11th International Conference
“Modern trends in science”
FMNS-2025

BOOK OF ABSTRACTS

ORGANIZING COMMITTEE:

Chairman: Assoc. Prof. Elena Karashtranova, South-West University "Neofit Rilski", Bulgaria

Members:
Emilia Varadinova, South-West University "Neofit Rilski", Bulgaria
Elitsa Chorbadzhiyska, South-West University "Neofit Rilski", Bulgaria
Ilinka Dimitrova, South-West University "Neofit Rilski", Bulgaria
Ralitsa Stanoeva, South-West University "Neofit Rilski", Bulgaria
Irena Atanasova, South-West University "Neofit Rilski", Bulgaria
Petranka Petrova, South-West University "Neofit Rilski", Bulgaria
Veselina Dalgacheva, South-West University "Neofit Rilski", Bulgaria
Miroslav Ivanov, South-West University "Neofit Rilski", Bulgaria
Boyana Garkova, South-West University "Neofit Rilski", Bulgaria
Svetoslav Kolev, South-West University "Neofit Rilski", Bulgaria
Radoslav Chayrov, South-West University "Neofit Rilski", Bulgaria
Kiril Chuchkov, South-West University "Neofit Rilski", Bulgaria

Blagoevgrad, June 2025
ISSN 2682-9630

SCIENTIFIC COMMITTEE:

Chairman: Prof. Dr. Ivanka Stankova – South-West University "Neofit Rilski" , Bulgaria

Members:

Prof. DSc. Vítor Hugo Fernandes – NOVA University of Lisbon, Portugal
Prof. DSc. Nikolay Miloshev – Bulgarian Academy of Sciences, Bulgaria
Prof. Dr. Vasile Zotic – Babeş-Bolyai University, Romania
Prof. Dr. Tamas Hardi – Regional Research Institute, Hungary
Prof. DSc. Kliment Naydenov – Sofia University “St. Kliment Ohridski”, Bulgaria
Prof. Dr. Jörg Koppitz – Bulgarian Academy of Sciences, Bulgaria, University of Potsdam, Germany
Prof. Dr. Dimitar Tonev – Bulgarian Academy of Sciences, Bulgaria
Prof. Dr. Boštjan Genorio – University of Ljubljana, Slovenia
Prof. Dr. Dimitar Simeonov – St. Cyril and St. Methodius University of Veliko Tarnovo, Bulgaria
Prof. Dr. Eylem Bayir – Trakya University, Turkiye
Assoc. Prof. Dr. Stefan Stefanov – South-West University "Neofit Rilski", Bulgaria
Assoc. Prof. Dr. Tatyana Koutzarova – Bulgarian Academy of Sciences, Bulgaria
Assoc. Prof. Dr. Vassil Grozdanov – South-West University "Neofit Rilski", Bulgaria
Assoc. Prof. Dr. Gana Gecheva – Paisii Hilendarski University of Plovdiv, Bulgaria
Assoc. Prof. Dr. Lyuben Mihov – South-West University "Neofit Rilski", Bulgaria
Assoc. Prof. Dr. Emilia Patarchanova – South-West University "Neofit Rilski", Bulgaria
Assoc. Prof. Dr. Maya Chochkova – South-West University "Neofit Rilski" , Bulgaria
Assoc. Prof. Dr. Nadezhda Borisova - South-West University "Neofit Rilski", Bulgaria
Assoc. Prof. Dr. Aleksandra Ravnachka – South-West University "Neofit Rilski", Bulgaria
Assist. Prof. Dr. Neda Neykova – Czech Technical University, Czech Republic

Conference Program

Registration (11.06.2025)

13:00 – 18:30

University Conference Centre “Bachinovo”

Opening Ceremony (12.06.2025)

10:00 – 10:30

Central Auditorium of the Conference Center

Plenary Lectures (12.06.2025)

Central Auditorium of the Conference Center

10:30 – 11:10

Prof. DSc Peter Boyvalenkov, Institute of Mathematics and Informatics, Bulgarian Academy of Sciences

"Polarization of spherical codes and designs"

11:10 – 11:50

Prof. Vesna Stankov Jovanović, PhD, University of Niš

“Advancements in Sample Preparation Techniques for the Analysis of Persistent Organic Pollutants: A Focus on PAHs”

11:50 – 12:30

Assoc. prof. António Domingos, PhD, Universidad PhD NOVA de Lisboa

“What is the professional

knowledge of teachers to integrate STEM into their teaching practices?”

Group photo - in front of the central entrance of the educational center of South-West University - "Bachinovo"

12.06.2025

12:30

Plenary Lectures (13.06.2025)

Central Auditorium of the Conference Center

10:30 – 11:10

Assoc. prof. Sanka Velichkova Gateva-Kostova, PhD, Institute of Electronics, Bulgarian Academy of Sciences

“Coherent Magneto-Optical Resonances in alkali atoms and their applications”

11:10 – 11:50

Prof. Stoyan Nedkov, PhD, National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences

"Mapping of ecosystem services and the transformative change of the European environmental policy"

11:50 – 12:30

Prof. Krasimir Manev, PhD, New Bulgarian University

„Mathematics in the early education of programmers”

Sessions

12.06.2025 and 13.06.2025

13:30 – 15:30 and 16:00 – 18:00

University Conference Center “Bachinovo”

Poster sessions

12.06.2025 and 13.06.2025

18:00 – 19:30

Special session

Conference Hall

"Challenges and Opportunities for Implementing STEM Approaches in Secondary and Higher Education"

14.06.2025

10:00 – 12:00

Welcome Party

12.06.2025

18:00 - 20:00

University Conference Center "Bachinovo"

Official dinner

13.06.2025

20:00

University Conference Center "Bachinovo"

Social program

14.06.2025

09:30 – 14:00

Section: Chemistry
Hall 4

Thursday, June 12th	
Chairman:	***Assoc. Prof. Mitko Stoev***
13:30-13:45	**O-C-1** Chemical composition of underground waters as a tool for finding connections between caves (applied for Nanzheng area, Shaanxi province, Central China) *David Havlíček*, *Michal Filippi, Zdeněk Motyčka, Kateřina Havlíčková*
13:45-14:00	**O-C-2** Preparation and characterization of molecular crystal based on 2D carriers of NLO properties Ivan Němec, *Irena Matulková, Ivana Císařová, Soňa Kohúteková, Petr Němec*
14:00-14:15	**O-C-3** Isoindoline-1,3-diimine Derivatives Investigated by NMR/XRD/DFT Approach *Stanislava Majerova, Ales Ruzicka*
14:15-14:30	**O-C-4** Structurally Tunable Main Group Metal Complexes Bearing an Electronically Versatile/Fluxional Biguanide Ligand *Lukas Vlk, Tomas Chlupaty, Alena Hoffmannova, Zdenka Ruzickova, Ales Ruzicka*
14:30-14:45	**O-C-5** Hydrogen Peroxide Production: A Sustainable Electrochemical Perspective *Desislava Apostolova, , Ivo Bardarov, Maris Mathew, Anders Tjell, Ema Gričar, Mark Stari, Igor Plazl, Pedro Martins, Miha Nosan, Torsten Mayr, Dušan Strmcnik, Boštjan Genorio*
14:45-15:00	**O-C-6** Upcycling Carbon Fiber Composites into Flash Graphene: A HighEfficiency Electrocatalyst for H_2O_2 Synthesis *Ivo Bardarov, Elitsa Chorbadzhiyska, Desislava Apostolova, Pedro Martins, Bostjan Genorio*
15:00-15:15	**O-C-7** The electrochemical activation of a ceria-based sensor for ofloxacin detection *Aleksandar Stanojević, Tijana Jovanović, Emilija Pecev-Marinković, Mihajlo Kulizić, Aleksandar Lolić, Aleksandra Pavlović, Ivana Rašić Mišić*
15:15-15:30	**O-C-8** The comparative evaluation of post-modification activated CPEs modified with MWCNTs, ZrO2 and Gd2O3 for fluoroquinolone detection *Tijana Jovanović, Aleksandar Stanojević, Boris Stanković, Emilija Pecev-Marinković, Branka Petković, Milica Petrović, Ivana Rašić Mišić*
Coffee break	
Chairman:	***Assoc. Prof. Petko Mandjukov***
16:00-16:15	**O-C-9** Production of hydrochar from rice husk by hydrothermal carbonization *A.B.Toibazarova, N.O.Appazov*
16:15-16:30	**O-C-10** Extraction of rice husk and preparation of fatty acid monoglycerides from rice husk extract. *Bekzhan Alimkhan, Nurbol Appazov, Magzhan Bekhozhaev*
16:30-16:45	**O-C-11** Battery Emulator built by using RISC Microcontroller architecture *Dimitar Boychev, Blagoy Burdin, Daria Vladikova*

16:45-17:00	**O-C-12** Porous One-dimensional Carbon Nanostructures Derived from Biomass Wastes as Efficient Pt-free Cathodes for Green Hydrogen Production *Sara Mahmood Adnan, Eiman. K. Almohannadi, Kamel Eid*
17:00-17:15	**O-C-13** Technologies for the production of activated carbon and features of the raw materials used *Saken A. Kanzhar, Nurlan O. Appazov*
17:15-17:30	**O-C-14** Metrological aspects of analysis of methyl-mercury in marine sediment and biota *Ava Amideina, Anna Maria Orani, Sabine Azemard, Petko Mandjukov*
17:30-17:45	**O-C-15** MP – AES determination of trace elements in waters. Method validation *Ava Amideina, Tsvetanka Avramova, Petko Mandjukov*

Section: Physics
Conference hall

Friday, June 13th	
Chairman: ***Assoc. Prof. Svetoslav Kolev***	
13:30-13:45	**O-P-1** Multiferroics- preparation method and physical properties *Svetoslav Kolev, Tatyana Koutzarova, Borislava Georgieva, Todor Cholakov*
13:45-14:00	**O-P-2** Impact of Nutritional Fortification on the Pulsed Photostimulated Luminescence Response of Salts *Aleksandar Krleski, Kristina Smokrović, Ivica Đilović, Luka Bakrač, Nadica Maltar-Strmečki, Ralitsa Stanoeva*
14:00-14:15	**O-P-3** Thermoluminescent Properties of Salt-Based Materials Modified by Nutritional Supplementation *Aleksandar Krleski, Ralitsa Stanoeva, Ivana Fabijanikj Sandeva, Lihnida Stojanovska-Georgievska, Margarita Ginovska, Hristina Spasevska*
14:15-14:30	**O-P-4** Gelatine - glass microbubbles hydrocolloid as potential medical phantom material in computed tomography *Ginka Exner, Veselina Georgieva, Yordan Marinov, Georgi Tankovski, Nikoleta Traikova*
14:30-14:45	**O-P-5** Some physical and physicochemical properties of jelly dessert prepared from gelatin and orange juice *Georgi Tankovski, Ivan Bodurov, Ginka Exner*
14:45-15:00	**O-P-6** Latest observations with the telescopes of the Astronomical Observatory at the University of Shumen *Dragomir Marchev, Borislav Borisov, Sunay Ibryamov, Teodora Atanasova-Sartliiska, Galina Yordanova, Alex Georgiev*
15:00-15:15	**O-P-7** Superscaling analysis of inclusive electron and (anti)neutrino scattering within the coherent density fluctuation model *Martin Ivanov, Anton Antonov*
Coffee break	

Section: Ecology and Environmental Protection
Hall 4

Friday, June 13th	
Chairman**:** ***Assist. Prof. Miroslav Ivanov***	
13:30-13:45	**O-EEP-1** Invasive alien freshwater fish species in Black Sea rivers and coastal lakes *Luchezar Pehlivanov, Stefan Kazakov, Tihomir Stefanov, Teodora Trichkova*
13:45-14:00	**O-EEP-2** Development of Asphalt Concrete Production Technologies Using Ash Residues from Thermal Power Plants and Oil Waste *Zhangyl Abilbek ,Panabek Tanzharikov, Koktem Yerimbetov, Nurzhan Suleymenov and Saken Seitzhanov*
14:00-14:15	**O-EEP-3** External moss walls: from the inside out *Gana Gecheva, Zhana Petkova, Stoyan Damyanov, Deyana Georgieva, Vesselin Baev, Mariyana Gozmanova, Elena Apostolova, Galina Yahubyan*
14:15-14:30	**O-EEP-4** Comparison of the density and biomass of macrobenthic communities from two regions of Marine Antarctic *Lyubomir Kenderov, Eli Mincheva, Raina Hristova*
14:30-14:45	**O-EEP-5** Development of an efficient "Compact module for filter water" *Polvon Sharipov, Khasan Khasanov*
14:45-15:00	**O-EEP-6** A new metric for ecological status assessment of standing water bodies in Bulgaria *Emilia Varadinova, Georg Wolfram, Violeta Tyufekchieva, Yanka Vidinova, Rabia Soufi, Monika Grossschartner*
15:00-15:15	**O-EEP-7** Macrophyte-Based Assessment of Upland Rivers: Reference Index and Pollution Index *Silviya Stankova, Gana Gecheva*
15:15-15:30	**O-EEP-8** Risk Assessment in Oil and Gas Production: A Case Study of the Kyzylorda Region *Zhangyl Abilbek, Panabek Tanzharikov, Aidana Nurman, Aigul Erzhanova, Nurlybek Akhmetov*
Coffee break	
Chairman: ***Assit. Prof. Veselina Dalgacheva***	
15:45-16:00	**O-EEP-9** Impact of coal fired power plant activity on the ecological status of the river ecosystems: Case study of Sokolitsa River, Bulgaria *Vanina Mitseva, Tsevetila Isheva, Mila Ihtimanska, Emilia Varadinova*
16:00-16:15	**O-EEP-10** Herpetofauna in the Northwestern Foothills of the Pirin Mountains *Aleksander Pulev, Emanuil Mitrevichin, Lidia Sakelarieva, Hristo Peshev, Krasimir Stoyanov, Galina Bezinska*
16:15-16:30	**O-EEP-11** Remote sensing based burn severity mapping and assessing post-fire impacts on forests vegetation in three cases of forest fires in Bulgaria *Miroslav Ivanov, Konstantin Tyufekchiev, Veselina Dalgacheva*

16:30-16:45	**O-EEP-12** Remote sensing based assessment of water quality in the Nador lagoon, Morocco *Miroslav Ivanov, Emilia Varadinova, Veselina Dalgacheva, Ouiam El Mekki, Konstantin Tuefekchiev*
16:45-17:00	**O-EEP-13** First Records of Autumn Activity of Xerotyphlops vermicularis (Merrem, 1820) (Reptilia: Typhlopidae) in Bulgaria *Aleksander Pulev, Lidia Sakelarieva, Krasimir Stoyanov, Emanuil Mitrevichin*
17:00-17:15	**O-EEP-14** New Records of Winter Activity of Mediodactylus kotschyi (Steindachner, 1870) (Reptilia: Gekkonidae) in Bulgaria *Aleksander Pulev, Lidia Sakelarieva, Krasimir Stoyanov, Hristo Peshev, Daniel Bisset, Emanuil Mitrevichin*
17:15-17:30	**O-EEP-15** Trail cameras based estimation of the brown bear (Ursus arctos Linnaeus, 1758) density in one isolated part of Rila National Park *Miroslav Ivanov*, *Georgi Manolev, Veselina Dalgacheva*
17:30-17:45	**O-EEP-16** Comparative analysis of the production and technological potential of the Stanushina variety under the condition of organic/intensive cultivation *Aleksandar Klincharov*

Geography
Hall 3

Thursday, June 12th	
Chairman**: *Assist. Prof. Vladimir Karadzhov***	
13:30-13:45	**O-G-1** Spatial Analysis of Employment and the Working Poor *Aleksandra Ravnachka, Velimira Stoyanova, Boris Kazakov, Poli Roukova, Emilia Patarchanova*
13:45-14:00	**O-G-2** Health status and integration of the Roma into the healthcare system of Bulgaria *Boris Kazakov, Aleksandra Ravnachka, Velimira Stoyanova*
14:00-14:15	**O-G-3** Social policy and the working poor in the context of regional demographic characteristics in Bulgaria *Gergana Nikolova, Emilia Patarchanova, Alexandra Ravnachka, Miroslav Ivanov, Vasil Pandurski, Boris Kazakov*
14:15-14:30	**O-G-4** Mapping and spatial analysis of vertical relief reshaping in the landslide near the village of General Geshevo (Eastern Rhodopes) *Alexander Gikov, Stelian Dimitrov, Martin Iliev*
14:30-14:45	**O-G-5** Integrating GIS in Water Resources Governance for Regional Sustainability: A Case Study from Blagoevgrad Province, Bulgaria *Galina Bezinska, Siyka Keseva, Krasimir Stoyanov*
14:45-15:00	**O-G-6** GIS and Internet of Things *Matija Milić*

