaborative network on space education related to Mars missions.

6.3 Psychological mechanisms of stimulating and energizing the learning process of quantum random walk

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Keywords: pedagogy, mechanisms of representation, motivation, quantum random walk

In this work we present methods of teaching high school pupils an University topic, the quantum random walk. The psychic mechanisms of operating the topic's information are presented: sensitivity, sensibility, perceptions, representations, cognition and memory. Hence, multiple representations related to quantum random walk are presented to the reader. The psychological mechanisms of stimulating and energizing this learning process are presented: motivation and affection. The reader is being encouraged to apply in his own daily life the newly acquired knowledge. For the ease of understanding we depart by studying the classical random walk. We offer everyday life examples with interdisciplinary character and different representations. For stimulating the pupil we extrapolate the cases of zero steps and an infinite number of steps. Then, we continue by studying the quantum random walk, enhancing its shifting character. We offer graphical representations, comparisons with the classical case, and possible modern applications.

Acknowledgement:
We thank professor Virgil Baran for useful discussions.

6.4 Physics classes enhanced by smartphone experiments

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Keywords: physics classes, experiment, smartphone, Phyphox

Amazing technological advancement has been made in the aria of communications. Modern communication technology has brought about an evolution in the access to knowledge, in globalization and also in the new ways of shaping education. Therefore, this period, called Knowledge Age or Information Age, opens up new possibilities in the field of formal and informal education, in the ways of delivering education, either in class or online, and also in the role of the teacher. Smartphones, due to their high speed internet access capabilities, large storage capacities, embedded multi-functional sensors, and integrated modern smart applications, are in fact mobile computers that can be integrated into learning environments. This article presents two physics experiments performed using smartphones, experiments that are meaningful because they relate reality to physics laws, creating theory-practice linkage, and that can be performed outside the classic physics laboratory. The cost-free application employed is called Phyphox. Following the experiments described in this paper, acceleration of a non-inertial frame of reference was calculated, respectively, Malus law was verified. Students were able to follow the real-time obtained graphs just by accessing a link (URL).

6.5 Nuclear physics with MightyOhm: the natural background radiation

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Keywords: Poisson distribution, cosmic rays, radon gas

The high cost of the commercial laboratory equipment needed for nuclear physics experiments can create accessibility issues in many high schools. At the same time, the increasing demand for medical physics majors mandates a more engaging and attractive curriculum exactly during these formative years. For this reason, we introduce the MightyOhm Geiger counter as a new and important player in the field of nuclear physics education. We present the Arduino code that performs the data collection, together with two classical experiments that explore the natural background radiation: the statistics of nuclear decay and the decay of Radon progeny.

6.6 Polarization energy of charged spherical dielectric layers

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Keywords: dielectric polarization, charge polarization, core-shell dielectric

We obtain the work classically necessary to generate an ensemble of two charges, one placed in the core and the other in the shell, for a core-shell spherical system (CSSS). The CSSS has different dielectric function of the core and shell and is embedded in environment characterized by another (a third one) dielectric constant. The charge polarization is also obtained. The expressions are verified by comparison with the expressions obtained for the simpler problem of Brus [1].

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6.7 Two-body motion in conservative force fields

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Keywords: two-body motion, gravitational force, elastic force, conservative force.

The two-body motion for the gravitational and elastic conservative force field is discussed by comparing the differential equations of motions. The inverse and direct square displacement dependency of the two force types is shown as emerging in the trajectories. The absolute and relative inertial systems of reference are considered in the description of motion.

6.8 Green energy in schools. From solar cells to photovoltaic panel systems

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Keywords: solar cells, photovoltaic panels, renewable energy, voltage, current, power, electrical energy

Human society has entered in a new stage of development, becoming an information and knowledge society [1]. This new level of society, marked by a complex and profound dynamism, requires a high energy consumption [2]. In this context, the world's energy reserves, based on fossil fuels (coal, oil, natural gas), are constantly declining [3]. By default, the price of these fuels and the energy produced by them becomes higher and higher. Consequently, renewable energy sources (solar, wind, tidal, geothermal) are becoming a necessity for the functioning of modern society [4]. These non-polluting sources support global efforts to reduce the negative effects of climate change, making a major contribution to reducing greenhouse gas emissions [5]. The activities of energy researchers are currently focused on the development of materials, devices and systems that allow a maximum efficiency of conversion of these alternative energies into electrical energy [6]. In the context of this transition of our society towards an energy future based on renewable resources, students must know and understand the principles and technologies of converting these types of clean energy into electrical energy [7]. Starting from this need, we initiated an interdisciplinary school project of Applied Physics in Technology: Green energy in schools - From solar cells to photovoltaic panel systems [8-14]. In addition to the didactic aspect, another very important reason for the elaboration of such a project was the fact that the geographical area in which we undertook this approach is solarized for most of the calendar year [15-16]. In this paper we have presented, for teaching purposes, a summary of the activities of design, building and implementation (at school level) of a smart system for converting solar energy into electrical energy, based on photovoltaic panels, with the possibility of real-time monitoring, via the Internet, of its functional parameters: voltage, current, power and electrical energy produced.

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6.9 Teaching geometrical optics by means of GeoGebra software

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Keywords: geometrical optics, spherical diopter, optical prism, problems solving, GeoGebra simulation, physics education

The use of digital tools in physics education increases the students' digital competencies, their motivation and highly contributes to develop cognitive learning processes during their interaction with software simulations. In this paper we present how to employ GeoGebra software for teaching geometrical optics phenomena. The proposed approach started with the study of spherical diopter, since optical systems, such as mirrors and lenses, are set of surfaces that reflect or refract light rays and the mathematical relations that describe these systems are obtained from the diopter formulas. Another system that combines light reflection and refraction, for which we created a dynamical model, is the optical prism. Dynamic simulations for these systems offer the possibility to examine, by geometrical tools, the involved physics laws. Moreover, one can identify various attributes or properties that are changing and their effects, leading to processes of reflection and to knowledge construction. We also explored the possibility to take the advantage of GeoGebra software in solving problems, by creating an attractive environment that promotes better comprehension of the concepts and of the involved optical phenomena. The use of images, instead of the commonly employed symbolic representations, can greatly support students having a lower capacity for abstraction and facilitates their understanding of physics problems.

6.10 M-learning in the study of quantities characteristic of pseudo-periodic oscillating motion

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Keywords: M-learning, Phyphox app, magnetic field, physics education

Effective teaching methods and strategies involve both practical scientific activities and integrated content, implemented based on today's technological developments. The approaches to an experimental Physics lesson presented in this paper emphasize the integrated learning of content, as knowledge of Physics, Mathematics, and Information Technology is required simultaneously to realize experiments. An example of one-dimensional fast-damping motion and one-dimensional slow-damping motion in which the variability of the magnetic field plays an important role in the study of motion is presented. We have proposed a way to study pseudo-periodic oscillations in a modern way of collecting data with a smartphone. Specifically, damped oscillating movements of some are studied

by mechanical systems such as the gravitational pendulum, respectively spring, following the values of the induction of the magnetic field indicated by the magnetic sensor of a smartphone accessed through the Phyphox app [1]. During experiments, the smartphone becomes inaccessible so data must be analyzed on another device. Phyphox removes the limitation that the phone becomes inaccessible during experiments. With a Wi-Fi connection, students could track real-time graphics by accessing a URL because the Phyphpx application can generate a private IP address. Experimental data were exported for analysis and further post-processing with Origin software. From the data, the damping coefficient, the logarithmic decrement, the half-life and the lifetime are calculated. The introduction of the smartphone at high school level in experimental physics lessons in the study of mechanical phenomena also develops the students' technological skills, while creating links between theory and real life, between formal and informal knowledge.

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Acknowledgement:
Authors thank the enthusiasm of high-school students of “I.L. Caragiale” National College, who participated in the study.

