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Bucharest University Faculty of Physics 2021 Meeting

1. **Atmosphere and Earth Science; Environment Protection**
   Location and Time: Online *Moderators:* Lect. Dr. Gabriela IORGA, Assoc. Prof. Dr. Cristian NECULA,
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   Location and Time: Online *Moderators:* Prof. Dr. Daniela DRAGOMAN, Assoc. Prof. Dr. Alexandru NEMNEŞ
10. **Theoretical Physics and Applied Mathematics**
    Location and Time: Online *Moderators:* Prof. Dr. Claudia TIMOFTE, Prof. Dr. Virgil BĂRAN

Section 1: Atmosphere and Earth Science; Environment Protection

Location and time: **Online**

Moderators:

Lect. Dr. Gabriela IORGA

Assoc. Prof. Dr. Cristian NECULA

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Study of macrophysical and microphysical characteristics of stratocumulus clouds over a site in southern Romania

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1.1 Variations of the major air pollutants in 2020 in three urban areas in Romania, from ground-based monitoring data

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Keywords: air pollutants, SARS-COV2 virus pandemic, urban areas, Romania

The year 2020 was marked by the SARS-COV2 virus pandemic, which was felt all around the globe, including in Romania, by various levels of restrictions of economic and travel activities (the schools will be closed during the lock-down period end temporary closure of restaurants, hotels, cafes, clubs, gradual closure of borders). This has led to a reduction in air pollution, with considerably lower concentrations of air pollutants observed at the country scale. For the present study we selected the time frame of the entire year and we chose three metropolitan areas of the cities of Bucharest (population about 2,155,240 inhabitants), Iasi (population-approximately 300,000 inhabitants) and Brasov (population-280,000 inhabitants). These cities often face problems of exceeding the air quality limits imposed by European legislation. Bucharest is permanently monitored by 8 static stations (traffic, urban, regional, suburban, industrial), Iasi is monitored by 6 static stations (traffic, urban, industrial, rural, suburban) and Brasov is monitored by 5 static stations (traffic, urban, industrial, suburban, regional). The data are provided by the National Air Quality Monitoring Network (RNMCA) and consisted of daily time series of mass concentrations of the main pollutants, SO2, NO2, O3, CO, PM10, PM2.5. These observations were analyzed from a statistical point of view for both the urban and the suburban area, on three time intervals: before lock-down, during lock-down and after lock-down. These time intervals are associated with implementation of different levels of outdoor socio-economic activities restrictions. The study shows that during lock-down the pollution levels were lowest for all cities, except for a few days when desert dust intrusions were identified. With the lifting of the lock-down and relaxation of the restrictions these levels began to increase. HYSPLIT and BSC-DREAM models were used to identify the sources of desert dust intrusions.

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1.2 Six-year monitoring of atmospheric pollen and major air pollutant concentrations in relation with meteorological factors in Bucharest, Romania

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Keywords: aerobiology, allergenic pollen, meteorological factors, urban air pollution

Air quality represents a significant problem, especially in rapidly urban developing areas, whose atmosphere contains a complex mixture of pollutants of various origins. Pollen grains are of particular interest due to their negative impact on human health, being responsible for the increasing prevalence of seasonal allergic diseases. However, the current knowledge on the correlations between air pollution, climate change and health impact of allergenic pollen is still limited, including Romania, where few studies have been performed until now. This study aimed to analyze multiyear data between 2014-2019 of the pollen concentrations in correlation with major air pollutants and meteorological parameters from Bucharest, the city with the highest inhabitant density in Romania, in order to find potential links between them. The pollen concentration was measured at Colentina Clinical Hospital using a Hirst-type spore trap that collects particles with an aerodynamic diameter between 2 µm and 200 µm on a weekly basis. Pollen particles data were classified by main species - trees, weeds and grasses depending on the flowering period and by the degree of spread (common or very common). Mass concentrations of PM10, PM2.5, NOx, CO, VOCs, O3, SO2 were obtained from the monitoring stations belonging to the National Air Quality Monitoring Network. Meteorology data were provided by the National Meteorological Agency. Pollen monitoring showed that maximum values of pollen concentration from trees are reached in early spring, from grasses in spring and early summer and from weeds in late summer and fall, corresponding to their flowering period. The correlation analysis was performed using the Spearman correlation coefficient on annual and seasonal basis and revealed the influence of air pollutants and meteorological parameters on pollen concentrations. Despite the seasonal correlations, no monotonic decreasing or increasing trend was detected for Bucharest during the investigated 6-year period, but a general constant behavior.

Acknowledgement:
This work was supported by European Regional Development Fund through Competitiveness Operational Programme 2014–2020, Action 1.1.3 creating synergies with H2020 programme, project Support Center for European project management and European promotion, MYSMIS code 107874, ctr. no. 253/2.06.2020. AMR was supported by the University of Bucharest, PhD research grant. SS and GI acknowledge the support from NO Grants 2014-2021, under Project EEA-RO-NO-2019-0423, contract no 31/01.09.2020. The authors gratefully acknowledge the National Air Quality Monitoring Network (NAQMN, www.calitateaer.ro) for data providing.

1.3 Role of meteorological parameters on PM10 mass concentrations in the urban agglomeration of Ploiesti, Romania

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Keywords: meteorological parameters, pollution episodes, PM10, particulate matter, Ploiesti urban area

A professional meteorological station belonging to "Ion Luca Caragiale" National College is used to study the influence of meteorological parameters (temperature, relative humidity, pressure and wind speed) on particulate matter PM10 levels in the city of Ploiești. The daily and hourly values of the PM10 mass concentrations were extracted from the air quality monitoring stations in Ploiesti, which belong to the National Air Quality Monitoring Network in Romania. Analysis of measured data from all monitoring stations show the problem of air pollution is not specific to a certain area of the city. Although there are some days and hours in a day when pollution is most intense in a specific location, the phenomenon is generalized throughout the city. Apart from the mean situation of air pollution by PM10, six urban pollution events, produced from August 2018 to May 2021 were analyzed and comparatively presented. State-of-the-art open-access numerical research models such as HYSPLIT and US GFS model (Global Forecast System), the DWD models (German Weather Service) were used to analyze air-mass back trajectories and the meteorological conditions al local and synoptic scale. It has been shown that the atmospheric stability has an important role in the accumulation of PM10 particulate matter at the scale of Ploiesti urban agglomeration. High-school students participated in data collection and presentation of results in present study, understanding the concepts of physics, mathematics and computer science in an interdisciplinary context.

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 2021. Authors thank the enthusiasm of high-school students of "I.L. Caragiale" National College, who participated in the study. SS and GI acknowledge the support from EEA-RO-NO-0423 project, contract no 31/2020.

1.4 Variations of major pollutants in the urban and suburban areas of Bucharest in the period 2015-2019

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Keywords: PM10, PM2.5, NOx, SO2, CO, C6H6, urban impact

The aim of present study was to assess the annual and seasonal variations of mass concentrations of gaseous species (NO, NO2, NOx, O3, SO2, CO, C6H6) and particulate matter PM10, PM2.5 (particulate matter less than 10 μm and less than 2.5 μm) in Bucharest area. The observational data set was extracted from the publicly available database of the Romanian National Air Quality for a period of five years: 2015–2019. Daily means of particulate matter and gaseous species mass concentrations at each site were statistically analyzed for the urban and suburban area. The hourly data were converted into daily means when it was necessary. The study assessed the annual urban impact over the surroundings of Bucharest and its evolution during the studied period. Results showed that urban impact is pollutant-specific and depends significantly on local pollution sources.

Acknowledgement:
The data regarding ground-based air pollution and local meteorology was extracted from the public available Romanian National Air Quality Database, www.calitateaer.ro, last accessed in August 2020. RVC and GI thank the support from EEA-RO-NO-0423 project, contract no 31/2020.

1.5 Influence of coal-mining activities on the air quality of the mine surrounding area

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

Atmospheric impact of coal mining activities is caused mainly by the carbon emissions. Present study is focused on the determination of airborne particulate matter produced by a coal open-mine and its impact on a close-by residential area. The main goal was to assess the mass concentrations and total carbon fractions (TC) of ambient PM10, PM2.5 and PM1. The samples were collected during two sampling campaigns, 10 successive working days (active mining), between 5-14 April 2018 and 5 successive days without mining activity on the site (12-16 January 2019). 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, as well. The results prove the impact of the mining activities on surrounding areas by showing significant variation of total mass concentration of particulate matter from full time working days to non-working days. Results also revealed the presence of crustal and anthropogenic origin elements such as C, O, Si, Ca, K, S, Cu, Ni, Fe, Mg, Ti.

Acknowledgement:
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1.6 Low-cost experimental system for independent air quality monitoring

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Keywords: air quality, air pollutants, Arduino, low-cost station

Urban air quality is nowadays a major issue for public health, especially in developing metropolitan areas. Unfortunately, the process of air quality monitoring involves expensive measuring instruments. Currently, the public market is abundant in many sensors for various air pollutant measurements. These sensors claim to be sufficiently accurate to perform air pollutant measurements and aim to compete the reference sensors. The purpose of present study was to develop a low-cost station using some sensors currently available on the market and to study its performance and limitations. The station made is based on the open-source Arduino platform and has a series of sensors that measure meteorological parameters (temperature, pressure, relative humidity, dew point temperature) and the mass concentrations of particulate matter fractions PM10, PM2.5 and PM1. As carbon dioxide is an important greenhouse gas, we also included a sensor to measure CO2 concentrations. The low-cost station was then used for measurements in various areas in the city of Bucharest (kerbside, parks, pedestrian area in the old city). Some measurements were performed in the Bucharest suburban area (Magurele) and even in some selected rooms of the Faculty of Physics. All measurements with the newly made low-cost station were performed in parallel with instruments approved for this purpose to study its effectiveness.

Acknowledgement:
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1.7 Turbulence detection using lidar and wind profilers

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Keywords: turbulence, lidar, CONTUR

Turbulence is one of the most common phenomena that cause damage for aviation also characterized by a low degree of predictability. The main objective of the CONTUR campaigns ("Emerging Technologies to Counteract the Effects Induced by the Turbulent Flows of Fluid Environments") was to use a synergy of instruments to validate lidar in its mission to detect a particular type of turbulence, Clear Air Turbulence (CAT), with significant importance for aviation. To detect CAT, we used as a proxy thermal turbulences which can be detected using ground-based lidars. Turbulences formed in the planetary boundary layer can be detected by lidars because pressure gradients generate variations of the molecular depolarization values but on specific conditions. A synergy of instruments with different wavelengths of the emitted radiation can increase the accuracy of observations in the investigated areas thus validating the results. In this study, we show the results from several measurement campaigns using a Raman lidar, a Doppler wind lidar, and a Sodar. These instruments were installed at a site in the south-western part of Bucharest and the measurements collected were used in a synergetic manner to understand CAT.

Acknowledgement:
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1.8 Study of macrophysical and microphysical characteristics of stratocumulus clouds over a site in southern Romania

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Keywords: clouds, stratocumulus, satellite

Stratocumulus clouds, low level clouds usually not associated with precipitation, represent one of the key components of the Earth's radiative balance because it generally reflects the incident solar radiation (i.e., high cloud albedo values). In this presentation, partial results from a study conducted between December 2019–February 2021 are presented. The aim of the study was to understand the occurrence and characteristics of stratocumulus clouds using satellite data supplemented with ground-based lidar measurements. Hourly data from the Clouds and the Earth's Radiant Energy System (CERES) database (i.e., SYN1DEG-1Hour) were used. A series of macrophysical and microphysical cloud parameters (e.g., cloud cover fraction, cloud types, cloud geometrical depth, cloud top temperature, cloud top pressure, cloud height, cloud optical depth, liquid water path) were extracted from the CERES database for a region in south western Bucharest, were the Măgurele Center for Atmosphere and Radiation Studies (MARS, 44.35°N, 26.03 °E) is located. MARS 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 further understand the stratocumulus clouds.

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1.9 A new approach to active control of clear-air turbulence vibrations

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Keywords: wing model, active control, vibration attenuation, clear-air turbulence, subsonic wind tunnel, LQG control, H infinity control

A topical issue in atmospheric science is to find ways to detect and predict clear-air turbulence (CAT). CAT is a physical phenomenon produced by the turbulent movements of air masses in cloudless areas that has potentially disastrous consequences for aircraft and/or passengers, being undetectable by the on-board equipment. In this paper, a new approach of the CAT attenuation methodology is proposed based on active control. The experimental model is represented by a realistic, elastic wing with aileron controlled by an electric linear servoactuator. Numerical simulations and experiments in the subsonic wind tunnel upgraded with a turbulence generator were performed.

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1.10 Use of meteorological RADAR in the characterization of some precipitation events in Bucharest area during 2019-2021

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Keywords: radar, Doppler, precipitation, convection

In the present study, RADAR products (Reflectivity, Echo Tops) of Doppler Meteorological Radar for Weather Surveillance (WSR), in C band, of National Meteorological Administration were used to characterize four precipitation events that took place in Bucharest metropolitan area during 2019-2021. The type of precipitation and its intensity were identified from the reflectivity data and from the Echo Tops product - the maximum height associated with the onset of the precipitation events. The study cases are as follow: a long-lasting moderate rain, a heavy rain and two case studies for long-lasting extreme rain/ hail above the Bucharest area (44 ° 26 'N, 26 ° 06' E). Three events took place during the convective season and one in end of February 2021. Dynamics of each event was pursued by combining RADAR outputs with synoptic weather charts and lifted index and convective available potential energy parameters for detecting the onset of convection.

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1.11 The impact of urban pollution on human health in the context of climate change

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Keywords: air pollutants, heat waves, PM10, O3, relative risk

Heat waves are extreme climatic events that bring high temperatures and drought. It is known that high temperatures cause thermal discomfort for living organisms and the drought affects the economy and agriculture, but what but what would be the combined effect of these two factors? That was the question we set out: to find out if higher temperatures have an effect on air pollution in Bucharest, Brasov and Iasi. Then, to show the impacts these air pollutants may have on health looking to see if we can find a correlation between high temperatures and the likelihood of people getting sick from such exposure to these air pollutants in the context of higher temperatures. The air pollutants chosen for this study were PM10, O3, NOx and CO, during the summer season of several years, the years being chosen so as to include periods with heat waves and periods in which the air temperature did not exceeded the normal values and no heat waves were recorded so that its results can be compared. The cities of Bucharest, Brasov and Iasi were selected for study because they revealed to be the most polluted cities in the country in the time long run. These cities are also specific targeted by the European Environment Agency with respect of the air pollution infringement procedure against Romania.

Acknowledgement:
GI thanks the support from EEA-RO-NO-0423 project, contract no 31/2020. Ground-based air pollutant data and meteorology by site were extracted from the public available Romanian National Air Quality Database, www.calitateaer.ro.

1.12 PREVENT - An integrated multi-sensor system for seismic monitoring of civil structures

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Keywords: seismic monitoring; civil structures; multi-sensor

The process of monitoring and tracking a structure`s integrity over time is referred to as Structural Health Monitoring (SHM). The SHM systems gained a lot of momentum in the last years, in conjunction with the development of more accurate and less expensive seismic sensors, the technological advancements and increased computing resources. For a country with a high level of seismic risk like Romania, the need of developing and implementing such multidisciplinary systems is crucial for continuous monitoring of the state-of-health of structures, their degradation over time and a more reliable post-earthquake evaluation. It is well known that other factors such as the structural peculiarities, the soil properties and the atmospheric conditions will add complexity to the framework. In this context, the PREVENT project (Open system for integrated civil structures monitoring) main objective is to put together the research outcomes and the computational capabilities in order to develop, implement and test an integrated dynamic platform. This modern instrument will be capable of using real-time data from various types of sensors and state-of-the art algorithms to provide decision support services based on the structural behaviour. The first action consists of extensive instrumentation of the case-study building (IFA) with various sensors (three velocity sensors, seven acceleration sensors, one GNSS antenna and one meteorological station). The present paper focuses on the description of the instrumentation setup, data-flow, the PREVENT platform architecture and some preliminary results for the most recent Vrancea intermediate-depth earthquakes ($ML \leq 4.7$). The expected results of the project will consist of the first database in Romania to offer quality raw and consistent processed data recorded in buildings (along with relevant engineering parameters) and will provide a valuable tool to the research community, earthquake engineering community, authorities and stakeholders as well as to teachers and students, for educational purposes.

Acknowledgement:
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1.13 Vertical deformations in the Carpathian-Danubian-Pontic area

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Keywords: Global Positioning System (GPS); Precise Point Positioning (PPP); Maximum Likelihood Estimation (MLE); vertical land motion; Geodesy; Median Interannual Difference Adjusted for Skewness (MIDAS); GPS Imaging;

We describe a comprehensive analysis of permanent Romanian Global Navigation Satellite System (GNSS) sites' on vertical position time series from data spanning 3-20 years. The GPS observations were computed using Gipsy X software, we apply Global Positioning System (GPS) Imaging, a new technique for robust estimation of the vertical velocity field of the Earth's surface (Hammond et al.,2016), and the final estimates to obtain the stations' vertical deformations velocities were analyzed using Maximum Likelihood Estimation (MLE) and Median Interannual Difference Adjusted for Skewness (MIDAS) trend estimator which is insensitive to undocumented steps, outliers, seasonality, and heteroscedasticity (Blewitt et al.,2016). We focus on the known national GPS observation level model in the Carpathian-Danubian-Pontic area to advance geodetic observation precision/accuracy toward 0.1 mm/year and therefore further constrain models of GIA and subsequent present-day ice mass change estimates at 45 degrees latitudes. Finally, we interpolate the data using weighted median estimation on a grid. The resulting velocity field is temporally and spatially robust, and edges in the field remain sharp. Our investigation results will be applied to the revised analysis strategies of vertical deformations over the Romanian region.

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Acknowledgement:
This paper was carried out within project SETTING Integrated thematic services in the field of Earth observation - a national platform for innovation, cofunded from the Regional Development European Fund (FEDR) through the Operational Competitivity Programme 2014-2020, Contract No. 336/390012 and NUCLEU Program MULTIRISC, supported by MCI, project no PN19080201

1.14 Investigations on the behavior of the sedimentary structure during earthquakes: the correlation between f0 and fpred

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Keywords: predominant frequency of resonance, seismic site effects, Vrancea crustal seismic area, H/V spectral ratio

Seismic site effects evaluation has a substantial impact on the assessment of seismic risk and hazard and it is a crucial step for the mitigation of potentially high seismic risk in densely populated urban regions. In this study, the predominant frequency of resonance (fpred) of S-waves was identified, interpreted and mapped along the regions covered by the National

Seismic Networks of Romania, Bulgaria and the Republic of Moldova, for the crustal event produced on November 22, 2014, with the magnitude of 5.7 ML, generated at a depth of 40 km in the Vrancea seismogenic area. The spectral ratio (H/V) technique was applied on the three – component single station measurements to investigate the local variability on each region. The predominant observed peaks coincide with the fundamental resonance frequency, f0, (calculated from the H/V technique applied to ambient vibration recordings) for some stations located on superficial sedimentary layers and reach values higher than f0 in the case of stations located on deep sedimentary basins. In case of the stations located along the Carpathian arc and in the intra - Carpathian area, the fpred are identified at almost all the stations as f0 from ambient vibration. In case of the stations located in the extra - Carpathian area, in the northern side of Danube river, fpred is matching the second peak or has a higher frequency indicating a complex seismic response of the Moesian Platform geological structure. A significant attenuation can be observed for the sites located outside of this area (i.e. Northern Bulgaria and Dobrogea), where fpred matches the fundamental one, the seismic energy generated by the crustal event is not able to excite superior vibration modes in the local structures. These new results increase our understanding of ground motion propagation by emphasizing the ground motion peculiarities in this area for Vrancea crustal events.

Acknowledgement:
The seismic networks cited are the Romanian Seismic Network (RSN, https://doi.org/10.7914/SN/RO), National Seismological Network of Bulgaria (BAS, https://doi.org/10.7914/SN/BS) and Moldova Digital Seismic Network (https://doi.org/10.7914/SN/MD).
The software suite Geopsy (www.geopsy.org) and ArcGis (www.esri.com/software/arcgis) has been used for this study.

1.15 The geomagnetic field variations recorded in Vrancea zone during 2000-2008 and the seismic energy release

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Keywords: geomagnetic anomalies, intermediate earthquakes, Vrancea zone,seismic energy released

This paper presents the relationship between anomalous geomagnetic variations recorded at the Muntele Rosu (MLR) station and the occurrence of intermediate-depth earthquakes. This research carries out geomagnetic data from September 2000 to May 2008. To better distinguish local anomalies from external geomagnetic variations (geomagnetic storms), the datasets recorded at Muntele Rosu (MLR), located inside the seismogenic zone, were compared with datasets recorded at Surlari (SUA), located 100 km away from the seismogenic area. For each geomagnetic anomaly identified, the seismic energy released daily was plotted logarithmically along with seismicity and Kp indices. So far, the variations are recorded only on the By component of the magnetic field and show two patterns, variations on the By component agree with small decreases/increases recorded over long periods and high decreases/increases of By component over long periods. To confirm the link between the magnitude of the geomagnetic anomaly measured at the Muntele Rosu seismic observatory (MLR) and the seismic activity of each anomaly, the standard deviation recorded on the By component of the magnetic field for each anomaly was calculated and compared to the total seismic energy released. The standard deviation measured on the By component (SDby) showed high values for anomalies accompanied by high seismicity and low values for anomalies with low seismicity. The morphology and variability registered on the By component of these local anomalies can be used in the partial prognosis of the seismicity from the Vrancea seismogenic zone. The correlation of the standard deviation with the released seismic energy will validate these models of local magnetic field behavior, and in the future, the standard deviation for the By component will be calculated for the 2000–2020 period.

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1.16 Determining the seasonal signal and noise in different CORS GNSS Network from Romania

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Keywords: GNSS time series; noise, seasonal signal, MLE

Daily coordinate time series from Global Navigation Satellite System (GNSS) exhibits important seasonal signals for horizontal and vertical component. These essential signals must be estimated because it plays a very important role in the final estimates, especially for site velocity. The seasonal signal experience mainly an annual and semi-annual period which can be modeled with a constant amplitude and phase-lag. The article is analyzing in terms of seasonality and noise 152 stations from 5 different Continuously Operating Reference Stations (CORS) that have GNSS stations in Romania. The importance of this study is twofold: the first one is given by the relevance of separating various geophysical signals which truthfully can reflect critical crustal deformation or the effect of different surface mass loadings, and second, is the compare relatively close stations which are part of two different CORS networks. Due to the fact that the underlying noise of the GNSS station is related to the seasonal signal, using Maximum Likelihood Estimation (MLE) we are able to estimate both seasonal signals, the type of noise and its amplitude for the Romanian GNSS CORS network. The results of the noise analysis show that at low frequencies we have spectral indices that varies between -2 and 0, which reveals that the dominant type of noise is flicker and random noise.

1.17 Photometry of the minor planet (99942) Apophis

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Keywords: Apophis, asteroid, photometry, light curve, minor planet, NEA, PHA.

Asteroids have the answer about how our solar system was formed, them being remains from that time. Most of the asteroids are found in the first asteroid belt between Mars and Jupiter, but even those are too far away and too many to send at each one of them a space probe to learn about them. What are we trying to do is to obtain as many information possible we can from the ground with telescopes. Obtaining a light curve is a method used to determine the rotational period of an asteroid. The most common one is the differential photmetry, where the brightness of an asteroid is compared with the magnitude of a star or more, stars that are not variable and similar to the light that the asteroid is reflecting, so Sun type stars. To do this, we need to observe and measure the brightness of an asteroid for a long period of time. The result of the photometric measurements is called a light curve, and it's a brightness variation graphic in time of the asteroid. Depending on the shape of the asteroid and the orientation of the axis of rotation, the minims and the maxims of a light curve may be uneven or even non-existent in case of a round asteroid. Using Fourier analysis we can identify a specific period of an asteroid. The rotation period of an asteroid, named synodic is equal with the time between two minimum or two maximum. The light curve depends on geometric considerations, phase angle, the angle that the axis of rotation makes with the direction Of observation and the obliquity orbit. In this conference, we present the photometry of the minor planet (99942) Apophis between January - March 2021. The images were taken with an 0.8 meter telescope - Calar Alto Schmidt (Z84) from Spain. The observations and measurements were part of the IAWN Apophis Campaign 2021.

1.18 The fragmentation of comet C/2019 Y4 (ATLAS)

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Keywords: comets, photometry, lightcurve

Using the remotely controlled telescope from Berthelot Observatory (MPC L54) we detected and monitored unusual cometary activity of long period comet C/2019 Y4 (ATLAS), involving the breakup of the nucleus of the long period comet C/2019 Y4 (ATLAS).
We observed three fragmentation events of the nucleus of comet C/2019 Y4 (ATLAS) and we determined that speeds separation between 35 and 70 m/s, speeds in good agreement with Hui and Ye (2020). We also found that at the last fragmentation, the new fragment had older dust emission that the old one (Frag. B).
We also studied the lightcurve the comet and concluded that it had two maxima of brightness, at T-65 and T-20 days before perihelion, and that the apparent magnitude was 10 magnitudes fainter that the predicted one.

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Acknowledgement:
This research has made use of the scientific software at www.comet-toolbox.com (Vincent, J.-B., Comet-toolbox: numerical simulations of cometary dust tails in your browser, Asteroids Comets Meteors conference, 2014, Helsinki).