15:00-15:15	**O-G-7** A socio-geographical analysis of demographic aging in Bulgaria and Italy at the Nuts II level *Dimitar Simeonov*
Coffee break	
Chairman: ***Assist. Prof. Miroslav Ivanov***	
15:45-16:00	**O-G-8** Heavy metal content in bottom sediments of the Arda River basin upstream of the Kardzhali Dam *Zornitza Cholakova*
16:00-16:15	**O-G-9** Spatial and temporal analysis of the distribution of copper in soils affected by a long-term impact of copper smelter *Nadezhda Nikolova, Miglena Zhiyanski*
16:15-16:30	**O-G-10** Morphological and Hydrological Features of the Krajiste Region (Southeastern Serbia) *Milena Milenova; Krasimir Stoyanov; Galina Bezinska*
16:30-16:45	**O-G-11** Climatic Characteristics of the Krajiste Region (South-east Serbia) and Their Impact on Relief and Geomorphological Processes *Krasimir Stoyanov; Milena Milenova; Galina Bezinska*
16:45-17:00	**O-G-12** An overview of European geographical research on natural borders and their effects *Marina Pehlivanova*
17:00-17:15	**O-G-13** Virtual Tourism as a Tool for Enhancing Destination Accessibility and Sustainability *Vladimir Karadzhov, Emilia Patarchanova*
17:15-17:30	**O-G-14** Contemporary tourism-geographical development of Karlovy vary – a comprehensive model for sustainable development *Maria Nosikova*

Friday, June 13th	
Chairman**: *Assoc. Prof. Aleksandra Ravnachka***	
13:30-13:45	**O-G-15** Geography of the transport system in the academic field of the Velikotarnovski geographical school *Emel Bilyalova*
13:45-14:00	**O-G-16** Classification of Rural Areas in Southwest Planning Region in Bulgaria Based on Socioeconomic Development Criteria *Krasina Radomirska, Plamen Patarchanov*
14:00-14:15	**O-G-17** Social Processes in the Border Municipalities of the Southwest Region in Bulgaria *Vasil Pandurski*
14:15-14:30	**O-G-18** Household well-being and the risk of poverty *Emilia Patarchanova, Gergana Nikolova, Aleksandra Ravnachka, Veselina Dalgacheva, Vladimir Karadzhov*

14:30-14:45	**O-G-19** Foreign Direct Investment in the Trakia Economic Zone: Models and Economic Effects *Olga Gavrilova*
14:45-15:00	**O-G-20** The Policy of the European Union for the Development of the Agricultural Sector in Rural Areas. *Valentin Shlyakov*
15:00-15:15	**O-G-21** Conditions, factors and spatial organization of viticulture in Pazardzhik region *Doycho Vaklinov*
Coffee break	

Section: Mathematics
Hall 5

Thursday, June 12th	
Chairman: ***Prof. DSc Peter Boyvalenkov***	
13:30-13:45	**O-M-1** An algebraic approach for construction of (t, s)−sequences *Vassil Grozdanov, Vesna Dimitrievska-Ristovska, Petar Sekuloski*
13:45-14:00	**O-M-2** Multidimensional Quasi-Monte Carlo integration in weighted anchored Sobolev spaces *Vassil Grozdanov, Elmi Shabani*
14:00-14:15	**O-M-3** The Erdös-Turàn-Koksma inequality in Cantor systems *Atidzhe Hodzhova, Vassil Grozdanov*
14:15-14:30	**O-M-4** About a new view on the golden ratio *Mikhail Kolev, Stanislava Stoilova*
14:30-14:45	**O-M-5** On some methods of calculation of specific types of integrals *Mikhail Kolev, Stanislava Stoilova, Yana Vasileva*
14:45-15:00	**O-M-6** Criterion of connectedness by clopen coverings *Zoran Misajleski*
15:00-15:15	**O-M-7** On sequence convergence in (3,j)-metric spaces, j∈{1,2} *Tomi Dimovski, Dončo Dimovski, Pavel Dimovski*
15:15-15:30	**O-M-8** Some asymptotic results for the generalized directional short-time Fourier transform with fixed direction *Jasmina Veta Buralieva*
Coffee break	
Chairman: Prof. Dr. Mikhail Kolev	
16:00-16:15	**O-M-9** Simulations of Electoral Systems: How Different Methods of Vote Allocation Affect Political Representation *Georgi Bratkov, Boyana Garkova*
16:15-16:30	**O-M-10** On Some Applications of Second-Order Linear Differential Equations in Economy *Sashka Kandilarova*

16:30-16:45	**O-M-11** Estimation of the difference between continuous and impulsive models *Tzanko Donchev, Nikolay Kitanov, Saba Iftikhar, Dimitar Kolev, Boyana Garkova*
16:45-17:00	**O-M-12** Existence and stability for a parabolic initial and boundary value problem *Tzanko Donchev, Boyana Garkova, Saba Iftikhar, Dimitar Kolev, Nikolay Kitanov*
17:00-17:15	**O-M-13** Attractors of M-Dissipative Evolution Inclusions *Tzanko Donchev, Iveta Nikolova, Nikolay Kitanov, Alina I. Lazu*
17:15-17:30	**O-M-14** Mixed Semicontinuous Riemann-Liouville Evolution Inclusions *Tzanko Donchev, Boyana Garkova, Alina I. Lazu, Iveta Nikolova*

Friday, June 13th	
Chairman: Assoc. Prof. DSc Vassil Grozdanov	
16:45-17:00	**O-M-15** Tolerance and Interval Graphs for Strategic Planning During Health Crises *Limonka Koceva Lazarova, Natasa Stojkovik, Aleksandra Stojanova Ilievska, Marija Miteva, Dusan Bikov*
17:00-17:15	**O-M-16** Graph Theory Applications in Investment Analysis and Risk Modeling *Limonka Koceva Lazarova, Anastasija Antova, Natasa Stojkovik, Aleksandra Stojanova Ilievska, Vasko Kokalanov*
17:15-17:30	**O-M-17** One More Result on Products of Distributions in Colombeau Algebra *Marija Miteva, Limonka Koceva Lazarova, Biljana Zlatanovska*
17:30-17:45	**O-M-18** Persistent Homology-Based Regime Detection for Time Series Forecasting *Petar Sekuloski, Vesna Dimitrievska Ristovska*
17:45-18:00	**O-M-19** Applications of LLM in geometry teaching *Petar Sokoloski*

Section: Informatics
Hall 5

Friday, June 13th	
Chairman: ***Assoc. Prof. Nadezhda Borisova***	
13:30-13:45	**O-I-1** Integrating Exon–Gene Structure into Neural Architectures for RNAseq Classification *Aleksandar Jovanović, Michael Sammeth*
13:45-14:00	**O-I-2** Applications of Machine Learning Algorithms *Eyal Sadeh*
14:00-14:15	**O-I-3** Comparative Analysis of Classification Algorithms on Big Datasets using WEKA *Aleksandar Stoimenovski, Irena Atanasova*
14:15-14:30	**O-I-4** The Accessibility Impact from Changing Existing Schools into Experimental Schools without the Establishment of New Schools: Analyzing Kindergarten and Primary Schools of Florina, Greece, a Case Study *Irena Atanasova, Ilias Solakis*

14:30-14:45	**O-I-5** Some Robotic Process Automation (RPA) Use Cases and Applications in Financial Industry *Vladislav Yurukov, Irena Atanasova*
14:45-15:00	**O-I-6** Data mining - based predicting of students' evaluation and students' acceptance of Distance E-learning. Case study: South-West University "Neofit Rilski" *Irena Atanasova, Aleksandar Stoimenovski*
Coffee break	
Chairman: ***Assoc. Prof. Irena Atanasova***	
15:30-15:45	**O-I-7** Collaborative mindset and AI empowered Knowledge Management *Vladislav Yurukov, Irena Atanasova*
15:45-16:00	**O-I-8** Numerical solution of some facility location and inventory control problems *Stefan Stefanov*
16:00-16:15	**O-I-9** Analysis of data mining algorithms for predicting physical activity of urban populations *Irena Atanasova, Svetoslav Petkov*
16:15-16:30	**O-I-10** Enhancing Computational Thinking and Code Comprehension through Advanced Parsons Puzzles *Ivo Damyanov, Martin Madzhov*

Section: Methodology in Education
Conference Hall

Thursday, June 12th	
Chairman: ***Assist. Prof. Dr Damyana Grancharova***	
13:30-13:45	**O-ME-1** STEAM: learning content development, how to use it, difficulties Ginka *Exner*
13:45-14:00	**O-ME-2** Distance and Independent Learning Contents in a Digital Environment *Juraqulova Zulayxo Ixtiyor, Boboev Abrorjon Khotamovich, Toshniyozova Farangiz Burxon*
14:00-14:15	**O-ME-3** Application of Metacognitive Strategies and Artificial Intelligence in the Learning Process *Lyuba Petrova*
14:15-14:30	**O-ME-4** Continuity issues in the content of the chemistry course between secondary school and *university* *A.B. Toibazarova, N.O. Appazov*
14:30-14:45	**O-ME-5** Cross curricular relationships in teaching mathematics and informatics in lower secondary school *Mediha Topalova, Daniela Tuparova*
14:45-15:00	**O-ME-6** Methods for Introducing Optimization Algorithms and Mathematical Modeling into the High School Mathematics Curriculum (Grades 8–10) through Interactive Platforms – Wolfram Alpha and Matlab

	Elitsa Atanasova, Feim Musankov
15:00-15:15	**O-ME-7** *Trakya University STEM Innovation Lab: Philosophy, Structure, Projects, and Future Vision* *Sertaç Arabacioğlu, Eylem Bayir*
15:15-15:30	**O-ME-8** Modeling with scratch for solving movement problems at the lower gymnasium le*vel* *Rositsa Georgieva*
Coffee break	
Chairman:	***Assist. Prof. Aleksandra Tencheva***
16:00-16:15	**O-ME-9** Interactive Learning with Virtual Reality and 3D Printing *Damyana Grancharova*
16:15-16:30	**O-ME-10** Non-formal style in mathematics teaching *Nataliya Pavlova*
16:30-16:45	**O-ME-11** Integrating Sudoku into 5th grade mathematics classes *Ivayla Gergova, Boyana Garkova*
16:45-17:00	**O-ME-12** Prospective Teachers' Demographic Characteristics and Their Beliefs about Their Preparedness to Teach Mathematics *Metodi Glavche*
17:00-17:15	**O-ME-13** The role of the competency-based approach in stem education *Krasimir Harizanov*
17:15-17:30	**O-ME-14** Creative Activity in Food Industry Engineering *Rano Mirsamikova, Botir Usmonov*
17:30-17:45	**O-ME-15** The implementation of stem education in the higher education system *Gulnora Aripova, Abror Boboev, Mahmuda Tadjibaeva*
17:45-18:00	**O-ME-16** Application of a research approach in stem education *Sevinch Mustan*
18:00-18:15	**O-ME-17** Challenges in Informatics Education: Analysis and Improvement Proposals *Samuil Zherev, Elena Karashtranova*

Special session

Central Auditorium of Conference Center

"Challenges and Opportunities for Implementing STEM Approaches in Secondary and Higher Education"

14.06.2025

10:00 – 12:00

12:00-12:30 Coffee break

POSTER SESSION

Chemistry	
P-C-1	Could an Aurophilicity play a role in dimeric Au (III) Diiminoisoindole Complexes? The Group 11 Complexes for the 11th FMNS! *Stanislava Majerova, Zdenka Ruzickova, Ales Ruzicka*
P-C-2	Positively charged heteroboranes: Synthesis and reactivity *Vlastimil Němec, Josef Holub, Maksim A. Samsonov, Jan Vrána, Aleš Růžička*
P-C-3	Biosorption of industrial dyes by the dried and inactivated lichen Usnea barbata *Katarina Stepić, Radomir Ljupković, Jovana Ickovski, Slobodan Ćirić, Aleksandra Đorđević, Tijana Jovanović, Aleksandra Zarubica*
P-C-4	Ethnopharmacological applications of Salvia officinalis L. in the Niš district: Traditional use in oral health disorders *Jovana Ickovski, Slobodan Ćirić1, Aleksandra Đorđević, Katarina Stepić, Radomir Ljupković, Marija Marković, Vesna Stankov Jovanović*
P-C-5	Antimicrobial activity of Hypericum barbatum Jacq. essential oil *Aleksandra Đorđević, Goran Petrović, Jovana Ickovski, Radomir Ljupković, Jelena Stamenković, Slobodan Ćirić, Katarina Stepić*
P-C-6	Using innovative USB sensors in chemistry *Aleksandra Tencheva, Elitsa Chorbadzhiyska*
P-C-7	Characterization of electrocatalysts for cathodes in a microbial electrolysis cell *Katerina Angelova, Yordan Angelov, Elitsa Chorbadzhiyska*
P-C-8	Quantitative determination of calcium in the chicken eggshell by ICP-OES method *Emilija Pecev-Marinković, Aleksandra Pavlović, Jelena Mrmošanin, Ivana Rašić Mišić, Enisa Selimović, Katarina Milenković, Stefan Petrović, Denis Mitov*
P-C-9	DFT Study of the Thermodynamic Aspects of Lutein Oxidative Transformations *V. Staykov, Zh. Velkov*
P-C-10	Boron and Aluminum Complexes of Electronically Diverse Biguanide Ligand: Synthesis and Reactivity *Alena Hoffmannova, Lukas Vlk, Tomas Chlupaty, Zdenka Ruzickova, Ales Ruzicka*
P-C-11	Evaluation of Antioxidant Activity and Total Phenolic Content of Red and Green Pepper (Capsicum annuum L.) *Jelena Nikolić, Violeta Mitić, Milica D. Nikolić, Milijana Zlatković, Mihajlo Halilović, Milan Mitić, Vesna Stankov Jovanović*
P-C-12	Assessment of the chemical composition and biological activity of essential oil from Bulgarian yarrow (Achillea millefolium) *Krastena Nikolova, Natalina Panova, Anelia Gerasimova, Yulian Tumbarski, Ivan Ivanov, Ivayla Dincheva, Christina Tzvetkova6, Galia Gentscheva*

P-C-13	Determination of Cd, Cu, and Zn in White, Integral, and Red Rice Varieties Using ICP-OES *Stefan Petrović, Snežana Tošić, Milica Marković, Ava Amideina, Violeta Mitić, Jelena Nikolić, Vesna Stankov Jovanović*
P-C-14	Impact of Wildfire on the Antioxidant Potential of Doronicum columnae: A Biochemical Assessment of Methanolic Extracts from Fire-Affected and Control Sites *Vesna Jovanović, Jelena Nikolić, Marija Marković, Marija Ilić, Marija Dimitrijević, Milan Mitić, Violeta Mitić*
P-C-15	Argan shell-derived carbon material as an efficient sorbent for water treatment *Petranka Petrova, Elitsa Chorbadzhiyska, Maya Chochkova, Tarik Chafik, Katerina Angelova, Jordan Angelov, Georgios Uzunis*
P-C-16	Design and multifunctional performance of a novel zinc-based MOF constructed from TCPT ligand *Rusi Rusew, Hristina Lazarova, Magdalena Angelova, Vanya Kurteva, Rositsa Nikolova, Boris Shivachev*
P-C-17	Mineral resource base of Uzbekistan for obtaining modern geopolymers *Zebo Babakhanova, Shokhnoza Ruzimova*
P-C-18	*New cysteine derivatives with amantadine, rimantadine and memantine and evaluation of their chemical stability* *Antoniya Stoymirska, Kiril Chuchkov, Radoslav Chayrov, Ivanka Stankova*
P-C-19	Chemical stability of new aminoadamantane analogues with N-acetylcysteine *Antoniya Stoymirska, Kiril Chuchkov, Radoslav Chayrov, Ivanka Stankova*
P-C-20	Double-layer leather handcraft belt: Design, Technology and Chemistry *Mitko Stoev, D. Zheleva, N. Spasova*
P-C-21	Substrates with natural zeolites and fertilizers for smart orchid cultivation *Mitko Stoev, Elitsa Chorbadzhiyska*
P-C-22	A Direct Microwave-Accelerated Wittig reaction for synthesis of substituted cinnamates *Maya Chochkova, Ernst Lankmayr*, *Petranka Petrova, Tsenka Milkova*
P-C-23	Synthesis, hydrolytic stability and antiviral studies of Sulfur-based anti-influenza drugs *Maya Chochkova, Boyka Stoykova, Petranka Petrova, Nejc Petek, Martin Štícha, Jurij Svete, Lubomira Nikolaeva*-Glomb*, Yuhuan Li*
P-C-24	Residual Deviations Analysis – A Powerful Calibration Linearity Criterion. Visual Test or Reliable Statistical Tool? *Ava Amideina, Petko Mandjukov*