6.11 A modern method of teaching Applied Physics using an automatic weather station in an air quality study

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Keywords: PM10, air pollution, synoptic maps, wind rose, meteorogram, descriptive statistics, physics education

There is a constant need to study concepts of Physics in an interdisciplinary way in order to understand real-life phenomena. The weather influences not only the take-off and landing of the planes, the development of the activities at sea, but also the dispersion of the air pollutants. Air pollution is a risk factor for human health with implications for the economy, the environment, and food security. The study aims at an interactive modern way of teaching concepts of Mechanics and Fluid Thermodynamics, analyzing how weather conditions influence the air pollution, using a professional automatic weather station. The research has two objectives. First one involves the gathering, storage and processing of experimental data provided by the weather station, which belongs to the National College „I.L. Caragiale” from Ploiesti. As an outcome of the data processing, specific graphs are performed in order to investigate the occurrence and the characteristics of an urban pollution event in December 2020. The results are complemented with those provided by state-of-the-art numerical research and meteorological prediction models designed for atmosphere research: HYSPLIT [1], with a complex data assimilation and a software architecture system, and the online resource wetter3.de [2], which offers an extensive collection of weather maps, calculated from the data of the German weather service model ICON and the American model US GFS. Students are able to analyze PM10 (the respirable fraction of particulate matter with diameter less than 10 μm suspended in the atmosphere) data series, provided by The National Air Quality Monitoring Network [3], in the context of specific meteorological conditions. Second objective is to understand how to use the equipment in optimal conditions. The progress of the understanding of multiple interdisciplinary concepts is reflected in results of a survey conducted among students.

References:
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[2] www.wetter3.de
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Acknowledgement:
The data regarding ground-based air pollution was extracted from the public available Romanian National Air Quality Database, www.calitateaer.ro, last accessed in May 2022. Authors thank the enthusiasm of high-school students of "I.L. Caragiale" National College, who participated in the study.

6.12 3d modelling of extra-terrestrial human habitats based on environmental parameters of different celestial bodies

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Keywords: habitat, 3D modelling, solar system, artificial gravity, Life Supporting Systems, human space exploration, Starship

3D modelling is used in physics for observing different phenomena and visualizing the applicability of parameters in a virtual environment. This paper presents two types of extra-terrestrial human habitats developed by software modelling using Rhinoceros 3D. In order to select a location for virtually implementing the habitat, the most suitable environments for supplying the Life Supporting Systems must be detected. We propose to perform an accurate analysis of different parameters including sidereal rotation period, surface gravity, radiation (Solar Energetic Particles and Galactic Cosmic Rays), atmospheric composition, pressure, space debris, local resources, and magnetosphere. These parameters will be presented in form of a Microsoft Excel chart and the result is a selection of celestial bodies defined as suitable for supplying a closed biosphere. Based on the environmental properties, two different types of habitats were created: one to be located on the surface of a celestial body and a different one orbiting, using artificial gravity. To ensure the logistics and determine the maximum amount of cargo, the spacecraft with the biggest payload volume was taken into consideration. The reusable Starship system by SpaceX, including Super Heavy booster, can transport one habitat to another planet by one single launch. The 3D Model has its applicability in creating an interface for manually configuration of a human habitat, for educational purpose. The habitat can contribute to the development of extra-terrestrial constructions, resource mining for Life Supporting Systems supply, or to human space exploration.

6.13 Space technology in the school lab. Physics experiments with Raspberry Pi and Sense HAT

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Keywords: physics education, school lab, Raspberry Pi, Sense HAT, gravity

Raspberry Pi is a small but powerfull single-board computer. It can do all the things you'd expect from a computer, but it also has a GPIO (general-purpose input/output) header that can be used to connect various sensors and other devices. This is a very useful feature for physics experiments. It is used in the space industry and other fields, but can also be used in the school laboratory. In our experiments we used Raspberry Pi to study gravity. In most space projects, the Raspberry Pi was used together with a device called "Sense HAT". In the first experiment we have used the same device to measure the components of the gravitational force on the inclined plane. In the second experiment we have used Raspberry Pi, a pendulum and a digital Hall sensor to determine gravitational acceleration. In both experiments the results can be displayed on a smart board and the whole class can see them.

References:

6.14 Employing IMAGEJ software for improving physics lessons

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Keywords: ImageJ software, smartphones, irregular surfaces, image processing

ImageJ software is a non-commercial software that is widely used in scientific research, in medicine and biology for the analysis of images obtained in digital microscopy, in engineering for the analysis of materials etc. ImageJ is a Java-based open source program that was originally developed to investigate images at the National Institute of Health (NIH), USA. ImageJ software can be further enhanced using macros and dedicated plugins, to be implemented to a lot of interesting applications available today, especially in the fields of microscopy and biology. In this article, we present specific paths to use ImageJ program for educational purposes, in particular for teaching Physics. In this study, we determined the area and perimeter of irregular surfaces (for example a tree leaf). By means of a smartphone, for taking photos, a laptop and ImageJ software, students can analyze the pictures taken and can establish certain physical quantities that, in a direct measurement, would be more difficult to evaluate. The software is easy to use and could be adapted for accuracy measurements in many physics laboratories ranging from primary school up to faculty level.

6.15 The study of capillary phenomena by means of ImageJ software

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Keywords: Capillary tubes, capillary ascension, ImageJ software, plugin

Capillary phenomena are frequently found in nature and technology, but also inside living organisms. They represent the basis for the circulation of sap in plants; they can also explain the dehydration of some bodies with capillary-porous structure and so on. The study of capillary phenomena requires precision measurements of very small diameters, contact angles, and meniscus radii of curvature. These quantities are difficult to determine by direct measurements yet can be obtained with the ImageJ software from the images recorded by a digital camera of a smartphone. The software is a free analysis program and can be downloaded from https://imagej.nih.gov/ij/. The aim of this paper is to determine the surface tension coefficient of a KMnO4 aqueous solution using Jurin law and make diameter measurements and capillary ascents on images by using ImageJ software. We also study the capillary phenomena between parallel plates and between non-parallel plates. In the case of non-parallel plates, we managed to determine the equation of liquid surface curve, with the help of a special plugin (ClickCoordinatesTooltxt) from within ImageJ. ImageJ measurements are accurate and do not require much effort or increased computer knowledge on the part of the experimenter.

6.16 Excel didactic tools for the study of the circular motion

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Keywords: Excel, didactic tool, circular motion, angular velocity, centripetal acceleration, physics education

This paper describes two interactive didactic tools created with Excel spreadsheets for the study of the circular motion. With the help of the first tool we can study the uniform circular motion, while with the second the non-uniform circular motion. For a moment in time introduced in the input data we calculate the angular coordinate of the mass point in the circular motion and the number of rotations carried out until the respective moment. Also, we calculate the Cartesian coordinates in relation to the reference system whose origin coincides with the centre of the circular trajectory. Alongside the input data, we have rendered the motion chart so that by modifying the moment in time we can visualize the motion of the mass point on the circle. We have shown how to obtain the tool for the study of the non-uniform circular motion by completing and adapting the tool spreadsheets for the study of the uniform circular motion. The classroom use of these tools helps students with a better grasp of the analogy between the measures that describe a linear motion and, respectively, a circular motion. A series of notions can be clarified such as angular velocity, angular acceleration, centripetal acceleration etc. At the same time, students have the possibility of exploring the connection between the polar coordinates and the Cartesian coordinates in describing the circular motion. The tools can be adapted to numerically and interactively solve some common problems of circular motion. It is thus shown how the issue of meeting of two mobiles moving at different velocities on a circle of a given radius.

6.17 An Excel didactic tool to simulate the composition of the perpendicular harmonic oscillations

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Keywords: Excel, didactic tool, harmonic oscillations, Lissajoux figures, Physics Education

The present paper describes an interactive didactic tool created with the help of Excel spreadsheets to simulate the composition of the perpendicular harmonic oscillations. The periods and amplitudes of the oscillations are used as input data, together with the phase difference between them. The graph placed next to the input data renders the resultant trajectory obtained by the composition of the two oscillations. Depending on the ratio of the frequencies and the phase difference the Lissajoux figures are obtained. It is thus verified that when the ratio of the oscillation frequencies is a rational number stable closed trajectories are obtained, while when the ratio of the frequencies is an irrational number the trajectories are open and they gradually cover an area. In addition, the particular case when the frequencies of the oscillations are equal is verified, and thus an elliptic resultant trajectory is obtained. The position of the mass point on the resultant trajectory can be visualized at any moment of time introduced in the input data. The Cartesian coordinates and the polar coordinates of the mass point are calculated. Concurrently, in the time moment set in the input data, the velocity of the mass point are calculated. Besides the main graph with the resultant oscillation, there are placed, on the same spreadsheet, two more graphs showing how the velocity depends on the Cartesian coordinates. By creating and using this tool in the classroom, students can study in an interactive and pleasant manner, how two perpendicular harmonic oscillations are composed. The rapid feedback for the input data change allows, in a short timeframe, the analysis of a large number of Lissajoux figures. Thus, students are able to assimilate more easily the knowledge regarding the composition of perpendicular harmonic oscillations.