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Section 2: Atomic and Molecular Physics. Astrophysics. Applications

Location and time: **Online**

Moderators:

Assoc. Prof. Dr. Mircea BERCU

Assoc. Prof. Dr. Vasile BERCU

2.1 - Nicoleta-Claudia JERCA, Leonard GEBAC
Structure of a hydrogen cluster inside of the dodecahedrane molecular cage

2.2 - Andrei-Ieronim CONSTANTINESCU, Ana CARAMETE, Laurentiu-Ioan CARAMETE
Gravitational Waves and Noise Classification Using Neural Networks

2.3 - Florentina PISLAN, Gergely KOSA, Voicu GRECU, Mircea BERCU
1D Model of Carbon Nanotubes for Longitudinal Wave Propagation

2.4 - Oana Stere
Tracking CMEs Using ESA's SWE Service Network

2.5 - Mihaela-Alina MUNTEANU, Leonard GEBAC
Encapsulation of Li inside dodecahedrane

2.6 - Răzvan A. BALAȘOV, Laurențiu I. CARAMETE
New growth mechanism for black holes and implications for future gravitational wave experiments

2.7 - Andra-Cătălina STĂNESCU, Vasile BERCU
EPR study of the antioxidant activity of some commercial products

2.8 - G. CHIRITOI, M. ZOTOV, E. M. POPESCU, F. POPESCU, F. CONSTANTIN, G. SIMIONESCU
Preliminary analysis of the TUS UV Telescope data taken in meteor/nuclearite mode above South-East Europe

2.9 - Vlad-Andrei BÂSCEANU, Alexandru JIPA, Florin Adrian POPESCU, Gabriel CHIRIȚOI, Eugeniu Mihnea POPESCU
Generation of synthetic images for the analysis of the centroiding algorithms used in the operational activities of the LISA Constellation Acquisition Sensor

2.1 Structure of a hydrogen cluster inside of the dodecahedrane molecular cage

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Keywords: dodecahedrane; ab initio; cluster; pressure; compression ;hydrogen

The study aims at investigating the geometries of a cluster of hydrogen atoms confined in the dodecahedrane C20H20. The theoretical analysis is based on ab initio quantum calculations at STO-3G level of approximation. The investigation focuses on calculating the geometries of the encapsulated hydrogen atoms while one of the cage's normal modes of vibration, called "breathing mode", is imposed. The expanded cage, in which the hydrogen atoms tend to arrange as separate molecules with hexagonal symmetry, is compressed. It is observed that, during compression, the geometrical arrangement of the encapsulated atoms changes into a regular hexagon and then, into a 3D crystalline structure. Also, the potential energy distribution inside the cage is calculated. Then, a force is derived and with it, the pressure is calculated. The order of magnitude found is around a few hundreds of GPa. It is suggested by the geometry of the atoms and by the order of magnitude of the pressure, that a transition from a molecular hydrogen into a metallic form may be observed during the compression of the dodecahedrane.

2.2 Gravitational Waves and Noise Classification Using Neural Networks

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Keywords: gravitational waves, noise, neural network

Gravitational waves (GW) have gained a lot of visibility since the first official gravitational wave has been detected in 2015 by the Ligo-Virgo Collaboration. Currently there are only ground-based gravitational waves detectors. LISA (Laser Interferometry Space Antenna) which is planned to be launched in 2034 will be a GW observer in space consisting of three

satellites with a range of 2.5 million kilometers between them that are placed in a triangle with different arm lengths. The two main objectives of this mission, among many other, are to detect gravitational waves as well as to emit alerts to other observatories for multi messenger astronomy purposes, meaning we want to observe the event that emits the gravitational waves from the gravitational and electro-magnetic point of view. In order to achieve these main objectives a fast signal analysis method is required on board of the satellites. Neural network (NN) algorithms have been approved for this kind of necessities. In this paper it is presented a recurrent bi-directional long-short term memory neural network that is capable to characterize and classify GW signals and noises. This NN characterizes GW signals and noise based on two spectral characteristics (instant frequency and spectral entropy), and classifies them by the source parameters. The NN is afterwards tested on a month worth set of data consisting mainly noise and just one GW signal in order to observe its performance.

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2.3 1D Model of Carbon Nanotubes for Longitudinal Wave Propagation

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Keywords: Carbon Nanotube, Deformation waves

Waves propagation in single walled carbon nanotubes (SWCNT) were calculated by means of a proposed 1D model. The 3D atomic structure has been represented as a chain of virtual atoms having the mass and positions corresponding to the single cell weight and to local mass center respectively. The interaction between the nearest neighbors has been represented by Morse type potential. The gap value was assumed from ab-initio molecular orbitals calculations, applied to two consecutive unit cells of the SWCNT. The equilibrium distance results from C-C chemical bonds of relaxed nanotube. The third parameter that gives the profile of the gap has been found by fitting the deformation waves velocities of 1D model , relative to that calculated for 3D-real structure of SWCNT. The representativity of the simplest model has been investigated for the propagation of the waves up to their first reflection at the opposite end of SWCNT, relative to that where external force is applied, more precisely below a strain of 9%. This study on the limits of 1D models has been developed to sustained analytic descriptions of energy transmission through carbon nanotubes via progresive and solitonic waves.

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2.4 Tracking CMEs Using ESA's SWE Service Network

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Keywords: space weather, ESA, CME

In this presentation it will be shown how to analyze a solar active phenomenon (particular case, the coronal mass ejection), using the existing data in the ESA's SWE Service Network. Starting from the ESC Solar Weather services for the

data observed at the surface of the Sun, I will follow the CME of interest into the interplanetary space with the help of ESC Helioshperic Weather. I will observe its evolution by studying several specific parameters and we will compare these data with the data recorded at the Earth's surface, using ESC Geomagnetic Conditions services. I will present all the products involved in this process, as well as the weather forecast services and alerts that we need in order to do our work.

References:
https://swe.ssa.esa.int/current-space-weather

2.5 Encapsulation of Li inside dodecahedrane

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

Fullerenes are molecules that present a great interest because of their unique structure and excellent properties. The most fascinating thing about these molecules is the capacity to encapsulate other atoms or clusters and transport them to the affected area and release them there. The present work investigates the formation mechanism of the endohedral system Li@C20H20. This theoretical study is based on ab initio molecular dynamics simulations at the level of approximation 6-31G. The static potential energy of interaction is calculated in the approximation of a fixed cage. It is observed that by launching the lithium atom with a kinetic energy almost equal to the height of the potential energy barrier, the incident atom is captured inside the molecular cage, which could represent a visual representation of a tunneling process in which the kinetic energy necessary to penetrate a potential barrier is less than the barrier height. Also, an algorithm to extract and to calculate the dynamic energies exchanged in the interaction is presented. It is observed that with the increase of the initial kinetic energy of the lithium atom, its minimum value of the kinetic energy is found at smaller values of the distance between the center of the pentagonal entry ring and the lithium atom. In addition, it is suggested that the radius of the pentagonal side is increasing slower in proportion to the initial kinetic energy of the lithium atom.

2.6 New growth mechanism for black holes and implications for future gravitational wave experiments

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Keywords: massive black hole star cluster growth accretion merging rate

The future gravitational waves observatories, including ESA's LISA Space Mission, will study the merging black holes (BHs) processes in great detail and also will shed light on the evolution of the BH masses. In order to estimate the detection rates for the future gravitational wave observatories, we conducted simulations to study the growth process [1-2]. Here, we describe the results of our investigations for a new implementation regarding the BH growth, star gulping (SG), in which stars are absorbed by BHs [3]. There are two main mechanisms for the growth of BHs, accretion of surrounding material and merging with another BH [4-9]. Both must be taken into account when one tries to model the growth processes of the most massive BHs (MBHs) from the moment of their origin to the present. Extensive studies and our own simulations showed that even if you consider these processes at their maximum, it is very difficult to grow BHs to the masses that we measure today. So, we performed detail simulations to study another growth mechanism, SG, that has the potential to add more mass to BHs. Our simulation setup is the following: we start with a Plummer distribution of stars in a star cluster and we perform

simulations without a central BH and, afterwards, with a central BH of 10^8 solar masses. We used the only star simulation as a base line to study the potential of stars to travel, in a normal star evolution scenario, close to the center of the star cluster and to enter a gravitational influence sphere generated by a 10^8 solar mass BH. This gave us a simple linear grow potential, the number of stars that enter the gravitational influence sphere increase linearly with time. When we place a BH in the center of our star cluster, the number of stars diminishes and the rate of growth for the BH is a direct characterization of how the star cluster is affected by the newly introduced gravitational potential. This new growth mechanism can affect not only the rate of merger, but also the overall evolution history of BHs and so it is very important to study it in great detail.

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2.7 EPR study of the antioxidant activity of some commercial products

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Keywords: Antioxidant, free radicals, resonance spectroscopy

It is well know that the oxidative stress is one of the most important risk factor in the pathogenesis of numerous diseases. An antioxidant is any substances which inhibits oxidative damage and this is carry out by trapping the free radicals. The antioxidant products contain compounds (phenolic acids, polyphenols and flavonoids) which scavenge this free radicals and thus inhibit the oxidative mechanisms. The antioxidant products are commercially available under the form of teas or food supplements. In this study we have used the Electron Paramagnetic Resonance (EPR) spectroscopy to analyses the antioxidant activity of some commercial products sold in pharmacies. By using DPPH scavenging assay method we demonstrate the antioxidant activity of the products and furthermore from the quantitatively analyses we successfully demonstrate the differences between the products.

2.8 Preliminary analysis of the TUS UV Telescope data taken in meteor/nuclearite mode above South-East Europe

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Keywords: Extended Air Showers, TUS, meteor, nuclearites

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 Tracking Ultraviolet Setup (TUS) detector was launched on April 28, 2016 as a part of the scientific payload of the Lomonosov satellite and recorded data for more than one year. During its operation, for short periods of time, TUS was switched in the meteor observation mode that allows the detection of luminous moving event with a time resolution of 6.6 ms. In the present contribution, we report the preliminary analysis of the data taken in meteor/nuclearite mode above South-East Europe.

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2.9 Generation of synthetic images for the analysis of the centroiding algorithms used in the operational activities of the LISA Constellation Acquisition Sensor

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Keywords: LISA mission, centroiding, synthetic images

At first, gravitational waves were a prediction of Einstein's general relativity theory, but as of 2017 when the Laser Interferometer Gravitational-Wave Observatory (LIGO) reported the first detection of such waves they became reality. Because the gravitational wave spectrum covers a large span of frequencies, the need for complementary observations arose. The Laser Interferometer Space Antenna (LISA) is the first space-based gravitational wave observatory that operates at frequencies between 0.1 mHz and 1 Hz. As of 2017, LISA was selected as the third large mission of the European Space Agency. This paper addresses the need and the preliminary results of the simulation of synthetic images. The purpose of these images is to evaluate different centroiding algorithms that will be used by the Constellation Acquisition Sensor (CAS) aboard the three spacecrafts in order for the three satellites of the mission to get precisely aligned into the triangular formation which will allow for the interferometric detection of gravitational waves.

Section 3: Biophysics; Medical Physics

Location and time: **Online**
Moderators:
Prof. Dr. Aurel POPESCU
Assoc. Prof. Dr. Claudia CHILOM

3.1 - Claudia G. CHILOM, Aurel I. POPESCU
High performances of biosystems, bionics and beyond bionics

3.2 - Andreea Alexandra UDREA, Mihai DUMITRACHE, Alina DUMITRACHE, Maria VLĂSCEANU, Aurel POPESCU
End-to-end IMRT evaluation using the CIRS thorax phantom

3.3 - Nicoleta SANDU, Claudia CHILOM, Sorina IFTIMIE, Maria BĂLĂȘOIU, Andrey ROGACHEV, Oleg ORELOVICH, Sergey STOLYAR
Spectroscopic and molecular docking study of interactions between chemically synthesized ferrihydrite nanoparticles and human serum transferrin

3.4 - Mihai Daniel SUDITU, Alexandru Daniel OLĂRESCU, Cosmin Marian MIU, Loredana Elena MILITARU, Alexandru OPREA
Comparison of two detector array solutions for radiosurgery patient specific quality assurance

3.5 - Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Mihaela BACALUM, Vlad-Andrei ANTOHE, Sorina IFTIMIE, Stefan ANTOHE
Bio-NanoPlatinum generated from nettle leaves and grape berries: potential applications in osteosarcoma therapy

3.6 - Andrei ANICA, Mihai Daniel SUDITU, Loredana Elena MILITARU, Alexandru OPREA, Cosmin Marian MIU, Alexandru Daniel OLĂRESCU, Dana Lucia STĂNCULEANU
Dosimetry analysis on IMRT-VMAT technique in Hippocampal-sparing whole brain irradiation with simultaneous integrated boost for metastatic cancer

3.7 - Mihai-Ștefan BÂRHALĂ, Cristina PETROIU
The acceptance and commissioning of the linear accelerator Halcyon

3.8 - Alexa CREȚU, Nicoleta SANDU, Claudia CHILOM
Bovine serum albumin properties in the presence of rutin

3.9 - Ana-Maria UDREA, Simona STROESCU, Mihai BONI, Mihail Lucian PASCU, Angela STAICU
Mechanism of action prediction of TPPS4 photosensitiser in melanoma treatment using molecular docking

3.10 - Ana-Maria IGNAT, Nicoleta SANDU, Claudia CHILOM
The interaction of BSA and levothyroxine with vitamins C, B12 and folic acid

3.11 - Andreea-Cristina POPA, Oana RISTEA
Monte Carlo study of doses produced by different nuclear radiations in radiotherapy

3.12 - Ioana FIDEL, Diana SERAFIN, Florin TELEANU, Silvana VASILCA, Roxana POPESCU, Andi CUCOANEȘ, Paul VASOS, Vasile BERCU
Magnetic resonance methods in the study of the effects of ionizing radiation on biological systems

3.13 - Alina Mihaela PĂUNOIU, Mihaela Raluca MITITELU, Maria Alina GHERMAN, Alexandru JIPA
Scintigraphy and its role in medical imaging

3.14 - Roberta Maria NEAGOE, Mihai DUMITRACHE
Radiotherapeutic treatment of prostate cancer by Intensity-Modulated Radiation Therapy (IMRT) vs. 3D Conformal Radiation Therapy (3D-CRT)

3.15 - Mădălina-Georgiana CHIVU, Marcela-Elisabeta BĂRBÎNȚĂ-PĂTRAȘCU, Mihaela BACALUM
Artificial lipid membranes: applications in cancer therapy

3.16 - Andreea IONESCU, Mihai DUMITRACHE
Treatment of ears, nose and throat (ENT) malignant lesions by Intensity-Modulated Radiation Therapy (IMRT)

3.17 - Tia POPESCU, Cristina PETROIU
Annual quality assurance tests for medical linear accelerators

3.18 - Melania-Beatrice ISTRATI
Assurance of the optimal conditions in radiotherapy treatment

3.1 High performances of biosystems, bionics and beyond bionics

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The living matter is an inexhaustible source of ingenious solutions to a large variety of biological structures and functions the biosystems are endowed with. These optimal solutions are a direct consequence of the competition for resources (food, water, air, and space) and, consequently, of the natural selection permanently exerted during the long evolution of life on Earth. This work presents some examples of such surprising solutions and their transfer from living matter to engineering and medicine. This transfer offers a fertile perspective to future technologies, which are claimed to be cheaper, more efficient, and ecological. Due to human cleverness, some practical bionics products have already overpassed the Nature performance!

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3.2 End-to-end IMRT evaluation using the CIRS thorax phantom

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Keywords: end-to-end test, intensity modulated radiation therapy, point dose, uncertainty, patient specific quality assurance

The purpose of this study was to evaluate the intensity modulated radiation therapy (IMRT) treatment chain using the ”end-to-end” approach, i.e. following the pathway similar to that of a real patient, through imaging, treatment planning, and dose delivery. For this work, a CIRS Thorax Phantom 002LFC which represents an average human torso in proportion, density, and 2D structure, was used. The dose-volume objectives and constraints were selected according to those currently used by eight radiotherapy (RT) centers participating in International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP) E24017 Program. Point dose measurements were performed with the Semiflex 0.125 cc ionization chamber in different locations into the phantom: the planning target volume (PTV) and organs at risk (OARs) followed by a 2D dose

distribution measurement with a diode array. The combined standard uncertainties (k = 1) associated with the dose measurements were calculated. Overall, the results showed that that in our radiotherapy department, an accurate treatment delivery, within the recommended tolerance, is achieved, thus confirming a high quality of IMRT clinical implementation.

3.3 Spectroscopic and molecular docking study of interactions between chemically synthesized ferrihydrite nanoparticles and human serum transferrin

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Keywords: ferrihydrite nanoparticles, human serum transferrin, binding mechanism, molecular docking

Human serum transferrin (HST) is a glycoprotein that binds and transports iron and other ligands such as flavonoids and vitamins in human plasma. Considering this aspect in this study the interaction between HST and simple ferrihydrite nanoparticles (Fh-NPs) but also doped with cobalt (Co) and copper (Cu) was analyzed by spectroscopic and molecular docking approaches. Fluorescence spectroscopy and molecular docking studies revealed that Fh-NPs bind with a low affinity to HST characterized by a static quenching mechanism of the fluorescence of the HST by the simple Fh-NPs and a combined mechanism for the NPs doped with Co and Cu. Fluorescence resonance energy transfer (FRET) allowed the estimation of the distances between the donor (HST) and the acceptors (Fh-NPs). The distance estimated between the donor (HST) and the acceptor (Fh-NPs) in the range of 3.10 - 3.23 nm is less than 7 nm which indicates that the energy transfer occurs with high probability between HST and nanoparticles. To establish the stability of the apo-HST and HST-NPs at different temperatures the denaturation temperature (Tm) was determined. The results obtained almost the same transition of temperature for all HST-NPs complexes, but the presence of NPs seems to increase the protein stability. The biophysical effect of Fh-NPs on serum proteins can be an important step in their use in biological applications as hyperthermia, drug targeting, and diagnostic applications.

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3.4 Comparison of two detector array solutions for radiosurgery patient specific quality assurance

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Keywords: radiation therapy, radiosurgery, patient specific quality assurance;

Linac based radiosurgery has evolved substantially and has become a viable solution for treating brain metastases. Because of very high complexity of radiosurgery treatments, the patient specific quality assurance process is a mandatory and

complex step and the selection of proper detector array is crucial. Purpose: The purpose of this work is to compare two commercially available patient specific quality assurance devices, with different detector arrays: PTW Octavius 4D with SRS1000 detector matrix and SunNuclear SRSMapCheck. Material and method: A radiosurgery treatment plan was made for a group of five patients with single brain metastases, using Philips Pinnacle treatment planning system. The plans were delivered using Elekta VersaHD linac with Agility Collimator equipped with flattening filter free beam. The dose delivered to target was in the rage of 18-20 Grays using a single treatment fraction. Results: Both devices showed good agreement between the calculated dose distribution and measured dose, for all plans the gamma analysis passing rate for both 2 percent dose difference, 2 mm distance to agreement and 3 percent dose difference, 1 mm distance to agreement was higher than 95%. Conclusions: Both devices present a viable solution for radiosurgery specific quality assurance with the mention that SRS 1000 detectors have high dose rate dependence that needs to be taken into account, requiring more steps during measurements and cannot be used for measuring non coplanar beams.

3.5 Bio-NanoPlatinum generated from nettle leaves and grape berries: potential applications in osteosarcoma therapy

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Keywords: “green” platinum nanoparticles; osteosarcoma; antiproliferative activity

Cancer remains the leading cause of millions of deaths annually, worldwide. Every year many people are diagnosed with osteosarcoma, the most common type of cancer starting in the bones. Recent advances in Green Nanotechnology are trying to fight against this disease. Thus, a special interest has been given to noble metal nanoparticles. In this study, bio-platinum nanoparticles (bio-PtNPs) were generated through a “green” bottom-up approach, from an aqueous extract of a mixture of nettle leaves and grape berries. The obtained bio-PtNPs were characterized by UV-Vis absorption spectroscopy, as well as by Scanning Electron Microscopy (SEM) and Atomic Force Microscopy (AFM). These bio-PtNPs presented antiproliferative activity against MG-63 osteosarcoma cells. The morphology of MG-63 cells treated with various doses of bio-PtNPs was studied by epifluorescence microscopy. These findings could be exploited in the development of novel biohybrid systems to be used in osteosarcoma therapy.

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3.6 Dosimetry analysis on IMRT-VMAT technique in Hippocampal-sparing whole brain irradiation with simultaneous integrated boost for metastatic cancer

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Keywords: radiation therapy, hippocampal-sparing, volumetric modulated arc therapy

Background: Advanced radiotherapy treatment techniques limit the cognitive morbidity associated with whole-brain radiotherapy (WBRT) for brain metastasis through avoidance of hippocampal structures. However, achieving durable intracranial control remains challenging. Methods: We conducted a single-institution single-arm phase I trial of hippocampal-sparing whole brain irradiation with simultaneous integrated boost (HSIB-WBRT) to metastatic deposits in adult patients with brain metastasis. Radiation therapy consisted of intensity-modulated radiation therapy delivering 30 Gy in 10 fractions over 2 weeks to the whole brain with a simultaneous integrated boost of 40 Gy in 10 fractions to metastatic lesions. Hippocampal regions were limited to a maximum dose of 17 Gy. Patients were treated using an Elekta VERSA HD equipped with the Agility™ 160 multileaf collimator for high-speed Results: A total of 29 patients, median age 54 years (interquartile range, 54-65), were enrolled. Mean dose for hippocampus was 9 Gy when the boost was located at a distance greater than 1 cm from hippocampus avoid region and the maximum dose was 16 Gy. For patients with boost < 1 cm from hippocampus avoid region, the dose obtained could not met the dose constraints for hippocampus Conclusions: Hippocampal-sparing whole brain irradiation with simultaneous integrated boost for metastatic cancer is feasible when the boost is administered > 1 cm from hippocampus avoid region. For patients with metastatic lesions < 1 cm from hippocampus avoid region, the dose constraints could not be met.

3.7 The acceptance and commissioning of the linear accelerator Halcyon

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Keywords: Acceptance; Commissioning; Linear Accelerator

In the past years, because of the increase in the number of cancer patients, it was necessary to accelerate the process of finding new and innovative ways of treating this disease. Aside from the surgical intervention, the chemotherapy treatment and even the immunotherapy treatments, radiotherapy started to be a viable alternative or concomitant treatment, once the understanding and perfecting of the devices reached its peak. This method of destroying cancer cells by means of ionizing radiation had a significative evolution in the past 50 years, now that the top-tier methods of irradiation started to be available with ease, also being able to use different beam types, like X-ray beams, electron beams, proton beams and so on. From the point of view of this treatment method, in the present, being taken into account the degree of error given by all the devices used for measuring data, along with the errors given by the linear accelerator itself, by means of its component movement or radiation beam deviation, the dose that has to be delivered to the target volume should not deviate more than 5% out of the prescribed dose. This criterion assumes a high degree of responsibility from the physicist team at the moment of measuring and implementing a linear accelerator with the purpose of treating patients. These steps assume two sequences of measurements, the first one, in which the specific parameters of the linear accelerator are compared with the data given by the vendor and the second sequence, in which specific parameters needed to be implemented in the treatment planning system. Keeping this in mind, the responsibility of the medical physicist is to assure the correct measurements, so that the treatments could be performed with a high degree of confidence, leading to the final purpose of the treatment, the local control of the tumor or palliative action.

References:

3.8 Bovine serum albumin properties in the presence of rutin

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Keywords: BSA, rutin, quenching mechanism, FRET, denaturation

Bovine serum albumin (BSA) is the most abundant globular protein in the circulatory system. In the biomedical field, BSA is mainly used as carrier protein for small molecules and drugs, due to the long half-life, preferential accumulation in tumor tissue as a result of the enhanced permeability and retention effect and due to the ability to cross the blood-brain barrier. The drugs used for chemoterapy bind to BSA in three ways: covalent, non-covalent and as nanoparticle formulations [1]. Rutin is a flavonoid in the flavonol category, found in fruits, vegetables, tea and wine. It is a highly potent molecule obtained from the process of glycosylation of quercetin that has various medical, pharmaceutical and biological activities such as hepatoprotective, cardioprotective and antidiabetic activity [2]. Rutin acts as a strong antioxidant agent, by neutralizing free radicals and preventing lipid peroxidation. It has anti-inflammatory, anticancer and antibacterial properties. Rutin can cross the blood-brain barrier and fight neuroinflammation, being a very effective compound for treating neurodegenerative diseases, such as Alzheimer's and Parkinson's disease. The aim of this study was to assess the physico-chemical properties of BSA, its stability under the action of temperature and urea and the changes induced by rutin in the conformational stability of the protein. The spectroscopic techniques used were fluorescence spectroscopy and Förster resonance energy transfer (FRET). For both thermal and chemical denaturation, the fluorescence quenching was observed. Using van't Hoff representation, the thermodynamic parameters that characterize the process of thermal denaturation, such as entropy and enthalpy variation and the melting point for apo-BSA and BSA in the presence of rutin were determined. The distance between the two fluorophores and the efficiency of the energy transfer between the BSA and rutin were evaluated based on FRET.

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3.9 Mechanism of action prediction of TPPS4 photosensitiser in melanoma treatment using molecular docking

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Keywords: Melanoma; Photodynamic therapy; TPPS4; Molecular Docking

Melanoma appears when the melanocytes become maligned. Usually, melanomas appear on the skin but may also occur in the brain or gastrointestinal tract. Melanoma had a bad prognostic: for the five-year relative survival rate, for patients with stage IV melanoma, is 10% [1]. Photodynamic therapy (PDT) is an alternative cancer treatment. PDT uses a light source to photoactivate a sensitiser to generate singlet oxygen. Previous studies reported that PDT had positive results in melanoma [2–4]. This study investigates 5,10,15,20-tetrakis(4-sulfonatophenyl) porphyrin (TPPS4) efficiency as a photosensitiser in melanoma treatment using Molecular Docking simulations. The photosensitiser should be close to the target since singlet oxygen has a short migration. We predicted the binding affinity of the photosensitiser to receptors that might be a target in melanoma or PDT treatment. The predictions include: Serine/threonine-protein kinase B-raf (BRAF), erythropoietin-producing hepatocellular receptor A2 (EphA2), B-cell lymphoma-extra-large (Bcl- xL), Myeloid cell leukemia 1 (Mcl-1),

BID, Proaspase-3 and Procaspase-7. We obtained high biological activity (due to low free energy of binding) on all the possible targets in PDT or melanoma. The shifted position of the TPPS4 from the binding sites of the target also suggests that the photosensitiser has no effect without light exposure after administration.