Physics	
P-P-1	Electron beam welding of titanium and aluminum alloys with a vanadium filler *Darina Kaisheva, Georgi Kotlarski, Maria Ormanova, Vladimir Dunchev, Angel Anchev, Borislav Stoyanov, Stefan Valkov*
P-P-2	Investigation of laser produced noble metal-semiconductor nanostructures *Mihaela Koleva, Anna Dikovska, Nikolay Nedyalkov, Tsanislava Genova*
P-P-3	All-optical characterization of the magnetic properties of nanocomposite bulk samples *Elena Taskova, Svetoslav Kolev, Tatyana Koutzarova*
P-P-4	Crystallography and electrical impedance spectroscopy of TiO2 thin films deposited on Al substrates *Daniela Stoeva, Georgi Kotlarski, Dimitar Dechev, Nikolay Ivanov, Stefan Valkov, Maria Ormanova, Valentin Mateev, Iliana Marinova*
P-P-5	Influence of diffusion on the propagation of optical beams in alkali metal vapors *Nikola Nikolov, Stoyan Tsvetkov, Sanka Gateva*
P-P-6	Analysis of the decay of the ^{9}B nucleus in the dissociation of the ^{10}C nucleus *Ralitsa Stanoeva*
P-P-7	Modeling in electrochemical characterization of electrode materials *Pavel Chorbadzhiyski, Metodi Popstoilov, Elitsa Chorbadzhiyska*
P-P-8	Modeling in energy efficiency - autonomously powered systems *Pavel Chorbadzhiyski, Metodi Popstoilov, Elitsa Chorbadzhiyska*
P-P-9	Stimulated Raman Scattering in quartz fibers around the point of zero dispersion *Lyuben Ivanov*
P-P-10	Applicability of quartz for dosimetric purposes *Ivana Fabijanikj Sandeva, Aleksandar Krleski, Lihnida Stojanovska-Georgievska, Margarita Ginovska, Hristina Spasevska*

Geography	
P-G-1	Anthropophysiological characteristics of the contemporary Bulgarian population in Northeastern Bulgaria *Nadezhda Paraskova, Magdalena Pirinska – Apostolu*
P-G-2	Presence of wormian bones in adult human skulls from Late Roman period - Salona, Dalmatia *Ralitsa Bogdanova, Magdalena Pirinska-Apostolu*
P-G-3	The influence of social factors on the physical development and maturation of girls (12-16 years old) from Sliven district - Bulgaria *Pirinska - Apostolu Magdalena, Nadezhda Paraskova, Ralitsa Bogdanova*
P-G-4	Geographical studies of urbanization processes and their spatial organization in Bulgaria *Evelina Filatova, Emilia Patarchanova*

P-G-5	Evaluating Urban Expansion Using a City-Scale Dasymetric Population Map: A Case Study of Bursa, Türkiye *Mustafa Köse; Nilanchal Patel, Galina Bezinska*

Ecology and Environmental Protection	
P-EEP-1	First and confirmative records of four mayflies (Insecta: Ephemeroptera) from the Republic of North Macedonia *Biljana Rimcheska, Yanka Vidinova*
P-EEP-2	Optimizing nitrogen retention through novel magnesium-urea complexes: monitoring ammonia emissions in soil environments *Gergana Velyanova*
P-EEP-3	Some aspects of the chemical pollution from CFPPs of Razmetanitsa and Sokolitsa rivers *Vanina Mitseva, Elena Karashtranova, Emilia Varadinova*
P-EEP-4	Monitoring European beech phenology in two long-term ecological research sites by remote sensing *Svetoslav Anev, Sonya Damyanova*
P-EEP-5	Microbiological status of soils within the scope of the site Petrohan, LTER-BG *Bilyana Grigorova-Pesheva, Sonya Damyanova, Pavel Pavlov*
P-EEP-6	Data Fusion for Ecosystem Services Assessment: a Case Study in Bulgarian South-western Rila Mountains *Kostadin Katrandzhiev, Kremena Gocheva, Radka Fikova, Svetla Doncheva*

Mathematics	
P-M-1	Obtaining an Analytical Solution of First-Order Differential Equations with ChatGPT *Biljana Zlatanovska, Marija Miteva, Natasa Koceska, Saso Koceski, Limonka Koceva Lazarova, Mirjana Kocaleva Vitanova*

Informatics	
P-I-1	Application of Computer Visualizations in Scientific Data Analysis *Radoslav Mavrevski, Miglena Trencheva, Metodi Traykov, Tereza Trencheva, Ivan Trenchev*
P-I-2	Adaptive Learning in Mixed Reality: New Horizons for Personalized Education *Vladimir Angelov, Yana Karshiyska, Kamelia Shumanova, Borislav Zashev*
P-I-3	Construction and optimization of the seventh-order polynomial convolutional interpolation 2P kernel *Zoran Milivojevic, Nataša Savić, Bojan Prlinčević, Violeta Stojanović, Dijana Kostić*

Methodology in Education	
P-ME-1	Robots and Reassurance: Teacher Insights into a New Curriculum for Anxiety-Free Math Learning *Nadezhda Borisova, Elena Karashtranova, Ineta Helmane, Linda Daniela, Hasan Arslan, Yasemin Abalı Öztürk, Kadir Tunçer, Danguole Rutkauskiene, Kornelia Daukintyte, Aleksandra Zając*
P-ME-2	Chemistry - fun and *interesting using STEM approaches* *Aleksandra Tencheva, Elitsa Chorbadzhiyska*
P-ME-3	How Important is STEM In*tegration in Modern Teaching: Survey Insights* *Damyana Grancharova*

Plenary Lectures

POLARIZATION OF SPHERICAL CODES AND DESIGNS

Peter Boyvalenkov
Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, 8 G Bonchev
Str., 1113 Sofia, Bulgaria
Email address: peter@math.bas.bg

Abstract: We prove universal lower and upper bounds for max-min and min-max polarization problems for spherical codes by linear programming. The concept of spherical designs is crucial to derive our bounds. The universality is understood in the Levenshtein sense and for a large classes of potential functions (thus, in the Cohn-Kumar sense). Moreover, our bounds are computed in certain nodes and have certain weights which are independent of the potential, providing this way another aspect of their universality. Certain optimality properties of spherical designs in the class of all spherical codes of the same cardinality are proved along with many examples attaining our bounds.

Joint work with S. Borodachov (Towson University, Towson, MD, USA), P. Dragnev (Purdue University Fort Wayne, IN, USA), D. Hardin and E. Sa_ (Vanderbilt University, Nashville, TN, USA), M. Stoyanova (So_a University, Bulgaria).

Advancements in Sample Preparation Techniques for the Analysis of Persistent Organic Pollutants: A Focus on PAHs

Vesna Stankov Jovanović
University of Niš, Faculty of Science and Mathematics, Department of Chemistry, Višegradska 33, 18000 Niš, Serbia
(vesna.stankov-jovanovic@pmf.edu.rs**,** https://orcid.org/0000-0001-7885-0476)

Abstract: Persistent Organic Pollutants (POPs), particularly polycyclic aromatic hydrocarbons (PAHs), represent serious environmental and public health concern due to their persistence, bioaccumulation, and toxicological effects. While the first principle of Green Analytical Chemistry encourages the direct analysis of samples without pretreatment, this is rarely achievable in practice. Preparation is essential for real-world samples, especially environmental ones, to isolate and enrich target analytes, eliminate matrix interferences, and improve detection limits. Over the past three decades, sample preparation has advanced significantly, with a clear focus on miniaturization, environmental sustainability, operational simplicity, and improved analytical performance.

Key innovations emerged during the 1990s and early 2000s, including solid-phase extraction (SPE), solid-phase microextraction (SPME), single-drop microextraction (SDME), hollow-fiber liquid-phase microextraction (HF-LPME), and dispersive liquid-liquid microextraction (DLLME). These techniques drastically reduced solvent and sample consumption and allowed rapid, sensitive, and selective PAH analysis. Since then, modifications such as using magnetic sorbents, greener or less hazardous solvents, and portable and automated platforms have further improved method efficiency and ecological compatibility.

However, it's important to note that the initial enthusiasm for extractants like ionic liquids (ILs) has been tempered by the discovery of toxicity associated with certain fluorinated anions, calling into question their green status. A similar trend is occurring with deep eutectic solvents (DESs) and their natural analogs (NADESs), where a lack of thorough toxicological evaluation raises concerns about their widespread use. These issues reflect a deeper challenge within the scientific community, which often emphasizes publication output over rigorous environmental assessment. It's crucial that we address these challenges and ensure that our advancements in sample preparation techniques are not at the expense of environmental safety.

Among recent breakthroughs, solid-phase nanoextraction (SPNE) has emerged as a promising, environmentally friendly approach for PAH extraction from water. Pressurized hot water extraction (PHWE) combined with LC-GC analysis offers another solvent-minimizing method, particularly for sediment samples. This closed-system approach allows in-line analyte trapping and

transfer, eliminating the need for extensive clean-up while providing detection limits below 0.01 μg/g and excellent linearity and precision.

In parallel, innovative sorbents such as physicochemically modified natural zeolitic mineral clinoptilolite have shown extraordinary potential for treating water and soil samples for PAH analysis. Clinoptilolite, a naturally occurring zeolite, offers a high surface area, tunable adsorption properties, and chemical stability, making it ideal for extracting PAHs before gas chromatography-mass spectrometry (GC-MS) analysis. Its natural origin and modifiability also align well with green chemistry principles, making it a promising candidate for future sample preparation techniques.

Additionally, cutting-edge electrochemiluminescence (ECL) systems have benefited from incorporating PAH derivatives into metal-organic frameworks (MOFs), enhancing signal intensity and offering ultralow detection limits for biosensing applications.

In conclusion, the field of sample preparation for PAH analysis is advancing rapidly toward greener, more efficient, and highly sensitive methodologies. The potential of future directions, integrating innovative sorbents, greener detection technologies, and a deeper chemical understanding, instills hope for sustainable analytical practices.

Keywords: Green analytical chemistry**,** Sample preparation, Extraction techniques, PAH, Environmental analysis, Sorbent materials

Acknowledgements - The research is supported by the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia (Contract No. 451-03-137/2025-03/ 200124 **)**.

What is the professional knowledge of teachers to integrate STEM into their teaching practices?

António Domingos
New University of Lisbon, Portugal
Email: amdd@fct.unl.pt

Abstract: This session aims to problematize and clarify the different types of knowledge that mathematics teachers must possess in order to provide meaningful learning experiences for their students when implementing STEM

tasks in their pedagogical practices. We begin with knowledge models originating from the work of Shulman (1986), which were later developed for mathematics teaching and the use of technology (Ball, Thames, and Phelps, 2008; Koehler, Mishra, and Cain, 2013).

Based on work carried out within professional development programs for elementary school teachers aiming to promote the STEM approach, we are faced with the need to extend existing models to better explain how teachers can develop hands-on STEM tasks with their students. We therefore present a more robust model that integrates this type of task, supporting its development through concrete examples.

We conclude that, alongside the types of knowledge identified in the literature, there is a specialized knowledge that is essential for teachers to successfully develop and implement interdisciplinary mathematics practices in the classroom. This specialized knowledge must be taken into account in order to ensure effective teacher training and meaningful student learning experiences.

Keywords: STEM, professional knowledge, teaching

Coherent magneto-optical resonances in alkali atoms and their applications

Sanka Gateva
Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria
sgateva@ie.bas.bg

Abstract: There is a permanent interest in investigations of new magnetic sensors for different applications and last years a rapid progress in development of magneto-optical sensors with high sensitivity and potential for miniaturization.

Magnetometers, based on magneto-optical sensors have high sensitivity - comparable to, or even surpassing this of the SQUIDs. Microfabrication of components using the techniques of Micro-Electro-Mechanical Systems (MEMS) developed for atomic clocks gives the opportunity for building small, low consuming, low cost and non-cryogenic (as SQUIDs) sensors. Coherent optical effects can be applied for magnetic field detection and offer perspectives

for development of high-precision optical magnetometers. These magnetometers are appropriate for geomagnetic, space, nuclear and biological magnetic field measurements (cardio and brain magnetic field imaging), environmental monitoring, magnetic microscopy, investigations of fundamental physics, etc. Coherent magneto-optical resonances have many applications not only in magnetometry, but in high-resolution spectroscopy, lasing without inversion, laser cooling, ultraslow group velocity propagation of light, etc.

Coherent magneto-optical resonances in alkali atoms are investigated from point of view of magnetometry applications in the Institute of Electronics, Bulg. Acad. Sc. The measurements are performed in Hanle configuration. The parameters of the resonances registered in fluorescence and transmission are compared. The capability of the laser system to work with magnetically unshielded cell is demonstrated. The registration of bright and dark magneto-optical resonances in fluorescence by controlling the optical thickness is analyzed. The influence of the laser power and transverse magnetic field are considered.

Magneto-optical resonances can be prepared and registered in different ways. Most frequently Coherent-Population-Trapping (CPT) is observed when two hyperfine levels of the ground state of alkali atoms are coupled by two laser fields to a common excited level. When the frequency difference between the laser fields equals the frequency difference between the two ground states, the atoms are prepared in a non-absorbing state, which can be registered as a fluorescence quenching and transparency enhancement in spectral interval narrower than the natural width of the observed optical transition.

In degenerate two-level systems coherent states can be created by means of Hanle effect configuration. In this case the coherent non-absorbing state is prepared on two Zeeman sublevels of one hyperfine level by monochromatic laser field (the so-called single frequency CPT). Hanle configuration is important for performing significantly simplified experiments and to build practical devices as well.

For all applications, where narrow signals and high signal-to-noise ratios are important, ensuring reliable operation requires good knowledge of the resonance shape and the internal and external factors influencing it.

In this lecture, the influence of different factors on the shape of the CPT resonances obtained by means of the Hanle effect configuration and registered in fluorescence is analyzed in uncoated, room temperature vacuum cells from

point of view of cell diagnostics and building high-sensitive magneto-optical sensors.

Keywords: Coherent Population Trapping, Electromagnetically Induced Transparency, Optical Magnetometry, All-optical sensors

Mapping of ecosystem services and the transformative change of the European environmental policy

Prof. Dr. Stoyan Nedkov PhD,
National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences

Abstract: Ecosystem services (ES) are human-derived benefits flowing from the environment, and their provision and flow are dependent on the ecological structures and functions, which make up the biophysical environment.

The biophysical quantification of ES is focused on measuring ecosystem structure and functioning powered by biodiversity. Biophysical methods for mapping ecosystem services are used to quantify ecosystems' capacity to deliver ecosystem services and the amount of harvested yield of such capacity for human benefit.

Recent years have seen the emergence of a transdisciplinary, systematic, integrative, and sustainability-oriented concept for ES, which has developed into a robust framework to enable the integration of important values of nature into public and business decision-making at different levels. The main aims of ES applications are the protection, restoration, and sustainable use of ecosystems and their services, enabling transformative change.

Keywords: Ecosystem services, biophysical quantification, ecosystem structure, biodiversity

Mathematics in the early education of programmers

Prof. Krassimir Manev, PhD
Private Academy “Nikola Tesla”, Sofia
krmanev@gmail.com

Abstract: Computer programming is one of the most modern and promising professions of our time. In order to provide sufficient personnel for the software industry, not only nationally, but also globally, systematic and comprehensive training of narrow specialists in the field is necessary. It is of great importance that the training of future programmers begins as early as possible. Programming competitions (Olympiads) are a traditional form of early training of highly qualified programmers.

Youngest enthusiasts start to participate in Bulgarian competitions in programming when they are in 5-th, and even in 4-th, grade. Because the tasks for these competitions are of algorithmic nature, for successful participation, beside the high level of commanding of the programming language, a solid mathematical background is necessary also. That is why it is necessary to specify what mathematical knowledge and skills are necessary for participating in programming contest in this age and to decide which knowledge the pupils will obtain in math classes and which has to be learned during the preparing for participation in contests. For the purpose we investigated more than 350 tasks from the national competitions in programing for the age group to identify the necessary mathematical knowledge which is a subject of this presentation.

The full overview of the investigated tasks with description of necessary mathematics, algorithms and programming approaches are published in the book referenced in presentation.

Keywords: programming contests; early training; mathematical background

Section: Chemistry

O-C-1 Chemical composition of underground waters as a tool for finding connections between caves (applied for Nanzheng area, Shaanxi province, Central China)

David Havlíček[1], Michal Filippi[2], Zdeněk Motyčka[3]and Kateřina Havlíčková[4]

[1]Department of Inorganic Chemistry, Faculty of Science, Charles University, Praha 2, Czech Republic

[2]Institute of Geology, Praha 6, Czech Republic

[3]Czech Speleological Society, Praha 5, Czech Republic

[4]Forestry and Game Management Research Institute, Jíloviště, Czech Republic

havlicek@natur.cuni.cz

Abstract: For the first time we have used the chemical analyses of underground waters as a tool for finding connections among water streams during exploration of Bohemia cave in Mt. Owen area in New Zealand. This karst area is located in very clean territory and all the analysed water has autochthonous origin. Bohemia cave is one of the most beautiful aragonite cave in the world and contains giant dome, the largest one in New Zealand. Four years ago we have presented in this conference (FMNS 2021) study of chemical composition of underground waters in Demänová valley (Slovakia) as a tool for finding connections between Štefanová and Demänová cave system. Waters in Demänová valley are both of autochthonous and allochthonous origin and this karst area is located in populated middle Europe, where acid rains influence karst water composition. In the year 2018 we have used the same approach (chemical analysis of karst water from different sources and solution of the sets of mixing equations) in four hydrographic systems in Nanzheng area (Shaanxi province, central China). Our results are a subject of this lecture.