Section 7: Polymer Physics

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

Moderators:

Prof. Dr. Valentin BARNA

Assoc. Prof. Dr. Cătălin BERLIC

7.1 - Valentin BARNA
Special micrometric confined systems for crafting highly efficient light amplification and laser emission devices

7.2 - Valentin BARNA, Dedy SEPTIADI, Dhruv SAXENA, Riccardo SAPIENZA, Damiano GENOVESE, Luisa DE COLA
Spectral Biometrics of Discrete Cells via Fluorescence and Laser Action

7.3 - Catalin BERLIC, Valentin BARNA, Eduard GATIN, Daciana ZMARANDACHE
Surface anchoring of nematic liquid crystals

7.4 - Raluca RUSU, Catalin BERLIC
Computer simulation of a linear polymer using the Random-Walk method

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Poly(N-isopropylacrylamide-butylacrylate) Copolymer coatings obtained by MAPLE for bioapplications

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Novel iron oxide modified with cetyltrimethylammonium bromide (CTAB) with potential application in environment remediation

7.1 Special micrometric confined systems for crafting highly efficient light amplification and laser emission devices

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Keywords: Small-scale light emitters, Micrometric systems, Micro-lens array

In this study we characterize laser action phenomena in special micrometric configurations of dye doped ionic liquids confined in special geometries. Because of low vapor pressure, low inflammability, liquidity over a broad temperature range, recyclability these matrices are excellent contenders for building, as demonstrated, a series of interesting mirrorless laser devices. Cylindrical micro-capillaries and special micro-lens array systems grant the possibility to obtain highly-compact hazard-free narrow banded (FWHM ca. 0.5 nm for each laser mode) emitters that outshine because of the low laser threshold (a few microJ/pulse in some situations), superior efficiency, long term robustness, cheap construction costs and versatility in terms of potential configurations. A detailed spectral analysis for the designed samples and an interpretation of the far field modal profiles is performed, which clearly confirms a random laser behavior for these systems. In addition, the presented small-size optical systems are also highly robust and prone for immediate exploitation in the micro technological arena.

7.2 Spectral Biometrics of Discrete Cells via Fluorescence and Laser Action

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Fluorescent dyes are a common bioimaging tool, whose spontaneous emission is used to monitor in real time and real space the activity of cells, organelles, and biomolecules with high resolution and sensitivity. Nonetheless, in the presence of strong excitation fields and of optical feedback, stimulated emission can overcome fluorescence and eventually lead to laser action. Lasing, compared to spontaneous emission, carries information not only on the solvating environment in the direct vicinity of the dyes, but also on the optical system (e.g., cavities, microresonators or scatterer density) that generates the amplification, since it determines at a large extent the allowed spectral and spatial properties of laser emission, i.e., the lasing modes. Here, lasing is triggered by cells floating in a low quality factor resonator composed of a disposable poly(methyl methacrylate) (PMMA) cell counting-slide, hence in absence of conventional high-reflectivity optical cavities. The exceptional spectral narrowing and the steep slope increase in the input–output energy diagram prove occurrence of laser action in presence of cells. The observed biolasing is an intrinsically dynamic signal, with large fluctuations in intensity and spectrum determined by the optical properties of the individual cell passing through the pump beam.

7.3 Surface anchoring of nematic liquid crystals

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Keywords: liquid crystals, surface anchoring, computer simulations, tensor order parameter

Surface anchoring of molecules liquid crystals molecules influence local orientational order properties in nematic cells. Two of the most common types of anchoring are parallel (planar anchoring) and perpendicular (homeotropic anchoring). Using computer simulations, we investigate influence of the temperature and of electric field on the tensor order parameter for both types of anchoring. We concluded that, in both the presence or the absence of the electric field, temperature play a central role in determining the orientation of the liquid crystal molecules.

7.4 Computer simulation of a linear polymer using the Random-Walk method

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Keywords: computer simulation, random-walk, polymer, end to end square distance, radius of gyration

In this paper, we present a computer simulation program for a linear polymer. The software use the Random-Walk method on a tri-dimensional cubic lattice for a non self-avoiding linear chain. The simulations were performed for a macromolecule with a number of chain segments variable from 10 and 100. For each polymer, were made 1,000,000 Randow Walk-type generations and at the end of each of we determined the end to end square distance and radius of gyration. The results of the simulations are in very good agreement with theoretical predictions for a gaussian chain.

7.5 The influence of different polypyrrole polymer and carbon material morphologies on electrical properties

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Keywords: semiconducting polymers, polypyrrole, electrochemical impedance spectrscopy, conductivity, carbon materials, nanostructures

Polypyrrole powders are prepared using two different reaction routes in order to obtain different morphologies. Polypyrrole was "grown" on a fibrous complex of methyl-orange dye and FeCl3 template which enabled the pyrrole to assemble in tubular nanostructure. This sample was named PPY-T. The second approach consisted of a classic oxidative polymerization using ferrous chloride as the oxidizing agent and p-toluensulfonic acid as an anionic dopant to improve electrical conductivity. This second sample was indexed PPY-R. The different morphologies of the polymer species were confirmed using scanning electron microscopy (SEM). In order to obtain the carbonic materials, the polymers were raised to 900°C under N2 constant flow. X-Ray Diffraction (XRD) was used to

confirm the transition from polymers to nitrogen containing carbon nanostructures, which were labelled PPY-T-900 and PPY-R-900. The study of the electrical conductivities was done by two approaches: I-V characteristics, and electrochemical impedance spectroscopy (EIS) on a broad range of frequencies. In order to extract the electrical resistances and, eventually the electrical conductivities, a Nyquist plot was used to fit the data from the EIS and identify the capacitive or inductive behaviour of the materials.

7.6 New Computational Perspective on Quantum Computing and Polymer Physics

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Keywords: quantum computing; computation physics; polymer physics; PYSIMM

The paper will bring into readers attention the importance of quantum computing and computational physics, underling the strengths and the main advantages why these two disciplines should be considered as a main bridge between theoretical physics and experimental physics. This is performed and achieved through quantum computers and its applications, representing a unique direction in the current context, mainly quantum computing era. As a case study we have choose to show how the polymer physics could be modelled by using the quantum annealing machines, in such way to have an optimization process for identifying the global minimum for a certain objective function based on a set of candidate solutions and states. The simulation is performed using PYSIMM (Python Simulation Interface for Molecular Modeling) tool which is open-source object-oriented Python package for molecular simulations. The tool can handle the data organization and provide a unique developing and simulation workflow.

7.7 Computational Physics: Python Packages for Quick Analysis of Dynamics Simulations

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Keywords: applied physics; python packages; computation physics

The paper will examine the most important tools that are used in field of computational physics, tools developed in Python programming language, and which make up a powerful baggage of tools for researchers and practitioners from different fields (industry, academia, research centers, private laboratories etc.). The goal of the current examination is to point out the main advantages and disadvantages of such tools, to cover an important gap that exist currently in field of computational physics, to make it more attractive to researchers no matter which are the fields in which the researcher is performing their research (e.g., theoretical computer science, applied computer science, theoretical physics, experimental physics, mathematics, quantum computing, quantum mechanics, chemistry etc.).

7.8 Challenges of computational methods towards physics phenomena studies

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Keywords: applied physics; image processing; PlasmaPy open-source package

Applied physics domain represents the bridge between theory, and daily life applications. In this line, computer science plays a major role, due to its wide and complex capacity to simulate and predict the physics phenomena. Therefore, in our paper, we will highlight the importance of analyzing via computer-based methods, both, the obtained material, and, in particular case, the plasma. Moreover, by using image processing, the obtained materials offer a new perspective of the physics processes. On the other hand, open-source packages (e.g., PlasmaPy) are the key of simulating the physics processes, in an accurate mode.

7.9 Methyl Orange Removal from Aqueous Solutions using Polyaniline/Zinc Oxide Nanocomposite as Adsorbent

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Keywords: nanocomposite, polyaniline, dye removal, adsorption

The adsorbents based on conductive polymer with different inorganic products have proven to be promising for the high removal of organic and inorganic pollutants. The nanocomposite of polyaniline/zirconium oxide was synthesized through the chemical polymerization using ammonium persulphate as oxidant. Fourier transform infrared spectroscopy and X-ray diffraction were used to prove the synthesis of nanocomposite material. Polyaniline/Zinc Oxide nanocomposite was used as effective adsorbents for the removal of methyl orange from aqueous phase. The effects of different system variables such as initial dye concentration, temperature and contact time were investigated. The results indicated that Polyaniline/Zinc Oxide nanocomposite have considerable potential for the removal of methyl orange from aqueous solution.