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3.10 The interaction of BSA and levothyroxine with vitamins C, B12 and folic acid

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Keywords: BSA, vitamins, levothyroxine, competitive binding, protein stability

Bovine serum albumin (BSA) is a globular protein with many significant properties such as transport, antioxidant and anti-inflammatory functions. The structure and the stability of BSA depend of pH value, temperature or antioxidants such as vitamins. Furthermore, due to its ability to improve the results of patients with cirrhosis, BSA is considered a niche medicine and it is used in manufacturing process of the biopharmaceuticals. The most recommended treatment for thyroid dysfunctions is levothyroxine (LT4), the synthetic form of the thyroid hormone T4 [1]. Thus, in case of hyperthyroidism, LT4 is suppressing the concentration of hormones produced by the thyroid gland. On the other hand, when a patient suffers of hypothyroidism, LT4 is used as a replacing hormone. The vitamins are organic compounds which can be classified as water soluble vitamins and fat soluble vitamins. One of the best known and used water soluble vitamins is the vitamin C, which has an essential role in formation of tendons and skin. Vitamin B12 is an important factor in the production of erythrocytes and performs important roles at the cellular level. Folic acid is an essential vitamin for cell growth and it is responsible for the DNA synthesis, being a recommended treatment in pregnancy. The structure of the BSA protein is influenced by the action of the vitamins and thyroid hormone T4 [2]. The aim of this study was to determine the stability of BSA protein in terms of structure as well as to present the binding mechanism of the vitamins C, B12 and folic acid to the BSA-LT4 complex. By using fluorescence methods, important parameters have been determined – the strength of the interactions and the thermodynamic parameters - enthalpy and entropy variation along with the Gibbs free energy variation.

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3.11 Monte Carlo study of doses produced by different nuclear radiations in radiotherapy

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Keywords: Monte Carlo, ion beams, simulation, hadrontherapy, SRIM, GEANT4

Protons and heavy ion beams at high energies, due to the specific interaction mechanisms with matter, have some advantages in the treatment of deep local cancer, as compared to the photon or electron beams that are usually used in traditional radiotherapy. A special feature of hadron therapy is low entrance dose in tissue and the Bragg peak which represents the maximum delivered dose towards the range's end. Additionally, heavy ions have a higher biological efficiency in the Bragg peak region, generated by intense ionization and in conjunction with a lower cell repair rate make them the perfect candidate for radiotherapy of local tumours. GEANT4 (Geometry ANd Tracking) and SRIM (Stopping and Range of Ions in Matter) Monte Carlo codes were used to simulate different ion beams striking different types of tissues and to study the stopping power and the range of analyzed ions. We will present the results of the simulations of protons and heavier ions (C-12 and O-16) in different materials using the mentioned Monte Carlo codes. The interactions of these ions have been studied in bone tissue, blood, and striated muscles for a wide energy range (50-300 MeV per nucleon). The energy and material dependence of the stopping power, Bragg curve, and range of protons, C-12 and O-16 ions will be presented. Both simulation code data and the obtained results are similar. Due to the higher electric charge, the heavier ions energy loss per unit length is larger compared to the proton dE/dx, for all studied energies.

3.12 Magnetic resonance methods in the study of the effects of ionizing radiation on biological systems

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Laser radiation can accelerate particles, which in turn act as ionizing radiation. This type of radiation is similar to that produced by particle accelerators. When interacting with matter, a series of reactive molecular species are generated such as the hydroxyl radical (*OH) or the superoxide anion (*O2-)that play a negative role in cell development. These free radicals are paramagnetic species that have an unpaired electron on the valence layer. A significant increase in free radical concentration will lead to alteration and malfunction of nucleic acids, enzymes or proteins, also changing the concentrations and kinetics of metabolites inside cells. Investigation of water radiolysis may provide representative results for investigating the interaction of radiation with matter because water is found in large amounts in the body [1] and studies show that most ionization due to interaction with radiation is caused by contact with water [2]. The spin-trapping technique involves the capture of free radicals (which have a short lifespan) by a spin trap that leads to the formation of a longer-lived adduct (molecular species that resist for minutes or longer in solution at ambient temperatures). Paramagnetic electron resonance spectroscopy is used to detect the presence of unpaired electrons in biological samples [3]. The experiments we have conducted have the role of preparing the future experiments that will be performed with the help of high-power lasers. Following irradiation with protons or electrons of water samples with BMPO, at different dose rate, a series of EPR analyzes were performed in order to obtain information about the type and quantity of free radicals produced. We comment in this work on the observed quantities of free radicals and draw preliminary conclusions about the possibility of following by magnetic resonance the effect of radiation with different dose rates on living systems.

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3.13 Scintigraphy and its role in medical imaging

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Keywords: diagnosis, scintigraphy, radiopharmaceutical, distribution, SPECT/CT

Modern nuclear imaging methods have become indispensable tools in investigating and treating various diseases. The widespread use of SPECT (Single Photon Emission Computed Tomography) and PET (Positron Emission Tomography), fused with CT (Computerized Tomography) are key technologies, which provide ample information in terms of diagnosis. A more specific, non-invasive, imaging technique is scintigraphy, employed to locate certain anomalies in the body, related to either bones or soft tissues. The aim of this study was to highlight the importance of scintigraphy by observing the distribution of radioactivity of several radiopharmaceuticals. Each one corresponds to a different type of investigation, namely of bone, salivary gland, kidney, parathyroid and neuroendocrine system. The radiotracers employed were 99mTc – HDP, 99mTc – pertechnetate, 99mTc – DTPA, 99mTc – MIBI, 99mTc – Tektrotyd. They were delivered to the patients, taking into consideration factors such as weight, in the case of bone scintigraphy, and dose limits, specific to each acquisition protocol. Once injected, the radiopharmaceuticals accumulate in target organs and emit gamma rays, which are detected by a pair of gamma cameras belonging to a SPECT/CT scanner. The resulting scintigrams provided valuable information about the structure and function of the areas of interest. Parathyroid and neuroendocrine scintigraphies implied the additional use of hybrid SPECT/CT technology, which offered more accurate results due to its high image quality.

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[2] T. K. Gupta (2013) Radiation, Ionization, and Detection in Nuclear Medicine, Edition Springer
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3.14 Radiotherapeutic treatment of prostate cancer by Intensity-Modulated Radiation Therapy (IMRT) vs. 3D Conformal Radiation Therapy (3D-CRT)

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Keywords: Radiotherapy, prostate cancer, IMRT, 3D-CRT

This work describes the experimental steps we carried on during planning of radiotherapy treatment for prostate adenoma by two radiation therapy techniques, namely intensity-modulated radiotherapy (IMRT) and three-dimensional conformal radiotherapy (3D-CRT). A set of treatment plans were compared in terms of dose distributions and dose delivered to critical structures in the vicinity of target volume. To optimize and evaluate the treatment, some figures of merit specific to computerized dosimetry were used. Then, to highlight the main differences, we present and comparatively evaluate the

dosimetric parameters for a group of 10 patients subjected to the two treatment methods. To certify that the treatment and the results comply with the well accepted evaluation rules regulating the radiation exposure of organs to radiological risk, and appreciate the dose homogeneity within the target volume, we present examples of dose-volume histograms and the values for the homogeneity index. Previous results and the analysis of our values allows us to conclude that, in most cases, the IMRT technique is superior to the 3D-CRT one.

3.15 Artificial lipid membranes: applications in cancer therapy

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Keywords: liposomes, folic acid, silver nanoparticles

It is well known that cancer is a vast clinical and research domain being very interesting one in the scientific fields. This disease is in the attention of the researchers and physicians, in order to find new methods for therapy. To achieve this goal, researchers are turning their attention to the world of nanotechnology. In the last decade, metal nanoparticles have been shown to have a significant effect in improving the specific targeting of drugs in cancer therapy. In this study, folic acid-functionalized silver nanoparticles (FA-AgNPs) have been shown to be effective against HT-29 colon cancer tumor cells, in a concentration-dependent manner. Thus, for FA-AgNPs concentrations higher than 0.71 µM, the viability of HT-29 cells decreased drastically. These metallic nanoparticles can be used as therapeutic agent delivery systems, being useful for the development of an alternative treatment strategy for cancer therapy in the near future. Chlorophyll a (Chla) was used as an optical sensor to monitor in vitro, by UV-Vis absorption spectroscopy, the effect of FA-AgNPs on artificial cell membranes. Chla detected the insertion of FA-AgNPs into artificial lipid membranes. Thus, as the concentration of FA-AgNPs increased, the spectral signature of absorbance of Chla in the biomimetic membranes changed. This can be explained by generation of an energy transfer or electron transfer process when the porphyrin ring of Chla located at interface of the lipid bilayer/aqueous medium interacts with the FA-AgNPs surface. Folic acid-functionalized AgNPs can be used in the development of liposome-based biohybrids, which can be used in the treatment of colorectal cancer.

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3.16 Treatment of ears, nose and throat (ENT) malignant lesions by Intensity-Modulated Radiation Therapy (IMRT)

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Keywords: Radiotherapy, IMRT, cancer treatment

Our work assesses the strategy of designing treatment plans for ENT (ears, nose and throat) malignant lesions by an advanced computerized method, namely IMRT (Intensity-Modulated Radiation Therapy). Specifically, we show that it is possible to deliver higher doses of radiation to a tumor while affecting less the surrounding healthy tissues in comparison with other treatment techniques (e.g., 3DCRT). A number of 15 treatment plans were devised and evaluated in terms of computerized dosimetry parameters such as dose-volume histograms, homogeneity, and conformity indexes. To examine the quality and extent to which the treatment plans agree with the general rules regarding the radiation exposure of surrounding organs to radiological risk, we compared the results against the QUANTEC (Quantitative Analysis of Normal Tissue Effects in the Clinic) recommendations concerning the level of exposure of the healthy organs. In most cases, all prescribed doses

were delivered appropriately while protecting the adjacent organs as much as possible. However, in a few cases, the values obtained for the parotid glands exceeded the benchmarks due to the fact that these organs were partially included in the planning target volume. In such circumstances, according to the ALARA principle (as low as possible achievable), the dose constraints were applied to reduce the exposure without adversely affecting the dose distribution.

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3.17 Annual quality assurance tests for medical linear accelerators

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Keywords: Quality Assurance; Linear Accelerator;

In the last few years an uprising attention was pointed towards the treatment quality of oncologic patients, keeping in mind that every patient deserves to receive the best treatment suited in order to obtain the cure, the long term control of the tumor or the palliation. This aspect became more and more achievable with the technological advance regarding the equipment used for treatment or even the devices used for the verification of the treatment. Keeping this in mind, it is necessary the introduction of a quality assurance program in every radiotherapy department, so that trough verifications, the patient will receive the best care. This quality assurance can be defined by the totality of test and procedures, so that the delivery of the treatment to respect the prescribed dose and also to achieve the adequate and reproducible distribution of dose in the target volume. A quality assurance program contains a series of tests performed on the treatment equipment, whose frequency is given by the importance of that parameter or the way in which the analyzed parameter is fluctuating in time. At the reception of a new device or after a serious intervention that implies modification of the known parameters, it is necessary to establish the baseline values for every parameter that has to be verified. The main purpose of the quality assurance program is that the functioning of the linear accelerator, or its parameters, do not deviate significantly from the reference values obtained during the commissioning or acceptance. This is very important because the majority of the tested parameters are used in the treatment planning system in order to calculate the dose delivered patients. In order to avoid any significant errors, those tests should be simple, fast and reproducible. For this purpose, in the past years the development of specialized devices for quality control has expanded, according to the general recommendation of TG-40, so that the tests are performed in a more efficient manner. Also, it is recommended that the measuring devices should detect the changes smaller than the tolerance levels of the analyzed parameter.

3.18 Assurance of the optimal conditions in radiotherapy treatment

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Keywords: radiotherapy, absorbed dose, water phantom

A certain level of accuracy in the dose supplied to the patient is essential to get a favorable clinical outcome in radiation treatment. Because the absorbed dose determination is complex and dependent on a variety of external and internal factors, the dosimetry communities:International Atomic Energy Agency (IAEA), the Bureau International des Poids et Mesures (BIPM), the International Commission of Radiation Units and Measurements (ICRU)have introduced protocols for physicists. This work focuses on calculating the uncertainty of the dose absorbed in water during a routine calibration for clinical beams of radiations in the range of energies used in external-beam radiotherapy. We performed the calibration of the electrometer, considering different components of uncertainty (temperature, pressure, polarity effect and recombination effect). The beam quality correction factor was theoretically determined using Monte Carlo simulations. Throughout the

entire work, we were able to determine dose at the depth of dose maximum from measurements made at the reference depth for photon beams. The calibrations were carried out in a water equivalent phantom utilizing water proof ionization chambers for a 10 cm × 10 cm field size and at SSD = 100 cm (SSD - the distance between the source and the phantom surface). The results match the calibration factors for a cylindrical ionization chamber in Clinac iX medical linear accelerator from the Institute of Oncology Bucharest (IOB), Romania. The calibration procedure follows the IAEA TRS-398 reference Code of Practice.

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Section 4: Nuclear and Elementary Particles Physics

Location and time: **Online**

Moderators:

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Prof. Dr. Ionel LAZANU

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Wobbling Phenomenon in Odd-Mass Nuclei

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Cosmic rays and radiation protection

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Atomic spectrometry techniques applied in the analysis of the spectrum of chemical pollutants in the sludge resulting from urban wastewater treatment. Statistical interpretation.

4.19 - Radu DOBRE, Elena FIRU, Ionel LAZANU, Titi PREDA
The DsTau experiment (NA65): Study of tau neutrino production at the CERN-SPS

4.1 Faculty of Physics and the fifty years of Relativistic Nuclear Physics with accelerator systems

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Dr. Phyllis Freier and his team, in 1948, begun the studies of the relativistic heavy ion collisions using cosmic rays. Since the beginning of the '70, accelerator systems have been used for such studies. At the JINR Dubna, the Synchrophasotron U-10 and a linear accelerator, for injection, have been used for investigation of the cumulative negative pions production in d-C collisions at 5 A GeV. After this moment, many people worked in the filed and extremely scientific results have been obtained. In the fifty years of relativistic and ultra-relativistic heavy ion Physics using accelerator systems many important results and discoveries have been reported, including those related to the quark-gluon plasma formation and connections with the Big Bang cosmological scenario. This work try to present the involvement of members of the staff and students of the Faculty of Physics, University of Bucharest, in this very interesting and important filed, from the cumulative production of the pions, to the quark-gluon plasma formation and new Physics.

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4.2 Overview of Neutrino-Nucleus Interactions - incomplete theoretical knowledge of the nuclear effects

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Keywords: neutrino nucleus interactions, experimental data, models, computing codes

It is clear that at present more ambiguities of the neutrino interactions with nuclei exist. This is a stringent problem for the next generation of neutrino experiments. The experimental results are insufficient and non-systematic and a complete theory or extended models for neutrino interactions with nuclei do not exist. A way to solve these difficulties consists in trying to find the best models for different processes. But those models have free parameters and an indispensable way to solve the problem is to obtain a great number of experimental data for a large range of energies and higher numbers of interaction processes. In any process will exist initial interactions, several different (competing) nuclear effects and different detector resolutions. These experimental results for different types of hadrons in nuclei must be considered for modeling the intranuclear processes and represent a way to choose between models and to impose a constrain of the parameters in those models. The analysis presented in this communication puts in evidence the necessity to identify a way to isolate different channels and thus to constrain models, or to find new observables that permit to separate out different effects. In parallel, in this presentation, an analysis of different event generators was done. A particular discussion about the models of interactions included in the new Marley code for 40Ar(νe, e−)40K* inclusive cross-sections was done.

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4.3 Preliminary results on neutrons TOF experiment using the Neutron Array

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We have refurbished and tested a neutron array composed of 81 BC400 plastic scintillator detectors dedicated for neutron measurements in future fusion-fission experiments (1). The Neutron Array (NA) detectors, installed at the 9MV Tandem accelerator facility of the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH), have been refurbished and the data acquisition system has been updated (2). We present the characteristics and performances of the NA and of the associated electronics.

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4.4 Soft Photon Study in Hadron and Nuclear Interactions

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For over 30 years there has been no comprehensive understanding of the mechanism of soft photons formation. Soft photons (SPh) are the direct products of high energy interactions. They are not decay products of secondary particles and their energy is smaller than 50 MeV. Experimental data indicate an excess of their yield in hadron and nuclear interactions. The existing theoretical calculations based on the quantum electrodynamics can not predict and explain this excess. For a more thorough study of this phenomenon the building of the future accelerator complex NICA makes possible to carry out such studies in different interactions. Up to now the nature of SPh remains enigmatic. Apparently, they are formed in the region of non perturbative quantum chromodynamics and physicists build phenomenological models. The most successful model is based on the hypothesis of the cold quark-gluon plasma (QGP) formation. This model implies the formation of a quark-gluon system which consists of a few quarks, antiquarks and gluons (about 40 partons). These partons are encountering each other and reradiate soft photons because they do not have enough energy to produce hadrons, the main reactions being Compton scattering and pair annihilation.

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4.5 On the possibility of strangelets detection

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The new generation of neutrino experiments opens a window for searches of physics Beyond Standard Model (BSM), a particular case being strange quark matter (SQM) that is a hypothetical strongly interacting matter composed of roughly equal numbers of u, d, s quarks and a small number of electrons. The SQM objects are considered as cold dark matter candidates and may be present in the cosmic radiation reaching Earth. Light SQM objects ($A < 10^{7}$) are usually called strangelets, while heavier ones are known as nuclearites. In this communication, we are exploring the peculiarities of strangelets interactions and also the possibility to put in evidence the capabilities of this material to detect and identify the produced signals.

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4.6 New ways in the investigation of the very dense and hot nuclear matter

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Keywords: nuclear matter in extreme collisions, phase transitions, bulk and specific properties

The relativistic and ultrarelativistic nuclear collisions offer an unique opportunity to investigate nuclear matter in extreme conditins. There are significant results and methods for these investigations. In the present work we try to combine old and new results. Some connections with experiments (SKM 200, at JINR, BRAHMS, at RHIC-BNL, CBM, at FAIR-GSI) are presented.

4.7 SPATIAL SYMMETRY BREAKING EFFECTS IN SLOW NEUTRONS INTERACTIONS WITH LEAD NUCLEUS

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Keywords: slow neutrons, spatial parity breaking, non-leptonic weak matrix element

Spatial parity breaking effects in the interaction of slow and resonant neutrons with Lead nucleus will be investigated. For scattering and capture processes spin rotation, asymmetry of emitted neutrons and asymmetry of emitted gamma quanta were evaluated and compared with existing experimental data. Spatial parity violation effects were evaluated in the frame of the formalism of the mixing states of compound nucleus with the same spin and opposite parities [1]. Applying the approach described in [2], from theoretical evaluations related to scattering and capture experimental data, weak matrix element was extracted. Matrix element of weak non leptonic weak interaction is of order of meV and in the range of slow neutrons, parity violation effects are of order of 10-6-10-4 and lower. Similar values were obtained in the analysis symmetry breaking effects on other processes and nuclei [2]. From obtained results the existence of a new negative resonance near the neutron threshold it is confirmed [3]. Symmetry breaking effects in the scattering and capture process on Lead nucleus are planned to be measured at basic facilities from FLNP JINR Dubna and from other neutrons research centers from Russia and abroad.

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4.8 Radiation hardness studies of RPCs based on low resistivity glass

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

Search of the different phase transitions and critical points, predicted by Quantum Chromodynamics (QCD) is a challenging task for the ongoing and next generation experiments at relativistic and ultra-relativistic energies. Rare probes and multi-differential studies, mandatory for understanding the physics behind the observed experimental trends, require unprecedented statistics. This could be achieved using high luminosity or high intensity beams and experimental setups based on detection and identification systems which at least maintain the performance of the present ones but in a very high counting rate environment. An experiment where such collisions will be performed is the future Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt. This experiment is expected to cope with interaction rates up to 10 MHz for Au-Au collisions. CBM experiment is supposed to run for 2 months a year for 10 years, hence ageing tests of different sub-detectors, Front End Electronics (FEE) and components of the Data Acquisition (DAQ) in high irradiation dose are mandatory. One of the main sub-detectors of CBM is the Time-of-Flight (ToF) wall based on Resistive Plate Counters (RPC) essential for particle identification. Studies of ageing effects on Multi-Strip Multi-Gap RPC (MSMGRPC) in high irradiation dose and proposed solution for their reduction will be presented.

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4.9 Search for nuclearites with the KM3NeT detector

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Keywords: strange quark matter, nuclearites, KM3NeT detector, Monte Carlo simulations

The Strange quark matter (SQM) was introduced by Edward Witten in 1984 as a hypothetical type of matter composed of approximately equal quantities of up, down and strange quarks, which has a slightly higher density than that of nuclear matter. Massive SQM particles are called nuclearites. Nuclearites enter in the Earth atmosphere with typical galactic velocities of about 250 km/s. The SQM particles with masses higher than 10^{13} GeV could reach the Earth and interact with atoms and molecules of sea water within the sensitive volume of the deep-sea neutrino telescopes. Thus, the massive SQM particles can be detected with the KM3NeT detector (whose first detection units are already installed in the Mediterranean Sea and taking data) through the visible blackbody radiation generated along their path inside the instrumented area. In this work, the results of a study using Monte Carlo simulations of down-going nuclearites are presented.

4.10 A simple method of energy calibration for plastic and liquid scintillators

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Keywords: plastic and liquid scintillators, energy calibration

The response function of the detectors is strongly dependent on the atomic number. If the photoelectric cross-section is large in detectors with high atomic numbers, this phenomenon is practically irrelevant in plastic or liquid scintillators and the dominant response is the continuous Compton spectra. We propose a simple method for energy calibration using the Compton edge of various standard gamma sources. This method was tested for two different plastic scintillators (EJ 440 and EJ 200) and liquid scintillator (EJ 309), all produced by Eljen Technology/Scionix.

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4.11 Photon background produced by beta electrons in liquid argon

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Keywords: background, neutrino, experiment, beta decay, scintillation, Cherenkov

The next generation of neutrino experiments is going to use the liquid argon time projection chamber (LAr-TPC) technology. Even though the liquid argon used for the sensitive volume will have a high purity, one can not completely eliminate some radioactive elements like 39Ar and 40K. The electrons produced in the decay of these elements have enough energy to emit Cherenkov radiation, as well as to produce scintillations inside the sensitive volume. In this work the results obtained using Monte Carlo simulations of the Cherenkov and scintillation radiation produced by beta decay electrons will be presented.

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4.12 The response of a model hexagonal detector area to radio signals from ultra-high energy cosmic rays air showers

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

Ultra-high energy cosmic rays (UHECRs) are subatomic charged particles accelerated at astounding energies in violent astrophysical processes. They travel vast distances through the outer space and every so often enter the Earth's atmosphere. Here they interact and initialize the development of cascading secondary elementary particles, known as extensive air

showers (EASs). From characteristics of the induced air showers, properties of primary cosmic rays are deduced, such as mass, energy and arrival direction, and so they serve in complementary indirect measurements of UHECRs. The radio detection technique is used to record radio signals emitted by the electromagnetic component of air showers, employing arrays of radio antennas.
In this paper we look at the response of a model hexagonal layout of 37 antennas, by using a sample of CoREAS simulated proton events at two different energies: 10^18 and 10^19 eV. First we look at the general characteristics of the registered polarized radio signals, in correlation with the position of the observer, with respect to the shower core and distance to the showers axis. In a second step we explore some particular characteristics of the radio emission.
This analysis, among others, is implemented into an YAD (yet another dialog) tool for creating graphical dialogs from shell scripts based on the user interface GTK+ and programming languages like Unix Shell and C. This tool is aimed for new users, with application on educational purposes, for an easy and friendly introduction to the physics of the present studies.

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4.13 Optical simulation of radiation in air with FLUKA code

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Keywords: radioluminescence, FLUKA, simulations

Alpha particle detection it's a very important issue that specialized personnel has to face because the inhalation or ingestion of such radiation can cause severe damage to living tissue. Due to the short-range (few centimeters in air) and high

stopping power, traditional detectors which require direct interaction with alpha particles must be used in very close proximity to a source. This method is time-consuming, tedious and exposes the personnel to other hazards and risks. So, we need a new method for remote detection of alpha radiation and this can be done using the radioluminescence process. Excited nitrogen molecules by alpha particles emit photons which can be used to reveal the presence of alpha sources. In detecting alpha sources it's important to evaluate all the background sources that can emit photons in the same wavelength interval as alpha particles. The aim of this work is to analyze the possibility to distinguish between the signal obtained from alpha particles and background sources. EXPACS [1] code was used to estimate cosmic ray fluxes – which are a major component of the background, especially electrons and positrons which can excite nitrogen molecules followed by photon emission and also can produce Cerenkov in the same wavelength as photons produced by alpha. Monte Carlo code, FLUKA [2], was used to estimate photon fluence produced by radiations in air.

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4.14 Digital signal reconstruction of AERA data

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Keywords: cosmic radiation, radio emission, electric field reconstruction, simuations

When cosmic rays enter the Earth's atmosphere, they interact with its components, leading to the formation of secondary particle cascades, called Extensive Air Showers. The radio emission associated with these cascades can be measured using antennas positioned on the ground and based on these measurements, the reconstruction of different observables can be performed (e.g. arrival direction), thus giving information about the primary particle. At the Pierre Auger Observatory (Argentina), in addition to the two main detection systems (surface detectors and fluorescence detectors), an array dedicated to the detection of radio signals associated to these secondary particle cascades, has been developed, named AERA (Auger Engineering Radio Array). This array consists of 153 detection stations equipped with low frequency radio antennas (30-80 MHz) and it covers an area of 17 km^2 . The voltages measured by the antennas are used for the reconstruction of the electric field associated with EAS, but these voltages are affected by noise. Therefore, it is necessary to use a reconstruction method which minimize the influence of the noise. Using simulations of radio signal induced in air showers, the quality of the reconstruction performed by a new reconstruction method, the analytical method (also called "forward-folding" method) has been tested. Hence, different quantities associated with air showers were reconstructed and compared with the simulation truth, but also with the results obtained with the method currently used (standard method).

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4.15 Wobbling Phenomenon in Odd-Mass Nuclei

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The wobbling properties of several odd-mass nuclei are studied using a semi-classical framework that is based on the Particle Rotor Model (PRM). Nuclear wobbling motion consists of the precession of the total angular momentum around the rotational axis, combined with an oscillation of its projection on the quantization axis around a steady position. For odd-mass nuclei without any symmetry axis, this collective motion arises from the coupling of an even-even triaxial core and a single odd-j nucleon (proton or neutron). Depending on the angular momentum alignment between the two systems, two wobbling regimes can occur: longitudinal and transverse. Almost all nuclei in which wobbling motion has been experimentally confirmed behave as transverse wobblers. Recently, two new isotopes (^{183,187}Au) were discovered. Remarkable is the fact that for ^{183}Au, the coexistence of both wobbling regimes has been identified. In the present work, the excitation energies belonging to the wobbling spectrum for both nuclei are described using an expression for the energy function that depends on several parameters such as the moments of inertia, single-particle potential strength, and the triaxiality parameter $gamma$. Interpretation of the obtained results is given in terms of the parameters.