Keywords: cave water chemistry, mixing equations, hydrographic model

O-C-2 Preparation and characterization of molecular crystal based on 2D carriers of NLO properties

Ivan Němec, Irena Matulková, Ivana Císařová, Soňa Kohúteková, Petr Němec
Charles University, Faculty of Science, Department of Inorganic Chemistry, Faculty of Mathematics and Physics, Department of Chemical Physics and Optics
Prague, Czech Republic
e-mail: ivan.nemec@natur.cuni.cz

Abstract: Molecular crystals containing hydrogen-bonded 2D organic molecules, acting as carriers of nonlinear optical (NLO) properties, belong to a family of materials that can be used in a wide range of technical applications exploiting numerous NLO effects (including SHG - Second Harmonic Generation, THG - Third Harmonic Generation, and cascaded self-frequency doubling and tripling). Studied molecular materials (i.e. mainly salts of selected organic molecules) benefit from hydrogen bonding as a key interaction in the molecular self-assembly process leading to crystal formation. This contribution presents the study of selected molecular crystals based on guanidine, pyrimidine and their derivatives with selected inorganic/organic anions - by the combination of experimental (IR spectroscopy, Raman spectroscopy, X-ray diffraction and calorimetry) and theoretical (solid state quantum chemical calculations) methods. Special attention will be paid to the phase characterization and understanding of the existing phase transformations observed in the studied crystal family.

Keywords: Nonlinear optics, Crystal structure, Vibrational spectra, Phase transformations

Acknowledgements - **A**dvanced **M**ultiscale **M**aterials for **K**ey **E**nabling **T**echnologies (**AMULET**) project, supported by the Ministry of Education, Youth, and Sports of the Czech Republic (project No. CZ.02.01.01/00/22_008/0004558) is gratefully acknowledged.

O-C-3 Isoindoline-1,3-diimine Derivatives Investigated by NMR/XRD/DFT Approach

Stanislava Majerova, Ales Ruzicka
Department of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Pardubice, Czech Republic
ales.ruzicka@upce.cz

Abstract: Phthalocyanines and its building blocks – isoindoline-1,3-diimines (diiminoisoindoles, DIIs), represent a structurally-diverse class of compounds with ability to make metal complexes and perform in various fields from medicine to photovoltaics and homogenous catalysis. According to the present study monosubstituted diiminoisoindoles, their higher homologues, and complexes can be effectively prepared by an addition of silylated lithium amides to 1,2-dicyanobenzene followed by mild hydrolysis or a condensation. An addition of DII to carbodiimides or reactions of lithiated DIIs with acylchlorides give DII-guanidines and amido derivatives. Dynamic behavior and structure of all studied classes of compounds were investigated from the stereochemical point of view – possible E/Z-isomerization and dimerization (DIIs and amido derivatives), tautomerism (guanidines) and stability both in solution as well as in solid state. The resonance-assisted hydrogen bonds are present in all species, except reduced amides, predetermining them to be exceptional ligands in coordination chemistry.

Keywords: Diiminoisoindoline, Lithium, Prototropy

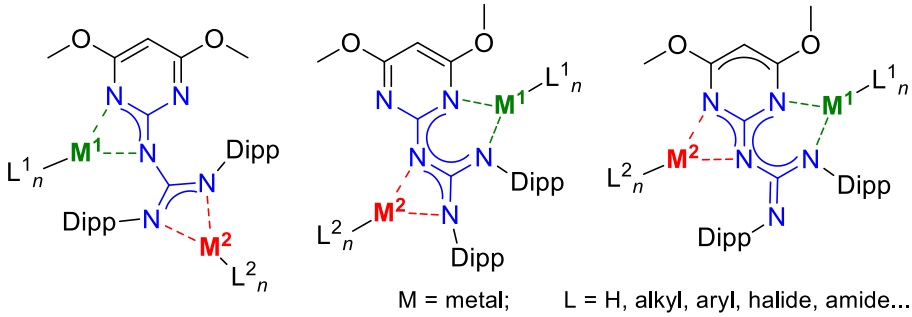
Acknowledgement: The work was supported by the Czech Science Foundation (No. 25-17434S).

O-C-4 Structurally Tunable Main Group Metal Complexes Bearing an Electronically Versatile/Fluxional Biguanide Ligand

Lukas Vlk, Tomas Chlupaty, Alena Hoffmannova, Zdenka Ruzickova, Ales Ruzicka
Department of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Pardubice, Czech Republic

st54138@upce.cz

Abstract: In the past few decades, the increasingly popular and versatile guanidinate ligands were used for coordination of many transitions as well as main group metals/elements. In contrast, the chemistry of biguanides and dianionic guanidinates or biguanides has been far less described [1]. In our group, we developed a doubly deprotonable biguanide ligand, capable of forming heterobimetallic species in multiple structural arrangements. Several compounds of (mostly) main group elements were synthesized, and their structure was investigated. The effect on the behavior of titled complexes in homogeneous catalysis was studied in detail.



Keywords: biguanide, main group metals, catalysis

Acknowledgement: The work was supported by the Czech Science Foundation (No. 25-17434S).

References: [1] Carrillo-Hermosilla, F. *et al. Molecules*, **2022**, *27*, 5962–5992.

O-C-5 Hydrogen Peroxide Production: A Sustainable Electrochemical Perspective

Desislava Yordanova Apostolova[1], Ivo Bardarov[1,2], Maris Minna Mathew[1], Anders O. Tjell[3], Ema Gricar[1], Mark Starin[1], Igor Plazl[1], Pedro Martins[2], Miha Nosan[1], Torsten Mayr[3], Dusan Strmcnik[2], Bostjan Genorio[1]

[1]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Vecna pot 113, 1000 Ljubljana, Slovenia

[2]Department of Material Chemistry, National Institute of Chemistry,

Hajdrihova 19, 1000 Ljubljana, Slovenia
[3]Institute of Analytical Chemistry and Food Chemistry, Graz University of Technology, Stremayrgasse 9/II, 8010 Graz, Austria
e-mail: desislava.apostolova@fkkt.uni-lj.si

Abstract: Hydrogen peroxide (H_2O_2) is a widely used oxidizing agent used in pulp and paper bleaching, wastewater treatment, chemical synthesis, and energy storage. However, its large-scale production relies on the anthraquinone process, which is energy-intensive, requires scarce platinum group metals (PGMs) as catalysts, and involves the transportation of highly concentrated H_2O_2, posing safety and logistical challenges. Therefore, research efforts have focused on alternative synthesis methods, including direct H_2O_2 synthesis and electrochemical production via the oxygen reduction reaction (ORR). While direct synthesis poses significant safety risks due to the handling of explosive hydrogen-oxygen mixtures, electrochemical production offers a decentralized and potentially more sustainable approach. In particular, ORR in alkaline media via the two-electron pathway has shown high selectivity for the formation of H_2O_2. However, its sluggish kinetics require the development of efficient electrocatalysts with high activity, selectivity, and stability. Noble metal-based catalysts such as Pd-Au and Pt-Hg show high performance but are expensive and scarce, which raises interest in transition metal and carbon-based alternatives. In addition, the development of optimized electrocatalytic devices for H_2O_2 production on a practical scale is essential. Innovations such as solid electrolyte fuel cells, membranelles electrolyzers and microfluidic electrochemical flow cells (MEFCs) have proven to be promising technologies. In this study, an electrochemical two-plate reactor and an integrated real-time optical sensor system for the quantification of H_2O_2 is presented. The production of H_2O_2 was probed using electrochemical techniques such as cyclic voltammetry (CV) and chronoamperometry (CA). Additionally, samples collected during the experiments were analyzed using an electrochemical sensor for comparative data assessment. After the electrochemical experiments, the electrodes were characterized using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), Fourier transform infrared spectroscopy (FTIR), and X-ray photoelectron spectroscopy (XPS) to examine changes in the electrode properties post-electrochemical analysis. The results provide insights into the optimization of microfluidic H_2O_2 production and promote the development of

scalable and efficient electrochemical reactors for decentralized applications.

Keywords: Hydrogen peroxide (H2O2), Two-electron oxygen reduction reaction (ORR), Carbon catalyst, Electrosynthesis, Electrochemical reactor

Acknowledgement: The financial support of the Slovenian Research and Innovation Agency (ARIS) through grants P2-0423, P1-0447, J7-4636, J2-50086, and J7-50227 is gratefully acknowledged.

O-C-6 Upcycling Carbon Fiber Composites into Flash Graphene: A High-Efficiency Electrocatalyst for H2O2 Synthesis

Ivo Bardarov[1], Elitsa Chorbadzhiyska[2,3], Desislava Yordanova Apostolova[4], Pedro Martins[5], Bostjan Genorio[4]

[1]Institute of Electrochemistry and Energy Systems "Acad. Evgeni Budevski" - Bulgarian Academy of Sciences, Sofia, Bulgaria,

[2]Department of Chemistry South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[3]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[4]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Ljubljana, Slovenia

[5]Department of Materials Chemistry, National Institute of Chemistry, Ljubljana, Slovenia

ivobardarov@iees.bas.bg

Abstract: The electrochemical production of hydrogen peroxide offers a safer, more energy-efficient, and environmentally sustainable alternative to the conventional anthraquinone process. By enabling direct synthesis from oxygen and water under mild conditions, this approach eliminates the need for hazardous solvents and complex processing steps, paving the way for decentralized and greener H2O2 generation. In this study, we present a new strategy for upcycling carbon fiber- reinforced polymer (CFRP) waste into turbostratic flash graphene (CFC-FG) via a cost-effective flash Joule heating (FJH) process. FJH offers a rapid, robust, and readily scalable method for converting

hard-to-recycle waste materials into valuable carbon nanomaterials, addressing key challenges in waste management and materials sustainability. The resulting CFC-FG exhibits excellent electrochemical performance in the two-electron oxygen reduction reaction (2e ORR) for hydrogen peroxide electrosynthesis, achieving nearly 100% selectivity and demonstrating strong activity in 0.1 M KOH. Stability tests confirmed the retention of performance over time, highlighting the potential of CFC-FG for practical and scalable electrosynthesis applications.

Keywords: Graphene, flash Joule heating, electrochemical synthesis

O-C-7 The electrochemical activation of a ceria-based sensor for ofloxacin detection

Aleksandar Stanojević[1], Tijana Jovanović[1], Emilija Pecev-Marinković[1], Mihajlo Kulizić[2], Aleksandar Lolić[2], Aleksandra Pavlović[1], Ivana Rašić Mišić[1]

[1]University of Niš, Faculty of Sciences and Mathematics, Department of Chemistry, Niš, Serbia

[2]University of Belgrade, Faculty of Chemistry, Department of Analytical Chemistry, Belgrade, Serbia

Abstract: Commercially available electrodes are rarely used for electrochemical detection of analytes due to their poor electron transfer kinetics and limited effective surface area. These drawbacks are often overcome via electrode modification – specifically modification with nanomaterials. Not only does nanomaterial modification enhance the electroactive surface area (ESA) and electron transfer kinetics, but it also provides new active centers for functionalization and analyte sorption. Commonly used nanomaterials for electrode modification include metal nanoparticles, metal oxides, and carbon-based nanomaterials. Another common way of enhancing these properties is electrochemical activation of the electrodes. This type of pretreatment shows the most drastic effects in altering the microstructure and physicochemical properties of commercially available electrodes. Electrochemical activation methods can be cathodic (which is based on applying a negative potential on the electrode or cycling in the cathodic region) and anodic (applying a positive

potential over a period or cycling in the anodic region). Studies have shown that electrochemically activated electrodes offer better sensitivity, selectivity and lower limits of detection.

In this work, a carbon paste electrode modified with cerium-oxide (CPE/CeO_2) was electrochemically activated and evaluated for the detection of ciprofloxacin (CIP) and ofloxacin (OFL). To the best of our knowledge, electrochemical activation of metal oxide-modified electrodes has not yet been reported in literature. CPE/CeO_2 was subjected to both cathodic activation (held at constant potential -1 V for 100 s) and anodic activation (held at constant potential of 1 V for 100 s) in 0.01 mol/dm^3 H_2SO_4. The ESA of the non-activated electrode was 1.05 cm^2, while the ESAs of pre-anodized and pre-cathodized electrodes were 1.25 cm^2 and 1.61 cm^2, respectively. The activated electrodes were used for recording square-wave voltammograms (SWV) of CIP and OFL. The pre-cathodized electrode yielded the best performance for OFL detection. The current peak of non-activated CPE/CeO_2 for CIP was 5.3453 μA. The anodically activated electrode failed to register a CIP peak in SWV, while the cathodically activated electrode recorded a peak of 6.2121 μA. Concerning OFL, the current peak of non-activated electrode was 1.8870 μA, while the cathodic activation of electrode resulted in a 8.7259 μA current peak. Anodic activation didn't show notable changes in OFL peak current compared to the non-activated electrode. It is evident that electrochemical activation, in this case cathodic treatment, enhances the performance of CPE/CeO_2 electrode for the detection of these fluoroquinolones, especially OFL. Not only do the results show the increase in the EAS and peak current, but they also underline the possible use of electrochemical activation as a post-modification strategy. In contrast, anodic activation showed no improvement in the performance of this sensor.

Keywords: Sensor, modification, antibiotics, cathodization, anodization

Acknowledgement - The research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contract number 451-03-136/2025-03/ 200124, 451-03-137/2025-03/200124)

O-C-8 The comparative evaluation of post-modification activated CPEs modified with MWCNTs, ZrO_2 and Gd_2O_3 for fluoroquinolone detection

Tijana Jovanović[1], Aleksandar Stanojević[1], Boris Stanković[1], Emilija Pecev-Marinković[1], Branka Petković[2], Milica Petrović[1], Ivana Rašić Mišić[1]

[1]University of Niš, Faculty of Sciences and Mathematics, Department of Chemistry, Niš, Serbia

[2] University of Priština in Kosovska Mitrovica, Faculty of Sciences and Mathematics, Kosovska Mitrovica, Serbia

Abstract: Electrochemical sensors are analytical tools that are widely used in a variety of fields, ranging from environment monitoring to health care and food safety. These sensors are highly selective, sensitive, often portable and economic, opposed to conventional analytical methods such as liquid chromatography (LS), mass spectrometry (MS), etc. Electrochemical sensors are commercially available electrodes that have been modified in various ways, because bare electrodes portray low selectivity, sensitivity, slow electron transfer kinetics and a lack of sufficient functional groups interacting with the analyte. Main materials used for modifying electrodes are carbon-based, metal and metal oxide nanomaterials. Another appealing way of surface electrode modification is electrochemical activation – a surface pretreatment technique that includes applying a constant potential on the system or cycling in the anodic or cathodic region of potential. Based on the available literature, there is no evidence of electrochemical activation being done after electrode modification.

This study compares the electrochemical performance of three CPEs modified with ZrO_2 (CPE/ZrO_2), Gd_2O_3 (CPE/Gd_2O_3) and multi-walled carbon nanotubes (MWCNTs), each subjected to electrochemical activation, for the detection of ciprofloxacin and ofloxacin via square wave voltammetry (SWV). The electrodes were activated in 0.01 mol/dm^3 H_2SO_4, by applying a constant potential of 1 V and -1 V for 100 s. The CPE/ZrO_2 electrode had the best response for OFL after being cathodically activated, yielding a peak of 16.3486 µA, which represented a 119% increase in the signal, compared to the non-activated electrode (7.4625 µA). In contrast, the base signal for CIP was 8.4390 µA, but neither anodic nor cathodic activation was beneficial for CIP detection (5.43%, and 39.51% decrease, respectively).

The non-activated CPE/Gd_2O_3 electrode demonstrated a high response to CIP, producing a peak current of 14.9296 μA. Electrochemical treatment proved detrimental, where anodic activation resulted in a 43.29% decrease in the signal, while the cathodic treatment led to a 13.35% decrease. In the detection of OFL, the non-activated electrode yielded a signal of 10.5224 μA. Cathodic activation led to a signal increase of 21.00%. The anodic activation resulted in a 22.63% signal drop, suggesting a negative effect on the electrode's surface reactivity toward OFL.

The signal of the non-activated CPE/MWCNTs electrode for CIP detection was 8.7328 μA. Both the anodic and the cathodic treatments of this electrode yielded in a signal increase for CIP detection, which were 2.53% and 18.54%, respectively. In the case of OFL, the anodic treatment resulted in a 32.71% decrease in current signal, while cathodic treatment resulted in a 6.90% increase in the signal.

This study shows that the choice of modifier and the type of activation influences the sensitivity of CPE-based sensors toward fluoroquinolones. Cathodically activated CPE/ZrO_2 exhibited the highest current response for ofloxacin, while non-activated CPE/Gd_2O_3 showed superior performance for ciprofloxacin. MWCNT-modified electrode exhibited more moderate signals, but responded positively to both activation treatments for CIP detection. These findings highlight the importance of tailoring both the surface composition and activation strategy to optimize sensor performance for specific analytes.

Keywords: nanomaterials, modification, cathodization, anodization, fluoroquinolones

Acknowledgement - The research was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (contract number 451-03-136/2025-03/ 200124, 451-03-137/2025-03/200124)

O-C-9 Production of hydrochar from rice husk by hydrothermal carbonization

A.B.Toibazarova, N.O.Appazov

Korkyt Ata Kyzylorda University, Institute of Engineering and Technology, Kyzylorda, Kazakhstan

toibazarovaaltynkul@gmail.com, nurasar.82@korkyt.kz

Abstract: This study investigates the synthesis and characterization of hydrochar derived from rice husk using the hydrothermal carbonization (HTC) method. Rice husk is an abundant agricultural by-product, and its effective utilization contributes to waste valorization and sustainable materials development.