7.10 Deposition of Fe2O3 doped PANI thin films by DC plasma polymerization

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Keywords: Polyaniline, plasma polymerization, FTIR Spectroscopy, thin films

Polyaniline (PANI) thin films have been shown an increased interest by the scientific community for their impressive properties 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 analyzing the properties 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 1 Pa, 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 grow 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 analyses have shown a uniform distribution of particles on the surface and imbedded in the film, claims that are also supported by EDS (Energy Dispersive X-Ray Spectroscopy) measurements. Furthermore, size distribution of Fe2O3 particles range between 200nm and 3µm. FT-IR (Fourier Transform Infrared Spectroscopy) presents some modification in the PANI spectra from obtaining a core-shell conformation.

7.11 Poly(N-isopropylacrylamide-butylacrylate) Copolymer coatings obtained by MAPLE for bioapplications

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Keywords: smart hybrid platform; pNIPAM-co-BA; MAPLE

New smart hybrid platform targeting stimuli responsiveness based on innovative and complex hybrid coatings (pNIPAM-co-BA with/without single active bio-compound (i.e., antimicrobial peptides and proteins) and their conjugates were obtained by MAPLE. Different laser fluences values were used for different solvents to obtain the desired surface for cell-bio interface applications. AFM and SEM methods were used to characterize the surfaces obtained, in order to correlate to biological response. Chemical characteristics of the coatings were evaluated by Fourier-transform-IR spectroscopy. Tumoral cell viability and morphology were analyzed using colorimetric (MTS) and SEM methods. Biological assays proved morphological and proliferation changes were conditioned by the cell line and type of coating preparation.

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7.12 Development and characterisation of novel ZnO/hydroxyapatite/chitosan composites for wound treatments

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The aim of this study was to obtain new ZnO/hydroxyapatite/chitosan (ZHC) compositesand to study their physico-chemical and biological properties. The biological properties were evaluated by in vitro and in vivo assays. The antifungal activity of ZHC composite against Candida albicans ATCC 10231 fungal strain was also studied. On

the other hand, complex physico-chemical characterisations of the obtained composites was performed using methods such as: Fourier transform infrared spectroscopy (FT-IR) and scanning electron microscopy (SEM). The ZHC composite were obtained by an adapted coprecipitation method. The SEM studies revealed that the obtained samples consist in nanometric particles with arod-like morphology. Energy dispersive X-ray (EDX)spectra highlighted the presence of Zn, O, Ca, P and N in the ZHC composite. Moreover, the presence of chitosan on the surface of the ZHC was sustained by the results of the FTIR studies. Also, the presence ofZn–O bond at 467 and 415 cm−1 was noticed in the FTIR spectra.The results of antifungal assay proved that the ZHCS composites inhibited C. albicans biofilm formation having an excellent inhibitory effect against the development of C. albicansmicrobial cells. The cytotoxicity of ZHC composite was evaluated using human osteosarcoma MG63 (ATCC CRL 1427) cell line. The results of the MTT assay, suggest that the ZHC possess a good biocompatibility and did not induce any harmful effect on the studied cells. The results of the in vivo test conducted on the rats with artificial induced wounds and treated with ZHC composite, suggest that our composite promote their accelerated healing. Therefore, our results indicate that the novel ZnO/hydroxyapatite/chitosan compositesmay represent a starting point for the development of new innovative wound treatments.

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7.13 Novel iron oxide modified with cetyltrimethylammonium bromide (CTAB) with potential application in environment remediation

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Keywords:

This research was focused on the development of new iron oxide nanoparticles functionalized with cetyltrimethylammonium bromide (FO-CTAB) by an adapted coprecipitation method for environment remediation. For this scope, the physico-chemical characteristics of obtained FO-CTAB nanoparticles were x-ray photoelectron spectroscopy (XPS), transmission electron microscopy (TEM) and X-ray diffraction (XRD) measurements. The results of our studies revealed that the FO-CTAB particles were obtained at nanometric scale (DTEM=20.88 ±1.5 nm) exhibiting a spherical morphology. On the other hand, the results of XRD studies highlight the presence of a cubic phase Fd-3 m of Fe3O4 in the studied sample. Furthermore, the results of the adsorption batch experimentsthat FO-CTAB samples were favourable for the adsorption of As(III) ions from aqueous solutions. Finally, the biological properties of FO-CTAB were studied by in vitro and in vivo test.The results of the in vitro cytotoxic assays obtained after24 h of incubation of FO-CTAB samples, showed that the studied sample did not alter the morphology of the HeLa cells and neither their proliferation.Moreover, the results of the histopathological studies conducted on various organsprelevated from the rats that have been feed with the water obtained after the As(III) decontamination (using the FO-CTAB), did not show any major alteration of the studied organs architecture. In conclusion, we could say that FO-CTAB samples could be excellent candidate's environment remediation applications.

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

Location and time: **Amf. 1**

Moderators:

Assoc. Prof. Mircea BULINSKI

Assoc. Prof. Dr. Alexandru NEMNEŞ

8.1 - Alexandru MĂGUREANU, Septimiu BĂLĂŞCUŢĂ, Petru GHENUCHE, Mihail O. CERNĂIANU, Ana-M. LUPU, Bogdan DIACONESCU, Cătălin M. TICOŞ, Domenico DORIA

Plasma imaging diagnostics for high power lasers experiments

8.2 - Petre Cătălin LOGOFĂTU

Impure geometric progression of synthetic frequencies: a well-defined and precision-optimized method for absolute distance measurement

8.3 - Alexandru-Gabriel STOICA, Eusebiu-Rosini IONITA, Marian BAZAVAN

Development of a low cost system for plasma jets generation at atmospheric pressure

8.4 - Ruxanda MIREANU, Valentin ION, Ovidiu TOMA

Optical properties of the oxidized Terfenol-D thin film obtained by pulsed laser deposition

8.5 - Ana-Maria Statie, Doina Bejan

Tuning the wavelength and threshold characteristics of a double quantum well laser with a non-resonant intense laser

8.6 - Dorina TICOS, Adrian SCURTU, Jeremiah WILLIAMS, Maria Luiza MITU, Cătălin M. TICOS

Electron beam induced dust flows in a plasma crystal

8.7 - Bianca-Georgiana ŞOLOMONEA, Luiza-Izabela JINGA, Vlad-Andrei ANTOHE, Gabriel SOCOL, Iulia ANTOHE

Cadmium ions (cd2+) detection using a portable plasmonic based optical fiber sensor

8.8 - Claudiu Caraiani, Lucian Ion

Behavior of paramagnetic currrent-current correlation function of a two-dimensional electron gas at low temperatures

8.9 - Ana-Maria PANAITESCU, Dan GIURGIU, Vlad-Andrei ANTOHE, Sorina IFTIMIE, Ana-Maria RĂDUŢĂ, Adrian RADU, Lucian ION, Ştefan ANTOHE

Study of AII-BVI zinc based thin films for sensor applications

8.10 - Oana Diana Baban, Ciceron Berbecaru

Dielectric and optical properties of triglycine sulphate crystals

8.1 Plasma imaging diagnostics for high power lasers experiments

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Plasma imaging diagnostics are powerful tools in high-power laser-driven experiments that provide real-time information about the interaction. In this work, we describe the design of a shadowgraphy system equipped with either a standard CCD camera or a wavefront sensor camera. We also report on the results attained during the commissioning campaign of the 1 PW laser of the ELI-NP facility [1]. The 1 PW laser system has a maximum beam energy of 24 J, with pulse duration and central wavelength of 24 fs and 810 nm, respectively [2]. The shadowgraphy was performed by using a probe beam with the fundamental wavelength of the laser and synchronizing it with the main laser beam. This technique was used for imaging the interaction of the focused laser beam with either a solid target or a gas cell target. The shadowgraphy with the wavefront sensor was employed with gas targets, in the laser-driven electron acceleration experiment, to measure the phase change of the wavefront of the probe beam after passing throughout the plasma channel generated during the acceleration process. This wavefront modification provides information about the electron plasma density. The standard shadowgraphy was used with solid targets during the TNSA experiment to attain information about the laser temporal contrast by looking at pre-plasma signature in the interaction.