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4.16 Temperature dependence of the radio signal from extensive air showers as seen in experimental data

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During their passing through the atmosphere, when colliding with an atmospheric compound, cosmic rays induce cascades of secondary particles called air showers. In the last years, radio detection became a stable technique for the detection of air showers. The largest radio detection array in the world, named AERA (Auger Engineering Radio Array), investigating and assessing different configurations of radio stations while taking efficient measurements in the field, is operating at the Pierre Auger Observatory located in Mallargue, Argentina. Electronic devices have a specific sensitivity towards the temperature of the environment, and implicitly to their intrinsic temperature, as well. This sensitivity is reflected in the amplitude of the recorded signal, since it varies as a function of temperature. Therefore, the amplitude should be corrected for this influence. This research analyses the results of implementing a module of temperature correction in the reconstruction algorithm of air showers within the Offline software framework of the Pierre Auger Observatory.

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4.17 Cosmic rays and radiation protection

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Keywords: cosmic radiation, primary cosmic rays, radiation dose, solar activity

Protons and helium nuclei are the major components of the primary cosmic radiation at the top of the terrestrial atmosphere. Because the cosmic ray studies are important for the radiation protection domain, the contributions to the radiation field of the protons and of the helium nuclei at low kinetic energies are presented in this study. Comparison of the resulting doses with the valid data from the literature showed the real connection between the particle flux and the radiation dose value.

4.18 Atomic spectrometry techniques applied in the analysis of the spectrum of chemical pollutants in the sludge resulting from urban wastewater treatment. Statistical interpretation.

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Keywords: sludge, waste water, AAS, water content

The dynamic process of environmental pollution, both naturally and through anthropogenic activities, requires the establishment of scientific methods for assessment and analysis of pollutants. The category of the main environmental pollutants also includes chemical elements (heavy metals - conventionally considered chemical elements with a density greater than 5 kg / dm3) whose concentrations exceed the maximum permitted limits for each of the chemical elements in the environment, thus becoming harmful to health human. The concentrations of heavy polluting metals can be determined with priority by Atomic and Nuclear Methods (MAN), of high sensitivity and precision, combined with the biomonitoring technique using bioindicators. One of the most widely used methods of atomic and nuclear (MAN) analysis of heavy metals is atomic absorption spectrometry (Atomic Absorption Spectrometry), applied in conjunction with the bioindicator technique used to monitor environmental pollution. By applying the method of atomic absorption spectrometry (AAS) in the analysis of the elemental composition, some heavy metals were determined from the sludges resulting from the urban water treatment in Târgoviște, on these results the statistical analysis was performed. We used the correlations of Pearson, Kendall's, Spearman and the analysis of the main components combined with the Varimax rotation method with Kaiser normalization.

4.19 The DsTau experiment (NA65): Study of tau neutrino production at the CERN-SPS

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

The DsTau (NA65) is an approved CERN experiment begining with 2019 which is proposing to study tau-neutrino production aiming to provide important information for future tau-neutrino measurements. First direct evidence of tau-neutrino interaction was reported by the DONUT (Direct Observation of NU Tau) Collaboration in 2000, when they measured the tau-neutrino chargedcurrent (CC) cross section, but this was done with a systematic uncertainty larger than 50%. Therefore, one of our goals is to measure tau neutrino production and also to reduce the systematic uncertainty in the cross section evaluation to the 10% level to test Lepton Universality in neutrino scattering. This can be realized by measuring the tau-neutrino production from the sequential decay of the strange D meson, more specifically by knowing the double differential production cross section of the Ds meson. Because there are several background events that can imitate the decays of short lived particles, the Multiple Coulomb Scattering method for momentum estimation was used to kill these events. For this, I wrote a program where I used the MCS method to test our algorithms using real data and MC data generated with FLUKA and GEANT4. The difficulty of measuring tau-neutrino production and interactions is due to the relative rarity of the sources of tau-neutrino and difficulty to identify the short-lived tau-lepton produced in tau-neutrino charged-current interactions. One of the best options is the use of nuclear emulsions because they are the most suitable devices to detect the tau lepton, thanks to their good spatial (~50 nm) and angluar resolution (~2 mrad). For reaching the experiment's goal, experimental set-up prototypes were exposed to a 400 GeV proton beam at CERN-SPS. At the same time, a considerable effort was paid for software development used for data processing and MC simulations.

Section 5: Optics, Spectroscopy, Plasma and Lasers

Location and time: **Online**

Moderators:

CSI Dr. Gheorghe DINESCU

Assoc. Prof. Dr. Iulian IONIŢĂ

5.1 - Ioana KUNCSER, Gabriel SOCOL, Iulia ANTOHE

Development of a numerical algorithm for surface plasmon resonance based optical sensors on waveguide configuration

5.2 - Lavinia Gabriela CARPEN, Tomy ACSENTE, Bogdan BITA, Valentina MARASCU, Veronica SATULU, Alina ARDELEANU, Gheorghe DINESCU

Control of tungsten surface roughness by thermal and plasma treatments

5.3 - Sasa-Alexandra YEHIA, Maria ZARIF, Lavinia CARPEN, Bogdan BITA, Nicoleta PETREA, Sorin VIZIREANU, Gheorghe DINESCU

Methylene blue dye decolorization in water using atmospheric pressure plasma jet immersed in liquid

5.4 - Catalin CONSTANTIN, Ciprian DUMITRACHE, Bogdana MITU

The use of optical emission spectroscopy in the study of a filamentary argon plasma jet

5.5 - Cristina ONEA, Paul E. STERIAN, Ionut Relu ANDREI, Mihail Lucian PASCU, Mircea BULINSKI

Numerical simulation of chaotic multimode dynamics of a semiconductor laser optical coupled with two external cavities

5.6 - Viorel NASTASA, †, Adriana SMARANDACHE, *, †, Ruxandra A. PIRVULESCU, †, Ionut-Relu ANDREI, George SIMION, Gabriel POPESCU, Mihail-Lucian PASCU

Ocular tumor tissues imaging with white light diffraction phase microscopy

5.7 - Adrian SIMA, Petre Cătălin LOGOFĂTU, Mihail Lucian PASCU, Ionuț NICOLAE

Monitorization of droplet evaporation via real-time digital holographic interferometry using a phase only SLM

5.8 - Iulian Alexandru Chelmus

Increasing Accuracy of Laser Doppler Vibrometry Method for Multilayered Objects Conservation Status Control

5.9 - George Zarnescu, Adela Bara, Mihai Badic, Valentin Girleanu
RF Plasma device for supercapacitor carbon electrodes etching

5.1 Development of a numerical algorithm for surface plasmon resonance based optical sensors on waveguide configuration

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One of the most sensitive optical techniques for determining in real time tinny changes in the refractive index of an analyte is based on the surface plasmon resonance effect. The method consists in tracking the intensity of the evanescent wave coming from a highly conductive metallic layer in direct contact with the investigated analyte and is very suitable for following chemical and bio-medical [1] processes. Either the incidence angle or the wavelength/frequency of the incident wave can be tuned in order to approach the plasmon frequency in the conductive metallic layer modulated by the refractive index of the analyte (coupling condition). The most common configurations for surface plasmon resonance sensors (Kretschmann configuration using a prism and respectively optical fiber [2] as waveguides) are considered herein. The algorithm providing the evolution of the intensity in the light totally reflected on a metallic film in contact with an analyte will be discussed in this work. The corresponding simulations performed in case of a convenient waveguide covered by a nanometer thick metal layer in contact with the analyte provide quantitative information on the shift of the absorption peak versus the angle of incidence (at constant wavelength) and versus the wavelength (at constant incidence angle). Experimental data (resonant wavelengths) obtained with an optical fiber based sensor covered by a 40 nm thick Au layer and with the incident radiation entering the fiber at constant angle are verified for calibration analytes consisting in different sucrose solutions.

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5.2 Control of tungsten surface roughness by thermal and plasma treatments

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Keywords: Tungsten, Fusion technology, Oxidation, Reduction, Hydrogen plasma

Tungsten (W) surface behavior in extreme thermal conditions and after plasma interaction represents an issue truly relevant to Plasma Facing Components (PFC) in next-generation reactors like ITER [1]. The potential of oxidation, surface exfoliation and increase roughness can lead to core contamination, because the surface properties will be modified, which may lead to the adverse performance of a fusion device. Because the appearance of oxides on the surfaces of PFC is extremely undesirable, the reduction of tungsten oxides has increasingly become the subject of ITER research. In this work, we focus on the evaluation of tungsten surface behavior after a two-step process, characterized by a thermal oxidation followed by a reduction in H2 plasma [2]. Both processing steps were performed using a linear furnace allowing the heating of the samples simultaneous with plasma ignition. We used an ITER-like laboratory model flat, uniform, large W surface (30x30x3mm3) for these experiments. The oxidation of the samples was performed in air at a temperature of 800 OC for four hours. Further on, two types of reduction processes in H2 plasma were performed: at room temperature and by heating the sample at 800 OC. Each sample was characterized using profilometry (roughness), scanning electron microscopy SEM (morphology) and X-ray photoelectron spectroscopy XPS (chemical composition). After oxidation, the roughness increases from 100 nm to 13000 nm, remaining in this range after plasma reduction at room temperature; still, plasma reduction at 800 OC results in a final roughness of 2000 nm. The results show that after oxidation the surface chemistry is dominated by WO3 and this oxide is totally reduced to metallic W only at a higher temperature. Therefore, we highlight that this type of two-step approach can remove W oxide from surfaces and also can produce rough W surfaces starting from smooth surfaces.

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5.3 Methylene blue dye decolorization in water using atmospheric pressure plasma jet immersed in liquid

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Keywords: wastewater decontamination, filamentary plasma jet, methylene blue dye decolorization

One of the main environmental problems is water pollution from colored dyes due to the increasing the global textile industrial developments. This wastewater contains organic dyes which have non-biodegradable aromatic structure [1]. These dyes are toxic for human body and may be responsible for various illnesses. Several techniques have been developed for organic dyes degradation: photo-catalysis, chemical decontamination, UV light exposure, biological degradation. Chemical and biological decontamination involves major disadvantages due to the use of strong chemicals which affect the quality of water and the low efficiency in the removal of pollutants [2]. Atmospheric pressure plasma treatments are considered a promising method for water decontamination due to their potential for environment, biomedical and material processing application [3]. In this contribution we report the dielectric barrier discharge (DBD) filamentary plasma jet sources for intentionally contaminated water with Methylene Blue dye (MB, C16H18ClN3S), in concentration of 25 mg/L. These sources are very versatile, because they can operate at atmospheric pressure immersed in liquids within a large domain of parameters (various gases types, flow rates, and powers). These DBD sources have the advantage of not implying additional cooling systems. In order to identify the optimal dye decolorization conditions we varied several conditions: the gas flow rate (Ar 1000–20,000 sccm), the RF (radiofrequency) power values (50–200W), and the discharge geometry configuration. In addition, the influence of reactive gases (e.g. nitrogen, oxygen, compressed air and helium) and photocatalysts (e.g. Ce2O,

TiO2, GO+TiO2) were also tested. Optical emission spectroscopy (OES) investigations were performed for plasma analysis and the decolorization process was evaluated by absorption spectroscopy. The decolorization time of MB (50mL, conc. 25 mg/L) varied from 30 to 13 min after increasing the Ar gas flow. The shortest decolorization time (6 min) was achieved for argon and nitrogen gas mixture (Ar/ 10%N2).

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5.4 The use of optical emission spectroscopy in the study of a filamentary argon plasma jet

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Keywords: RF-plasma jet, Optical Emission Spectroscopy, Plasma Diagnostics

A stable argon plasma jet discharged in ambient air is spectrally characterized herein. The plasma is sustained inside a glass tube with an internal diameter of 4 mm using a radio-frequency generator operating at 100 W and 13.56 MHz. An interesting regime is observed when the discharge is operated with only one external electrode on the tube and in the absence of any grounded electrode in discharge proximity (floating ground). In such a configuration, the plasma jet develops two distinct regions: a filamentary-like (high electron density) core and a surrounding diffuse zone where emission comes mainly from excited molecular nitrogen[1]. As such, in this study we focus our attention on the plasma jet generated at 3000 sccm Ar exiting the tube. The jet has a length of ~40 mm and is the result of the mixing of the argon plasma with the surrounding air. The study includes spatially resolved measurements of electron number density obtained from Stark broadening analysis performed on the Hα (656 nm) and Hβ (486 nm) lines [2]. In order to separate the hydrogen lines from the background molecular nitrogen emission (primarily N2 (B-A)), a small amount of H2 (1 sccm) was used for post processing the Stark broadening data. It was shown previously that H2 tends to raise the plasma v = -2) is identical with and without H2 injection. This is an important point as the N2(SPS) is primarily generated through electron impact reactions with ground state N2. Therefore, the fitted rotational temperature from the N2(SPS) spectrum is indicative of the actual gas temperature[4].Δtemperature through the generation and dissociation of the ArH radical [3]. To ensure that H2 addition does not alter the properties of our plasma jet, we verified that N2(SPS) spectra at 380nm (

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5.5 Numerical simulation of chaotic multimode dynamics of a semiconductor laser optical coupled with two external cavities

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Keywords: external cavity semiconductor laser, double external feedback, multimode, simulation model

In this paper we presented the modeling and numerical simulation of the chaotic dynamics of a semiconductor laser with double external cavity (D-ECSL) [1]. Laser emission dynamics of the D-ECSL system operating multimode with moderate optical feedback is given for every laser active mode by Lang-Kobayashi set of equations describing the rates of variation of the internal field and carrier density [2]. The developed multimode model simulates a system with 3 active modes (3 coupled single-mode systems). All modes are coupled having the same "feed" source but evolving under different feedback conditions (feedback intensity and round-trip time of the external cavity). The time series of the emission power represent the summing of the signals generated by the three modes [3]. The numerical results show that the developed numerical multimode model simulates with good approximation the chaotic dynamic of D-ECSL system for a specific set of parameter values.

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5.6 Ocular tumor tissues imaging with white light diffraction phase microscopy

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Keywords: eye tumor; white light diffraction phase microscopy; quantitative phase imaging; phase map; refractive index

In the current context of histopathology, where the gold standard relies on manual investigation of stained tissues [1], the development of new sensitive and quantitative methods for early disease diagnosis and automatic screening of samples is required. It has been found in the last decades that by combining holography and microscopy, highly sensitive measurements, capable of detecting very small refractive index variations of thin biological specimens, can be achieved [2], [3]. This paper

aims to perform a comparative analysis of the limits of surgical resection of eye tumors by both conventional and white light diffraction phase microscopy, a quantitative phase imaging technique. Sample images were acquired by microscopy in bright field and in phase contrast, coupled with white light diffraction phase microscopy. A comparative histological analysis was performed to evidence the characteristics of biological structures. We showed that white light diffraction phase microscopy can reveal cellular and subcellular structures in transparent tissue slices based on the refractive index distribution. This study responds to the current need for providing quantitative data from the obtained images at larger penetration depth with good contrast, down to molecular specificity.

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5.7 Monitorization of droplet evaporation via real-time digital holographic interferometry using a phase only SLM

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Keywords: holographic interferometry, optofluidics, geometric approximation

In a previous study [1] we have shown that it is not possible to investigate via interferometric means the modifications in shape and refractive index within a water droplet if the instrument used for investigation is a plane parallel wave, because the rays are diffracted at large angles, the image of the droplet is distorted beyond recognition and drowned in the spurious information coming from diffraction of the light at the edges of the droplet. Things are different, however, if we use a divergent beam as an instrument of investigation. The image of the droplet is less distorted and confined within a reasonably small space that can be adjusted from the divergence angle. Also, the diffraction at the edges is now sent away at large angles, most of it outside the shadow of the droplet. Moreover, supplementary advantages are drawn from the use of a dynamic digital holographic arrangement which can perform real time observation of the optical path modifications induced by the droplet evaporation. Holographic sequences are recorded on a digital camera sensor, immediately subtracted from the initial hologram. The results are holographic interferograms which are instantaneously and sequentially displayed on a spatial light modulator (SLM) for an instant, optical reconstruction of a real-time holographic interferometry "movie" with a 15 fps display rate. Any changes in the optical path due to evaporation (or any other factors) can be observed in real time in the dynamic fringe pattern generated through SLM reconstruction. For qualitative comparison and quantitative fitting the fringe dynamics induced by the droplet evaporation was also theoretically simulated. This experimental version is a modified and improved version of a holographic arrangement used for the monitorization of the salinity spatial distribution in water [2]. For now, we used this holographic arrangement for the monitorization of the droplet evaporation, but the extension of the technique to the study of more complex phenomena, such as the perturbation of the droplet by inelastic and elastic interaction with a pulsed laser is straightforward.

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5.8 Increasing Accuracy of Laser Doppler Vibrometry Method for Multilayered Objects Conservation Status Control

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The Laser Doppler Vibrometry (LDV) method has many advantages that makes it one of the most suitable methods for investigating hidden defects or structural problems. Its non-contact, non-invasive character makes it highly applicable in cultural heritage but it is successfully used in many other fields. Laser Doppler vibrometry works by emitting a continuous laser beam on the target surface and measuring the surface vibration using Doppler displacement between the incident beam and the reflected beam. This paper presents laboratory measurements done on multilayered objects build with known in-depth defects. This study allows increasing accuracy of future in-situ data interpretation. Every object was investigated using four different excitation signals making possible this way, by comparison, to observe which one induced vibrations better in layers and also to identify the frequencies that marks accurately the known defects in data. Also a workflow protocol that aims to increase the accuracy of acquired data and minimizing or canceling human errors is presented. In conclusion, a future possible solution is described, which will be tested in a subsequent study, to improve further more the accuracy of the method, respectively obtaining more precise identification of areas with structural problems in multilayer objects by correlating LDV data with thermal imaging or electric resistivity. Both been known and used to identify hidden defects or structural degradations.

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5.9 RF Plasma device for supercapacitor carbon electrodes etching

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Keywords: radio frequency, plasma, supercapacitors

Here we propose a vacuum plasma device that can be used for capacitive and inductive coupling at the same time. One capacitive electrode can be moved together with a glass and red silicone-covered stainless-steel rod to decrease and increase the distance from 100mm up to 300mm. Also, the coil can be moved along the 90mm diameter, 500mm length quartz tube in the same distance range. By having these two mechanical adjustments the device can be used for many other experimental setups, to observe and further adjust the plasma characteristics, not only to obtain very large surface carbon electrodes. DC and RF produced plasma was investigated for a vacuum range between 2 Torr and 0.003 Torr and by adjusting the voltage

from 700 V up to 1200V. Experiments showed that a 1.8-2 MHz or/and 13.5 MHz RF excited plasma is a much more stable and precise process than a DC-controlled plasma, where large graphite chunks can be ripped apart without any control. 3D simulations were made to see the complete plasma characteristics for different voltages, pressures, electrode distances, and different working gases.

Section 6: Physics and Technology of Renewable and Alternative Energy Sources

Location and time: **Online**

Moderators:

Lect. Dr. Sanda VOINEA

Lect.Dr. Adriana BĂLAN

6.1 - Cristian PREDICA, Adriana BĂLAN
Technical solution for reuse and recycling of laptop batteries as energy storage devices in solar power supply system for holiday houses

6.2 - Ionuț TĂNASE, Adriana BĂLAN
Solar panel water pumps for sustainable agriculture

6.3 - Anda CIOBANU, Florian POMPIERU, Ana-Maria CONSTANTIN, Ana Apetrei, Nazar ERNYAZOV, Florin-Lucian COMAN, Nursena KARA, Sorin COSTACHE, Carmen MARUNTIS, Ioana-Daniela SOMOIAG, Cristina HUMA, Roxana DUMITRACHE
Green Motorway Project

6.4 - Radu TIRCA, Luca MIHAILESCU, Eleonora POPESCU, Cristina HUMA, Sanda VOINEA
Innovative Educational Resources in Renewable Energies

6.5 - Paul DOGARU, Cornelia DIAC, Cornelia NICHITA, Sanda VOINEA
Study of a bioremediation technology of soils polluted with hydrocarbons and heavy metals

6.6 - Anda CIOBANU, Sanda VOINEA
Software application to determine the theoretical potential and efficiency of fuel cells.

6.7 - Florian POMPIERU
Study of a high efficiency hybrid electric/biodiesel propulsion system for automobiles

6.8 - Florin-Lucian COMAN
Trombe wall

6.9 - Adina DOBRIN, Adriana BĂLAN
Gas pressure diagnosis in fuel cells by electrochemical impedance spectroscopy

6.10 - Tugce ERNIYAZOV
Carbon Dioxide reduction using photoelectrolysis

6.11 - Cristina HUMA, Sanda VOINEA
Solar power satellites a future source of energy in space

6.12 - Miruna OANCEA, Cornelia NICHITA, Adriana BĂLAN
Study of the degree of N-acetylation in different samples of chitosan by differential scanning calorimetry

6.13 - Sorin Costache
Construction of a carousel type electricity generation system

6.14 - Adela TANASE, Elena MOROIANU, Paul DOGARU, Cornelia NICHITA, Sanda VOINEA

Analysis of the atmosphere above the polluted soil before and after bioremediation using FTIR Gas Analysis

6.15 - Aganazar ERNIYAZOV
Ways to capture solar energy

6.16 - Ana-Maria CONSTANTIN, Sanda VOINEA
Comparison between energy performance of passive and traditional houses

6.17 - Ioana Diana SOMOIAG, Cornelia NICHITA
The impact of pharmaceutical compounds on the water environment

6.18 - Carmen MARUNTIS, Sanda VOINEA
Comparative study of wind turbines with horizontal and vertical axis.

6.19 - Ana Lăcrămioara APETREI, Cornelia DIAC, Cornelia NICHITA
Study of the water quality in the Brașov area and the influences of bio ecosystems

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

6.21 - Esmaeil JALALI LAVASANI, George ZĂRNESCU, Ioan STAMATIN
Thermoelectric materials based on Cobalt Oxide for humidity sensor applications in high-temperature

6.22 - Cornelia NICHITA
Pharmaceutical applications and Bio-synthesis strategies to design colloidal silver solutions

6.1 Technical solution for reuse and recycling of laptop batteries as energy storage devices in solar power supply system for holiday houses

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Keywords: batteries, energy storage devices, solar power supply system

The purpose of this paper is to design an integrated solar power supply system of a holiday home, as it is widely known as an inexhaustible, clean and sustainable energy source. The challenge is to capitalize on it efficiently, transform it into electricity and store it in a cost-effective way. We propose an alternative method of storing the energy generated by the photovoltaic panels, i.e. employing 18650 laptop cells recovered from spent laptop batteries. Unfortunately, most of the spent laptop batteries end up in the landfill, some of them are recycled, and others forgotten on shelves or in end-user storage rooms for long periods of time. These practices are harmful to the environment, causing additional pollution, which could be avoided by reusing these batteries. Another reason to recycle laptop cells is that the manufacturing process becomes more expensive year after year due to the global pressure on the few lithium deposits. Therefore, the first step is to dismantle spent laptop batteries into their basic components: ABS plastics, circuit board, copper wires, galvanized metal strips and 18650 battery cells, obviously. Battery cells are then integrated in the solar power supply system. The proposed solution is solar power supply with 22 250W polycrystalline photovoltaic panels as the energy generator, an MPPT charge controller with 450V dc input voltage from the photovoltaic panels, a 5.5kW inverter that transforms the energy stored into the 18650 cells from direct current into pure sinusoidal alternating current voltage and 560 18650 cells of about 4V per cell and 2A (8W stored per cell). This paper includes the full diagram of the integrated system and technical arguments for the sizing of each component.

6.2 Solar panel water pumps for sustainable agriculture

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Keywords: Solar panel water pumps, renewable energy, sustainable agriculture

Water supply has always been a problem, especially when electricity is not available. Individual irrigation systems that use solar panels or wind turbines have proven to be the ideal solution and are increasingly used in agriculture. These systems use submersible or surface pumps. Essential in these applications are direct current pumps that have very high efficiency, using a very small amount of electricity for pumping water. The solar pumping project aims to expose the characteristics, uses, advantages and disadvantages of its use. Solar panel water pumps are a relatively new concept, used more and more often in residential and non-residential buildings. These pumps run on solar energy, so a renewable, free and green energy. Pumping water with solar pumps can provide significant environmental and socio-economic benefits. At the individual level, the pumping system can be a viable alternative, especially in isolated, non-electrified communities. At the national level, solar pumping can contribute to the creation of an efficient irrigation system, growth and diversification of agricultural products. Solar pumping systems can include two categories of pumps, centrifugal and positive displacement pumps. The solar pump is powered by a minimal photovoltaic system, sized according to its energy needs. The solar water pumping system is able to support all types of electric water pumps ranging from irrigation to household requirements. Irrigation pumps such as submersible, surface or deep, can also be coupled with drip irrigation systems to increase the cost-effectiveness of this configuration.

6.3 Green Motorway Project

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In a dynamic society built on consumption, the means of transportation are a question of national interest. Economical growth is based on homogenous infrastructure and equal opportunities. Industrial and agrar hubs need to be connected in all means possible and short to medium commutes need to be streamlined flawlessly. Up until recent years, these dynamic paces were made possible by fossil fuel dependency, but the current social acknowledgement of several world-crafted agreements on environment protection, including but not limited to global warming slowdown, impose a cleaner way of planning future transport solutions. One of those solutions is addressed in our study below. The Green Hydrogen-based Motorway that we planned connects Timișoara to Constanța and sustain up to 30.000 hydrogen powered cars traffic per day. All the power needed for splitting the water molecule to the energy-indorsed potent gas liquified at tremendous pressures is provided exclusively by green sources (Photovoltaic, Wind-power, Hydro). The refuelling stations are sparsed at strategic points and dimensioned as the highest traffic would require. More than 400MW of installed-peak power are available to the electrolysers that provide the green fuel for the low-emission vehicles on route. Subsequently, up to 300.000 tons of CO2 emissions are saved each year by the 800 km long 4-lane proposed motorway built around Hydrogen. Even the low 2 digits emissions that are tackled by the massive investment, spread to its period of life, are addressed by the 800 meters wide forest curtain that follows the winding geopolymer concrete monster from the the Transylvanian plateau through the scenic Olt river valley and dams, down the Subcarpathians then as low as the sunny Bărăgan plains before it reaches up into the wind again in Dobrogea country and bite the Black Sea at Constanța, reporting zero emissions, aka neutrality of Carbon.