The objective of the study is to develop and optimize a process for producing hydrochar from rice husk using HTC and to investigate the physicochemical and adsorption properties of the resulting product. The experimental design involved varying temperature (230°C to 800°C) and carbonization time (1–4 hours).

Results demonstrated that the highest carbon yield (41.22%) and iodine adsorption activity (63.37%) were achieved at 800°C for a reaction time of 60 minutes. Hydrochar produced at 800°C showed the most developed porous structure and adsorption characteristics, as confirmed by scanning electron microscopy (SEM) analyses. Increasing the carbonization temperature enhanced the porosity and improved the physical properties of the hydrochar. Elemental analysis revealed an increase in SiO_2 content from 11.59% at 230°C to 25.81% at 800°C, indicating higher ash and mineral content at elevated temperatures.

The synthesized hydrochar exhibited excellent potential as an adsorbent for water treatment and as a component of bio-transformed fuel due to its high surface area, porosity, and carbon content. These findings highlight the benefits of using agricultural waste for producing value-added materials that contribute to environmental protection and resource efficiency.

In conclusion, the proposed HTC process offers an efficient and eco-friendly method for producing hydrochar from rice husk. The approach minimizes environmental impact by recycling agro-waste and provides a high-performance sorbent suitable for water purification applications. Further research is needed to scale up the production process and explore the application of hydrochar in multifunctional environmental and energy systems.

Keywords: hydrochar, hydrothermal carbonization, rice husk, biofuel, sorbent, agricultural waste

Acknowledgements: This work was supported by the Ministry of Science and Higher Education of the Republic of Kazakhstan under the program BR21882415.

O-C-10 Extraction of rice husk and preparation of fatty acid monoglycerides from rice husk extract.

Bekzhan Alimkhan, Nurbol Appazov, Magzhan Bekhozhaev
Korkyt Ata Kyzylorda University, Institute of Engineering and Technology, Kyzylorda, Kazakhstan
mortalbeka@gmail.com

Abstract: This study is dedicated to the integrated processing of rice husk to extract oil-containing components and subsequently synthesize monoglycerides. Rice husk is a by-product of rice processing, characterized by a high content of silica, cellulose, lignin, and wax-containing substances, including oils (1–5%). Using a semi-automatic Soxhlet extractor (ASV–6M), various organic solvents (acetone, hexane, chloroform, ethyl acetate, xylene, and benzene) were tested for oil extraction. Ethyl acetate proved to be the most effective solvent, providing the highest yield of extract—2.82%.

The obtained oil extract was then used for the synthesis of monoglycerides via glycerolysis. In a 500 mL autoclave-type reactor equipped with a stirrer, thermometer, and gas outlet, 50 g of rice oil, 25 g of glycerol, and 0.75 g of catalyst (CaO, NaOH, or KOH) were placed. The mixture was continuously purged with nitrogen through the gas outlet and heated under stirring to 200–240 °C for 4 hours. After the reaction, the mixture was cooled to 160 °C, and 1.25 mL of orthophosphoric acid was added, resulting in the formation of a precipitate. The mixture was further cooled to 85 °C, and the sludge was filtered out. Excess unreacted glycerol was removed by settling at 85 °C for 4 hours, followed by decantation.

The resulting reaction mass, containing approximately 47% monoglycerides, 37% diglycerides, 9% triglycerides, and 7% glycerol, was placed in a 3-liter vessel equipped with a stirrer and heating device, and dissolved at 35–40 °C in 375 g of acetone under stirring. Then, 112.5 g of water was added, the mixture was stirred, cooled to 5–10 °C, and held for 6 hours, leading to the precipitation of di- and triglycerides. The solution was filtered, and the solvents were evaporated; the obtained residue represented the target fraction, which was dried by vacuum distillation and cooled.

After the reaction, the mixture was further purified by column chromatography to remove residual diglycerides and obtain a highly purified product. The chemical composition of the final product was determined using

gas chromatography–mass spectrometry (GC-MS) and infrared (IR) spectroscopy. The monoglyceride content reached up to 93% when KOH was used as a catalyst. The GC-MS analysis was performed using an Agilent 7890A/5975C chromatograph (USA). Chromatographic conditions: carrier gas – helium; evaporator temperature – 325 °C; split ratio – 1000:1; column oven program – initial temperature 50 °C (1 min), temperature ramp 5 °C/min, final temperature 280 °C with 5 min hold, total analysis time – 53 minutes.

IR spectra were recorded on an IR-Prestige 21 spectrometer (Shimadzu, Japan, 2008) in the wavelength range of 400–4000 cm^{-1} without special sample preparation, using a DuraSampl IR II single-reflection ATR attachment (diamond prism on ZnSe base) from Smiths (USA).

The glycerolysis method of rice oil combined with adsorption column separation is effective for producing high-quality monoglycerides. The resulting high-purity product can be used as a functional additive in the food and pharmaceutical industries.

Keywords: extract, rice husk, glycerolysis, synthesis of monoglycerides, diglycerides, triglycerides

Acknowledgements: This research was financially supported by grant No. AP23490056 from the Ministry of Science and Higher Education of the Republic of Kazakhstan.

O-C-11 Battery Emulator built by using RISC Microcontroller architecture

Dimitar Boychev, Blagoy Burdin, Daria Vladikova
Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Sofia, Bulgaria
d.boychev@iees.bas.bg

Abstract: First the main question is why is chosen Reduced Instruction Set Computer (RISC) microcontroller architecture? In this way can be composed the most reliable computer machine. The advantages of this technical solution are a lot. For example the instruction comes undersize of one code word. More over execution takes only one machine cycle. There are relatively more general purpose registers, which can be addressed during execution of the program.

The most important is that the programmer cans track what happened in every step of programmer counter. But applying a RISC architecture microcontroller for solving relatively complicate tasks is limited from lack of multiplication register. For this reason the calculation algorithm has to be adapted for controller architecture. In this way the multiplication has to be represented as repeated addition and division as repeated subtraction like well known. Bearing in mind the above it has to be done an algorithm for solving the every current task. In this work is developed an algorithm for applying PIC microcontroller architecture to generate a reference voltage for regulator of a programmable battery emulator using look-up tables. The regulator is clearly analog. So the emulator is composed of two basic modules – analog and digital. In current work is considered the digital part.

Keywords: Fully programmable Battery Emulator, RISK architecture

Acknowledgements – 2020-2027 "Energy storage and hydrogen energetics (ESHER)" under grant agreement No. DO1-349/13.12.2023.

O-C-12 Porous One-dimensional Carbon Nanostructures Derived from Biomass Wastes as Efficient Pt-free Cathodes for Green Hydrogen Production

*Sara Mahmood Adnan, Eiman. K. Almohannadi, and Kamel Eid**,
Gas Processing Center (GPC), College of Engineering, Qatar University, Doha 2713, Qatar
kamel.eid@qu.edu.qa

Abstract: The rational design of efficient and low-cost Pt-free electrocatalysts is the main bottle neck for the large-scale green hydrogen production via the hydrogen evolution reaction (HER). In this work, we tailored the scalable synthesis and physicochemical merits (i.e., porosity, catalytic, electrical conductivity, and stability properties) of porous one-dimensional nanostructures (i.e., wires, fibers, and tubes) derived from biomass wastes (i.e., cotton and coconut) for the HER. The fabrication process is simple, green, low-energy demand (i.e., low annealing temperature, and atmospheric pressure) and efficient for facile transformation of biomass wastes into value-added

hierarchical porous carbon nanostructures embedded with multiple heteroatoms (P, O, N, B, and F) or metal atoms (i.e., Co, Cu, Mo, Bi, and W) via the impregnation of biomass wastes and then argon-assisted carbonization. This process enables the high-yield synthesis (i.e., up to several grams scale) of ultra-long fibers (CNFs), wires (CNWs), and tubes (CNTs) (≤3 mm) with multimodal porosity, abundant active sites, and a proper surface area (i.e., 150-270 m^2/g). These structural and composition merits promoted the HER activity and durability. Among the heteroatom-doped variants, metal-free oxygen-enriched h-CNFs (O/h-CNFs) exhibited superior activity in acidic media, outperforming boron-, phosphorus-, and fluorine-doped counterparts. Remarkably, O/h-CNFs achieved ~40% of the HER activity of commercial Pt/C (20 wt.% Pt) despite their low oxygen content (2.5 wt.%). Likewise, the performance of Cu/NFs was superior to Co/CNFs, W/CNFs, Mo/CNFs, Bi/CNF, and CNFs, respectively. The obtained current density was above 300 mA/cm^2 with low η_{10} of 154-300 mV, and H_2 production rate of 19.5-25.5 $mol \cdot g^{-1} \cdot h^{-1}$. This work demonstrates the potential of biomass wastes as a sustainable and economical precursor for high-performance HER catalysts, offering a viable pathway toward low-cost green hydrogen technologies.

Keywords: Green hydrogen, hydrogen evolution, Pt-free electrocatalyst, biomass, porous carbon nanostructures

Acknowledgements: All Authores greatly appreciate the Gas Processing Center (GPC) for supporting this research work.

O-C-13 Technologies for the production of activated carbon and features of the raw materials used

Saken A. Kanzhar, Nurlan O. Appazov
Korkyt Ata Kyzylorda University, Institute of Engineering and Technology, Kyzylorda, Kazakhstan
sakenkanzhar@gmail.com

Abstract: Activated carbon is a universal sorbent with high adsorption properties, widely used for purification of gases, steam, and liquids, removal of harmful substances, and water filtration. The production method and quality of raw materials significantly influence the properties of the final product. This

study explores various activation technologies and assesses the influence of different raw materials on the quality of the resulting activated carbon.

The main objective of this research is to identify the most efficient methods for producing activated carbon and to study the influence of different raw materials on its characteristics. The study focuses on the following activation methods: steam-gas, chemical activation, thermolysis, and co-thermolysis. Analytical techniques such as scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR) were employed to characterize the structural and chemical properties of the samples.

The results demonstrate that activated carbon derived from different biomass sources exhibits varying properties. Samples produced from plant waste showed higher porosity, indicating a greater specific surface area and, consequently, higher adsorption capacity. However, samples obtained from manure had a higher ash content, which could negatively affect their adsorption efficiency.

A significant advantage was observed in the co-thermolysis method, where different raw materials were combined during the carbonization and activation process. This method enabled the production of high-quality activated carbon with reduced ash content and enhanced adsorption properties. The synergy between the components in the feedstock resulted in improved physicochemical characteristics of the final product.

This research highlights the environmental and economic benefits of using waste materials, such as agricultural residues and organic waste, for the production of activated carbon. Co-thermolysis, in particular, offers a sustainable approach by enabling the efficient recycling of waste into valuable adsorbents. Moreover, this method supports the development of cost-effective sorbents for industrial and environmental applications, contributing to circular economy principles.

In conclusion, the findings of this study underscore the importance of choosing appropriate activation methods and raw material combinations. Co-thermolysis stands out as an efficient, eco-friendly, and economically viable technology for producing activated carbon with high performance characteristics. Further research will focus on scaling the process and optimizing the parameters for industrial applications.

Key words: activated carbon, adsorption, thermolysis, raw material, co-thermolysis, waste recycling

Acknowledgements: This research was financially supported by the Rector's Grant Project of Korkyt Ata Kyzylorda University.

O-C-14 Metrological aspects of analysis of methyl-mercury in marine sediment and biota

Ava Amideina[a], Anna Maria Orani[b], Sabine Azemard[b], Petko Mandjukov[a]*

[a] Department of Chemistry, South-West University "Neofit Rilski", 66 Ivan Mihajlov Str., 2700 Blagoevgrad, Bulgaria

[b] International Atomic Energy Agency, Environment Laboratories, 4 Quai Antoine 1er, MC 98000, Monaco

*a_amideina@abv.bg

Abstract: Methylmercury (MeHg), one of the most toxic and widely studied marine pollutant. It is extremely toxic and strongly affects, even at rather low concentrations, the human health due to consumption of contaminated seafood. Since the ocean is the biggest Hg sink, MeHg is being permanently monitored in all three main marine environmental media: water, sediment and biota. The most frequently applied analytical technique is based on a modification of EPA Method 1630 (Gas Chromatography – Pyrolysis – Atomic Fluorescence Spectroscopy). This an automated analytical technique is capable to determine ultralow levels of MeHg (ppt range). The complexity of its determination is due to the sample treatment which is not at all a trivial, especially for the sediment and biota matrices. The most particular part of the method is the time – dependent and manually performed ethylation step, integrated in the instrumental measurement which aim is to convert the relatively less volatile species CH_3Hg^+ and Hg^{2+} into highly volatile $(CH_3)(CH_3CH_2)Hg$ and $(CH_3CH_2)_2Hg$, respectively. In such a case, the correct evaluation of Measurement Uncertainty (MU) and its components, as well as some important validation parameters (e.g. LOQ), is a challenging task. The subject of the present study is a statistical approach, based on unbalanced single parameter ANOVA, allowing separate evaluation of the MU contributions related to analytical measurement, calibration and sample preparation procedure. Combining the listed above components with the trueness of the

analytical results estimated using matrix CRMs (certified reference materials) allow obtaining of more precise and realistic estimate of the combined MU of the measurand. Besides the mentioned, the MU contribution due to the moisture content correction of the sample's weight was considered and included in the final combined MU of the measurand. Marine sediment and biota CRMs were employed as a case of study. The KERNEL density method was applied to verify the statistical distributions of the data obtained from instrumental and procedural blanks, calibration standards and matrix CRMs measurements. The proposed approach might be employed for verification / validation of the sample preparation procedure in terms of bias and MU. Gaussian and robust (median based) estimates based on the data obtained from instrumental and procedural blanks measurements were obtained and discussed.

Keywords: methylmercury, trace analysis, QC, measurement uncertainty, LOQ, unbalanced single parameter ANOVA

O-C-15 MP – AES determination of trace elements in waters. Method validation.

*Ava Amideina, Tsvetanka Avramova, Petko Mandjukov**

Department of Chemistry, South-West University "Neofit Rilski", 66 Ivan Mihajlov Str., 2700 Blagoevgrad, Bulgaria

*pmandjukov@abv.bg

Abstract: The quality of the drinking water is strictly regulated to protect public health. Within the framework of EU, it is revised and assured according to the requirements of the Directive (EU) 2020/2184 of the European Parliament and of the Council on the quality of water intended for human consumption. The Directive specifies maximum permissible values (MPVs) for the chemical parameters that could pose risks if present in excessive levels. Most of the MPVs are based on the latest scientific advices from the World Health Organization (WHO) and aimed to ensure safe water for consumption. For some of the chemical parameters, a decreasing of the MPVs, as compared with the previous regulations, is observed. Such concentration levels are hardly

measurable by the commonly used techniques in most of the accredited laboratories for testing drinking waters.

An analytical technique, which can be used as an alternative of the ICP-MS or ICP-OES in the trace element determinations is the Atomic Emission Spectroscopy with Microwave Plasma (MP-AES) as an excitation source. It is a convenient multielement method, far less expensive than ICP-MS and ICP-OES. However, it is less sensitive due to lower N_2 plasma temperature.

The aim of the present study is to reveal the applicability of the MP-AES for direct determination of trace elements in water samples fulfilling the requirements of the Directive (concentration levels within the range of μg L^{-1}). The elements (chemical parameters) of interest are: Al, As, B, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Se, Sb and Zn.

The validation of an analytical method implies providing of evidences for its fitness for the intended application. Considering the low target concentrations and lack of sample pretreatment or matrix effects, the critically important validation parameters are LOQ as well as some related parameters: sensitivity, calibration range, linearity (goodness of fit), instrumental repeatability, measurement uncertainty, selectivity etc. Another validation parameter also important to be evaluated is the robustness of instrumental settings. It can be assessed applying the Plackett-Burman fractional factorial design at two levels. Usually, this approach is applied with respect to the analytical signal as a target function and acceptance criterion based on repeatability expressed as a standard deviation.

An alternative approach for robustness evaluation based on modified experimental design and multiple linear regression is proposed. If certain instrumental parameter is robust, the corresponding regression coefficient would be statistically insignificant. The proposed approach allows to change the target function e.g. to LOQ. Besides this, it allows to perform additional optimization of instrumental parameters being not robust, as well as to perform more detailed statistical analysis revealing additional, usually hidden information.

The outcome of the present study is an optimized analytical procedure, list of the elements which is possible to be determined directly by MP-AES and estimation of necessary pre-concentration magnitude required for the rest of the elements studied.