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8.2 Impure geometric progression of synthetic frequencies: a well-defined and precision-optimized method for absolute distance measurement

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Keywords: Absolute length measurement, multiwavelength interferometry, synthetic frequency

The method for the determination of the absolute distance from the excess ratios of multiwavelength interferometry, invented by Benoît in 1898 [1], was seriously confronted with the problem of ambiguity and the lack

of a analytical formula for calculations. From the beginning it was intuitively known that the ambiguity may be removed by using a large number of frequencies and selecting frequencies that are not in an obvious rapport with each other, such as a small integer ratio. But only much later sufficient theoretical progress was made toward the elimination in principle of the ambiguity [2] and finding an analytical formula for the absolute distance [3]. I offer here a solution for the elimination of the ambiguities at the ends of the period, which are not dealt in reference [2], a true analytical formula for the determination of the absolute distance, (reference [3] offers only an easily implemented computer procedure, not really an analytical function) and other improvements. My method is proven rigorously to be well-defined (i.e. non-ambiguous) and optimized for precision. It is shown here that my method is the boundary between ambiguity and precision. There are more precise methods, but they are ambiguous; there are also other non-ambiguous methods, but they are less precise.

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8.3 Development of a low cost system for plasma jets generation at atmospheric pressure

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Keywords: atmospheric pressure plasma, DBD configuration, high voltage generator

Plasma at low temperature and atmospheric pressure is of interest for a variety of processes: surface processing, decontamination, polymerization. This paper presents the development of a low cost system for the generation of plasma jets at atmospheric pressure in DBD configuration, using a converter with the push-pull topology. The switching frequency and the duty cycle can be changed either by the control panel or by remote control from a PC.

8.4 Optical properties of the oxidized Terfenol-D thin film obtained by pulsed laser deposition

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Keywords: Terfenol-D, Pulsed Laser Deposition, metallic alloy, oxidized thin films, Spectroscopic Ellipsometry, AFM, SEM, EDX, magnetostriction, Lorentz model, Effective medium approximation (EMA) model.

The main goal of this thesis consists in the characterization of Terfenol-D thin films, through spectroscopic ellipsometry measurements. For this research activity we have realized Terfenol-D (TbxDy1-xFe2) thin films of two different concentrations: Tb0.3Dy0.7Fe2 and Tb0.4Dy0.6Fe2, knowing that the magnetostrictive property of

Terfenol-D changes with the variation in the Tb and Dy ratio. The analyzed probes were deposited on Si (100), Si (111) and Pt/Si substrates, at room temperature as well as temperatures of 300oC, 500oC, 600oC. In the PLD configuration we have used the solid body Nd:YAG laser as a light source, characterized by a wavelength of 266 nm and a pulse repetition rate of 10 Hz. Other important deposition parameters were the heating rate of 50oC, cooling temperature of 10oC per minute, distance between target and film of 4 cm and the number of pulses of 36000 per hour. Moreover, the deposition process took place in vacuum conditions, using a laser fluence of 1.2 J/cm2. Optical constant's dispersion was analyzed through the sensitive technique of spectroscopic ellipsometry (SE), which uses the elliptically polarized light reflected by a sample to fit the (ψ, Δ) parameters. The product of Δ and tan(ψ) gives the ratio of Fresnel reflection coefficients for s- and p-polarized light. The basic mechanism of SE consists in the comparison of the experimental data with a generated model constructed using proper dispersion equations. In this paper we have used a combination of the Lorentz oscillator model and the effective medium approximation (EMA), in order to fit the Terfenol-D films which indicated the presence of iron oxides on their surface, due to deposition conditions. Besides the SE analysis, different probes were characterized through AFM, SEM, EDX and resistivity measurements.

8.5 Tuning the wavelength and threshold characteristics of a double quantum well laser with a non-resonant intense laser

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Keywords: double quantum well, intense laser, threshold current density, wavelength

We theoretically investigated the interaction of an asymmetric double quantum well in GaAs/Al0.3Ga0.7As with an intense non-rezonant laser radiation and its effects on energy spectrum, absorption, wavelength of the emitted radiation, threshold current density and characteristic temperature if this structure is embedded in a resonant cavity becoming the active medium of a laser. The study shows that the potential of the asymmetric double quantum well is strongly influenced by the presence of the intense laser. The results reveal an increase/decrease in the energy of the conduction/valence subbands (mainly of the first energy levels) of the well leading to an increase in the effective width of the band gap with the augment of the intensity of the external laser. This decreases the wavelength of the radiation emitted by radiative recombination. The laser emission conditions and the dependence of the threshold current density and the temperature characteristic on the laser dressing parameter and cavity length were discussed. It has been pointed out that the tunable semiconductor laser based on asymmetric double quantum well is characterized by a larger variation of the wavelength, much lower threshold currents and a higher characteristic temperature than single quantum well lasers, which gives them great stability and makes them attractive for optical communications.

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8.6 Electron beam induced dust flows in a plasma crystal

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Dusty plasmas are ubiquitous in nature being encountered in space and astrophysical objects but also in laboratory plasmas such as in the semiconductor fabrication processes that employs cold plasmas for manufacturing chips [1-2]. Besides the typical plasma constituents (electrons, ions, electric and magnetic fields, and radiation), dusty plasmas have in their composition one unique component: particulates of solid matter (or dust) made up of a large number of atoms. It is the presence of these dust particles that lead inherently to some unusual physical properties, from single or collective behavior to self-organization and the existence of a multi-range of time and space scales. In laboratory plasmas, the dust particles are electrically charged and settle in the sheath surrounding one of the electrodes and are suspended by the electric force of the sheath field. Particles with different masses settle at different positions inside the sheath, depending on their charge and electric field spatial profile [3]. We review some experiments performed in our lab in which an external electron beam with energy ~10 keV and with a current of a few milliamps can induce some interesting nonlinear dynamical phenomena within a plasma crystal, from laminar to turbulent dust flows and formation of vortices [4,5]. The visualization of electron beam-driven dust flows is realized using the particle image velocimetry (PIV) technique for mapping the velocity fields [4,5] or the particle tracking velocimetry (PTV) technique for inferring the dynamical features at the particle level [6].

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8.7 Cadmium ions (cd2+) detection using a portable plasmonic based optical fiber sensor

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Keywords: Cadmium ions, fiber optic (FO) technology based on surface plasmon resonance (SPR) phenomenon, bovine serum albumin(BSA), polyaniline(PANI), X-ray photoelectron spectroscopy (XPS)

Cadmium is one of the most studied nonessential heavy metal nowadays. It is found on Earth's crust in significant quantities and is used industrially for batteries and pigments manufacturing [1]. This heavy metal proved to be very harmful for the ecosystem and people's health, therefore, the amount of cadmium allowed in water is

0.005 ppm [2]. There are several sources that bring cadmium into organism such as: air and cigarette smoke and food (mushrooms, cereals, cocoa powder) [3]. Unfortunately, cadmium ions (Cd2+) can cause multiple system disorders such as cancer, heart diseases, muscular and bones problems and gastrointestinal diseases [4, 5]. There are some traditional methods for Cd2+ detection, such as the spectrometric and the chromatographic methods, but they require expensive and complex instruments, costly maintenance and highly qualified personnel to handle the equipment [6]. Distinct than the detection techniques mentioned above, fiber optic (FO) technology based on surface plasmon resonance (SPR) phenomenon is relatively new and offers many advantages such as simplicity, portability, viability, low cost and possibility for miniaturization. Two strategies for cadmium ions Cd2+ detection in water samples were used in this study: using a gold coated fiber optic- surface plasmon resonance sensor (FO-SPR) functionalized with bovine serum albumin (BSA) protein and polyaniline (PANI) conductive polymer, respectively. The two Cd2+ detection methods were analysed and compared. The BSA functionalized FO-SPR sensor indicated better sensitivity and limit of detection (LOD) for Cd2+ down to nanomolar level. Using the X-ray photoelectron spectroscopy (XPS) technique, one could confirm the presence of Cd2+ on the fiber optic sensor surface and also to determine the atomic percentage of absorbed Cd2+. Concluding, the FO-SPR sensors have indicated good sensitivity for Cd2+. Moreover, the proposed FO-SPR sensor is also low-cost and easy to manufacture and could be used for in-situ environmental monitoring and drinking water quality control.