6.4 Innovative Educational Resources in Renewable Energies

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Keywords: renewable energy; online learning; innovative educational practices; educational video

The field of renewable energies is one whose development is intrinsically tied to the experimental method and experimental experiences. Students in all STEM fields rely heavily on in-person work where they get to physically interact with the system they are studying. As such, in an online learning scenario, whether it be a consequence of the COVID-19 pandemic or a matter of comfort and preference, students should be provided with accessible and engaging materials that fulfill the role of the traditional laboratory work. The creation of a truly effective and functional alternative requires some ingenuity, as one has to take into account both the content and the production quality of the end product. This paper focuses on the development of the first two parts of what will be a three part series on the study of water electrolysis in the context of hydrogen and oxygen production. The first part is an introduction to the subject, that doubles as a science popularization material, which requires little to no familiarity with the subject. The second part offers a more in depth look at the phenomenology of water electrolysis and it is dedicated to students studying renewable energies, however it is accessible to all in STEM fields. The third part will contain a remote-lab available through a web interface for the purpose of replicating a hands-on experience. This article offers the walk-through of the production of viable material to serve as a tool for online learning, or even as auxiliary material for in-person learning.

6.5 Study of a bioremediation technology of soils polluted with hydrocarbons and heavy metals

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Keywords: bioremediation, hydrocarbons, heavy metals, biodegradable absorbent, oil spill, Sphagnum mosses, Petrolsynth, biodegradable detergent, in-situ

This study investigates a soil bioremediation technology by mainly using the natural biodegradable absorbent Sphagnum mosses, in combination with a series of non-toxic ecological products used as bioremediation accelerators, such as environmentally friendly biodegradable detergent LDC (based on coconut oil) and Petrolsynth (based on degradation enzymes and microorganisms). The effect of the decontamination system on soils polluted with hydrocarbons was analysed. We added several components with action in the biodegradation of hydrocarbons from the oil-spills with the intention to study the synergistic effect of the decontamination process. The process of petroleum hydrocarbons removal from different polluted soils was investigated using UV-VIS spectroscopy. The spectra of the samples were acquired in the range of 200-800 nm and their analyse highlighted the decreasing of the absorbance values for the wavelengths corresponding to the analyzed pollutants. The study is oriented also to monitor the heavy metals concentrations in the soil samples before and after the treatments with the biodegradable absorbent and bioremediable accelerators. An Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) is used to determine the concentration of the metals As, Cd, Cu, Fe, Pb, Co, Cr, Mn, Zn, Se, Co. The analysis shows that the soil polluted with hydrocarbons and heavy metals treated with natural absorbent and organıc accelerators was bio-remedied and restored to its original potential of use. The components added in the bioremediation technology of hydrocarbons contaminated soil, induce a dynamic of the bioremediation process, in the sense that they accelerate the bioremediation process of the polluted soil and shorten the necessary time for the soil's restauration. A great advantage of using these environmentally friendly products is that they can be used in in-situ technology for decontamination of soils polluted with hydrocarbons, with low costs and much faster results than conventional technologies.

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6.6 Software application to determine the theoretical potential and efficiency of fuel cells.

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Keywords: fuel cell, theoretical potential, efficiency, software application

The continuous increase in energy consumption, the reduction of fossil fuel resources and the critical issues problems related to pollution, lead the researchers to obtain energy for alternative solutions. The fuel cell represent a simple way to convert the chemical energy stored in the hydrogen bond, in the presence of a catalyst, and to transform into heat or mechanical work. Regardless of the type of fuel cells, their study start from the chemical reactions that take place at the anode, cathode and general reaction, in order to finally determine the theoretical potential and efficiency of the fuel cell. Because the calculation steps are the same for any type of fuel cell, we created an application using the Colaboratory platform, a free Jupyter notebook environment that requires no setup and runs entirely in the cloud, to calculate the parameters described above. The application was designed as an interface between the user and the program algorithm. Thus, the user enters, step by step, the data as reaction coefficients, entropies or enthalpies of the substances involved in the reaction and runs the code cells to obtain the theoretical efficiency of the fuel cells. The software application is presented in detail for calculating the parameters of the H2-O2 fuel cell and tested for the alcohol-powered fuel cells (methanol, ethanol).

6.7 Study of a high efficiency hybrid electric/biodiesel propulsion system for automobiles

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Keywords: propulsion system, efficiency, hybrid cars, biodiesel, low emissions, sustainable mobility

Nowadays, the low efficiency of ICE (Internal Combustion Engine) powered personal vehicles is a delicate issue in the context of CO2 emissions and climate change. This paper begins with the study of the real efficiency and emissions of a typical diesel European automobile in a mixed use cycle. Based on the results, in the second part proposes a series of significant improvements, using a hybrid high-efficiency electric/Biodiesel propulsion/generation system with the following particularities: exclusive electric propulsion; 2Stroke diesel generator engine, small capacity <600cc, electric brushless supercharged, with constant maximum load and rotation, powered by biodiesel fuel; heat recovery using additional water injection cycle and external exhaust thermionic heat recovery generator; heat accumulator built into the biodiesel tank; advanced system for predicting and optimizing the generator-motor set functions depending on the specifics of the route ahead (the car will always know how to optimally manage its resources). The efficiency and emissions study will be based on collecting real-life data from a typical European ECU in a small car, monitoring energy losses and emission specifics for streamlining a hybrid engine/generator system. The theoretical analysis aims to show that such an engine could reduce emissions and consumption below or similar to those of a fully electric car (powered by the public grid), thus the autonomy with a 20-liter tank, in the combined WLTP cycle and real use can exceed 1500km. Emission control is much more facile especially due to the constant intake / exhaust flow which eliminates the need for inertial EGR (Exhaust Gas Recirculation) type controls and NOx / PM post-treatments due to fluctuations in the stoichiometric ratio in case of load and speed variation of the wheel-connected ICE.

6.8 Trombe wall

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Keywords: renewable energy, solar power, passive house

In this paper, a new design is presented for heating and ventilating rooms using solar energy that is recommended in the winter season and for reducing the cooling load in the summer season. The first step in creating a pleasant environment in a building is to understand the connection between climate and the human need for shelter. Buildings are subject to a wide variety of climates, they can be centrally continental, or oceanic climates globally, or on the dark side of a hill or street, locally. All this will influence a building in terms of its relationship with the sun. This, depending on the proposed solution, can be a positive element or on the contrary can have a harmful influence on the building. Poor climate design can be seen in many examples of contemporary buildings, for example due to the ensemble chosen for the facades they overheat, in climates where this problem did not exist for traditional buildings. Solar power should be understood and respected for a good design of passive solar buildings in which solar energy is used in such a way that it does not interfere with the comfort and health of the occupants. The purpose of the article is to clarify these terms and also to create a brief presentation of some passive methods, traditionally applied to buildings, as well as to describe some details and procedures for the passive use of solar energy: greenhouse and atrium, Trumpet wall, double facade. A Trombe wall is a south-facing wall of a building that is thick and is usually painted black to absorb heat. In the southern hemisphere of the world, this wall would be the northern wall of the building, because this is the part of the winter sun. A glass or plastic window is installed on the outside of the wall a few centimeters apart, which creates an air gap between the window and the wall. In winter, this configuration allows the wall to heat up during the day, as glass does not allow heat to escape easily. At night, the wall cools, which leads to heat loss in the building. In summer, the same wall can be used to cool the building.

6.9 Gas pressure diagnosis in fuel cells by electrochemical impedance spectroscopy

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Keywords: fuel cell, impedance, circuit modelling, system diagnostics

In the general context of climate-changing and environmental pollution, fuel cells have become an attractive candidate as a green energy source for automotive, stationary generation and portable power applications. Nevertheless, further improvement in performances and operating control parameters, including reaction activity, durability, operating temperatures or gas fueling conditions, are required for large-scale commercialization of proton exchange membrane fuel cell (PEMFC). Electrochemical impedance spectroscopy (EIS) is a powerful tool in the diagnosis and fundamental understanding of PEMFC performances. This paper deals with EIS analysis of gas pressure influence on the PEMFC. Gas pressure can affect redox reaction rates and mass transport in PEMFCs, which impact directly system performances. Therefore, EIS sensitivity to inlet gas pressure is employed for optimizing operating conditions and also for the diagnosis of cell malfunctioning.

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6.10 Carbon Dioxide reduction using photoelectrolysis

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Keywords: photoelectrochemistry, carbon dioxide, reduction, electrode, current

The topic of the work at hand is the photoelectrochemical reduction carbon dioxide to hydrocarbons. In the first part of the paper, basic principles of electrochemistry were introduced. In addition to this different metal and metal-based catalysts were compared based on the literature. Afterwards photoelectrochemistry was clarified and each component of the cell used was defined. Finally, the experimental results were shown and interpreted.
A photoelectrochemical cell uses light for CO2 reduction reaction. There are 3 electrodes in a photoelectrochemical cell: reference electrode, counter electrode and the working electrode. The working electrode support used throughout the experiments is a square FTO (fluorine doped tin oxide) based glass electrode. The working electrode was fabricated by spray depositing copper form a CuCl2 solution.
The aim of the thesis is to compare the currents obtained in reducing carbon dioxide to hydrocarbons. To achieve this, two experiments were done in two different conditions. Afterwards, the results obtained were compared within the two experiments and the literature.
In order to obtain the current, the first experiment was done with ink deposited electrodes baked for an hour at 400 oC whereas the second experiment was done with ink deposition while the electrode is on a 400 oC surface. The current obtained was lower than expected due to different limitations such as inhomogeneous deposition of ink and unwanted particles on the electrode surface. In the future, improvement on the conditions that cause limitations can be done. For inhomogeneity, an automatic air brush can be used for spraying the ink, for the unwanted particles electrodes can wait in pure water.

6.11 Solar power satellites a future source of energy in space

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Keywords: renewable energy, planets, solar energy satellites, wireless, antenna

This paper studies the options for renewable energy sources in the context of the colonization of other planets. The earth is currently heavily affected by pollution. This has led to effects such as global warming. Colonization of other planets is a good backup plan in case of irreparable damage to planet Earth. This can happen either by defeating the harsh conditions of the planets in our galaxy, or by building a spaceship fast enough to reach the habitable planets in other galaxies in a time comparable to human life. Scientists are currently studying terraforming planets such as Mars. Although we do not yet have the technology to do this, in the future it will be possible to easily terraform new planets and we need energy to live there. The main source of energy studied in this paper are solar energy satellites (SPS), which are both non-invasive and efficient. There are several types of STS: Planar, multi-rotary joints (MR) and Module Symmetrical Concentrator (MSC), which collects solar energy in the two huge panels and is transmitted through a part of the joint to the antenna, and it transmits wirelessly to the planet. Because these systems have an equivalent antenna architecture, the differences occur mainly in the dimensions of the solar arrays and their power joints. For MR the huge solar matrix is replaced by many separate small solar sub-matrices, and the high power pivot joint is replaced by many medium power rotary joints, the modular design makes the system easier to assemble. In the case of MSC there are 2 large reflectors that rotate so as to collect and reflect incident sunlight on two centrally located photovoltaic panels. Therefore, the use of renewable energy sources is one of the most important criteria to live harmoniously on a new planet. Solar energy taken directly from space is a feasible and efficient option at the moment.

6.12 Study of the degree of N-acetylation in different samples of chitosan by differential scanning calorimetry

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Keywords: chitosan, thermal analysis, degree of N-acetylation

Chitosan is the most important chitin derivate, the second most important natural polymer in the world, it is a constituent of the cell walls of some fungi or of the shell of some crustaceans, obtained by thermochemical deacetylation of chitin. Chitosan has a wide spectrum of applicability in medicine and pharmaceuticals (anti-inflammatory drugs, anti-cancer drugs, vaccines, bone and cartilage tissue engineering, etc.), food packaging, agriculture (pollution water treatment) and textile industry. The degree of N-acetylation influences chitosan properties and, therefore, it is crucial to determine this parameter before using the material for different applications. Differential scanning calorimetry (DSC) is an efficient thermal method to characterize the physical properties, allowing the study of the thermal dehydration and degradation of chitosan. We propose a comparative DSC study of different chitosan samples, where we estimate the degree of N-acetylation and the water content. The water-polymer interaction is discussed in terms of degree of N-acetylation and cross-linker in the case of chitosan films.

6.13 Construction of a carousel type electricity generation system

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Keywords: Electricity generation system, carousel, permanent magnets, generator, neodymium

The paper presents a system to produce electrical power consists in a permanent magnet generator or motor with stationary coils placed in a circle, with a rotor on which are placed permanent magnets and a carousel which is carrying corresponding groups of permanent magnets to the centers of the already specified coils. The carousel is moving in tandem with the rotor by virtue, since those 2 moving parts are magnetically coupled, one with the each other. Sensors and logical electrical devices are needed as well, sensors in order to let the electrical devices know the location of the moving parts in relationship with the coils. The logical electrical devices will turn power into different coils on and off, depending on where the moving (rotary and carousel) parts are, compared with the location of the stationary coils. The carousel is initially rotated manually, the entire system will start to spin and also to turn the power in coils on and off, in order to increase the speed of the carousel/rotor and to minimize the friction and the other forces which oppose to the carousel's rotating movement. The speed is increased by using the properties of the interactions between permanent magnets and coils. The coils are basically generating magnetic fields around them, hence, the arrangement of the groups of permanent magnets and their poles has to be done in relationship with the instant magnetic poles, so the speed of the carousel can be increased and maintain. The system is using electrical power (but only episodically) in order to maintain the high speed of the carousel, and the movement of the carousel is producing more mechanical work when compared with the energy used to maintain the movement of the carousel. This is happening due to the potential energy which is stored within magnets. This system has a limited life, since all the magnets are losing between 1% and 6% of their magnetic power per year. A very similar idea was patented in US in 1997(the request for it was made in 1994) within publication of US5625241A and patent number is 5625241 from 29th of April 1997. The patent is now expired but it is not widely used. The aim of this project is to rebuild the generator, observe its limitations and to try to use it as an alternative electric generator.

Acknowledgement:

6.14 Analysis of the atmosphere above the polluted soil before and after bioremediation using FTIR Gas Analysis

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Keywords: FTIR, bioremediation, methanol, benzene, environment

This paper presents the analysis of the environment above the soils polluted with hydrocarbons and also after different treatments with natural absorbent and organic solutions. This study aims to highlight the bioremediation effect of natural muscles absorbing Sphagnum, accelerated by organic products such as biodegradable detergent LDC (based on coconut oil) and Petrolsynth (based on degrading enzymes and microorganisms). The gaseous emissions are studied using the Gasmet DX-Series Fourier Transform Gas Analyzer (FTIR) and the Calcmet software, which is connected to the former. Initially, we analyzed the atmosphere above the soil samples polluted with two types of petroleum hydrocarbons: original engine oil and used engine oil from car service. Next, we applied various bioremediation treatments based on Sphagnum moss and biodegradable detergent LDC or Petrolsynth. Atmosphere monitoring above the samples was recorded weekly. The results show a regular decrease close to zero in the concentration of harmful substances such as benzene and methanol after soil bioremediation treatment. Experimental data highlight differences between the atmosphere above polluted soils before and after they have been treated with organic solutions and moss. This study is complementary to the one in which the impact of bioremediation substances is evaluated directly in soil samples, by UV-VIS spectrometry. The measurements highlight the correlations between the time required to clean the soil of hydrocarbons by applying these treatments and the time of removal of pollutants from the environment.

6.15 Ways to capture solar energy

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Keywords: energy,sunlight ,alternative source,efficiency,Sphelar,lat solar panel

Throughout history, human progress has been energy dependent. In the early stages of life, wood was used to cook food, to provide heat and later to melt metals, generally providing the main source of energy. The economic development and standard of living of communities is directly dependent on the useful forms of energy available. Electricity is such a useful form that it can be made from readily available energy sources and is used all over the world. The use of sunlight to generate electricity has been discussed for many years as an alternative source. As the sun rotates, the light falling on the Earth is constantly changing. So the question is how can we use sunlight most effectively? Scientists have tried different methods of using solar energy more efficiently. For example, active and passive solar tracking systems have been tried. These systems are still widely used today, but people are still looking for more efficient methods for solar energy efficiency. This spherical microcell is called Sphelar and this cell avoids the traditional photovoltaic design and uses a much more efficient shape. While traditional flat solar cells are easy to design and manufacture, their main problem is that their efficiency depends on their relative position relative to the sun. Sphelar is small and is designed to absorb sunlight from any angle. The design and geometry of Sphelar cells make it more efficient than flat solar panels. Solar energy is a promising type of renewable source of energy since we can produce vast amount of energy without harming the environment. Due to this, several methods to capture sunlight has been used and there is still so many methods to discover throughout the upcoming years. The spherical

system is a promising one and is the most efficient design found till today but in time more efficient methods will be discovered by scientists.

6.16 Comparison between energy performance of passive and traditional houses

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Keywords: passive house, energy efficiency, non-polluting material,insulation, ventilation, renewable energy

A European directive that came into force in December 2020 requires all new buildings to reduce energy consumption. In recent years, the Romanians have begun to develop an interest in passive houses, because this type of house is much healthier and the maintenance costs are even 10 times lower compared to a conventional house. This paper presents a comparison between the performance of a passive house and a traditional house. A passive house leaves a low carbon footprint because it uses non-polluting materials. Moreover, it can maintain an almost constant temperature throughout the year due to its very good insulation and active ventilation, so lower energy consumption. Although the cost of building such a house is about 10% higher than that of the traditional house, living in a passive house is significantly cheaper in the long term. On the other hand, in a traditional house a significant amount of energy is lost during the heating process. Heat is lost through walls, windows, roofs, floors, and this happens because this type of house is not compact; it does not have very dense insulation and good ventilation. A further case study of the energy consumption to heat and ventilate a passive house using renewable energy sources will be done.

6.17 The impact of pharmaceutical compounds on the water environment

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Keywords: pharmaceutical compounds, pharmaceutical pollution, water environment

Environment and health are directly or indirectly affected by pharmaceutical effluents especially in the adiacent of pharma industrial zones. Most large pharmaceutical companies pollute the environment, a significant problem in waste management being generated third-party companies that manufacture and supply important components of drugs (active pharmaceutical ingredients). There is ample evidence that pharmaceutical pollution has become a global problem. As a result, even drinking water sources have been contaminated with measurable amounts of hazardous chemicals which include therapeutic drugs, phytotherapeutics, biotechnological products, veterinary drugs. Different classes of pharmaceutical compounds like analgesic, antidepressant, antihypertensive, contraceptive, antibiotic, steroids and hormones have been detected in water samples between concentration ranges ng/L to µg/L. In this context, the present paper aims at an extensive study on the impact of pharmaceutical compounds on the environment. This review presents the dynamics and the development of research over the past ten years about the presence of non-steroidal anti-inflammatory analgesics, antihypertensives, antibiotics and other drugs in water. In addition, physical and chemical properties of the active pharmaceutical ingredients are highlighted such as: n-octanol-water partition coefficient(Kow), solid–water distribution coefficient(Kd) distribution and solubility.

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6.18 Comparative study of wind turbines with horizontal and vertical axis.

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Keywords:

The modern world is a big consumer of energy. From personal comfort, to travel, jobs and industry we consume fuels. Fossil fuels are exhausting resources and, at the same time, their combustion has irreversible effects on the environment, such as the greenhouse effect or the release of pollutants harmful to our health. Unlike fossil fuels, renewable energy sources such as solar energy, wind energy, ocean energy or bioenergy are inexhaustible resources and mainly have no impact on the environment. This paper discusses wind turbines, such as devices for transforming wind energy into electricity. Wind energy and wind resources in our country are analyzed here. Also, the physical phenomena that appear at the intersection between the wind and a turbine are presented. An in-depth comparison between the horizontal-axis and the vertical-axis wind turbine is the main topic of this paper. Finally, there is an analysis of the research carried out to increase the reliability and reduce the manufacturing and maintenance costs of the components of a wind turbine with a horizontal axis. Additional work will be done to build and test a horizontal axis turbine in the laboratory.

6.19 Study of the water quality in the Brașov area and the influences of bio ecosystems

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Keywords: water indicators, nitrate, heavy metals, bioecosystems

The paper present the water quality from Brasov area including Codlea district. The water resources of Codlea include the underground-groundwater and deep waters and the surface waters represented by the network of rivers that cross the territory of the locality. Groundwater resources fall into two categories, namely: the mountainous area (where the active layer is deep) and the shallow area (consisting of newer detrital rocks, which allow the formation of rich aquifer horizons, with appropriate qualities for different uses. Groundwater is found at depths between 1-2 m to 10-15 m with normal flow and mineralization of 0.5 g/L. At the base of Măgura Codlei there are several springs, the one on "Valea Caldă" with a constant temperature of 18℃, arranged for recreation and the springs on "Mărul Dulce". This paper consists in analysis of the influence of ecosystems: especially the mountain "Măgura Codlei" and "Codlea Forest", on water quality as well as evaluation of chemical pollutants impact. The physical and chemical indicators potentiometric pH, electrical conductivity, nitrate concentration(ppm), metals concentration will be determine in a further study. In addition the monitoring of heavy metals will be investigate by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) to determine concentration of the metals As, Cd, Cu, Fe, Pb, Co, Cr, Mn, Zn, Se, Co.

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6.20 Passive buildings optimization methodology considering energy demand, thermal comfort and cost

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Keywords: passive house, energy efficiency, comfort, cost, thermal insulation

Global energy consumption in the post-war period recorded the highest values. Buildings are responsible for about 40% of annual energy consumption. The solution is to increase the energy efficiency of buildings by renovating and covering. Energy performance is also influenced by the use regime of buildings. For residential buildings, the minimum requirements for the design of buildings from the energy point of view are structured on the maximum thermal resistance of the construction elements.. The passive house is part of the category of energy efficient buildings. The elements that define energy-efficient buildings as thermal insulation and thermal insulation layer with compact volume, windows, a good orientation of the building, tightness, heat recovery are a challenge for researchers and builders. This paper proposes two case studies in America and Romania to optimize a passive house into a house with zero consumption, respectively a traditional building into a passive house. The materials used, the energy calculations, respectively the costs involved are presented.

6.21 Thermoelectric materials based on Cobalt Oxide for humidity sensor applications in high-temperature

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Keywords: thermoelectric material, moisture effect, cobaltite oxide, humidity sensor

Thermoelectric generators are promising systems for harvesting energy from any heat source with temperature gradient. When the difference temperature is constant, the output voltage is almost fixed. However, many parameters can affect thermoelectric properties and output voltage. In this study, the effect of humidity on the thermoelectric properties of Calcium Barium Cobaltite Oxide was investigated. The experiment observation has shown that if the thermoelectric being exposed to moisture, they can exhibit different behaviors. In addition, the type of this reaction depends on the kind of moisturizing material. In this experiment, the Calcium Barium Cobaltite Oxide tablet with 30 mm diameter and 3 mm height was put at 353 K constant temperature difference and was used the Aluminum collectors to measure the voltage output. Water and Ethanol exposed the material to moisture in regular periodic time. The observation has illustrated that an amount of voltage is repeated in regular intervals with constant moisture. Calcium Barium Cobaltite Oxide under the influence of 4 µl of water reaches 1.4 V and then returns to the initial voltage (250 V) after fifteen minutes and it can repeat regularly. For the same amount of ethanol, this voltage was 400 mV and the return time to the initial value was 5 minutes. Therefore, due to the reaction with humidity and reversible voltage change too, this material can be used as a moisture sensor. As well, Calcium Barium Cobaltite Oxide is a type of ceramics, so, it can be used as a humidity sensor especially in high-temperature environments such as ovens and power plants.

6.22 Pharmaceutical applications and Bio-synthesis strategies to design colloidal silver solutions

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Keywords: colloidal silver, bioreduction mechanisms, polyphenolic compounds

Silver nanoparticles (AgNPs) have been exploited in a wide range of potential applications in medicine, cosmetics, renewable energies, environmental remediation, and biomedical devices. Also colloidal silver nanoparticles (AgNPs) have applications in the pharmaceutical area due to its antibacterial, antifungal and antiviral properties as well as due to the possibility of use as a transport vector for drugs or natural compounds.This contribution of present paper focuse on the biosynthesis strategy of AgNPs with polyphenolic components from plant extracts, but also on the possibility of using these nanoparticles as transport systems. The aim of the study is to investigate the relation between the bioreduction mechanisms and the composition of the polyphenolic components: total phenolic contents (TPC) quantified in equivalent gallic acid, total flavonoid contents (TFC) expressed quantified in equivalent rutin. Are analyzed the polyphenols extracts from Ocimum basilicum L., their bioreduction kinetics and the specific mechanisms. The design and obtain kinetics, as well as the specific characteristics of AgNPs: surface plasmon resonance, Mie scattering, size, zeta potential, are analyzed by UV-VIS spectroscopy and dinamic light scattering (DLS) technique.