Keywords: MP-AES, waters analysis, analytical method validation, optimization, incomplete factorial design, multiple linear regression

Section: Physics

O-P-1 Multiferroics- preparation method and physical properties

Svetoslav Kolev[1,2], Tatyana Koutzarova[1], Borislava Georgieva[1], Todor Cholakov[2]

[1]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee, 1784 Sofia, Bulgaria

[2]Neofit Rilski South-Western University, 66 Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria

svet_kolev@swu.bg

Abstract: Multuferroics have long been the object of extensive studies because of their great possibility for applications-permanent magnets, highdensity recording media, microwave devices, in biomedicine, to name but a few. Lately, many researchers' efforts have been focused on the existence of the magneto-electric effect in some hexaferrite systems and the appealing possibility of them being used as single-phase multiferroic and magnetoelectric materials. As indicated by theoretical analyses, the origin of the large magneto-electric effect can be sought in the strong interaction between the magnetization and the electric polarization that coexist in insulators with noncollinear magnetic structures. The hexaferrites' magnetic structure and, particularly, the specific magnetic spin ordering are the key factors in observing magneto-electric phases in hexaferrites. Some of these phases are metastable, which hampers their direct practical use. However, as the hexaferrites' phase diagrams reveal, chemical doping can be used to prepare a number of noncollinear stable magnetic phases. Since the magneto-electric effect has to do with the magnetic moments ordering, it seems only logical that one should study the cation substitutions' influence on the magnetic phase transition temperature. In this paper, we summarize recent examples of advances in the exploration of magnetic phase transitions in Y-type hexaferrites. In particular,

the effect is emphasized by substituting in Y-type hexaferrites the nonmagnetic Me^{2+} cations with magnetic ones and of the magnetic Fe^{3+} cations with nonmagnetic ones on their magnetic properties and magnetic phase transitions. The work deals with the structural properties of and the magnetic phase transitions in a specific Y-type hexaferrite, namely, $Ba(Sr)_2Me_2Fe_{12}O_{22}$.

Keywords: hexaferrie, multiferroics, magnetic properties.

Acknowledgements - The work was supported by the Bulgarian National Science Fund under contract KP-06-N48/5.

O-P-2 Impact of Nutritional Fortification on the Pulsed Photostimulated Luminescence Response of Salts

Aleksandar Krleski[1,2], Kristina Smokrović[3], Ivica Đilović[4], Luka Bakrač[5], Nadica Maltar-Strmečki[3], Ralitsa Stanoeva[1,6]

[1]South-West University Neofit Rilski, 66 Ivan Mihaylov Street, 2700, Blagoevgrad, Bulgaria

[2]Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University in Skopje, North Macedonia

[3]Division of Physical Chemistry, Ruđer Bošković Institute, Zagreb, Croatia

[4]Department of Chemistry, Faculty of Science, University of Zagreb, Zagreb, Croatia

[5]Secondary Standard Dosimetry Laboratory, Ruđer Bošković Institute, Zagreb, Croatia

[6]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee blvd, 1784, Sofia, Bulgaria

krleski@feit.ukim.edu.mk

Abstract: Accurate radiation exposure assessment is crucial in radiological and nuclear incidents, particularly when conventional dosimeters are unavailable. Pulsed Photostimulated Luminescence (PPSL) has emerged as a rapid and efficient method for retrospective dosimetry, utilizing short photon pulses to release trapped charge carriers and produce a measurable luminescent signal. Salts, known for their widespread availability and strong luminescent response to ionizing radiation, have been studied as viable

candidates for PPSL-based dosimetry. Furthermore, the increasing demand for health-conscious nutrition has led to the commercialization of various modified table salts with distinct chemical compositions, presenting an opportunity to examine their impact on luminescence properties.

This study investigates the PPSL characteristics of four different types of sea salts produced by Solana Pag, Croatia. The sample set consists of natural fine-grain sea salt and three nutritionally enhanced variants: one with a 50% reduction in sodium, another enriched with potassium, and a third fortified with calcium and magnesium. PPSL measurements were conducted using a SUERC portable PPSL reader, utilizing red and blue light stimulation to examine variations in luminescent behavior, including differences in signal intensity, detection limits, and fading characteristics over time. The samples were irradiated with doses from 1 mGy to 5 Gy, and their responses were compared to those of unfortified salts. Additionally, the effect of dose rate on the luminescent signal was examined. The minimum detectable dose (MDD) and limit of detection (LOD) were determined for all investigated salts to assess their sensitivity in low-dose radiation measurements.

Significant differences in PPSL sensitivity were observed among the fortified salts, highlighting the influence of chemical composition. Variations in photoionization efficiency and charge detrapping rates were evident, particularly in potassium, magnesium and calcium enriched samples. The dose response and detection limits were analyzed, revealing a strong correlation between fortification and luminescence efficiency. Additionally, differences in signal retention and fading behavior suggest that specific additives enhance or suppress recombination pathways, affecting the stability of the stored luminescent signal. These findings demonstrate that fortified salts, when analyzed with a portable PPSL reader, can serve as effective materials for rapid retrospective dosimetry. The observed differences in luminescent response emphasize the role of compositional modifications in influencing charge trapping mechanisms, contributing to the broader understanding of alternative PPSL dosimeters.

Keywords: Pulsed Photostimulated Luminescence (PPSL), Fortified salts, Retrospective dosimetry, Luminescence efficiency.

O-P-3 Thermoluminescent Properties of Salt-Based Materials Modified by Nutritional Supplementation

Aleksandar Krleski[1,2], Ralitsa Stanoeva[1,3], Ivana Fabijanikj Sandeva[2], Lihnida Stojanovska-Georgievska[2], Margarita Ginovska[2], Hristina Spasevska[2]

[1]South-West University Neofit Rilski, 66 Ivan Mihaylov Street, 2700, Blagoevgrad, Bulgaria

[2]Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University in Skopje, North Macedonia

[3]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee blvd, 1784, Sofia, Bulgaria

krleski@feit.ukim.edu.mk

Abstract: Radiological and nuclear incidents pose a significant risk of exposing the general public to harmful radiation, necessitating the development of reliable emergency dosimetry techniques for triage. In such scenarios, retrospective dosimetry plays a crucial role in assessing radiation exposure, especially when conventional dosimeters are unavailable. Various materials have been explored for their potential use in retrospective dosimetry, including household and naturally occurring substances with inherent luminescent properties. Among these, salts have recently gained attention due to their widespread availability and ability to store radiation-induced signals. As modern lifestyles evolve, along with increasing health awareness and nutritional trends, consumers are increasingly seeking healthier food choices and meal options. Consequently, a variety of modified chloride table salts with enhanced compositions are now widely available on the market.

The objective of this study was to investigate the thermoluminescent properties of fortified nutrient salts and evaluate their feasibility for retrospective dosimetry within the dose range associated with triage scenarios. Additionally, this study aims to establish the relationship between the presence of nutritional supplements in salts and the resulting changes in their thermoluminescent properties. Our investigation focused on the thermally stimulated luminescence (TL) signal present in the samples, including the limit of detection, dose response, reproducibility, and fading. The kinetic parameters, including activation energy, frequency factor, and kinetic order, were analyzed through deconvolution of the TL glow curves. This analysis provided insight into

the charge carrier dynamics and the stability of trapped electrons, which are crucial for understanding the luminescent behavior of the examined materials.

Four distinct types of sea salts produced by Solana Pag Croatia were examined. The sample set encompassed fine sea salt and three distinct fortified sea salts: one with a 50% reduction in sodium compared to regular salt, one fortified with potassium, and one fortified with calcium and magnesium. The measurements were carried out using a Riso TL/OSL DA-20 reader, and the TL investigation was performed under different optical conditions to assess variations in signal detection and spectral response.

Significant radiation-induced TL was observed in all examined samples. The dose response analysis demonstrated a linear relationship over the investigated dose range, indicating consistent and predictable behavior in response to varying radiation doses. The type and concentration of nutritional supplements present in the salt composition played a dominant role in modifying the luminescent response, significantly affecting intensity, peak structure, and signal stability. Additionally, the optical conditions used influenced the TL properties, further contributing to variations in the measured signal.

Keywords: Thermoluminescence, Retrospective dosimetry, Modified salts, Radiation response.

O-P-4 Gelatine - glass microbubbles hydrocolloid as potential medical phantom material in computed tomography

Ginka Exner[1,], Veselina Georgieva[1,2], Yordan Marinov[3], Georgi Tankovski[1], Nikoleta Traikova[2]*

[1]Department of Physics, Faculty of Physics and Technology, Plovdiv University Paisii Hilendarski, 4000 Plovdiv, Bulgaria

[2]UMBAL St. Georgi, 66 Peshtersko Shose Blvd, 4001 Plovdiv, Bulgaria

[3]Georgi Nadjakov Institute of Solid State Physics, Bulgarian Academy of Sciences,
72 Tzarigradsko Chaussee Blvd., Sofia 1784, Bulgaria

*e-mail address: ginka.exner@gmail.com

Abstract: Medical X-ray diagnostic techniques are the most commonly used imaging methods at present. They are constantly evolving, aiming to achieve better image quality with reduced patient dose and increased patient comfort. Image quality is of utmost importance for correct diagnosis and subsequent treatment planning. Since X-rays are ionizing i.e. harmful to humans, the decision whether to use them depends on the benefit - harm balance.

Testing medical equipment is a daily routine in which the dose and the X-ray distribution are checked, where special phantoms are employed. There are some important aspects of each X-ray technique: a) to find the lowest possible patient dose, keeping the good image quality; b) to establish the sensitivity of the technique, especially when new diseases appear, as in the case of COVID-19. Here, instead of instead of acquiring knowledge through direct exposure to patients, tissue replacing materials (for anthropomorphic phantoms) are under development.

In our previous studies, we have shown the ability of using gelatin-based hydrocolloids, made of gelatin and different low-budget fillers, to serve as such materials in computed tomography, CT [1,2]. In fact, many types of fillers are able to mimic soft tissues but very limited number is appropriate for bones and lung tissues. In our investigations, just one, glass microbubbles (GMB), have shown a potential to mimic the lung tissue, with respect to the lung Hounsfield units, being in the range (-650 HU -950 HU). The initially achieved values for a 0.08 g/ml GMB concentration, depending on the X-ray tube voltage, were -191 HU (at 70 kVp) and -214 HU (at 120 kVp). Here we discuss the possibilities to reach lower HU values, at increased the GMB concentration, and we draw the limits of such hydrocolloid as tissue-mimicking material, due to the breakdown of the gelatin hydrogel. We also demonstrate the 3D printability of the GMB hydrocolloid.

Keywords: Computed tomography, medical phantoms, hydrogels

Acknowledgements: This work was supported by the Ministry of Education and Science of Bulgaria (MESB), through the National Research Fund of Bulgaria (research project ”Liquid crystal nanocomposites for applications in photonics, sensors and biomedicine“, No. KP-06-N58/6/2021).

References:

1. V. Georgieva, G. Tankovski, N. Traikova, G. Exner (2025) J. Phys. Conf. Ser., 2952012014
2. G. Tankovski, V. Georgieva, N. Traikova, G. Exner (2025) J. Phys. Conf. Ser. 2952012015

O-P-5 Some physical and physicochemical properties of jelly dessert prepared from gelatin and orange juice

Georgi Tankovski[1], Ivan Bodurov[1], Ginka Exner[1]*
[1]Department of Physics, Faculty of Physics and Technology, Plovdiv University
Paisii Hilendarski, 4000 Plovdiv, Bulgaria
e-mail address: georgitankovski@uni-plovdiv.bg

Abstract: Jellied desserts are extremely popular all over the world. Gelatin is one of the commonly used gelling agents in many of them [1]. It consists of proteins and its amino acids give many health benefits. It is made from animal or fish collagen, derived from their cartilage, bones or skin.

The organoleptic properties, such as taste, smell and touch, of the gelatin desserts depend on the particular recipe, which may include gelatin, fruit juice, sugar or other sweeteners, water, colorants and other ingredients. In fact, the physical and physicochemical characteristics of the final mixture are directly related to the organoleptic properties. Hence, understanding the relationship between the jellied desserts constituents and the specific physical and physicochemical properties would give the possibility to predict the final product's appearance.

In this study we investigate the effects of varying concentrations of gelatin (Bloom 250–260), freshly squeezed orange juice, sugar, and water on pH, electrical conductivity, refractive index, and mechanical properties, including Young's modulus, firmness, and work of deformation under cyclic loading.

The tested jellied desserts were prepared in the following way: first the water was mixed with the juice, and the gelatin was added to the liquid at room temperature. The mixture was left for 10 minutes, so that the gelatin can swell. The mixture was then placed at 60°C on a magnetic stirrer and homogenized at 600 rpm at this temperature for 3 minutes. When the sugar was added and the

mixture was further stirred for another 7 minutes. The final liquid was poured into home-made holders so that cylindrical samples with a diameter of 30 mm and height of 20 mm were prepared for the mechanical tests. The orange juice's pH was 3.64, its sugar content was 10 %, and its conductivity was 3.708 mS, at a room temperature of 21.7^{o}C. Adding water to the juice changes the pH of the mixture to a higher value, which makes it easier to prepare harder gels. Increase in sugar content results in linear conductivity decrease and changes the index of refraction but has no effect on the pH. The increase in gelatin content leads to an increase in the conductivity and in the refractive index. Due to different trends in the monitored properties, the mechanical performance has a complex behavior.

Keywords: gelatin, jelly desserts, conductivity, pH, index of refraction, mechanical properties

M. I. Ahmad, Y. Li, J. Pan, F. Liu, H. Dai, Y. Fu, T. Huang, S. Farooq, H. Zhang (2024) Int. J. Biol. Macromol., 254, 128037

O-P-6 Latest observations with the telescopes of the Astronomical Observatory at the University of Shumen

Dragomir Marchev, Borislav Borisov, Sunay Ibryamov, Teodora Atanasova-Sartliiska, Galina Yordanova, and Alex Georgiev

Shumen University, Faculty of Natural Sciences, Department of Physics and Astronomy,

115 Universitetska Str., 9712, Shumen, Bulgaria,

e-mail**:** d.marchev@shu.bg

Abstract: The work makes a brief overview of the available equipment at the Astronomical Observatory of the University of Shumen. The main emphasis is placed on the observations of interesting objects over the last year. The majority of the objects are variable stars of the symbiotic and cataclysmic type. The campaign of two interesting stars, MWC 560 and T CrB, is reflected. Future plans for observations are shared.

Keywords: Telescopes, Observation, Variable stars and Symbiotic stars,

Acknowledgements - This article was partially funded by projects: RD-08-95/2025 of the Scientific Research Found of Shumen University and Ministry of

Education and Science of Bulgaria (Bulgarian National Roadmap for Research Infrastructure).

O-P-7 Superscaling analysis of inclusive electron and (anti)neutrino scattering within the coherent density fluctuation model

Martin Ivanov[1,2], Anton Antonov[1]

[1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences,
72 Tzarigradsko Chaussee, 1784 Sofia, Bulgaria

[2]Department of Physics, Faculty of Mathematics and Natural Sciences, South-West University "Neofit Rilski", 66 Ivan Mihaylov St., 2700 Blagoevgrad, Bulgaria

m.ivanov@swu.bg

Abstract: The experimental data from quasielastic scattering of electrons and (anti)neutrinos on ^{12}C have been analyzed using a novel scaling variable, ψ^*. This variable is derived from the interacting relativistic Fermi gas model, which incorporates both scalar and vector interactions, leading to a relativistic effective mass for the interacting nucleons. We develop a new scaling function, denoted as $f^{QE}(\psi^*)$, to describe inclusive lepton scattering from nuclei, utilizing the coherent density fluctuation model (CDFM). This model is a natural extension of the relativistic Fermi gas model to finite nuclei. In this study, we derive the scaling function within the CDFM, assuming a relativistic effective mass of $m_N^* = 0.8\, m_N$, and subsequently compute theoretical predictions, which we compare with a large set of experimental data for inclusive (e, e') and (anti)neutrino cross sections. Good agreement with data is found over the whole range of electron and (anti)neutrino energies.

Keywords: lepton-induced reactions, nuclear effects, scaling

Section: Ecology and Environmental Protection

O-EEP-1 Invasive alien freshwater fish species in Black Sea rivers and coastal lakes

Luchezar Pehlivanov, Stefan Kazakov, Tihomir Stefanov, Teodora Trichkova
Department of Aquatic Ecosystems, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria
luchezarpehlivanov@gmail.com

Abstract: The spatial distribution and population status of invasive alien freshwater fish species of EU concern in Black Sea rivers and coastal lakes has been studied in 2024. The survey covered 14 rivers and 9 coastal lakes where three invasive alien freshwater fish species of EU concern (*Gambusia holbrooki, Lepomis gibbosus, Pseudorasbora parva*) have been reported according to the available retrospective data. In wadable river sections with low salinity sampling of fish with electricity has been applied. In standing waters (lakes, marshes, lagoons), as well as in the lowest river section where higher water salinity occurs, fish have been sampled with net tools (seine nets, gill nets, fish traps). The Eastern mosquitofish was found to be presented with abundant populations in all surveyed standing water bodies and in the slow-flowing mouth sections of Black Sea rivers but it was absent in some previously reported locations in partially drying river sections. Both Stone moroko and Pumpkinseed remain common while not abundant species in some large standing water bodies where fish stocking occurred, such as: Mandra Resevoir, Vaya lake, Durankulak lake, Shabla-Ezerets lake complex. Population of the Stone moroko remains existing also in the Stomoplo marsh where artificial stocking with Tench (*Tinca tinca*) was carried out in 1990th. Therefore, the most important pathway for spread of *Lepomis gibbosus* and *Pseudorasbora parva* is most likely the unintentional transfer with stocking material warm water fish species. In many previously reported locations in Black Sea rivers these two species were absent or presented by single specimens. Their presence in some river sections upstream from water reservoirs and downstream the dams can be considered temporary phenomenon resulting from seasonal anadromous fish migrations or passive transfer with released water. Ultimately the relatively stable hydrological conditions seem to be one of the main prerequisites for presence

of constant populations of invasive alien fish species. Significant fluctuations in the water discharge rate and salinity, as well as the low dissolved oxygen content can be considered the main natural factors limiting the distribution of the three target species.