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8.8 Behavior of paramagnetic currrent-current correlation function of a two-dimensional electron gas at low temperatures

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Within the framework of linear response theory we derive temperature dependent expressions for the paramagnetic current-current correlation function of a two-dimensional electron gas.We study the wave-vector and frequency dependent behavior of this correlation function in the low temperature regime. This allows us to gain insight into how the electrical conductivity behaves in the zero temperature limit.

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8.9 Study of AII-BVI zinc based thin films for sensor applications

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Keywords: ZnTe thin films; RF-magnetron sputtering; XRD; optical absorption; optical transmission; photodetectors.

ZnTe thin films were deposited via RF Magnetron Sputtering onto optical glass evaporated silver (Ag) substrates and electrically contacted with evaporated aluminium (Al). The sputtering procedure was carried out at 80 W in argon (Ar) gas atmosphere at 2.5*10^(-3) mbar working pressure, for 75 minutes at 220 °C. The samples were structurally characterized by X-ray diffraction (XRD) revealing amorphous ZnTe films. Morphological investigations allowed a first evaluation of the films' thicknesses. Optical characterization was performed via absorption and transmission measurements in the spectral range between 200-1500 nm at room temperature. Subsequently, the thicknesses and band gap energy of ZnTe thin films were evaluated at 508.4 nm and 2.2 eV respectively. Moreover, they revealed high transmittance in IR and NIR region. Electrical measurements of Ag/ZnTe/Al sandwich structures -current-voltage characteristics at 6 temperatures ranging from 303 K to 354 K- were performed, thus allowing the identification of the suitable charge transport mechanisms through the structure along with their corresponding parameters. Based on the good optical and electrical properties these ZnTe thin films display, they show great potential as candidates for performant small wavelength photodetectors.

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8.10 Dielectric and optical properties of triglycine sulphate crystals

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Keywords: triglicin sulphate, permittivity and losses, absorbance, optical bandgap, phonons

Quality TGS crystals were grown from aqueous solution at a constant 44 oC temperature in static regime by slow solvent evaporation. Cleaved (perpendicular on ferroelectric b axis) and polished plates were used in order to investigate for electrical and optical properties. Permittivity and losses were measured on a large temperature range, from room temperature (TC) till 70 oC, crossing up and down Curie temperature (TC), at three selected frequencies. Optical transmittance of TGS crystal was also measured in UV-VIS region. Permittivity show increased values with

temperature increasing, with maxims at TC. Beyond TC, for further increase of temperature, dielectric constant show decreasing values in paraelectric region. Non reproducible values of permittivity were registered in the ferroelectric phase while in paraelectric region these are reproducible. Losses with higher values at RT start to decrease toward TC with small maxims at TC and decreased values in paraelectric region. Also non-reproducible values of losses were registered in the ferroelectric phase with increased values after cooling the sample from paraelectric to ferroelectric phase. Both, permittivity and losses shows strong frequency dependencies. It was concluded that the ferroelectric domains evolution with the temperature and frequencies and associated relaxations processes are responsible for this behavior, [1],[2]. Our sample shows a very good transmittance of about 0.8 in the UV-VIS region beyond the edge of the fundamental band-gap in UV. Correction for reflectance was used in order to investigate the region of the identified indirect optical transitions with associated tail of absorbance curve. The band gap of the TGS crystal was found to be 4.9 eV with energies of absorbed and emitted phonons of about 0.2 eV and 0.15 eV. It was concluded that phonons involved in the optical transitions could be associated with internal vibrations of structural groups of TGS crystal, [3],[4],[5].

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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 - Ioan-Mihail DINU
Machine Learning Applications in Anomaly Detection for BSM Searches and Hardware Data Acquisition Triggering

9.2 - Eduard George Stan, Michele Renda, Călin Alexa
dimensional-aware scalar and vectorial operations in c++

9.3 - Ioana DUMINICĂ, Călin ALEXA, Andrei GEANTĂ, Roxana ZUS
From the Standard Model to the Minimal Supersymmetric Standard Model

9.4 - Dana Maria IOAN, Florin Vlad IANCU, Mihai MARCIU, Andrei COCOR, Roxana ZUS, Virgil BARAN
The accelerated expansion and dark energy phenomenon in f(G,T) gravity

9.5 - Florin Vlad IANCU, Dana Maria IOAN, Mihai MARCIU, Andrei COCOR, Roxana ZUS, Virgil BARAN
Two field dark energy models with specific contractions of the Riemann tensor - a machine learning approach

9.6 - Maria-Catalina ISFAN, Laurentiu-Ioan Caramete
Data analysis for gravitational waves using neuronal networks on quantum computers

9.7 - Vadim MUNTEANU, Mădălina BOCA
Classical and quantum description of Laguerre-Gauss modes of the electromagnetic field and applications

9.8 - Victor DINU
Nonlinear QED processes including the damping of particle states

9.9 - Cristian IORGA
Photoionization dynamics of low Z ions near the first ionization threshold

9.10 - Dragos Iustin PALADE
Transport of low-Z impurities in the presence of drift-type turbulence in tokamak plasmas

9.11 - Ligia POMÂRJANSCHI, Dragoș Iustin PALADE
Effects of non-Gaussianity on turbulent transport in magnetized plasmas and astrophysical systems

9.12 - Miruna-Ioana BELCIU, Mădălina BOCA
Optical Tweezers

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Imperfect quantum teleportation of two qubits by using a single entangled state

9.14 - Robert POENARU
New Results Concerning Collective Motion in Triaxial Nuclei

9.15 - Cosmin CIPU, Ema BOICU, Virgil BARAN
Exploring the collective dipole response toward drip-line

9.16 - Vasile Alin SEVESTREAN
Improved calculation of electron capture decay ratios

9.17 - Radu SLOBODEANU
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9.18 - Alexandru PENCU, Virgil BARAN, Roxana ZUS
Exploring the role of Dynamical Symmetries on Quantum Dynamics

9.19 - Andreea POPESCU-CRUGLIC, Maria-Beatrice OPREA, Andreea CROITORU, Roxana ZUS, Virgil BARAN
Typical misconceptions in Quantum Mechanics learning process: a comparative study between physics and mathematics students

9.20 - Adrian STOICA
On a conjecture about the minimum induced drag of ground effect non-planar wings

9.21 - Cristian-Valer VRACIU
Turbulent convective plumes in a uniform co-flow

9.22 - Andrei Ioan DOGARU, Ruben Campos DELGADO
Cylinder quantum field theories at small coupling

9.23 - Petre BOBOC, Cristian VRACIU, Gabriel PANA, Alexandru NICOLIN, Virgil BARAN
Evolution towards the self-organized states of seismic Vrancea region

9.24 - Mircea BARBUCEANU
Generalization of principles of extremum. The principle of evolution. Elimination of principles in physics

9.1 Machine Learning Applications in Anomaly Detection for BSM Searches and Hardware Data Acquisition Triggering

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Keywords: machine learning, bsm, anomaly detection, trigger

Machine Learning (ML) methods have seen increasing adoption rates within High Energy Physics (HEP) research. and this work attemots to continue those efforts in two critical areas of apolicability: exoerimental physics analysis and particle data acquisition triggering for particle detectors. Although most Beyond Standard Model (BSM) searches target specific theory models, there has always been a keen interest in developing model-independent methods in the HEP community. ML-based anomaly detection stands among the latest up-and-coming avenues tor creating model-agnostic BSM searches. This part of the research focuses on designing anomalous event taggers based on autoencoder models. Alongside the sana aschminauon power. a nan ororiv is paced on bow sana-mo an independence. To this end, the autoencoder is used in conjunction with a Normalizing Flow model tasked with latent space density estimation. Both event reconstruction error and latent representation likelihood are combined to mitigate the bias of the resulting event anomaly score. Overall this method is showing promising anomaly detection pertormance without losing much in terms or generalization power. Un the multiet LHC Olympics data, it can consistently identify BSM signals, even in the challenging scenarios posed by the Black Box datasets, where the signal content Is unknown. The hardware trigger application focuses on Micromegas-tvoe detectors used for muon detection from high-energy p - p collisions. The data acquisition trigger should identify tracks originating from the interaction point while rejecting both collision and non-collision backgrounds. We trained a convolutional neural network using simulated muons to identify muon tracks and determine if they originate from the supposed interaction point. This part or the work aims to study the teaslbllity or using machine learning models on FPGA for trigger algorithm implementation. Our results show that this approach is suitable and can provide a very good precision.