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Section 7: Physics Education

Location and time: **Online**

Moderators:

Prof .Dr. Ştefan ANTOHE

Assoc. Prof. Dr. Cristina MIRON

7.1 - Bogdan ZAHARIA, Bogdan GRECU, Dragoş TĂTARU, Cristian NEAGOE, Florin ŞERBU
Romanian Educational Seismic Network can monitor earthquakes worldwide

7.2 - Klaus Nicolae MICESCU, Gheorghe PUPEZĂ
About the "Physics in Images" Contest - good practices

7.3 - Fabiola CHIRIACESCU, Bogdan CHIRIACESCU, Cristina MIRON, Valentin BARNA, Cătălin BERLIC
Conceptual map – scientific investigation tool used to study elementary seismology notions

7.4 - Ștefan GALIN, Tiberius O. CHECHE
Mud thrown from a wheel

7.5 - Adriana RADU, Ionel GRIGORE, Valentin BARNA
The Mathcad didactic tool for the study of the electric dipole

7.6 - Sanda VOINEA, Cornelia NICHITA, Eliza BURCHIU, Cornelia DIAC, Iulia ARMEANU
Study of potable water from wells in the metropolitan Bucharest area, influences on human health - interdisciplinary lab

7.7 - Raj Alexandru GUȚOIU, Tiberius O. CHECHE
The dog-and-rabbit chase problem

7.8 - Adriana RADU, Mihai-Valerian POPESCU, Catalin BERLIC, Cristina MIRON, Valentin BARNA
Employing ImageJ software as a measurement tool for optics experiments in the didactic laboratory

7.9 - Contesina Maria RUSU
The study of the light interference using Young's double-slit real and virtual experiment

7.10 - Bogdan CHIRIACESCU, Fabiola CHIRIACESCU, Cristina MIRON, Valentin BARNA, Cătălin BERLIC
Whiteboard animation – a tool for teaching special theory of relativity notions

7.11 - Anda Mihaela CIOBANU, Cristina MIRON, Valentin BARNA
Damped oscillating motion study by means of GeoGebra software

7.12 - Marilena COLȚ, Florentina Loredana DRAGOMIR, Valentin BARNA
Electrical activity of the heart explained in an interdisciplinary study at a high school level

7.13 - Marin OPREA
Integration of Robotics projects in the teaching and learning of Physics

7.14 - Dragoș TĂTARU, Bogdan POPOVICI, Cosmina MIRONOV, Anca POPOVICI, Mihai STRATICIUC, Andrei NEACȘU, Eduard NĂSTASE, Radu ANDREI, Alex PETRE, Mihai BONI, Ioana FIDEL
MSciTeh – a pilot interdisciplinary science summer school program

7.1 Romanian Educational Seismic Network can monitor earthquakes worldwide

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Keywords: school seismology, earthquake, Raspberry Shake, educational seismometers

In the last decades numerous seismic educational networks have been installed all over the world. The Romanian Educational Seismic Network (ROEDUSEIS) was the first initiative to introduce seismology in Romanian schools and joined successful examples such as "Seismographs in school" promoted by the IRIS in the United States, the United Kingdom "Schools Seismology Network" administered by the British Geological Survey, or French "Sismo à l'école" projects. These initiatives have proven to be useful for connecting the students to Earth sciences and stimulate their motivation to continue learning using the multiple tools available online. The emergence of low cost seismic instruments connected to the global network has led to the densification of instruments installed in schools and to the involvement of a significant number of amateur seismologists. In addition to educational seismometers such as SEP or Slinky seismometers, since 2020 the ROEDUSEIS network has been equipped with 18 Raspberry Shake seismometers known worldwide as the smallest and most accessible electronic seismographs with semi-professional performance. The installation of Raspberry Shake seismometers increased the recording capacity of the network. Initially, the earthquake detection capacity of the ROEDUSEIS network was limited due to the lower performance of SEP or Slinky seismometers. Presently we can record earthquakes from worldwide starting with local earthquakes of magnitudes ML of 2.5 and reaching over 5000 km for teleseisms with magnitudes Mw of 6. Data from the network are distributed through the FDSNW service following the same protocol than for scientific networks. Methods and programs of data analysis are adapted for application in the learning process of geosciences in schools. Python codes and Jupyter Notebook used by seismologists to analyze seismic data are now available to teachers and students to improve their programing skills using real seismic data and to learn more about Earth sciences.

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7.2 About the "Physics in Images" Contest - good practices

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The contest aims to improve students' ability to understand the physical phenomena of the world in which they live using, with priority, the image as explanatory support. This competition, held at the pilot edition, has as its main idea to guide students to observe the phenomena around them. The first step in understanding and explaining phenomena is to observe them. Capturing physical phenomena with the camera is not enough. The scenario created by the students must convey messages that are correctly intercepted by the audience. A correct transmission must have a good understanding of the background. For image processing and creating a good quality audio-video montage, we rely on children's ability to use applications from new technologies. To give chances to affirm to all students, regardless of age, as well as regardless of the profile followed in school, the regulation contains three sections with different degrees of difficulty. In this pilot edition, the participation exceeded the expectations of the organizers both numerically and in terms of work quality. The concept, the organization methodology, the regulation, and the content of the evaluation form are original products of the authors of this article.

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7.3 Conceptual map – scientific investigation tool used to study elementary seismology notions

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Keywords: Seismology, conceptual map, investigation-based learning, physics education

Elementary seismology notions are studied by high school students, both as direct applications for mechanical waves and through other various optional courses. The domain is a current one because earthquakes are natural phenomena that are part of life. With a major impact on our lives, these events are sometimes misread and the information provided by mass media is often insufficiently explained from the scientific perspective. In this paper, a scientific investigation method based on conceptual maps that can be successfully applied in Seismology studies is presented. Structurally, we have a main conceptual map from which some other various elements that are adding more information go, such as new concepts, examples and applications. The main conceptual map introduces the basic notions as the sources and causes of the earthquake occurrence, their parameters, means of study and the earthquake inquiry usefulness. Connections towards three other conceptual maps can be found. These maps explain some aspects such as seismic waves (types, characteristics, propagation), seismometers (types and operation mode), and Earth's internal structure. Two interactive applications that allow students to establish the epicenter location and the earthquake magnitude can be found as well. Animations and illustrations that exemplify the studied phenomena as seismic waves propagation, earthquake effects, precaution measures etc. are also attached to the maps. In the creation process of all the materials, some open-source and free computer programs have been used: Cmap Tools for building the conceptual maps, Geogebra for interactive applications, Tupi and Kdenlive and Whiteboard Animation technique for animations, Inkscape for images. The study is built in a manner that allows its use both during face to face, as well as online activities. All the resources can be distributed in the cloud and the programs can run on any kind of device and under any operating system.

7.4 Mud thrown from a wheel

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Keywords: Kinematics, classical mechanics

The height at which the mud is thrown from a wheel that rolls over level ground at a constant speed forward is a classic instructive problem. An innovative pedagogical method that illustrates the basic concepts of kinematics and provides an analytical perspective of the results is proposed as a useful tool in teaching classical mechanics. To find the solution, we use the concepts of ballistic launch, cycloidal motion, and the elementary theory of differential equations.

7.5 The Mathcad didactic tool for the study of the electric dipole

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Keywords: Mathcad, didactic tool, electric dipole, electrostatic field, physics education

This paper describes an interactive didactic tool made with the help of the Mathcad program for the study of the electric dipole. We calculate the potential and the electric field in a point placed at a certain distance from a system consisting of two equal and opposite point electric charges. The electric dipole moment is specified in the input data by the distance between the negative charge and the positive charge and the absolute common value of the two electric charges. By modifying the input data we can verify the calculation relations for the potential and the electric field at a large distance from the center of the electric dipole. The use of this tool in the classroom helps students to more easily understand how the principle of overlapping electric fields is applied in a concrete case and to clarify the connection between the electric field and the electric potential. Similarly, with the Mathcad program, students have the opportunity to efficiently explore the polar coordinates in solving an electrostatic problem and to easily operate with the units of measurement of physical quantities involved in calculations.

7.6 Study of potable water from wells in the metropolitan Bucharest area, influences on human health - interdisciplinary lab

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Keywords: Drinking water, nitrate, metal concentration, human health, interdisciplinary laboratory

The quality of drinking water has a special importance on human health. This paper presents an interdisciplinary experimental lab for students to determine the water quality. The case study is focused on the waters coming from wells in the Bucharest metropolitan area, which may influence the health of the population living here. The experimental works measure the pH, electrical conductivity, nitrate concentration and metals concentration in the water samples. The results showed an important exceedance of the legal nitrate concentration value for drinking water from the northern neighborhood of Bucharest. At the same time, exceedances of the maximum allowed concentration for Cu in the Snagov area were identified. In these areas, further studies are needed related to the health of the inhabitants, taking into account the effects of

the presence of nitrates and metals in drinking water. The proposed laboratory is a model for understanding concepts in chemistry and physics related to human health and environmental issues.

7.7 The dog-and-rabbit chase problem

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Keywords: Kinematics, classical mechanics

The dog-and-rabbit chase problem is a classic problem that emphasizes the use of concepts of elementary kinematics and, therefore, can be used in introductory mechanics teaching. Relative motion, change of coordinates, and the elementary theory of differential equations are used to provide a more general approach to this problem. The effectiveness of the adopted approach is proved by applying it to another related problem.

7.8 Employing ImageJ software as a measurement tool for optics experiments in the didactic laboratory

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Keywords: Image processing software, ImageJ, optics experiment, physics education

In this paper, we used ImageJ as image processing software for analysis of the data obtained from experiments in optics physics laboratory. We employed the software to investigate the interference and diffraction patterns obtained from Newton's rings, Fresnel biprism and the diffraction patterns acquired by diffraction gratings. ImageJ is a free software that is extensively used in scientific research for measurement and inquiry. The program is very easy to use and merely demands computational hardware resources that can be found on usual computers. It is also easy to understand by most of the students while being very efficient and accurate. The tool is extremely useful and precise, helping the students to focus on understanding the concepts. It can be also adapted to many laboratories assisting to improve their educational aptitudes.

7.9 The study of the light interference using Young's double-slit real and virtual experiment

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Keywords: light interference, Young's double-slit, experiment, physics education

Teaching physics may be difficult process, mainly because of the issues that students have when learning physics. Therefore, it is important for physics teacher to investigate how technology can be integrated into effective teaching of

physics. Regarding the experiments, things are much more delicate because, on one hand, not all experiments can be easily carried out and, on the other, hand the school lab is unavailable for the whole classat once. In the actualcontext, the virtual lab comes in handy for a teacher. Through the virtual simulators, the students will be able to better understand physical phenomena. The study of the light interference using Young's double-slit could be very difficult to be carried out in a school lab, because it requires accurate measurement of distances, especially for the inter-fringe. Using both knowledge and the abilities gained in the study of the interference phenomenon of light using simulators could be useful in studying the phenomenon using the device available in the real lab.

7.10 Whiteboard animation – a tool for teaching special theory of relativity notions

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Keywords: Physics education, whiteboard animation, relativity

Special Theory of Relativity (STR) and Einstein's Postulates consequences brought a new perspective for some notions that previously were considered absolute: the simultaneity, time or space. Classical approaches of relativistic phenomena led to a series of paradoxes that need to be addressed by means of new ideas, entirely different from the things that we can find in daily life. It is obvious that explaining unusual, highly peculiar things, implies completely different didactic approaches from the classical ones. High school students that study STR do not have enough math knowledge, neither the abstraction capability in order to easily understand the considered notions. In this paper, we present one of the didactic tools, namely Whiteboard Animation, employed for introducing and explaining the "Garage Paradox" – a consequence of the STR Postulates. Herein, the relativistic contraction phenomenon is explained, starting from the relativity of simultaneity. The method is based on an animation built by means of free open-source computer programs. We show a conceptual approach with less math involved, to be better understood by high school students. Audio-video message has a great impact and helps to adapt the teaching manner to many learning styles. The phenomena are presented using comparisons and examples that correlate these concepts with the knowledge that the students already have, everything respecting scientific accuracy.

7.11 Damped oscillating motion study by means of GeoGebra software

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Keywords: Oscillatory motion, damped oscillation, GeoGebra, simulation, interdisciplinary learning

The study of oscillatory motion is one of the essential topics in physics, because it allows understanding the application of the fundamental laws of classical mechanics to simple physical systems and it can be used, by analogy, in the study of electrical circuits, powered by alternating voltages. In this paper we explain the use of GeoGebra software in the study of oscillatory motion, starting from the simple ideal system, the harmonic linear oscillator, in order to subsequently include some more complicated effects related to the damping oscillations (that are encountered in real-life systems). Damped oscillations are usually treated with a resistance force, which is proportional to the velocity. This approach has the advantage of a relatively simple mathematical solution, yet, in some situations, it is preferable to take into account the constant frictional force between the body and the surface on which it moves. Simulations created in GeoGebra have the advantage to operate on any desktop browser. All that is left is to understand the mathematics behind the physics. By developing and employing

simulations, the students have the opportunity to make important connections between their Math and Physical Science knowledge, further developing their skills in solving interdisciplinary problems.

7.12 Electrical activity of the heart explained in an interdisciplinary study at a high school level

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Keywords: ECG, interdisciplinary, portable devices, heart rate, physics education.

The human heart beats billions in an average life, but like any other organ, at some point, it can have certain diseases. Some of these may be due to poor nutrition and lifestyle, and others may be genetic in nature. Among the heart diseases, the most common are arrhythmias, which are disorders of the normal contraction of the heart or, in other words, disorders of the normal rhythm of the heart. Arrhythmias fall into two categories, tachycardias, ie too fast a rhythm, greater than 100 beats per minute, and brachycardias, ie too slow a heart rate, less than 60 beats per minute. The recording of an EKG, respectively of the electrical activity of the heart, provides the most important information about the heart rhythm of the heart. Heart rate control can be done with the help of various digital devices such as portable electrocardiograph, heart rate monitor and even with the help of smartphone, etc. In this paper, we aimed to familiarize students with the measurement of cardiac potential, by making electrocardiograms, with portable devices such as portable ECG monitor PM10 and pulse determination with the CMS50D + Pulse Oximeter. Lifestyle disorders can be prevented by educating the population about risk factors.

7.13 Integration of Robotics projects in the teaching and learning of Physics

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Keywords: Robotics project, obstacle avoiding robot, line tracking robot

The rapid progress of new technologies such as Internet of Things (IoT), Robotics, Artificial Intelligence (AI), has led to a global digital revolution whose influence is strongly exerted in all sectors of society, including the education sector. With the implementation of these technologies in Education, new educational models adapted to the digital economy have been launched. One such model adapted to the requirements of the digital labor market is the STEM educational model. Our students must be prepared for the professions of the future: specialist in human-robot interaction, augmented reality architect, developer of smart homes, etc. They need to be encouraged to explore more, discover and understand how things around them work. Numerous specialized studies attest to the major positive impact of Robotics, as a school discipline associated with the STEM educational model, on the training and development of scientific and technological key competencies of students. Starting from these studies, I decided to develop and test a method of integrating Robotics projects in the school educational environment, more precisely in teaching and learning of Physics. I have developed a wide range of projects associated with the basic fields of Physics: obstacle avoiding robot, mobile robot controlled by Bluetooth, robotic sorting arm, line tracking robot, exploration robot, self-balancing mobile robot, quadcopter type drone, etc. In this paper I have shown how two of the Robotics school projects developed on the Arduino platform can be realized and integrated within the Physics lessons: Line Tracking Robot and Obstacle Avoiding Robot.

7.14 MSciTeh – a pilot interdisciplinary science summer school program

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Research-based education is a well-established term especially in the higher education system. Recent studies have shown that education has to be based on cutting-edge research, and this approach can be applied not only for students programs, but also started from early stages in the learning cycle. It is also well documented that assessing the research-based teaching and learning outcome in a non-formal, out-of-the class environment such as extra-curricular activities or more extensively and intensively in a summer school program came much more naturally. In the present study we will describe how a science and technology summer school program (MSciTeh) could be structured as a testbed for developing a research-based methodology for teaching STEM subject for highschool students but also a valuable internship program for the undergraduate students interested to improve their pedagogical skills. The main element that makes this program unique, beyond linking directly education to a real research environment, is the multidisciplinary approach. The subjects students are exposed to a range of topics from engineering to robotics, artificial intelligence to biophysics, environment to nuclear physics. Participants are organized in small groups and work for two weeks, side by side with their mentors (researchers) and assistants (students) on projects, tackling a real challenge or working to improve a technology/instrument used to perform basic or advanced measurements. They have the chance to understand how knowledge is generated and to perform and conduct their own research. On the other hand, assistant-students have the opportunity to actively participate not only as monitors and link between pupils and their mentors, but truly getting involved in preparing and delivering the project activities, learning and mentoring at the same time.

Section 8: Polymer Physics

Location and time: **Online**

Moderators:

Prof. Dr. Valentin BARNA

Assoc. Prof. Dr. Cătălin BERLIC

8.1 - Valentin BARNA
Laser emission and light manipulation in confined micro-systems

8.2 - Valentin BARNA, Dedy SEPTIADI, Dhruv SAXENA, Riccardo SAPIENZA, Damiano GENOVESE, Luisa DE COLA
BioLasing from Individual Cells in a Low-Q Resonator for Spectral Fingerprinting

8.3 - Valentina DINCA, Valentina MARASCU, Anca BONCIU, Laurentiu RUSEN
Hierarchical bioinstructive interfaces obtained by laser processing for biological studies

8.4 - Valentina MARASCU, Mickael PAYET, Sebastien GARCIA-ARGOTE, Sophie FEUILLASTRE, Gregory PIETERS, Vincent MERTENS, Frederique MISERQUE, Etienne Augustin HODILLE, Elodie BERNARD, Christian GRISOLIA
Microwave (2.45 GHz) Plasma treatments of Tungsten particles as a source for Tritium retention studies

8.5 - Stefania RAITA, Gabriel PREDOI, Monica Luminita BADEA, Carmen CIMPEANU, George A. STANCIU, Radu HRISTU, Simona Liliana ICONARU, Daniela PREDOI

Polymer coated Fe3O4 nanocomposite for water remediation applications

8.6 - Madalina ICRIVERZI, Laurentiu RUSEN, Anca BONCIU, Valentina MARASCU, Anca ROSEANU, Valentina DINCA

Polymer-proteins-based coatings characteristics influence on cells behavior

8.7 - Simona Liliana ICONARU, Stefania RAITA, Monica Luminita BADEA, Gabriel PREDOI, George A. STANCIU, Radu HRISTU, Carmen CIMPEANU, Daniela PREDOI

Nanobiocomposites for agrochemical applications

8.8 - Simona Liliana ICONARU, Gabriel PREDOI, Carmen CIMPEANU, Monica Luminita BADEA, George A. STANCIU, Radu HRISTU, Stefania RAITA, Daniela PREDOI

Zero valent iron powders: synthesis and characterization

8.9 - Mircea BEURAN, Alina PRODAN, Simona Liliana ICONARU, Carmen Steluta CIOBANU, Anton FICAI, Bogdan Stefan VASILE, Ionela Andreea NEACSU, Ecaterina ANDRONESCU, Roxana TRUSCA, Carmen CHIFIRIUC, Daniela PREDOI

Zinc doped hydroxyapatite powders enriched with zinc oxide for biomedical application

8.10 - Simona Liliana ICONARU, Alina PRODAN, Mircea BEURAN, Mariana Carmen CHIFIRIUC, Carmen Steluta CIOBANU, Anton FICAI, Bogdan Stefan VASILE, Ionela Andreea NEACSU, Ecaterina ANDRONESCU, Roxana TRUSCA, Daniela PREDOI

New antitumoral biocomposites with controlled release

8.11 - Alina PRODAN, Mircea BEURAN, Simona Liliana ICONARU, Carmen Steluta CIOBANU, Carmen CHIFIRIUC, Luminita MARUNTESCU, Marcela BUCUR, George A. STANCIU, Radu HRISTU, Anton FICAI, Bogdan Stefan VASILE, Ionela Andreea NEACSU, Ecaterina ANDRONESCU, Roxana TRUSCA, Daniela PREDOI

Preparation and characterization of cerium doped hydroxyapatite thin films

8.12 - Mircea BEURAN, Daniela PREDOI, Simona Liliana ICONARU, Carmen Steluta CIOBANU, Anton FICAI, Bogdan Stefan VASILE, Ionela Andreea NEACSU, Ecaterina ANDRONESCU, Carmen Mariana CHIFIRIUC, Prodan Alina MIHAELA

Development and characterization of new ZnO materials for biomedical applications

8.13 - Gabriel PREDOI, Simona Liliana ICONARU, Stefania Mariana RAITA, Liliana GHEGOIU, Monica-Luminita BADEA, Carmen Steluta CIOBANU, Carmen Mariana CHIFIRIUC, Daniela PREDOI

Synthesis and preliminary characterization of FexOy-CTAB compounds

8.14 - Eduard GATIN, Catalin LUCULESCU, Stefan IORDACHE, Roxana R. ILICI

Influence of Light Curing Protocol on Volumetric Dimensional Change Of Dental Resin Composites. A New Approach Based on Raman Spectroscopy

8.15 - Eduard GATIN, Catalin LUCULESCU, Stefan IORDACHE

Dental Ceramics During Heating Treatment Process, Comparative Survey. Alumina Versus Zirconia Ceramic

8.16 - Catalin BERLIC, Eduard GATIN, Daciana ZMARANDACHE

Comparative study of the computer simulations techniques used in polymer crystallization

8.17 - Catalin BERLIC, Emil-Stefan BARNA, Cristina MIRON, Valentin BARNA

Simulation of the crystallization process of polymeric films

8.1 Laser emission and light manipulation in confined micro-systems

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Keywords: Micro-Systems, light amplification

Lasing phenomena and in particular random lasers have been a domain of intense theoretical and experimental studies in the last years. They are captivating examples of scientific topics that coalesce multiple scattering of light and optical amplification. Specifically, in a random laser system, several discrete modes are optically amplified within the host medium and exhibit individual resonant wavelengths with the spectral interval being usually in the range of a few nanometers. Ionic liquids prove to be perfect candidates for building, as shown, a series of exotic boundary-less or confined compact laser systems. Lasing is presented in standard wedge cells, freely suspended ionic liquid films and droplets. The optical emission properties are investigated in terms of spectral analysis, below and above lasing energy threshold behavior, emission efficiency, far field spatial laser modes intensity profiling, temporal emission behavior etc. As demonstrated, these materials can be employed as optimal near future replacements of conventional flammable solvents in already available dye laser instruments.

8.2 BioLasing from Individual Cells in a Low-Q Resonator for Spectral Fingerprinting

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Keywords: PMMA cell, BioLasing, Light Scattering, Spectral fingerprints

Lasing from cells has recently been subject of thorough investigation because of the potential for sensitive and fast biosensing. Yet, lasing from individual cells has been studied in high-quality resonators, resulting in limited dependence of the lasing properties on the cellular microenvironment. 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. Numerical simulations of the scattering efficiency rule out the possibility of optical feedback from either WGM (whispering gallery mode) or multiple scattering within the cell, and point to the enhanced directional scattering field as the crucial contribution of cells to the laser action. Finally, principal component analysis of lasing spectra measured from freely diffusing cells yields spectral fingerprints of cell populations, which allows discriminating cancer from healthy Rattus glial cells with high degree of confidence.

8.3 Hierarchical bioinstructive interfaces obtained by laser processing for biological studies

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This work presents the the nano and micro hierarchical biointerfaces influence on the osteogenic fate of MSCs. The complex interfaces were created via a laser texturing technique. Scanning Electron Microscopy, EDAX, contact angle and surface energy of the analyzed coatings were correlated to biological response on both short and longer term (72h, respectively 28 days). Human MSC were cultured on the developed coatings and viability, proliferation and morphology were evaluated. All surfaces were shown not to exhibit toxicity, as confirmed by LIVE/DEAD assay. Micro and nanotextured

ceramic interfaces exhibited an increase in osteogenic differentiation of hMSC cells, results supported by ALP and mineralization assays.

8.4 Microwave (2.45 GHz) Plasma treatments of Tungsten particles as a source for Tritium retention studies

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Keywords: W particles; materials; microwaves; hydrogen plasma, tritium gas

Microwave plasmas techniques represents an important domain due to their large applications, and capacity to synthesize or treat new materials, without producing major contaminations. Thus, depending on the material's nature, microwaves can start to heat the material in all its volume (materials containing carbon, e.g., polymers), or can heat only the material surface (e.g., metallic materials). In our approach, we have used a 2.45 GHz microwave (MW) plasma discharge to treat tungsten (W) particles, in order to study Tritium retention inside particles. Hydrogen was used as a main gas for the plasma discharge. The experiments have consisted of using two steps: in the first part, 40 mg of submicronic W particles (and having various shapes) were exposed to MW Hydrogen plasma, for 44 minutes, at 100W input power, and by using a static H2 pressure = 7 mbar. After plasma treatment, W particles were transferred in a secured Gloves Box, where were exposed to 100 mbar tritium gas, under heating conditions. Morphological investigations were made for W particles before, and after plasma treatments. Indeed, by analyzing SEM images it can be observed melted particles, and the occurrence of tube-like morphologies along with nanometric particles on top of the initial W particles. From XPS analyses we have observed the oxide reduction from W particles after plasma treatment. Tritium retention in W particles was analyzed via room temperature desorption and dissolutions methods. By using room temperature method, it was showed that plasma pre-treatment facilitated the retention of tritium in W particles in a higher quantity, compared with W particles which were treated only in Hydrogen gas atmosphere under heating conditions. Tritiated particles dissolutions were made by using Hydrogen Peroxide and Sodium Hydroxide. Our results have showed that hydrogen plasma pre-treatment has produced additional nanometric particles, increasing the specific surface area (SSA) of the initial W particles. This aspect conducted further on to a higher tritium retention in W particles. Further plasma treatments conditions will be made in order to observe the threshold of the additional nanometric particles, which are responsible of a higher tritium retention.

8.5 Polymer coated Fe3O4 nanocomposite for water remediation applications

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Keywords: iron oxide nanocomposites, water remediation, polymer coating

Functionalized nanoparticles are an emerging area of materials science with a great potential to solve problems on a global scale by manufacturing nanoparticles with controlled properties [1-2]. Magnetite (Fe3O4) and maghemite (γ-Fe2O3) are some of the most studied forms of iron oxides due to their special properties at the nanometer scale (large specific surface, superparamagnetism, etc.) [3-5]. Potential polymers used to coat iron oxide nanoparticles were chosen from the category of biopolymers, mostly from the family of natural polysaccharides. Cellulose is a linear linear polysaccharide polymer with many units of glucose monosaccharides and is a major component in the rigid cell walls of plants. Cellulose-functionalized Fe3O4 and Fe3O4 powders recovered after decontamination experiments (As:Fe3O4 and As:Fe3O4_Cz) were analyzed by X-ray diffraction and the obtained diffractograms showed the existence of diffraction maxima corresponding to cubic magnetite. Supplementary maxima associated with arsenic have not been identified. Scanning electron microscopy studies have shown that the As:Fe3O4 and As:Fe3O4_Cz samples have nanometric dimensions and have a spherical morphology. The EDX spectra confirmed the presence of the constituent elements of iron oxide (Fe, O) and also confirmed the presence of arsenic in the analyzed samples. FTIR and Raman studies have highlighted the presence of magnetite-specific vibration bands. In the case of the As:Fe3O4_Cz sample, a maximum can be observed that can be attributed to the presence of cellulose. None of the analyzed samples had an inhibitory effect on the strains tested by Escherichia coli (control strain ATCC 25922) and Shigella flexneri. Optical microscopy visualization of BHK21 cell morphology after incubation for 24 hours with arsenic-contaminated solutions showed that arsenic ions had a toxic effect on BHK21 cell morphology and also inhibited their proliferation. The results of the in vivo tests showed the toxic character of arsenic ions (even in small quantities in drinking water).