Keywords: Invasive species of EU concern, spatial distribution, coastal lakes, rivers, fluctuations

Acknowledgements: The study has been carried out under the project "Survey of the distribution of invasive alien species of EU concern" funded by the contract № 4561/01.03.2024 with EEA.

O-EEP-2 Development of Asphalt Concrete Production Technologies Using Ash Residues from Thermal Power Plants and Oil Waste

Zhangyl Abilbek[1], Panabek Tanzharikov[2], Koktem Yerimbetov[3], Nurzhan Suleymenov[2] and Saken Seitzhanov[2]

[1]SDU University, Kaskelen, Kazakhstan

[2]Korkyt Ata University, Kyzylorda, Kazakhstan

[3]Kyzylorda "Open" University, Kazakhstan

zhanyl.abilbek@gmail.com

Abstract: Asphalt concrete is widely regarded as the most commonly used material for paving in road construction due to its durability, versatility, and ability to withstand various environmental conditions. However, its production and installation involve significant material and labor costs. The procurement of raw materials, including inert and binding substances required for mixture preparation, constitutes a substantial financial burden. In light of these challenges, it is essential to explore potential cost-reduction strategies by lowering the expenses associated with the material components of the mixture. One promising approach is the consideration of alternative raw materials.

In this context, this study investigates the use of ash dumps and asphalt resinous paraffin deposits (ARPD), collected from the Kyzylorda Combined Heat and Power (CHP) plant. To examine the chemical composition and physicochemical properties of the ash slags, samples were collected from the

Kyzylorda CHP's ash dump. These samples were subsequently analyzed in a certified laboratory following established protocols, which facilitated the determination of their chemical composition, as well as their physical and technical characteristics.

Chemical analysis of the selected ash and slag samples revealed that they predominantly consist of acid oxides, indicating their hydraulic properties. The results of testing the prepared samples demonstrated that, with up to 15% ash and slag content, the strength of the samples increased from 17 MPa (standard) to 18.3 MPa. Furthermore, the frost resistance of the samples remained unchanged, with a resistance level of 15% both with and without impurities.

The phase composition of the ash slags was found to be as follows: quartz (23%), mullite (5%), glass (66%), and coal (6%). This detailed analysis of the qualitative and quantitative characteristics of the ash slags identified potential applications for their use in the production of building materials.

It was concluded that the studied ash slags are effective materials for producing slowly solidifying, cement- and bitumen-containing binders, which are integral to the construction of road surface bases. Laboratory tests indicated that the activity of a cement-slag binder, containing 20 to 50% ash-slag mixture, ranged from 25 to 37 MPa. Notably, the performance of the ash-slag binder as a slow-setting binder surpassed that of conventional binders. Moreover, it was determined that a concrete mixture based on a cement-slag binder could be used for the construction of road surface foundations of various categories. The strength of these foundations was found to range from 2.8 to 14 MPa for a mixture with a composition ratio of 1:5.

Keywords: asphalt concrete, oil wastes, inert and binding materials, ash and slag samples, frost resistance of samples, road surfaces.

O-EEP-3 External moss walls: from the inside out

Gana Gecheva [1,2], Zhana Petkova[3], Stoyan Damyanov[4], Deyana Georgieva[3], Vesselin Baev[1], Mariyana Gozmanova[1], Elena Apostolova[1], Galina Yahubyan[1]

[1]Faculty of Biology, Plovdiv University, Plovdiv, Bulgaria;

[2]Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria

[3]Faculty of Chemistry, Plovdiv University, Plovdiv, Bulgaria;
[4]Shuma Foundation, Sredets, Bulgaria;
ggecheva@uni-plovdiv.bg

Abstract: Moss walls are acknowledged, though not widely, for their urban environmental bene-fits: humidity control, noise reduction, and air filtration. In this pioneering study, three outdoor living moss walls were installed in separate urban green spaces in Plovdiv, Bulgaria. One and five months later, the primary moss species used, Hypnum cupressi-forme, a well-established biomonitor, was analyzed for 12 potentially toxic elements. The content of all measured elements increased, with zinc (Zn) and cadmium (Cd) showing the most significant rises - 17-fold and 3-fold, respectively. The element accumulation is believed to originate from industrial activities related to non-ferrous metals. In addition to accumulating toxic elements, the moss exhibited physiological responses to environmental stress. Total lipids and tocopherols, lipophilic antioxidants produced exclusively by photosynthetic organisms, showed adaptive changes. As a molecular biomarker, the expression of the rbcL gene, which encodes the largest subu-nit of Rubisco, was analyzed and showed a correlation with the Ecological Risk Index derived from the moss wall data. While living moss walls have been used to some ex-tent to enhance urban aesthetics and improve air quality, this study is the first to high-light their potential as tools for air quality monitoring.

Keywords: *Hypnum cupressiforme*; biomonitoring; biomarkers; air pollution

Acknowledgements: This research was funded by European Union-NextGeneration EU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, grant number BG-RRP-2.004-0001-C01.

O-EEP-4 Comparison of the density and biomass of macrobenthic communities from two regions of Marine Antarctic

Lyubomir Kenderov[1], Eli Mincheva[1], Raina Hristova[2]

[1]Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov Blvd., 1164 Sofia, Bulgaria; E-mails: lubomir.kenderov@biofac.uni-sofia.bg, eli_mincheva@uni-sofia.bg
[2]Institute of Oceanology "Fridtjof Nansen", Bulgarian Academy of Sciences, 40 Parvi May Str., Varna 9000, Bulgaria; E-mail; raina_hr_bg@yahoo.com
lubomir.kenderov@biofac.uni-sofia.bg

Abstract: Antarctic benthic communities are distinguished by a remarkable fauna, characterized by high levels of biodiversity and endemism. However, substantial areas of the Antarctic shallow-waters remain insufficiently unstudied. Considering contemporary climate change and the increasing impact of anthropogenic activities, there is an urgent need to advance our understanding of the composition, structure, and functioning of these communities. The present study provides a comparative assessment of macrozoobenthic community density and biomass in two shallow-water regions: Livingston Island (South Shetlands) and Horseshoe Island (Marguerite Bay). Sampling was carried out during the austral summers of 2018/19, 2019/20, and 2022/23 using zodiac boats and the research vessels Betanzos (Chile) and RSV 421 (Bulgaria).

The results indicate that amphipods (Order Amphipoda) constitute the most species-rich and abundant group within the studied marine ecosystems. In terms of biomass, isopods, polychaetes, amphipods, bivalves, and gastropods were identified as the principal contributors. The comparative analysis revealed that macrozoobenthic communities inhabiting the more southerly area (Marguerite Bay) exhibited slightly poorer in species richness relative to those of Livingston Island. Nevertheless, they were characterized by higher biomasses of sea urchins (Class Echinoidea) and holothurians (Class Holothuroidea), suggesting some differences in community structure.

Keywords: Antarctic, marine fauna, bottom sediments.

Acknowledgements: This study was supported by the National Program for Polar Studies, Polar Research Funding (2022/2023), project No. 70-25-30_17.01.2023, and by the Sofia University Research Fund for PhD students (2024), project No. 80-10-148/17.04.2024. We gratefully acknowledge the support of the National Centre of Polar Research, the Bulgarian Antarctic Institute, and the staff of the Bulgarian Antarctic Expeditions. We are also grateful to the Turkish Polar Research Program (TUBITAK MAM Polar Research

Institute) for their support and assistance during the IV Turkish Antarctic Expedition. We express our sincere thanks to Prof. Hristo Pimpirev and Dimitar Mateev for their invaluable assistance and continuous support.

O-EEP-5 Development of a "Compact module for water filtration"

Polvon Sharipov, Khasan Khasanov
Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
inspectormix@gmail.com

Abstract: Nowadays, drinking water is a problem in most countries of the world. In particular, in the Aral Sea region of Uzbekistan, organoleptic, physic-chemical and toxicological indicators of water are changing problematically. In addition, the shortage of drinking water is increasing every year. A three-compact water purification filter has been developed that improves the chemical composition of water in the Aral Sea region, especially in the Khorezm region and the autonomy Republic of Karakalpakstan. This compact module purifies water in three stages. At the first stage, the water is purified from mechanical impurities, such as stones and sand, using quartz sand. At the second stage, water is purified from dissolved salts in the presence of cationite KU-2. At the third stage, water is purified from extraneous odors and tastes using activated carbon.

Local quartz, activated carbon and russian cationite are used to purify water. This water filter is used in households and enterprises. According to technical specifications, the unit filters 36 liters of water per hour. The regeneration process is carried out after filtering every 200 liters of water. This is enough for a week for a small family.

During the regeneration process, a salt solution (1 liter, NaCl 10% solution) is passed through the cation exchange module and is retained in the system for 2 hours. Then drainage is carried out, after which the filter is washed with water twice.

This filter was installed in houses in the city of Urgench, Khorezm region, where samples of unfiltered and filtered water were collected for laboratory testing.

Laboratory analysis of the samples obtained showed that the water composition changed as follows:

taste - from 2 points to 1 point;

odor - from 2 points to 1 point;

pH - level from 7,4 to 6,2;

total hardness - from 10,1 ekv/dm3 to 0,9 ekv/dm3;

total mineralization - from 800 mg/dm3 to 126 mg/dm3;

sulfates $(SO_4)^{2-}$ - from 350 mg/dm3 to 56 mg/dm3;

chlorides $(Cl)^-$ decreased from 240 mg/dm3 to 63 mg/dm3.

That unfiltered water has a high "Total Hardness" indicator, and after passing through a 3-stage filtration module, all the identified indicators decrease. This leads to an improvement in water quality.

To summarize, the three-stage water purification system allows us to get softened high-quality drinking water from the water supply that meets the standards. This is important for improving the health and lifestyle of the population.

Keywords: Compact module, cationite, quartz, activated carbon.

Acknowledgements: This research was funded by the project RP-A2/25 from South-West University “Neofit Rilski,” Blagoevgrad.

O-EEP-6 A new metric for ecological status assessment of standing water bodies in Bulgaria

Emilia Varadinova[1,3], Georg Wolfram[2], Violeta Tyufekchieva[3], Yanka Vidinova[3], Rabia Soufi[3], Monika Grossschartner[2]

[1]South-West University “Neofit Rilski”, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Michailov Str. 2700, Blagoevgrad, Bulgaria,

[2]DWS Hydro-Oekologie GmbH, University of Vienna, Vienna, Austria

[3]Department of Aquatic Ecosystems, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel blvd., 1000, Sofia, Bulgaria,

vidinova@yahoo.com

Abstract: Benthic macroinvertebrates, which include several trophic guilds and consumer levels, permanently present in lentic ecosystems and provide an integrated response to different types of pressure. They could

effectively assess the health of the lake ecology and identify the strength of human disturbances. That's why the macrozoobenthos was chosen as one of the biological quality elements (BQE) required for the classification of ecological status and ecological potential of surface water bodies under the Water Framework Directive (WFD). Several experimental metrics for lakes and reservoirs such as Biotic index for slow flowing waters, Total number of taxa, adjusted variant - Potamal Trophic Index-PETI (part of Feeding Type Index) and % Oligochaeta, have been proposed during the years in the process of the development of a classification system for ecological status or potential assessment of the defined surface water types. The aim of this report is to present a suitable metric for ecological status/potential assessment of the lakes and reservoirs in Bulgaria.

A large-scale survey of representative stagnant water bodies (lakes and reservoirs) on the territory of Bulgaria was conducted. The goal was to develop a relevant type-specific methodology for ecological status assessment of the standing water bodies based on macrozoobenthos. Data from 59 monitoring lake sites sampled between June and September 2020 were collected. The sites represent 13 lake types (excluding the Black Sea coastal lakes' types. The benthic macroinvertebrate collection is performed through an adapted version of the multi-habitat sampling methodology developed on European AQEM/STAR projects in accordance with the standards BDS EN ISO 10870:2012 and EN 16150:2012. The method is regulated by the applicable water legislation Ordinance H-4 (2012, last amended 2023). Sampling took place in the littoral zone of the lakes and reservoirs. Sampling method was comparable to rivers, which means that one composite sample from all representative substrates at the site was taken. In order to identify the most suitable metric, 11 biological indices for lakes and 7 biological indices for rivers were calculated. For each of the metrics, the pressure-response relationship was estimated. We suggest the Bulgarian multi-metric index (BMMI) for lakes, which is an adapted version of the Hungarian Multimetric Macroinvertebrate Index. It consists of three separate metrics: total number of families and the indices Shannon-Wiever biological diversity (H) and Biological Monitoring Working Party (BMWP). This multimetric has been tested for national monitoring purposes of the standing water bodies as early as 2011-2012 as well as in subsequent scientific developments by the team. Class boundaries of the scales for ecological status assessment for each type of water body were determined.

Keywords: water quality, lentic freshwater ecosystems, multimetric, macrozoobenthos, Bulgaria

Acknowledgements: The study was funded by the World Bank through the project “Validation of the typology and classification system in Bulgaria for the ecological status assessment of the surface water bodies in categories “river”, “lake” and “transitional waters” (Grant no. 71 957 35/17.4.2020, DICON-UBA) and by the Executive Environment Agency, MEW, through the projects "Providing data from hydrobiological monitoring of surface waters and biota sampling for analysis of priority substances in accordance with the Order of the Minister of Environment and Waters" (Grants no. 4618/14.08.2024).

O-EEP-7 Macrophyte-Based Assessment of Upland Rivers: Reference Index and Pollution Index

Silviya Stankova[1,2], Gana Gecheva [1,3]

[1]Faculty of Biology, Plovdiv University, Plovdiv, Bulgaria;

[2] Executive Environment Agency, Plovdiv, Bulgaria;

[3]Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria

stankova_1991@abv.bg

Abstract: 32 sites from the Maritsa River catchment area were surveyed during two monitoring campaigns. A Reference Index (RI) and Ecological Quality Ratio (EQR) were calculated according to Gecheva et al. (2013). At 18 sites, representative macrophyte samples were collected for the analysis of 19 elements (Al, As, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, P, Pb, S, W, Zn). A Contamination Factor (for Zn, Cu, Cr, Pb, Ni, Cd) and a Pollution Index according to Soares et al. (1999) were calculated.

The main factor distinguishing the sites is the dominance of the aquatic moss P. riparioides. The inorganic content of the plant samples showed the greatest variation in Pb (over 900-fold), followed by Cd (almost 500-fold), and Cu (over 300-fold). Two sites showed predominantly minimal concentrations of the analyzed elements: the Maritsa River near the village of Raduil (Al, As, Ca,

Cr, Fe, Mg, and Ni) and the Trigradska River downstream from the village of Trigrad (Cd, Co, Fe, K, Na, W, and Zn).

In contrast, the site on the Luda Yana River downstream from the town of Panagyurishte stood out with the highest number of maximum element values—Co, Cr, Mn, Ni, P, and S.

More than half of the studied sites were assessed as being in good to excellent condition/potential during the observation period. Two sites were in very poor condition: the Elshishka River near the village of Apriltsi and the Chinardere River downstream from the village of Topolovo, within the Chinardere protected area.

Based on the calculated Pollution Index, only 6 out of 18 assessed sites showed no or only insignificant impact. The main pollutants identified at the studied river sites were Pb, Cd, Cu, and Fe, which caused extreme pollution at the sites on the Djurkovo and Yugovska Rivers, as well as the Byala, Stryama near the village of Pesnopoy, and Chepelarska River near Kemera.

A comparison between the two indices (RI and PI) shows that most sites receive a lower rating when the Pollution Index is taken into account. The most significant differences were observed at the sites on the Djurkovo, Yugovska, and Byala Rivers.

Keywords: bioindicators; biomonitors; rivers

Acknowledgements: We would like to thank Assoc. Prof. Dr. Violeta Stefanova and Assoc. Prof. Dr. Deyana Georgieva from the Department of Analytical Chemistry and Computer Chemistry, Faculty of Chemistry, Plovdiv University, for conducting the analysis of the plant samples. We also thank Assoc. Prof. Dr. Eli Pavlova-Traykova from the Forest Research Institute, Bulgarian Academy of Sciences, for preparing the maps.

O-EEP-8 Risk Assessment in Oil and Gas Production: A Case Study of the Kyzylorda Region

Zhanqyl Abilbek[1], Panabek Tanzharikov[2], Aidana Nurman[3], Aigul Erzhanova[2] and Nurlybek Akhmetov[2]

[1]SDU University, Kaskelen, Kazakhstan

[2]Korkyt Ata University, Kyzylorda, Kazakhstan

[3]Kyzylorda "Open" University, Kazakhstan

zhanyl.abilbek@gmail.com

Abstract: Currently, the importance of the topic of "health and safety" remains exceptionally high across all sectors of society. The impact of hazardous and dangerous factors on human life, as well as the environment, continues to be a critical issue, particularly in the context of labor activities. The nature of these risks can vary significantly, with factors such as exposure to toxic substances, physical hazards, and even psychological stressors presenting potential threats to both workers and the surrounding ecosystem.