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LHC Olympics Paper: https://doi.org/10.1088%2F1361-6633%2Fac36b9

9.2 dimensional-aware scalar and vectorial operations in c++

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Keywords: units of measurement C++ Vectors

We review the problem of a dimensional check as a language feature for most of the high-level programming languages and the possible solutions of this issue. We introduce our C++ library designed to make 2D and 3D vectorial operations using units of measurement. Eventually, we present our plans for future improvements of the current implementation

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9.3 From the Standard Model to the Minimal Supersymmetric Standard Model

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Keywords: Standard Model (SM), MSSM

For several decades, the Standard Model of particle physics, benefiting from strong experimental measurements and comprehensive theoretical developments, was able to describe with exceptional accuracy three fundamental interactions - electromagnetic, weak and strong. In addition, the mass generation mechanism that was predicted in 1964 has been experimentally confirmed in 2012. The non-zero mass of neutrinos, the coupling between gravity and all other fundamental forces, the particles which make up the dark matter and the asymmetry between matter and antimatter in the universe are not described by the Standard Model. Supersymmetry (SUSY), a robust theoretical extension of the SM, proposes the existence of new fermions and bosons, superpartners of the SM particles. To each well-known SM quark, lepton, vector boson or Higgs boson, SUSY is associating its own superpartner. In parallel to my conceptual understanding of SUSY, I started to learn about Monte Carlo simulation of the events produced in proton-proton collision that involves supersymmetric particles production, mainly, using PYTHIA simulation tool we produce a pair of squarks. Identifying the resulting decay products, we reconstruct several kinematic variables like invariant mass, transverse mass, transverse momentum, pseudorapidity, etc. A possible background, a quark-antiquark scattering into W boson, is also discussed.

9.4 The accelerated expansion and dark energy phenomenon in f(G,T) gravity

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In this work we investigate the properties of the accelerated expansion in a theoretical model which extends the fundamental Einstein-Hilbert action by considering geometrical effects from the Gauss-Bonnet invariant (G) and the square of the energy-momentum tensor (T). We investigate the physical properties by considering the linear stability theory, analyzing the phase space structure and the dynamical consequences. Lastly, we obtain various observational constraints for different parameters associated to this model, discussing the viability of the present cosmological scenario.

9.5 Two field dark energy models with specific contractions of the Riemann tensor - a machine learning approach

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In this work we further extend the action specific to the general relativity by including specific contractions of the Riemann tensor, discussing the emergence of the accelerated expansion in a two field model. The physical aspects of

our solution are investigated by considering a machine learning approach, obtaining various dynamical properties which can explain the evolution of the universe at large scale.

9.6 Data analysis for gravitational waves using neuronal networks on quantum computers

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In this study, we evaluate the possibility of using quantum neuronal networks for classifying gravitational waveforms, ran both on simulators and quantum computers. This analysis is quite interdisciplinary in its nature, combining knowledge of astrophysics, quantum information or quantum and classical machine learning. We saw that the quantum classifiers and hybrid classical-quantum layers give high accurate results when tested on a simple dataset and ran on a simulator; also, adding a quantum layer to an unsatisfying classical neuronal network can highly improve its accuracy. When running on a real quantum computer, error minimizing algorithms need to be implemented in order to obtain a satisfying accuracy.

9.7 Classical and quantum description of Laguerre-Gauss modes of the electromagnetic field and applications

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Keywords: Laguerre Gauss modes; QED; orbital angular momentum of the light; dynamics

The purpose of this work is to present the classical and quantum description of the Laguerre-Gauss modes of the electromagnetic field. These are particular solutions of the Maxwell equations, with a helical structure of the wavefornt which makes them carriers of angular momentum. The present work starts with a classical description of the electromagnetic field, where Hermite/Laguerre-Gauss modes are introduced as solutions of Helmholtz equation in paraxial approximation. Connservation laws of energy, linear and angular momentum are derived from Maxwell equations. Next, a numerical application, consisting in the study of the non-relativistic motion of a charged particle interacting with a LG mode is implemented in Python. The equations of motion are solved numerically using scientific libraries such as Numpy and Scipy. Algebraic manipulations are handled with Sympy library. In the second part, the quantum electrodynamics (QED) framework is introduced briefly and then the second harmonic generation is studied. We present the expression of the transition rate, as obtained in [12], and we show intensity profiles of LG modes emitted in the process.

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9.8 Nonlinear QED processes including the damping of particle states

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In the presence of an electromagnetic background plane-wave field, electron, positron, and photon states are not stable, because electrons and positrons emit photons and photons decay into electron- positron pairs. This decay of the particle states leads to an exponential damping term in the probabilities of single nonlinear Compton scattering and nonlinear Breit-Wheeler pair production. We investigate, analytically and numerically, the total and spin- and polarization- resolved differential probabilities of these nonlinear QED processes, taking the particle states' decay into account.

References:
First-order strong-field QED processes including the damping of particle states
T. Podszus and A. Di Piazza

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9.9 Photoionization dynamics of low Z ions near the first ionization threshold

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The field-induced interference between the direct photoionization and resonant Auger processes is highly non-linear leading to different ionization dynamics regimes depending on laser pulse parameters relative to the atomic system of interest [1]. Due to their simplicity, atomic data of low Z ions are fairly accurate and can provide benchmark case tests for investigating the field-induced photoionization dynamics [2]. Despite requiring low photon energies, near-threshold ionization brings new complexity in the form non-local time-dependent terms that cannot be neglected [3] as well as rapid oscillating many-body interaction terms associated with the bound-free processes [4]. This work is part of a larger project investigating these non-local, highly oscillating effects on the photoionization dynamics of C III ion. Atomic data is computed using the Dirac-Fock-Slater model-potential [5] and the evolution of populations for different ion and free electron states is given within the time-dependent perturbation theory.

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9.10 Transport of low-Z impurities in the presence of drift-type turbulence in tokamak plasmas

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Impurities are an important component of nowadays tokamak plasmas. Their presence at the center of the reactor can have detrimental effects on the burning reaction and, for that reason, one must understand and control their transport. The dynamics of low-Z impurities is dominated by the Ion-Temperature-Gradient and Trapped-Electron-Mode turbulence. In this work, we investigate how the drift-type features of these instabilities affect the transport of impurities. The problem is tackled both from an analytical and a numerical perspective. Quasi-linear analytical estimations are found for the convective motion. The behavior is confirmed with the use of direct numerical

simulations. Quantitative dependencies between transport coefficients and plasma parameters are evaluated numerically.

9.11 Effects of non-Gaussianity on turbulent transport in magnetized plasmas and astrophysical systems

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The electric fields in fusion plasmas and the magnetic fields in astrophysical media are known to exhibit strong turbulent features. Consequently, the turbulence leads to non-diffusive, anomalous transport of charged particles and cosmic rays. The relation between turbulent fields and transport is usually investigated under the assumption of Gaussianity of the former which is valid only to an approximate degree. In the present work we go beyond the standard approach and consider how non-Gaussian turbulent fields affect the transport of ions in tokamak plasmas and the cosmic-ray wandering in astrophysical space.
The problem is investigated within a statistical description using two methods: the Decorrelation Trajectory Method [1] and the Direct Numerical Simulation method [2]. We use fully non-linear numerical simulations to evaluate the relation between diffusion coefficients and the parameters of turbulence. Complementary, analytical estimations are constructed which turn out to be in line with the numerical results.

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9.12 Optical Tweezers

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Optical tweezers are systems based on precisely shaped and focused laser beams used to hold, move and manipulate microscopic particles, just as the “normal” tweezers would move macroscopic objects. In 2018 the Nobel prize for Physics was awarded to Gérard Mourou and Donna Strickland "for their method of generating high-intensity, ultra-short optical pulses" and to Arthur Ashkin "for the optical tweezers and their application to biological systems".
In my talk I will present, in the first part, the general theory of optical tweezers. There are two limiting cases: Rayleigh optical trapping regime for particles much smaller than the radiation wavelength, and the geometrical optics regime for very large particles. In the intermediate case, when the particle size is of the same order of magnitude as the radiation wavelength, optical forces can be described in the framework of the generalized Lorenz Mie theory. In the second part I will discuss an application of optical tweezers for the study of some biophysical properties of human red blood cells.

In conclusion, this field has been in great expansion due to the emergence of numerous possibilities to manipulate and characterize nanometric and micrometric objects of interest leading to remarkable theoretical and practical understanding of phenomena occurring at these scales.