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8.6 Polymer-proteins-based coatings characteristics influence on cells behavior

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Keywords: mesenchymal stem cells, oteogenic differentiation, lactoferrin, polymer composite

The potential of Mesenchymal stem cells (MSC) for implantology and cell-based therapy represents one of the ongoing research subjects within the last decades. In bone regeneration applications, the various environmental factors including bioactive compounds such growth factors, chemicals and physical characteristics of biointerfaces are the key factors in controlling and regulating osteogenic differentiation from MSCs. In our study we have investigated the influence of Lactoferrin (Lf) and Hydroxyapatite (HA) embedded within a biodegradable copolymeric matrix on the osteogenic fate of MSCs. The complex composite coatings based on biodegradable PEG-PCL copolymer and the two bioactive factors, Lf and HA were created via a laser evaporation technique. Scanning Electron Microscopy, EDAX, contact angle and surface energy of the analyzed coatings were correlated to biological response on both short and longer term (72h, respectively 28 days). Human MSC were cultured on the developed coatings and viability, proliferation and morphology were evaluated. All surfaces were shown not to exhibit toxicity, as confirmed by LIVE/DEAD assay. Lf-HA composite exhibited an increase in osteogenic differentiation of hMSC cells, results supported by ALP and mineralization assays. This is the first report about biodegradable composite layers directing osteogenic differentiation from hMSCs and the results indicated that the biodegradable layers have great potential for application in bone regeneration.

8.7 Nanobiocomposites for agrochemical applications

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One of the most widely used in plant foods, wheat, like many other cereals, contains low levels of essential iron micronutrients [1]. However, recent developments in science have led to a shift in targeted research on plants and led to the development of innovative technologies based on the use of nanoparticles in fertilizing plants to increase their micronutrient value. In this context, our study envisages the development of nanocomposites such as iron oxides (IO) and hydroxyapatite (HAp) to be used in agrochemical applications as fertilizers to improve plant quality. Nanocomposites based on iron oxide / hydroxyapatite were obtained by an adapted method. The hydrodynamic size of the particles measured by DLS was for the HAp nanoparticles of about 137 ± 5 nm and for the IO nanoparticles of about 23 ± 5 nm. The soils of wheat plant pots used in experiments, before and after fertilization of the soil with IO solutions were also investigated by Fourier transform infrared spectroscopy (FTIR). The FTIR spectra of the two soil samples before and after fertilization show no noticeable changes, which may be due to the fact that the wheat plants absorbed the iron ions from the iron oxide solution used as fertilizer. The ICP results showed that both soil fertilization and plant foliar fertilization influenced the iron content of the studied wheat plants. Moreover, it was observed that foliar fertilization had a more pronounced influence on the iron content from wheat plants compared to soil fertilization. Moreover, studies on changes in wheat plant organs following anatomical study after foliar and soil fertilization have been performed by optical microscopy. The images recorded on the optical microscope showed that there is an increase in the length of the trichomes depending on the treatment applied to the wheat plant with IO solutions.

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8.8 Zero valent iron powders: synthesis and characterization

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Due to technological development and industrialization in recent years, many areas have been contaminated with hazardous waste that contribute to the widespread contamination of soil and groundwater worldwide. Arsenic-contaminated drinking water has been found to cause serious health problems. In this context, over the years, studies have been conducted on obtaining nanoparticles for their use in the depollution of contaminated solutions. Zero-valent iron powders (Fe0) with nanometric dimensions were synthesized by coprecipitation method. Morphological characterization of Fe0 powders was performed by scanning electron microscopy (SEM) and results highlight both the nanoscale size of the powders and the fact that the powders are homogeneous and the particles have a spherical shape. The EDS spectrum of Fe0 nanoparticles revealed the presence of iron (Fe) in the investigated sample. The ability of As3 + ions to be removed by Fe0 powders was investigated by batch experiments and by monitoring the concentration of As3 + in aqueous solutions. The results of the studies showed that the efficiency of removal of As3 + ions by zero-valent iron powders was around 90%. In vitro studies on the cytotoxicity of Fe0 nanoparticles before and after removal experiments of aqueous arsenic ions from contaminated solutions was evaluated using the MTT viability test (using an HeLa cell line). The Fe0 powders did not show a high toxicity showing a behavior similar to that of the control culture after an incubation period of 24h, which indicates a good biocompatibility. On the other hand, in the case of Fe0 samples recovered after the removal experiments of arsenic ions from contaminated solutions, it was observed that they have a toxicity correlated with the concentration of As3+ from the contaminated solution. Therefore, Fe0 powders could be used successfully in the development of new technologies for depollution of waters contaminated with As3 + ions.

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8.9 Zinc doped hydroxyapatite powders enriched with zinc oxide for biomedical application

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It is well known that osteoporosis is a major public health problem mainly due to its frequency, morbidity and costs [1]. Fractures that occur after the onset of osteoporosis increase morbidity and have a major impact on quality of life [2]. Therefore, researchers are trying to find safe and effective therapeutic solutions to prevent and treat this silent disease. Due to its excellent physico-chemical and biological properties, hydroxyapatite is used in various biomedical applications (implantology, dentistry, filling material for bone defects, etc.) [3]. Therefore, the doping of hydroxyapatite with zinc ions could be a therapeutic solution that could be used in the management of osteoporosis. The purpose of this study was to obtain and characterize from a physico-chemical point of view the zinc-doped hydroxyapatite (HApZn) powders enriched with zinc oxide. Thus the HApZn/ZnO powders obtained by an adapted precipitation method were analyzed by: X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy and by in vivo experiments. Following XRD studies performed on HApZn samples were identify two main mineralogical compounds, namely hydroxyapatite and zinc oxide. According to ASTM sheets, the identified hydroxyapatite is part of the crystalline system hexagonal and zinc oxide in the crystalline system Hexagonal. Also, the nanometric dimensions of the nanoparticles have been noticed. SEM and TEM studies have highlighted the spherical morphology of HApZn / ZnO nanoparticles as well as their tendency to agglomerate. At the same time, Raman studies have shown the presence of vibrational bands specific to the HAp structure. Histopathological visualization revealed that the treatment with the analysed powders had a significant contribution to bone regeneration in ovariectomized mice. Thus, the analysed materials have superior physicochemical and biological properties and could be considered for use in the treatment of osteoporosis.

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8.10 New antitumoral biocomposites with controlled release

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The presence of magnetic nanoparticles in bone scaffolds can stimulate the proliferation and differentiation of osteoblasts, the expression of growth factors, and accelerate bone regeneration by improving osteoinductivity. The uniform characteristics of hydroxyapatite (HAp) and Fe3O4 nanoparticles will ensure a rapid response in contact with the magnetic field, which is of interest for their application [1]. 5-Fluorouracil (5-FU) is one of the most widely used chemotherapeutic compounds for the treatment of a wide variety of tumors. HAp-Fe3O4 / 5-FU antitumor systems were obtained by an adapted coprecipitation synthesis method. X-ray diffractograms highlight the presence of hydroxyapatite (ICDD 04-007-5086), magnetite (ICDD 04-011-5952) and 5-Fluorouracil antitumor agent (ICDD 00-039-1860) in the samples obtained. The SEM results highlight the presence of particles with nanometric dimensions and different morphologies. Thus, nanoparticles with a rod-like morphology characteristic of hydroxyapatite can be observed and on the other hand nanoparticles with a polygonal morphology specific to magnetite are also present. Following the SEM studies, the average size of the hydroxyapatite particles was estimated, obtaining a value equal to 90.48 ± 2.03 nm, respectively for the magnetite particles, this being equal to 162.55 ± 4.78 nm. Following the release studies of the antitumoral agent, it was noticed that processes of release and reabsorption of the antitumoral agent take place simultaneously. Cell viability studies performed with a primary osteoblast cell line have shown that cell viability is weakly influenced by the presence of antitumoral systems. Qualitative antimicrobial tests revealed that all investigated samples showed moderate antimicrobial activity against all bacterial strains (Gram-positive bacteria (Staphylococcus aureus ATCC 25923), Gram-negative bacteria (Escherichia coli ATCC 25922) and fungi (C. albicans ATCC 10231)) tested in vitro. The results obtained in this study showed that the HAp-Fe3O4 / 5-FU samples could be a new and effective platform for the treatment of bone metastases.

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8.11 Preparation and characterization of cerium doped hydroxyapatite thin films

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Keywords: cerium doped hydroxyapatite, thin films, antimicrobial properties, Confocal laser scanning microscopy

Recently, scientific research has focused on the development of new drug delivery systems. Hydroxyapatite [HAp, Ca10 (PO4) 6 (OH) 2] is a well-known bioceramic material that has been widely used as a bone substitute due to its suitable mechanical properties and similar to bone mineral composition. Improving the properties of HAp can be obtained by doping it with various ions. Therefore, obtaining thin layers of cerium doped HAp is of great interest for the biomedical field. The cerium doped hydroxyapatite (xCe = 0.1) thin films on Si substrate were obtained by spin coating method. The HApCe thin films were tested using scanning electron microscopy (TEM), scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and Raman spectroscopy. The surface of HApCe_1 thin films was homogenous and continuous with no evidence of cracks. The elemental mapping results shows a uniform distribution of the constituent elements on the sample surface. The FTIR spectra together with the Raman spectra highlight the presence of vibrational bands corresponding to the phosphate and hydroxyl groups specific to the HAp structure. In both spectra, no additional vibrational bands were noticed. The antimicrobial assays proved that HApCe_1 thin films strongly inhibited the development of C. albicans fungal strains compared to control. Confocal laser scanning microscopy (CLSM) was performed to assess the fungal biofilm development on the surface of HApCe_1 thin films, after 24 h of incubation, by visualization of the adherent fungal cells on the substrates. CLSM images emphasized that the studied samples strongly inhibited the development of C. albicans fungal cells. Morphological and optical characterizations showed that hydroxyapatite doping was performed efficiently with cerium ions thus obtaining thin layers with superior antimicrobial properties.

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8.12 Development and characterization of new ZnO materials for biomedical applications

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Bacterial infections are a serious health problem, and can lead to economic and social complications. ZnO nanostructures show significant antibacterial activity on a wide range of bacterial species explored by a large number of researchers. In this research were obtained ZnO powders (Zn2+ concentration was 0.3488 and 0.1744 (mol/L)) by a hydrothermal method in the microwave field. In the XRD diffractograms obtained on ZnO samples, the presence of well-defined diffraction maxima is observed, with high intensities, proving a high degree of crystallinity. It can be seen that in all diffractograms zinc oxide is present as a single phase, no diffraction interference being detected that corresponds to other minor phases. The results of electron microscopy studies indicate the presence of polycrystalline materials, with a high degree of crystallinity, in accordance with the structural aspects previously identified in X-ray diffractograms. From a morphological point of view, the nanoparticles obtained have a platelet and rod appearance, with thicknesses up to 50 nm, arranged mainly in the form of agglomerates, due to the large specific surface area associated with the nanometric dimension. FTIR spectra show a well-defined absorption band, characteristic of the Zn-O bond tensile vibration around 400 cm-1. The results of antimicrobial tests show visible antimicrobial effects on C. Albicans. Also, was noticed that the antimicrobial activity of ZnO powders is strongly influenced by de Zn2+concentration. The results obtained in this preliminary study are promising and create the premises for a possible use of new materials based on zinc oxide in biomedical applications.

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8.13 Synthesis and preliminary characterization of FexOy-CTAB compounds

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Keywords: As (III) removal, FexOy-CTAB nanocomposites, water treatment technology

Recently, the development of new materials with new specific properties that could be used successfully in environmental remediation has become a priority among researchers working in various scientific fields [1]. In recent years, the interest for the efficient synthesis of magnetic iron oxide nanoparticles and their functionalization has increased considerably due to their wide range of use in various applications, as well as their use for adsorption of metal ions from aqueous solutions [2- 4]. Previous studies have reported that different types of iron oxide, have the ability to remove both As (III) and As (V) from water [3, 5]. The aim of this study was to obtain CTAB-coated iron oxide powders (M-CTAB) by an adapted method. The obtained M-CTAB powders were investigated by: X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and batch adsorption experiments. Also, preliminary qualitative evaluation of cell viability and cell morphology by fluorescence microscopy was performed. The results of XRD studies highlight the purity of the obtained samples as well as the nanometric size of the particles (17.26 ± 3 nm). The SEM micrograph revealed the

spherical morphology of the nanoparticles. In the FTIR spectra can be easily identified the vibrational bands which are attributed to the stretching vibration and are characteristic of the iron from the tetrahedral and octahedral positions, respectively. AAS studies indicate that the best removal efficiency of As (III) from aqueous solutions using M-CTAB nanoparticles is obtained at pH 5. It can also be seen that the efficiency of As (III) removal decreases with increasing of pH. Preliminary biological test results show that M-CTAB nanoparticles do not induce morphological changes nor do they alter cell proliferation after 24 h of incubation. Our results suggest that M-CTAB nanoparticles could be used in new water treatment technology.

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8.14 Influence of Light Curing Protocol on Volumetric Dimensional Change Of Dental Resin Composites. A New Approach Based on Raman Spectroscopy

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Keywords: dental composites, filler, resin matrix, polymerization, pycnometer, RAMAN spectroscopy

Filler – polymer matrix coupling determines, to a large extent, the mechanical strength and clinical longevity of dental composites. Incorporation of filler into resin matrix greatly influences and improves material properties provided that filler particles are bonded to polymer matrix or otherwise it may weaken the resin. The dimensional stability of resin composite materials is affected by polymerization shrinkage, degree of conversion, thermal contraction and expansion, and interactions with an aqueous environment. It has been reported that the same degree of conversion is produced by a fixed amount of energy density, but we suggest to account for variations in irradiation intensity, time and working mode of the curing lamp. In our study it was used a curing LED lamp (Light emitting diodes, $\lambda = 420 \div 480$ nm), with different curing programs (variable light intensity, different time rates and mixed). Materials used through our investigation were two composites resins (RBC) with the same polymer matrix, but different filler (micro/nano filler). For sample properties evaluation there were used pycnometer technique (pycnometer from Paul Marienfeld Gmbh, Germany) and RAMAN spectroscopy technique (MiniRam Equipment from B&W Tek Inc, USA; 785 nm laser source). Results obtained are trying to suggest a better protocol for light curing process, for better mechanical properties and biocompatibility of the dental resin-based composites (RBC).

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8.15 Dental Ceramics During Heating Treatment Process, Comparative Survey. Alumina Versus Zirconia Ceramic

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Keywords: dental ceramic, crystal grain, phase frozen, modeling

Nowadays, two of the most used dental ceramic materials alumina based on Al2O3 and zirconia-based on ZrO2 have been investigated regarding heating treatment process influences on manufacturing dental ceramic core for applied veneer and glazer in the dental laboratory. It was noticed that alumina ceramic is more affected at morphological level by the thermal process, predicting a grain size diameter control to a decreasing value, less or about $dG = (1.137 \pm 1.018)$ μm and almost constant pore diameter size $dP \sim 2$ μm. Affected depth inside the material of alumina core caused by the thermal process, was estimated $d = 7.40 \pm 0.51$μm. Smaller size for zirconia grains (morphologic not affected by the heating temperature process conditions involved in our study, just on structural level) is predicting modeling of alumina surface with zirconia acting as a grain stopper for the cooling period.

8.16 Comparative study of the computer simulations techniques used in polymer crystallization

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Keywords: polymer crystallization, kinetic of nucleation, Avrami equation, Monte Carlo simulation

Crystallization of polymers is a process based on apparition and growth of expanding crystalline regions that appear in the bulk. The kinetics of nucleation of the polymeric crystalline domains strongly influences the structure of the materials that, finally, determine the physics, chemical, and technical properties of the solid polymers. It follows that a good insight into the kinetics of crystallization of polymers is very important not only from a scientific point of view but also for industrial applications. We present here several Monte Carlo techniques used in simulations and modeling of the crystallization process of polymers. Using these techniques, it is possible to determine the parameters of the Avrami equation that describe very well the kinetic of the process. Thereby, from the simulation data, it is very convenient to determine the overall crystallization rate constant and the Avrami index. The simulation programs are very versatile, being able to be used for both sporadic and instantaneous nucleation. The programs may be used for describing the kinetics of crystallization in both regular volume and in polymeric films or in some special restricted geometry.

8.17 Simulation of the crystallization process of polymeric films

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Keywords: polymer, crystallization, instantaneous nucleation, sporadic nucleation, Avrami equation, polymeric films

Polymeric film crystallization is a special type of polymer crystallization because the confined geometry drastically modifies the kinetics of crystallization and lead to complex behaviour that is difficult to study. We investigated the isothermal crystallization process in polymeric films using computer simulations. Both instantaneous and sporadic nucleation processes were investigated, finding some similarities with the bulk crystallization process. In that sense, we devised two special programs that simulate polymer crystallization in polymeric films. The analysis of the results allowed the determination of the overall crystallization rate and the Avrami index as they are defined by the Avrami equation valid for the volume crystallization. For both regimes, the values of the Avrami parameters are significantly influenced by the growth velocity that is more important as the thickness of the film decreases. We also found that the instantaneous nucleation in the polymeric film is more influenced by the film nucleation regime than the sporadic nucleation.

Section 9: Solid State Physics and Materials Science

Location and time: **Online**

Moderators:

Prof. Dr. Daniela DRAGOMAN

Assoc. Prof. Dr. Alexandru NEMNEŞ

9.1 - Claudiu LOCOVEI, Anda STANCIU, Cristian RADU, Simona GRECULEASA, Gabriel SCHINTEIE, Petru PALADE, Andrei KUNCSER, Nicusor IACOB, Aurel LECA, Andrei ALEXANDRU-DINU, Victor KUNCSER

AuxFe1-x nanophasic thin films with novel features

9.2 - Florin-Adrian POPESCU, Gabriel CHIRITOI, Eugeniu Mihnea POPESCU

Very accurate non-contact surface scan for the characterization of the materials used in space applications using Kevin Probes

9.3 - Mihaela Sofronie, Felicia Tolea, Monica Enculescu, Iuliana Pasuk, Bogdan Popescu

Microstructure, magnetic and magnetostrictive behaviour in the rapidly quenched off-stoichiometric Ni–Mn–Ga ferromagnetic shape memory alloys

9.4 - Alin Broasca, *, Madalin Greculeasa, Flavius Voicu, George Stanciu, Stefania Hau, Cristina Gheorghe, Catalina-Alice Brandus, Nicolaie Pavel, Lucian Gheorghe

Growth, optical and NIR laser properties of 3.5 at.% Nd:LGSB bifunctional crystal

9.5 - Andrei STOCHIOIU, Iulia ANTOHE, Theo MONACO, Quentin LOMBARD, Luiza-Izabela JINGA, Andreea MIHĂILESCU, Gianina POPESCU-PELIN, Gabriel SOCOL

Chemical polymerization of aniline on gold thin films for hydrogen gas sensing applications

9.6 - George Ormenisan, Ciceron Berbecaru

Structural and electric properties of ultrathin layers obtained by atomic layer deposition

9.7 - Marinel DAN, Luminita DAN, Horia ALEXANDRU

Analysis of triglycine sulfate crystal parameters

9.8 - Ana–Maria PANAITESCU, Vlad-Andrei ANTOHE, Sorina IFTIMIE, Ovidiu TOMA, Lucian ION, Adrian RADU, Ştefan ANTOHE,*

Effect of RF power on structural, morphological, optical and electrical properties of RF – sputtered ZnSe thin films for electronic and optoelectronic applications

9.9 - Ana-Maria RADUTA, Sorina IFTIMIE, Vlad A. ANTOHE, Claudiu LOCOVEI, Adrian RADU, Lucian ION, Stefan ANTOHE, *
EFFECT OF WORKING POWER AND THERMAL TREATMENT ON PHYSICAL PROPERTIES OF RF-SPUTTERED CdTe THIN FILMS FOR PHOTOVOLTAIC APPLICATIONS

9.10 - Rovena Pascu
Yttrium Oxide Thin Films Prepared by Pulsed Laser Deposition

9.1 AuxFe1-x nanophasic thin films with novel features

Claudiu LOCOVEI[1,2], Anda STANCIU[1], Cristian RADU[1,2], Simona GRECULEASA[1], Gabriel SCHINTEIE[1], Petru PALADE[1], Andrei KUNCSER[1], Nicusor IACOB[1], Aurel LECA[1], Andrei ALEXANDRU-DINU[1,2], Victor KUNCSER[1]
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Keywords: nanophasic system, thin films, Fe clusters self-assembling, uniaxial magnetic anisotropy, hcp Au structure

Nanoscale materials with novel properties have been found their place in a tremendous widely network of applications. Among them, multifunctional nanocomposite thin films present a very high interest due to the possible simple preparation and versatile engineering of their properties. In this reason, AuxFe1-x nanophasic thin films with different thicknesses were deposited by RF magnetron sputtering, and, subsequently, their morpho-structural, magnetic, and magneto-transport characterization has been performed. The results show that for a narrow interval of thickness and elemental ratios, Fe clusters self-assembles into lamellar forms embedded in the gold matrix. Also, the data collected at MOKE reveal the in-plane uniaxial magnetic anisotropy in case of the lamellar 2D organization of the magnetic clusters and no in plane magnetic texture of the same randomly distributed clusters. SQUID magnetometry performed in two geometries (with the field in the film plane and perpendicular to it, respectively) and at different temperatures confirm the strong in-plane magnetic texture for a series of samples with critical composition and thickness and a magnetic domain structure without magnetic texture in case of samples with a higher amount of Fe. The spectra acquired by Conversion Electron Mossbauer Spectroscopy were fitted with a hyperfine magnetic field distribution corresponding to distorted Fe configurations with Au impurities for the AuxFe1-x nanophasic systems of intermediate Fe content (30% at.) and with central superparamagnetic components in case of samples with lower Fe content. XRD and SAED analysis highlight the formation of hexagonal close-packed Au in the samples where is evidenced the uniaxial magnetic anisotropy together with lamellar formation of Fe clusters. Magneto-resistive (MR) data were recorded at various temperatures and with magnetic field orientated parallel, and respectively perpendicular to the substrate plane. MR curves show specific magneto-resistance effects related to the type of self-organization of the magnetic clusters and to the crystalline structure of the Au matrix.

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9.2 Very accurate non-contact surface scan for the characterization of the materials used in space applications using Kevin Probes

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Keywords: Kevin Probe, non-contact, control, instruments, space,

The various properties of materials can be revealed by the use of non-contact and non-destructive measurement devices such as macroscopic and microscopic KEvin probes. As the basic operation of a Kevin Probe relies on a vibrating capacitor, the measurement accuracy depends on the quality of the vibrating voice-coil that the measurement tip is attached to, and the adaptive control of the vibration amplitude over a wide frequency domain. Also, the use of Kevin probes in the characterisation of the materials involved in space applications require fast scanning of the sample areas and very accurate positioning of the measuring tip in order to acquire precise surface potential readings. This paper presents our latest achievements in the development of very accurate non-contact surface scan devices for the characterisation of the materials used in space applications using Kevin probes.

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9.3 Microstructure, magnetic and magnetostrictive behaviour in the rapidly quenched off-stoichiometric Ni–Mn–Ga ferromagnetic shape memory alloys

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Keywords: ferromagnetic shape memory alloys, martensitic transformation, magnetostriction

The ferromagnetic shape memory alloys (FSMA) applications are related to the well known martensitic transformation (MT), a first-order phase transition in the magnetically ordered domains. The transition takes place between austenite (with disordered B2 or ordered L21 structure) and a seven-layer (7 M), five-layer (5 M) modulated or a non-modulated (L10 tetragonal) martensite structure for Ni-Mn-Ga Heusler type FSMA, depending on composition and thermal history [1]. Rapid quenching techniques like melt-spinning [2] are used even in off-stoichiometric alloys to prevent the undesirable γ-phases, responsible for diminishing the shape memory effect [3]. This work reports the effect of the rapid solidification technique and thermal treatment on the martensitic transformation, magnetic and magnetostrictive properties on the off-stoichiometric Ni51Mn28Ga21 and Ni49Mn31Ga20 ferromagnetic shape memory ribbons. The samples were investigated by X-ray diffraction, differential scanning calorimetry, scanning electron microscopy, magnetic and magnetostrictive measurements. The temperature dependence of the X-ray phases analysis showed the presence of modulated structures, both tetragonal and monoclinic, at room temperature and allowed to study their evolution through MT. The thermal treatment induces changes in the microstructure with implications in MT and Curie temperatures evolution. The competition between the magnetization

orientation and twin boundary motion within martensitic variants under magnetic field evidenced in the magnetic-strain curves was discussed and correlated with the magnetic data.

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9.4 Growth, optical and NIR laser properties of 3.5 at.% Nd:LGSB bifunctional crystal

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Keywords: Crystal growth; Spectroscopy; Nonlinear optical crystal; Laser crystal; Bifunctional crystal

Bifunctional laser and nonlinear optical (NLO) crystal of 3.5 at.% Nd:LGSB with incongruent melting was grown by the Czochralski technique. The growth conditions were optimized and a high-quality crystal with relatively large dimensions of about 12 mm in diameter and 35 mm in length was grown along the c-axis. The pulling speed and the rotation rate were 2 mm/h and 8 rpm, respectively, and the composition of the starting melt was La0.64Nd0.038Gd0.572Sc2.75(BO3)4. The X-ray powder diffraction spectrum revealed the trigonal phase (space group R32) as the single crystalline phase of the grown crystal. The good crystalline quality of the obtained crystal was also confirmed by X-ray rocking curve measurements. The refractive indices of the crystal were measured by the minimum deviation method, and the dispersion curves of the refractive indices were determined by fitting the experimental data with Sellmeier equations. The phase-matching curves for the second harmonic generation (SHG) of type I and type II were also determined. The spectroscopic properties of the 3.5 at.% Nd:LGSB crystal were evaluated, and efficient laser emission at 1062 nm was obtained under the pump at 807 nm with a fiber-coupled laser diode. An uncoated crystal sample oriented along the phase-matching direction for type I SHG of 1062 nm radiation (θ= 35.3 and φ= 60 degrees) with a thickness of 6 mm was used in the laser emission experiments. A short (less than 10 mm length) plane-concave resonator consisting of a plane rear mirror and several concave out-coupling mirrors (OCM) with a radius of 100 mm and various transmissions T at laser wavelength were used. The laser operated with a high slope efficiency of ηsa= 0.56, delivering the highest output power of 2.1 W for 4.04 W of absorbed pump power for an OCM with T= 0.05.

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9.5 Chemical polymerization of aniline on gold thin films for hydrogen gas sensing applications

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Keywords: Conductometric sensors, Gold, Polyaniline synthesis, Hydrogen sensor

Hydrogen measurement is crucial in emerging industries that employ liquid H2 as an energy source. Hydrogen gas leak detectors, such as the one described in the present work, are used to prevent any accident because of the high explosion risks it has in the presence of air, as these can lead to serious injuries and damage. Polyaniline (PANi) has been proven to be an advantageous material for producing gas sensing devices, having very good sensitivity and short response times [1]. In this work, conductive PANi thin films were obtained via chemical polymerization of aniline directly on gold thin film and have been characterized by scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS), and then electrically characterized in a gas chamber. Aniline was polymerized on the substrate in an acidic solution bath with ammonium persulfate and hydrochloric acid according to a method described in the literature [2,3]. The electrical properties of the sensor inside the gas chamber have been investigated using a source-meter while under direct expose to hydrogen gas at varying concentrations. The developed PANi based sensor proved to be a very good hydrogen gas detector with reasonable sensitivity at very low concentrations of just 1 ppm H2.

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9.6 Structural and electric properties of ultrathin layers obtained by atomic layer deposition

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Keywords: nanometric structures, ALD deposition, High-k oxides, ferroelectric HfO2

Ultrathin HfO2 layers on p-silicon (p-Si) were obtained employing Atomic Layer Deposition (ALD) method, [1]. Scanning Electron Microscopy with Energy-Dispersive X-ray spectroscopy (SEM-EDX) and X-ray Photoelectron Spectroscopy (XPS) were used for structural characterization of the as deposited layers. Hioki type LCR bridges were used to investigate electrical properties of samples. All experiments were performed at room temperature. SEM-EDX revealed the presence of HfO2 on the p-Si substrate with well-defined interfaces. XPS analysis shows well evidenced peaks of the HfO2 and other constituents. An ultrathin layer of Si oxides at the interface of HfO2 with p-Si it has been shown to exist after carefully corrosion of the HfO2 layer with Ar. The interlayer diffusion has been not excluded. Capacity- Voltage (C-V) experiments showed thin and counterclockwise hysteresis curves. The investigation of dielectric parameters performed at different frequencies revealed high values of the series resistance even at high frequencies. Also in the C-V measurements,

conductance curves show a typical influence of the volume of the substrate covering the response of the trapping centers located at the interface of HfO2 with p-Si [2],[3]. It was concluded that high quality of HfO2 layers on p-Si substrates with high quality interfaces could be obtained by ALD method. Interfaces are also of great importance in the properties of devices based on ultra-thin high-K layers such as HfO2.

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9.7 Analysis of triglycine sulfate crystal parameters

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Keywords: triglycine sulfate, TGS, relaxation processes

Triglycine sulfate crystal (TGS for short) is a ferroelectric with a second order transition at 49.2oC. It is studied both on fundamental aspects and for electronic device applications the most sensitive material used for IR detection, i.e. almost one order of magnitude higher sensitivity than other materials. Use dielectric spectroscopy properties of TGS sample were measured vs. 1 Hz - 10 MHz frequency range during the temperature decrease from 60 oC towards the room temperature, at a constant rate of 0.6oC/min. The study of relaxation processes involved the interpretation and analysis of a large volume of data obtained from dielectric spectroscopy. We analyzed the real and imaginary components in terms of frequency, temperature and time, as well as the evolution of other parameters (AC & DC conductivity, relaxation time, activation energy, etc.). We present the values obtained by us compared to the values of the same parameters in the literature.

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9.8 Effect of RF power on structural, morphological, optical and electrical properties of RF – sputtered ZnSe thin films for electronic and optoelectronic applications

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Keywords: ZnSe thin films; RF-magnetron sputtering; XRD; SEM; AFM; spectroscopic ellipsometry

A comparative deposition power study has been performed for zinc selenide (ZnSe) thin films prepared by RF- magnetron sputtering on optical glass substrates. By varying their RF power between 60W and 120 W, 4 thin films have been structurally characterized by X-ray diffraction (XRD) revealing polycrystalline ZnSe films with pronounced (111) texture, whereas the crystalline structure parameters were determined by Bragg-Brentano theta-theta geometry analysis. Morphological investigations by scanning electron microscopy (SEM) and atomic force microscopy (AFM) allowed a first evaluation of their thicknesses, along with the samples' roughness. Optical characterization was performed via absorption and transmission measurements in the spectral range between 200-1200 nm at room temperature. Subsequently, the thicknesses and band gap energies of ZnSe thin films were determined, the values ranging between 37.6 nm up to 340.5 nm, and between 2.5 eV and 2.66 eV. By using spectroscopic ellipsometry (SE) the values obtained via absorption and transmission spectra were compared with the ones determine through SE. Moreover, the dependencies of the optical constants (refractive indices and extinction coefficients) on the incident wavelength of the RF-sputtered ZnSe thin films are envisaged. Electrical measurements of Au/ZnSe/Au sandwich structured with ZnSe prepared at 100 W RF-sputtered power were performed. The complete and thorough characterization of the ZnSe thin films revealed that the smoothest, having the best structural and optical properties ZnSe thin film has been obtained for 100 W RF power.

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9.9 EFFECT OF WORKING POWER AND THERMAL TREATMENT ON PHYSICAL PROPERTIES OF RF-SPUTTERED CdTe THIN FILMS FOR PHOTOVOLTAIC APPLICATIONS

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Keywords: CdTe thin films, AII-BVI semiconductors, RF magnetron-sputtering, thermal treatment, photovoltaic applications

Among the AII-BVI binary semiconducting compounds, CdTe is one of the most promising photovoltaic (PV) materials that can be used especially for applications in the field of thin film solar cells, recording conversion efficiencies of 21.5 %, as shown by the reports made by First Solar in February 2015 [1-3]. The aim of our work is to improve the quality of CdTe thin films, by using the rf-magnetron sputtering as a reliable deposition method, having the ability to control the deposition parameters more easily and for a complex study our films were deposited onto p-type Si substrate, at four different working powers (70W, 80W, 90W and 100W). The structural properties of fabricated samples were investigated by grazing incidence X-ray diffraction (GIXRD). It is already known that GIXRD experiments are not adapted to obtain quantitative information, and for this the microcrystalline properties of CdTe thin films were investigated by performing a profile analysis of (111) reflection in Bragg-Brentano theta-theta geometry. The topography of the surface of fabricated CdTe samples was analyzed by atomic force microscopy (AFM), in non-contact mode, using an A.P.E. Research equipment. Morphological investigations of CdTe thin films were performed by scanning electron microscopy (SEM). From the cross-section SEM images, the thicknesses of all the samples were examined. Perkin-Elmer Lambda 750 UV/VIS/NIR spectrophotometer was used to study the optical transmission and absorption spectroscopy of the films in the wavelength region 400-1800 nm, in air, at room temperature. Therefore, in order to investigate the effects of RF power variation on the structural, morphological and optical properties of rf-sputtered CdTe thin films we decided to subsequently subject these layers to a thermal treatment under

nitrogen gas flow using a Nabertherm oven. In particular, the physical properties of all the rf-sputtered CdTe thin films were investigated before and after the thermal treatment. The results obtained are promising and the related work deserves consideration in the future and in this sense our attention will be focused on the electrical characterization of the films.

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Support from the "Executive Unit for Financing Higher Education, Research, Development and Innovation" (UEFISCDI, Romania) through the grants: PN-III-P1-1.1-TE-2019-0868 (TE 115/2020) and PN-III-P1-1.1-TE-2019-0846 (TE 25/2020) is acknowledged.

9.10 Yttrium Oxide Thin Films Prepared by Pulsed Laser Deposition

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Keywords: Pulsed Laser Deposition, Yttirum Oxide, Oxygen sensor, Electrolytes, Sensing Element, Cauchy and Cauchy - Urbach model

Yttrium oxide (Y_2O_3) thin films were deposited on Si (100) 500^{o}C and 600^{o}C substrate temperature by Pulsed Laser Deposition (PLD) at Y2O3. The thin film was characterized using X-ray reflection, Atomic Force Microscopy, Scanning electron microscopy, electron energy loss spectroscopy measurements, X-ray photoelectron spectroscopy and spectroscopic ellipsometry measurements using the Cauchy and Cauchy - Urbach model.

Section 10: Theoretical Physics and Applied Mathematics

Location and time: **Online**

Moderators:

Prof. Dr. Claudia TIMOFTE

Prof. Dr. Virgil BĂRAN

10.1 - Marina CUZMINSCHI, Alexei ZUBAREV, Aurelian ISAR
Secure quantum teleportation using Gaussian resource states

10.2 - Aurelian ISAR

Dynamics of quantum correlations in Gaussian bosonic channels

10.3 - Maria-Cătălina IȘFAN
The quantum Hall effect - topological properties of the single-particle wave function. The Hall resistance

10.4 - Madalina BOCA, Alexandru GUȚOIU
Calculation of metastable states of the quantum Henon-Heiles system

10.5 - Madalina BOCA, Ștefan GALIN
Classical and quantum study of an electron in the presence of a Henon-Heiles type potential and a laser field

10.6 - Călin V. ATANASIU, Leonid E. ZAKHAROV, Matthias HOELZL
A mathematical model for moving the non-linear term from a differential operator to the r.h.s. of the equations

10.7 - Sebastian BAHAMONDE, Mihai MARCIU, Sergei D. ODINTSOV, Prabir RUDRA
Dynamical analysis of string-inspired teleparallel cosmology

10.8 - Dana Maria IOAN, Florin Vlad IANCU, Virgil BARAN, Mihai MARCIU, Roxana ZUS
Modern analytical approaches to the dark energy problem in scalar tensor theories

10.9 - Florin Vlad IANCU, Dana Maria IOAN, Mihai MARCIU, Virgil BARAN, Andrei COCOR, Roxana ZUS
Numerical features for various scalar tensor theories with non-minimal couplings

10.10 - Alexandra SCARLATESCU, Madalina BOCA
Monte Carlo simulation of single and double Compton scattering

10.11 - M. GHITA, D. I. PALADE, M. VLAD
Scaling laws of 2D incompressible turbulent transport

10.12 - L. POMARJANSCHI, D. I. PALADE, M. VLAD
Effects of intermittency on turbulent transport in tokamak plasmas

10.13 - Alexei ZUBAREV, Marina CUZMINSCHI
Plasma behavior in focus of frontal laser collision setup

10.14 - Florin-Ioan CONSTANTIN, Eugeniu Mihnea POPESCU, Gabriel CHIRITOI, Eduard NASTASE, Alexandra MUNTEAN
Local monitoring and forecasting the ionospheric Total Electron Content (TEC)

10.15 - Radu SLOBODEANU
Beltrami fields on compact spaces - topology and dynamics

10.16 - Adrian STOICA
Incompressible flow around a high aspect ratio arched wing in ground effect

10.17 - Renata BUNOIU, Claudia TIMOFTE
Asymptotic Analysis for a Diffusion Problem in Thin Filtering Materials

10.18 - Ema BOICU, Virgil BARAN
An optimized model with separable interaction for Pygmy Dipole Resonance and Giant Dipole Resonance

10.19 - Mircea BARBUCEANU
Mass and momentum of the material point. Relativistic consequences

10.1 Secure quantum teleportation using Gaussian resource states

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Keywords: Gaussian state, Quantum teleportation, entanglenment, steering

We describe the Markovian dynamics of the fidelity of quantum teleportation and entanglement in a system consisting of two coupled bosonic modes in contact with a thermal environment. The study is done in the framework of the theory of open systems based on completely positive quantum dynamical semigroups. We use the logarithmic negativity as the measure of entanglement in the system. As the initial state is chosen an entangled thermal or vacuum two mode Gaussian state. This state is taken as a resource for the teleportation of a coherent state. Employing the covariance matrix formalism we study the evolution in time of the fidelity of teleportation and of the logarithmic negativity, and their dependence on the temperature of the thermal bath, squeezing between the modes, coupling between the modes, frequencies of the two modes and the average number of thermal photons of the two bosonic modes [1,2]. We find that the squeezed vacuum state is the most beneficial as a resource of teleportation, due to the fact that the fidelity of teleportation decreases with the average number of thermal photons of the two modes. Optimal values of the squeezing and coupling parameters for the teleportation of a pure coherent state are determined. We show that the considered system assures values of fidelity of teleportation larger than the classical limit 1/2, and in some determined cases this fidelity has values even larger than 2/3, necessary for secure teleportation. Another necessary condition for secure teleportation is the two-ways steering, steering being a stronger correlation than entanglement.
In the limit of large times, for definite values of coupling between the modes and for low temperatures of the reservoir, the states remain entangled, which is a crucial condition for the realization of the quantum teleportation protocol[3].

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10.2 Dynamics of quantum correlations in Gaussian bosonic channels

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Keywords: Quantum correlations; quantum coherence; open quantum systems.

An impressive progress in the development of quantum information theory is reached presently from the quantum resource theory approach to quantum correlations, like entanglement, discord and steering, and to quantum coherence. Recently, a framework for the quantification of coherence has been established [1], in which quantum coherence is treated as a resource in a manner similar to quantum entanglement.
In the framework of the theory of open systems based on completely positive quantum dynamical semigroups, we describe the behaviour of continuous variable quantum correlations (entanglement, Gaussian quantum discord, Gaussian quantum steering) and quantum coherence in a system of two (coupled or uncoupled) bosonic modes evolving in a Gaussian noisy channel, in the case of a common environment of the form of a thermal bath or a squeezed thermal bath.
We solve the Markovian master equation for the density operator that describes the time evolution of the considered system and, using the symplectic formalism, we study the quantum correlations and quantum coherence in terms of covariance

matrices for Gaussian input states (squeezed vacuum state and squeezed thermal state). Depending on the initial state of the system, the coefficients describing the interaction of the system with the reservoir and the intensity of the coupling between the two modes, we observe phenomena like generation, suppression, periodic revivals and suppressions, or an asymptotic decay in time of quantum correlations [2-4] and relative entropy of coherence [5, 6].

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10.3 The quantum Hall effect - topological properties of the single-particle wave function. The Hall resistance

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Keywords: Hall effect, wave function, Hall resistance, topology

The quantum Hall effect is a phenomenon which consists in the quantification of the Hall resistance of a heterostructure in which an injection current flows and is placed in an external magnetic field. I present in the quantum formalism the solution of the time independent Schrodinger equation for an electron which is placed in a magnetic field and confined to two dimensions, using Landau, respectively symmetric gauges, aiming for discussing the physical interpretations of the wave functions. The degeneracy order is independent of gauge and it can be linked to the magnetic flux quantum interpretation. This idea is the precursor of Laughlin's argument for the quantum Hall effect, which I explained in detail. Then, I analyzed what happens with the single particle if the electron is placed in a real probe, with finite dimensions and disorder. At the interface that occurs between two semiconductors with different energy gaps the bi-dimensional electron gas is formed. The finite width of the probe leads to a potential barrier that keeps the electrons inside, but doesn't modify the single particle wave function. The disorder induces localized states, so that only the edge electrons produce Hall effect. I showed how the Hall resistance quantifies multiple times, using different approaches. Next, I studied the semiclassical limit of the single particle wavefunction in symmetric gauge and I found out that for large absolute values of the quantum numbers, the electron can be thought as having a circular motion along an orbit; the orbit has undetermined center coordinates.

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10.4 Calculation of metastable states of the quantum Henon-Heiles system

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Keywords: Imaginary time evolution, metastable states

We use the imaginary time evolution method in order to solve the energy eigenvalue problem of a Henon-Heiles type system. Our approach allows us to calculate the complex energies of the metastable states of the system. We compare our results with those obtained using a semiclassical approach. We also calculate the bound state energies in the framework of the perturbation theory, treating the cubic term as a perturbation.

10.5 Classical and quantum study of an electron in the presence of a Henon-Heiles type potential and a laser field

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Keywords: Henon Heiles potential, escape time, ionization rate

We study the behavior of charged particles placed in an Hénon-Heiles type potential, and a circularly polarized laser field. The chaotic behavior is illustrated by calculating the Lyapunov exponent, a general indicator of the presence of chaos in a dynamical system, providing a measure of the average exponential rate of divergence of close orbits. We also study the dependence of the escape time of the particle from the potential, on the laser parameters. Finally, we present a comparison with the results of the quantum approach, obtained by solving the time-dependent Schrodinger equation.

10.6 A mathematical model for moving the non-linear term from a differential operator to the r.h.s. of the equations

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It is known that due to the high non-linear dependence of the MHD solutions on the iron permeability, the MHD calculations are more complicated and more time consuming than in the absence of iron structures. By considering our media as a linear, isotropic and homogeneous one we can replace it by a homogeneous one (vacuum) and a surface-current density distribution on the separation surfaces between subdomains. For example, in the JET (Joint European Torus) tokamak geometry, each segment of a curve is a Liapunov curve, therefore the surface-current density is considered as continuous (Hölder continuity) and of bounded variation, admitting then a uniformly convergent expansion. For simplification, we have used Legendre polynomials, their weight function being equal to one. Thus, we have succeeded to perform MHD computations for an iron-core transformer tokamak in the same way as for air-core transformer tokamaks [1, 2] by developing a boundary integral equations method (Fredholm integral equation of 2nd kind). Our code for simulation of the electromagnetic wall response during Vertical Displacement Events (VDE) received the status of open source license, to be used now by the EUROfusion community in modelling tokamak plasma disruptions. Our mathematical model for calculation of the influence of ferromagnetic components in VDE and stability simulations of tokamak plasmas can be implemented successfully into codes like JOREK-STARWALL [3].

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10.7 Dynamical analysis of string-inspired teleparallel cosmology

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Keywords: cosmology, dark energy, accelerated expansion, teleparallel, string theory

In this work we analyze the phase space structure for a cosmological model constructed in the framework of teleparallel gravity which is based on specific couplings with the teleparallel Gauss-Bonnet invariants. The investigation showed that this model can explain the accelerated expansion of our Universe and the evolution at the cosmic level, offering a possible theoretical alternative to the cosmological constant. In the last part of our presentation we investigate the present model from a numerical point of view, revealing some possible trajectories in the phase space structure, corresponding to specific representations of the effective equation of state. The presentation is based on our recent work [1].

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10.8 Modern analytical approaches to the dark energy problem in scalar tensor theories

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Keywords: dark energy, cosmology, accelerated expansion

After a short introduction into the recent advances and developments of various cosmological models, we investigate the accelerated expansion in a specific model which takes into account special corrections to the Lagrangian, offering a possible solution to the dark energy problem. The investigation leads to the detection of the main features in the phase space, exposing the physical characteristics of various evolutionary paths.

10.9 Numerical features for various scalar tensor theories with non-minimal couplings

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Keywords: cosmology, dark energy, expansion

In this work we shall investigate various theoretical models in the framework of scalar tensor models, extending the Einstein-Hilbert action by considering different topological invariants. After we briefly deduce the field equations, we explore the physical features at the background level by adopting specific numerical methods, displaying the possible evolution of our universe in these scenarios.

10.10 Monte Carlo simulation of single and double Compton scattering

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Keywords:

We present results of Monte Carlo simulation of single and double Compton scattering. The code we developed allows for arbitrary initial conditions (electron energy, photon frequency and scattering geometry). In order to take advantage of the simplicity of the differential cross section in the case of the electron at rest, a Lorentz transformation is performed to a particular reference frame in which the electron momentum is zero and the photon is incident along the third axis, then the scattering is simulated in that frame. In the final step the 4-momenta of the emitted photons and of the recoil electrons are transformed back to the laboratory reference frame. We calculate expectation values of several observables and we analyze the polarization properties of the emitted photons.

10.11 Scaling laws of 2D incompressible turbulent transport

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Keywords: turbulence, transport, incompressible, scaling

One of the fundamental problems of turbulence is the relation between the Eulerian characteristics of velocity fields and the Lagrangian characteristics of flows – represented by transport coefficients. The case of two-dimensional incompressible turbulence is particularly important in the description of magnetically confined plasmas, astrophysical plasmas, incompressible fluids, magnetic field lines wandering, etc. The resulting transport is known to be anomalous with supposingly universal scaling laws. In the present work we intent to take under scrutiny the dependency between the scaling exponents and the Eulerian properties of turbulence using the direct numerical simulation method (DNS), a state-of-the-art statistical approach to stochastic transport. The results are confirmed qualitatively using an approximative statistical approach, the Decorrelation Trajectory Method (DTM). We find that the exponents are weakly dependent on the turbulence spectra (~10%). We proceed to a quantitative characterization of these dependencies.

References:

Acknowledgement:

10.12 Effects of intermittency on turbulent transport in tokamak plasmas

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Turbulence plays a major role in the dynamics and confinement of tokamak plasmas. The turbulent electric field E is able, mainly via the ExB drift, to transport plasma across magnetic surfaces toward the walls. In the Scrape-off Layer region, in contrast to the core of the plasma, the turbulence is also characterized by intermittent phenomena: blobs, Alfven modes, or ELMs. In this work we investigate how the turbulent transport is affected by these intermittent features. We compute semi-analytical estimations of the transport coefficients which are confirmed with the use of two different statistical approaches: the Decorrelation Trajectory Method (DTM) and the direct numerical simulation method (DNS). We have found that the intermittent phenomena, which depart the turbulent field from Gaussianity, tend to inhibit the transport with a linear dependence on the excess kurtosis of the potential. The characteristic susceptibility is strongly dependent on the correlation time τ_c with a peak value close to the time-of-flight τ_fl.

10.13 Plasma behavior in focus of frontal laser collision setup

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In modern high intensity laser installations the most common configuration for scientific experiments is placing of a target in focus of a single laser beam. This configuration is suitable for acceleration of electrons and ions, simulation of any astrophysical phenomena, study of nuclei and light interaction and X-ray production. However in some cases a symmetrical radiation of a target is required. Such configuration allows a uniform symmetrical confinement of radiated targets in inertial nuclear fusion experiment, and ensures more efficient plasma heating therefore it is promising for study of matter behavior in extreme conditions [1]. Usually a symmetrical laser collision is considered hard to implement, however plasma mirrors with finite decay time allow such experiments in safe conditions.
In our work we described the phenomena which have place in a target placed in the focus of two lasers with opposite propagation directions of the beams. We used EPOCH PIC code [2] to simulate the plasma-laser iteration and growing of the instabilities in the target. We describe the evolution of main plasma parameters such as temperature, pressure, concentration of the electrons and ions. As well we determine the electrical and magnetic fields distribution and the currents generated in plasma upon the laser radiation influence.
We observed that for short laser pulses only the electrons are influenced by laser radiation and their concentration increases in the center of the target for all pulse duration time. Respectively for long pulses both electronic and ionic components are influenced by laser radiation. The plasma in confined and the electronic and ionic temperatures increase. During the interaction of plasma with long laser pulses the secondary electromagnetic fields generated in plasma start to play an important role and instabilities are growing.

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10.14 Local monitoring and forecasting the ionospheric Total Electron Content (TEC)

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The observables associated with the signals sent by the satellites of the GPS constellation allow for the monitoring of the total electron content (TEC) of the ionosphere. As the main factor that influences the TEC is solar activity and TEC perturbations can potentially disrupt a large number of modern services, from telecommunications to power distributions, the importance of monitoring and forecasting the ionospheric TEC becomes apparent. This presentation details the procedures and mathematical techniques that have been developed to estimate and forecast the ionospheric TEC and its variation and across the territory of Romania, and how they have been integrated into an online Space Weather service developed and hosted by the Institute of Space Science and the National Institute for Earth Physics.

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10.15 Beltrami fields on compact spaces - topology and dynamics

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Keywords: force-free fields, chaos, exact solutions

Beltrami fields (aka force-free fields in magnetohydrodynamics) are special equilibrium solutions of Euler equations for inviscid perfect fluids. They are key ingredients in modelling of Lagrangian turbulence and exhibit chaotic dynamics almost

surely, as proved in a recent reserch. In the first part of this talk we present some results on nowhere vanishing Beltrami fields that are interesting from the contact topology viewpoint. In the second part, we present a numerical investigation (in collaboration with M. Marciu, FTMOPL) of chaotic dynamics of a special family of Beltrami fields on the 3-torus that mimicks the celebrated study of ABC flows.

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10.16 Incompressible flow around a high aspect ratio arched wing in ground effect

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By the aid of the method of images, in the frame of the Prandtl's lifting line theory, a singular integro-differential equation is obtained. For this equation an efficient numerical method is proposed. The numerical simulations confirm a reduction in induced drag caused by ground effect.

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10.17 Asymptotic Analysis for a Diffusion Problem in Thin Filtering Materials

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In this talk, we shall present some homogenization results for a diffusion problem in a thin heterogeneous composite medium made up of two materials separated by an imperfect interface. This mathematical model might have applications in the analysis of various filtering materials, such as textiles, paper, or biological tissues.

10.18 An optimized model with separable interaction for Pygmy Dipole Resonance and Giant Dipole Resonance

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Keywords: Pygmy Dipole Resonance, Giant Dipole Resonance, Separable Interactions, Random Phase Approximation

We investigate within a generalized Brown-Bolsterli model, with extended separable interactions, the properties of Pygmy Dipole Resonance and of Giant Dipole Resonance. We derive the optimal values for the coupling constants appearing in the residual interaction and discuss their meaning in connection to the density dependence of symmetry energy.

10.19 Mass and momentum of the material point. Relativistic consequences

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Keywords: inertial mass, internal parameters, mechanical state equations, momenter

In the general study of thermodynamic systems and phenomena, the mass is an internal state parameter, same as electric charge and temperature. However, in the study of mechanical phenomena, it appears as an external state parameter: the mass is defined dynamically in relation to the applied force and depends on the velocity relative to the system of reference. We have always considered this situation contradictory and paradoxical. In the present study, we reconstruct in the most natural way the concept of mass in mechanics, as an internal parameter of the mechanical system. We use an algorithm similar to the one by which the temperature was introduced. This involves the correct definition of the mechanical state and the principial construction of an empirical momentum measurement device (momenter). But in these conditions, the mass no longer depends on velocity, which is another reason to revise the relativistic physical models.

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