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9.13 Imperfect quantum teleportation of two qubits by using a single entangled state

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Keywords: entanglement, quantum teleportation

We analyze the quantum teleportation [1] of two qubits: one from Alice to Bob and the second one from Bob to Alice with the help of a single two-qubit entangled state. In order to generate imperfect copies of the quantum channel, one uses local optimal universal asymmetric cloning machines [2]. We evaluate the concurrence of the two imperfect clones of entangled state and find the conditions such that both states are simultaneously inseparable. Further, we compute the fidelity of teleportation for the two qubits.

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9.14 New Results Concerning Collective Motion in Triaxial Nuclei

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Wobbling motion is studied for a simple rotor and a quasi-particle coupled to a triaxial rotor. For the first case, the initial Hamiltonian is treated within the Harmonic Approximation, and the obtained analytical results are applied to the even-even nucleus ^{130}Ba. The excitation energies, quadrupole moments, and transition probabilities are evaluated and compared with the experimental data. In the second case, a quasi-particle + triaxial rotor (QTR) Hamiltonian is adopted, and a set of semi-classical equations of the wobbling spectrum is determined analytically. This theoretical formalism is applied to ^{163}Lu. By using the concepts of Signature Partner Bands and Parity Partner Bands, the four known triaxial strongly-deformed (TSD) bands in this nucleus are interpreted as zero-wobbling phonon for TSD1, TSD2, and TSD4, while TSD3 is a one-wobbling phonon band. The results concerning excitation energies for each band are shown in comparison with the experimental data. Moreover, if one finds the intersection curves between the energy surface (i.e., the triaxial ellipsoid) and the angular momentum sphere, then the classical trajectory of any state from the isotope can be calculated. Such geometrical representations are made and also applied to ^{163}Lu.

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9.15 Exploring the collective dipole response toward drip-line

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Keywords: Pygmy Dipole Resonance, Giant Dipole Resonance, Vlasov equation

The evolution of the properties of Pygmy Dipole Resonance and of Giant Dipole Resonance is investigated within a semi-classical transport model considering the Vlasov equation. For a chain of Ni isotopes the position of centroids, the Energy-Weighted Sum-Rule, the vibrational structure are obtained by employing an approach based on linear response. We evidence the role of the neutrons in in excess on the excitation of low-lying dipole collective mode.

9.16 Improved calculation of electron capture decay ratios

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Electron capture on nuclei plays an important role in several domains which include, but are not limited to, astrophysics (core-collapse, thermonuclear supernova), medicine (I-123 as a tracer to thyroid imaging), nuclear waste (Ca-41). Although the electron capture is known for over 80 years now, there is a need for improvement of the decay rate calculation due to their errors with respect to the experimental data. The decay rate contains two distinct parts: the nuclear matrix elements, which involve the nuclear structure of the parent and daughter nuclei and electron phase-space factors, which are described by the dynamics of the captured electron. My work focuses on the improvement of the calculation of electron phase-space factors. I used a more accurate electron wave function for the bound electrons obtained as a self-consistent solution of the Dirac-Hartree-Fock-Slater equations for the initial and final atoms (the excited configuration of the final atom was taken into account). The wave function was obtained with a slightly modificated version of the Fortran subroutine package RADIAL. For that, several codes in Wolfram Mathematica and Shell Scrip were implemented.For better results, the exchange and overlap correction was introduced using the Vatai's approach. The calculation was performed for allowed and forbidden unique beta transitions. To have a direct comparison with the experimental data, I computed the decay probability ratios for electron captures from different electronic shells, which are independent of the nuclear structure effects. The present work opens the path to extend the computation of the electron capture rates for many other nuclei that undergo allowed and forbidden unique beta decays and to include other corrections related to the accurate calculation of the phase space factors.

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9.17 Skyrme-Faddeev solitons and steady Euler flows

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Keywords: steady fluid, soliton

We introduce a kind of duality between steady inviscid fluids and solitons in the strong coupling limit of the Skyrme-Faddeev sigma model. This “duality” is confirmed in the case of a new exact solution on the 3-sphere that will be presented in detail.

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9.18 Exploring the role of Dynamical Symmetries on Quantum Dynamics

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Keywords: Dynamical symmetries, Lie group, Lie algebra, Constants of motion

We investigate the properties of quantum systems characterized by central field dynamics which manifest dynamical symmetries evidencing the connection between the group structure, the corresponding Lie algebra and the conserved quantities.

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9.19 Typical misconceptions in Quantum Mechanics learning process: a comparative study between physics and mathematics students

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Keywords: typical misconceptions, teaching of quantum mechanics

Despite the many decades in which Quantum Mechanics (QM) has played a central role in the education of a physicist, it is still challenging academics in finding the most appropriate methods and approaches to introduce the principles and concepts that lay at the base of this fascinating field. Therefore, we are actively looking forward to finding better and better solutions, trying different approaches and also studying their impact on student's understanding and abilities after taking the QM course. In order to understand the efficiency of the teaching methods and the difficulties encountered by the students, we have implemented a survey for the University of Bucharest Physics students, in their second year of study, and also for the Mathematics students choosing QM as an optional discipline. Two different questionnaires were designed and applied, one before the introductory lectures on QM and the second one, at the end of the lecture series. The first questionnaire aimed to identify preconceptions regarding some of the QM concepts. It was also intended to provide a realistic and clear view of students' abilities to use the mathematical apparatus needed to study QM and to discover any gaps and needs for improvement so that the course and seminar teachers may address those needs. The second questionnaire intended to verify if and which of the initial misconceptions were cleared for the students attending the lecture and to single out some common mistakes the students still make, testing their ability to put into use the studied concepts. Besides the comparative study between the physics and mathematics students, we have also analyzed the results of the second survey in relation to some previous generations of students.

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9.20 On a conjecture about the minimum induced drag of ground effect non-planar wings

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The conjecture which states that the optimum induced drag for a closed wing is a limit case of the optimum induced drag of a quasi-closed C-wing is extended to the case of a non-planar wing in ground effect. The numerical simulations are performed for circular and elliptical (quasi)-annular wing.

9.21 Turbulent convective plumes in a uniform co-flow

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Turbulent convective plumes appears in natural complex systems such as the oceans and the atmosphere. The theoretical description of these models is very important for understanding the convective transports in these complex systems. The behavior of the convective plumes is coupled with the environment in which they evolve. Although the effect of the environment stratification has been the subject of numerous experimental, analytical and numerical studies, the influence of the ambient co-flow received very little attention. Until this day, we still do not have a theoretical description for the three-dimensional round plumes in a uniform co-flow. In this work, the governing equations for the round turbulent plumes are derived and analytical and numerical results are presented. The obtained governing equations are the ordinary differential equations that represents the conservation of mass, momentum, kinetic energy and buoyancy. Finally, the comparison between the entrainment hypothesis and the energy-consistent entrainment is discussed.

9.22 Cylinder quantum field theories at small coupling

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Keywords:

We analyse the path integral of Liouville Field Theory compactified on a cylinder. At small coupling, the zero mode is weakly coupled to the Kaluza-Klein (KK) sector and is described by Liouville Quantum Mechanics. In this

framework, we recover the main properties of the 1-loop partition function, including T-duality. A wider class of models, in which our formalism is applicable, is discussed. We define novel cylinder QFTs starting from solvable quantum mechanical models, and compute their 1-loop partitions functions.

9.23 Evolution towards the self-organized states of seismic Vrancea region

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We analyze the seismic properties of the earthquakes produced in Vrancea region in the period 1970-2021 with the purpose to identify quantities able to evidence the emergence of the self-organized states. The time evolution of a number of entropy-like quantities is discussed.

9.24 Generalization of principles of extremum. The principle of evolution. Elimination of principles in physics

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Keywords: principles of extremum, exelix, principle of evolution

The ultimate goal of science is to describe the state and evolution of all material systems in terms of eliminating known principles, each principle being an unanswered question at this time. The existence of extremum principles in many scientific fields, equivalent to the fundamental principles governing the corresponding class of evolutions, and a recent paper that showed that such principles work in the living world, led us to seek a universal principle of extremum. This is the principle of evolution, formulated in absolutely general conditions and without postulating any physical hypothesis. Only two general principles of mathematical modeling were stated, meant to "standardize" the discussion framework. The success of the general modeling of material reality evolution is also due to the natural construction of the energy concept developed in a previous study, which eliminated the principle of conservation and transformation of energy and offered a fundamental scheme of reasoning.

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