The prevention of such harmful events, and the reduction of the subsequent damage they may cause, necessitates a comprehensive and methodical approach. It is essential to first examine the conditions under which these dangerous situations arise. Such investigations require the gathering of data and the development of strategies aimed at identifying risk factors before they can manifest in harmful outcomes. In this regard, the role of scientific inquiry into labor-related hazards is indispensable. Research focused on improving workplace environments not only mitigates the direct health and safety risks to individuals but also plays a pivotal role in enhancing the broader social and environmental well-being.

In addition to understanding the root causes of these hazards, it is crucial to employ preventive measures and implement effective safety protocols. The use of modern technology, such as real-time monitoring systems and risk assessment tools, has significantly advanced the ability to detect and address potential dangers proactively. Furthermore, legal and regulatory frameworks must be continuously updated to keep pace with the evolving nature of work environments, ensuring that standards for safety and health are always maintained at the highest level possible.

Training and education also play an integral role in the broader strategy for minimizing workplace hazards. Providing workers with the necessary skills and knowledge to recognize, assess, and mitigate risks can significantly reduce the occurrence of accidents and injuries. Moreover, fostering a culture of safety within organizations through leadership commitment and worker participation can reinforce the importance of health and safety protocols and ensure their consistent adherence.

The implications of neglecting health and safety protocols are far-reaching. In addition to the direct physical harm to individuals, there are often

long-term consequences for companies, including legal liabilities, decreased productivity, and damage to their reputation. The economic cost of workplace accidents and illnesses, both direct and indirect, can be substantial. Therefore, a proactive approach to health and safety is not merely a regulatory requirement but also an essential strategy for ensuring the long-term success and sustainability of any organization.

In conclusion, addressing the challenges of health and safety within the workplace is an ongoing and dynamic process. By conducting thorough investigations into the conditions leading to hazards, implementing cutting-edge preventive measures, and fostering a strong safety culture, significant progress can be made in safeguarding human life and the environment. Such efforts are not only necessary for the immediate protection of workers but also for the creation of a sustainable and ethical approach to labor across all sectors.

Keywords: health and safety, risk prevention, hazardous factors, labor activities, environmental impact, occupational safety

O-EEP-9 Impact of coal fired power plant activity on the ecological status of the river ecosystems: Case study of Sokolitsa River, Bulgaria

Vanina Mitseva[1], Tsvetelina Isheva[2], Mila Ihtimanska[1], Emilia Varadinova[1,2]

[1]South-West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2]Department of Aquatic Ecosystems, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel blvd., 1000, Sofia, Bulgaria,

vanim@abv.bg

Abstract: Aim: The study presents a negative change (deterioration) in the ecological status of the affected Sokolitsa River, tributary of Maritsa River as a result of the coal fired power plant (CFPP) pollution.

Materials and methods: In 2023 and 2024 monitoring was carried out before and after discharges of waste water from the facilities of CFPP "Contour Global Maritsa East 3" in the affected Sokolitsa River, including biological quality elements Phytobenthos and Macrozoobentos, the basic physico-chemical parameters (t°C, pH, dissolved oxygen (mg/l), electroconductivity (µS/cm), nutrients (mg/l)) and some parameters, indicative for water pollution from CFPPs as sulphates(mg/l) , calcium (mg/l), and calcium carbonate hardness (mg CaCO3/l).

Results: A relation between the high values of the analyzed pollutants in the studied Sokolitsa River after the CFPP facilities and the deterioration of the ecological status (biological quality elements, basic physico-chemical parameters and added indicative parameters of the studied Sokolitsa River was established.

Conclusion: The CFPPs activities in Sokolitsa River catchment change in a negative aspect the characteristics of the aquatic habitats and reduce the taxonomic richness of the benthic communities, as well as supporting aquatic parameters. The established changes cause deterioration of the ecological status of the studied aquatic ecosystems.

Keywords: CFPP, surface water pollutants, benthic communities, ecological status.

O-EEP-10 Herpetofauna in the Northwestern Foothills of the Pirin Mountains

Emanuil Mitrevichin[1], Lidia Sakelarieva[1], Hristo Peshev[1,2], Krasimir Stoyanov[1], Galina Bezinska[1], Alexander Pulev[1]

[1]South-West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2]Fund for Wild Flora & Fauna, 49 Ivan Mihaylov Street, Office 327, P.O. Box 78, Blagoevgrad, Bulgaria

mitrevichin.emanuil@gmail.com

Abstract: The study was conducted between March 2021 and March 2024. Its main aim was to determine the distribution, abundance, and certain population characteristics of reptile and amphibian species inhabiting the study

area. Additionally, threats to the species observed were recorded. Eight amphibian and ten reptile species were documented in the study area: *Salamandra salamandra*, *Bombina variegata*, *Bufo bufo*, *Bufotes viridis*, *Hyla arborea*, *Rana dalmatina*, *R. graeca*, *Pelophylax ridibundus*, *Emys orbicularis, Testudo hermanni*, *T. graeca*, *Lacerta viridis*, *Podarcis erhardii*, *Dolichophis caspius*, *Platyceps najadum*, *Zamenis longissimus*, *Natrix natrix*, and *N. tessellata*. The amphibians registered represent approximately 35% of all amphibian species in the country, while the reptiles account for about 26% of the national total. Altogether, the 18 species comprise around 29% of Bulgaria's herpetofauna. Most of the species (83%) are characterized by a high national conservation status. *Testudo hermanni*, *T. graeca*, *L. viridis*, and *P. erhardii* had the widest distribution within the study area. Furthermore, *T. hermanni*, *L. viridis*, and *P. erhardii* were found to be the most abundant species, along with *B. variegata*. In contrast, *Z. longissimus*, *B. viridis*, *N. tessellata*, *E. orbicularis*, and *R. graeca* were poorly represented. Road traffic was identified as the most significant threat to the local herpetofauna. Beyond incidental factors, this threat may be partly linked to negative attitudes held by some residents toward amphibians and reptiles.

Keywords: Reptilia, Amphibia, threats, population characteristics, Balkans

O-EEP-11 Remote sensing based burn severity mapping and assessing post-fire impacts on forests vegetation in three cases of forest fires in Bulgaria

Miroslav Ivanov[1], Georgi Manolev[2], Veselina Dalgacheva[1]

[1]South West University Neofit Rilski, Blagoevgrad, Bulgaria, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2]Independent researcher

m_ivanov@swu.bg

Abstract: The main idea of this research is to evaluate the possibility to use satellite composite indexes to evaluate the severity of the forest fires and the extent of the fire damages. Burn severity strongly depend on the fuel type

and the vegetation cover and influences post-fire vegetation, soil erosion, and wildlife populations in the areas affected by the forest fires. Because of that, maps of burn severity generated form satellite images can be useful tool in managing the fire fighting and the post fire restoration and forest managing practices. The most popular remote sensing index for assessment of burn severity is the NBR (Normalized Burn Ratio), therefore in this research NBR is used to assess the burn severity in three cases of forest fires occurred in Bulgaria between 2017 and 2024 based on the values of the differenced Normalized Burn Ratio (dNBR) derived from the pre- and post-fire Landsat TM/ETM+ data. Vegetation cover strongly influence the fire behavior and the severity itself, because of that a maps of the vegetation cover and the land cover types for each fire case have been done. The analysis of the results disclosed a strong relation between the variation of burn severity and the different types of vegetation cover. Additional to the burn severity mapping post-fire impact on the vegetation cover in the fire affected area has been done. The results indicated that the dNBR can be used as an effective means to map burn severity in different ecosystems and also it can be used as fast and cost effective alternative to the traditional methods for mapping and evaluation of the fire damages, which depend on *in situ* measurement and subjective evaluations.

Keywords: Satellite images, forest fires, remote sensing, Normalized Burn Ratio

O-EEP-12 Remote Sensing based assessment of water quality in the Nador lagoon, Morocco

Miroslav Ivanov[1], Emilia Varadinova[1], Veselina Dalgacheva[1], Ouiam El Mekki[2], Konstantin Tuefekchiev[1]

[1] South West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2] Laboratoire de la Lagune Marchica de Nador pour les Sciences Bio-Géo-Physique et Environnement (LOLMAN-BGPE), Faculté Pluridisciplinaire de Nador, Université Mohamed Premier-, Maroco

m_ivanov@swu.bg

Abstract: The main goal of this article is to compare the remote sensing and the *in-situ* measured data in order to check if the Sentinel 2 satellite images and the Case-2 Regional Coast Colour (C2RCC) MSI can be used as an instrument for ecological status assessment of stagnant water bodies instead of the traditional method for monitoring. The area of interest in this study is The Nador Lagoon, which is the most imposing lagoon expanse within the Moroccan territory and the second largest in the North African after the El Bidan Lagoon in Tunisia. It is oval shape lagoon with length of the longer axe up to 25 km and enclosed an area of 115 square kilometers with maximum depth of 8 meters. One indicator for the trophic status of the lagoon has been compared the - chlorophyll a. The in-situ measurements include field measurements in 18 locations along the Nador lagoon executed on 09.05.2023, 22.02.2023, 09.08.2023 and on 22.12.2023 the satellite data used in this research consists of three Sentinel 2 satellite images acquired on 05.05, 02.08 and on 22.12.2023. Due to the 4 day repeat cycle of the Sentinel 2 the time difference between in situ sampling and the satellite images are up to 4 days. The SeNtinel Application Platform – SNAP (9.0) and Case-2 Regional Coast Colour (C2RCC) MSI operator are used for the determination of the concertation of the chlorophyll -a and due to the high turbidity of the waters in the lagoon C2X neural networks are also applied. Comparison between the results from in-situ measurements and the satellite drived data show good corealtion between the values of the chlorophyll a and it proved that the use of satellite data is fast and is promising method for ecological monitoring and assessment that can be used as a cost effective alternative to the traditional methods for monitoring.

Keywords: Satellite images, chlorophyll a, ecological monitoring, remote sensing.

O-EEP-13 First Records of Autumn Activity of *Xerotyphlops vermicularis* (Merrem, 1820) (Reptilia: Typhlopidae) in Bulgaria

Alexander Pulev, Lidia Sakelarieva, Krasimir Stoyanov, Emanuil Mitrevichin

South-West University “Neofit Rilski”, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria
pulev.alex@abv.bg

Abstract: In Bulgaria, only one species from the family of Blind Snakes (Typhlopidae) occurs—the Eurasian Blind Snake (*Xerotyphlops vermicularis*). The species is nocturnally active and exhibits a subterranean lifestyle. In general, the seasonal activity of the Eurasian Blind Snake differs substantially from that of other snake species in Bulgaria. The active season begins in mid-April and is short—lasting only five months. Active individuals can be found under stones in April and May. In June and July, they are observed on the surface at night and dusk, but some individuals could also be found under stones. In August, they may still be encountered at night and under stones, though very rarely. By late summer, they retreat deep into the soil and are no longer observable on the surface. This behavior may be related to changes in weather conditions, particularly increasing drought. In the present study, we recorded specimens of the species in autumn for the first time in Bulgaria—three times in September and once in October. All snakes were found road-killed in the Kresna Gorge. The absence of previous records during the autumn months (September, October, and November) might be partly explained by the secretive lifestyle of the species. Despite these new observations, it can be suggested that the autumn activity of the species remains very rare.

Keywords: Serpentes, Eurasian Blind Snake, period of activity, phenology, Balkans

O-EEP-14 New Records of Winter Activity of *Mediodactylus kotschyi* (Steindachner, 1870) (Reptilia: Gekkonidae) in Bulgaria

Alexander Pulev[1], Lidia Sakelarieva[1], Krasimir Stoyanov[1], Hristo Peshev[1,2], Daniel Bisset[3], Emanuil Mitrevichin[1]

[1]South-West University “Neofit Rilski”, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria
[2]Fund for Wild Flora & Fauna, 49 Ivan Mihaylov Street, Office 327, P.O. Box 78, Blagoevgrad, Bulgaria
[3]Independent researcher
pulev.alex@abv.bg

Abstract: Until 2018, it was believed that only one species of Bent-toed Gecko occurred in Bulgaria, with three subspecies: *Mediodactylus kotschyi bibroni*, *M*. *kotschyi rumelicus*, and *M*. *kotschyi danilewskii*. Following the work of Kotsakiozi et al. (2018), *M*. *kotschyi danilewskii* was elevated to species rank, bringing the number of gecko species in the country to two. In Bulgaria, one of these two species—*Mediodactylus kotschyi*—is found in south-western Bulgaria (ssp. *bibroni*) and the Upper Thracian Valley (ssp. *rumelicus*). The territory of Bulgaria lies at the transition between a temperate continental and a continental–Mediterranean climate. It is characterized by pronounced seasonality and a significant annual temperature range (over 20°C). Within the country, *M. kotschyi* is usually active from mid-March to early November. Outside of the active season, during the climatic winter period (December, January, and February), the species has only been recorded once—on January 18, 2007, in the city of Plovdiv (ssp. *rumelicus*). The present study reports three new cases of winter activity of *M. kotschyi* in Bulgaria. All three occurred in south-western Bulgaria (ssp. *bibroni*) in February (on the 6th, 7th, and 21st) of 2021, at temperatures ranging from 11.5 to 17.5°C. Unlike some other reptile species that exhibit winter activity in the country, *M*. *kotschyi* has been observed extremely rarely during this period. This unusual winter activity may be partly explained by meteorological conditions. The winter of 2020–2021 was relatively warm, with average seasonal temperatures above normal (+3°C for the season). During the three observations, temperatures were relatively high or unusually high for the time of year. This winter activity may also be partly due to the species’ synanthropic nature and its tendency to overwinter in buildings within human settlements.

Keywords: Kotschy’s Gecko, ecology, seasonal activity, Balkan Peninsula

O-EEP-15 Trail cameras based estimation of the brown bear (*Ursus arctos* Linnaeus, 1758) density in one isolated part of Rila National Park

Miroslav Ivanov[1], *Georgi Manolev*[2], *Veselina Dalgacheva*[1]

[1]South West University Neofit Rilski, Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2]Independent researcher

m_ivanov@swu.bg

Abstract: The Brown bear (Ursus arctos, Linnaeus, 1758**)** is one of the most iconic species in Bulgaria which population size is subject of numerous discussions in the recent years. The approved monitoring methodology used by the Environment executive agency provided so far controversial data about the important for the species management indictors such as population size and density. On the other hand recently trail cameras have modernised the way of studing wildlife and present an opportunity for non-invasive monitoring with data collection without humans being present. Because of that in this article a different approach of monitoring and the density estimation of the brown bears population has been presented. The presented methodology of population density estimation is based on trial camera data collected in one isolated part of Rila National Park and the application of method without the need for individual recognition proposed by Rowcliffe in 2008 – the random encounter method. Based on the trail cameras data the results show that in the area of research can be observed a steady number of brown bears and high population density which is most likely due to the rich food base and luck of disturbance because of the high protection status of the research area.

Keywords: Brown bears, population density, ecological monitoring, trail cameras.

O-EEP-16 Comparative analysis of the production and technological potential of the Stanushina variety under the condition of organic/intensive cultivation

Aleksandar Klincharov
South West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences, Department of Geography, Ecology and Environmental Protection, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria
aceklincarov@gmail.com

Abstract: The text should be between 400 and 500 words. Abstracts must be written in English language. Font – Times New Roman; paper size – B5; margins: top - 2 cm, bottom -3.5 cm, left - 2.8 cm, right - 1.2 cm; line spacing – 1,5 lines; body text (12 pt); name, family name - 12 pt, centered; author's affiliation - 10 pt, centered. The name of the presenting author should be underlined.

The Tikvesh vineyard is a region in Republic of North Macedonia where the production of grapes end wine prevails. This wine region covers almost 45% of the territory of the country. At the same time, 87% of the total area with vineyards located in this wine region and 85% of the wineries are concentrated precisely here.

Stanushina is a well-known autochthonous grape variety in the Republic of North Macedonia, which representation is generally in the Tikvesh vineyard (with an area of about 250 ha), while in the rest of the vineyards are very rare and could be mainly found as sub-vines. Besides conventional production, today in Macedonia and the world trend is to encourage the production of organic grapes. The aim of our research is to determine the production and the technological potential of the autochthonous variety vineyards in Macedonia, Stanushina, which are cultivated in an organic way. For this purpose, an organic plantation" Popova Kula winery" established in 2005, with an area of 1,5 ha and altitude of 180 m situated at the Demir Kapija locality was used.

The following parameters were studied: fertility rate, yield, technological characteristics of the variety (bunch mass, chemical composition of must, organoleptic evaluation of the resulting wine). The obtained parameters were compared with the conventional one plantation of the Stanushina variety.

Determination of the difference between two types of planting of the Stanushina variety and the justification for expanding it to reveal the advantages of the organic grape production was done.

Keywords: Tikvesh vineyard, Stanushina, fertility, yield, technological characteristics, organic production.

Section: Geography

O-G-1 Spatial Analysis of Employment and the Working Poor

Aleksandra Ravnachka[1,2], Velimira Stoyanova[1], Boris Kazakov[1], Poli Roukova[1], Emilia Patarchanova[2]

[1]National Institute of Geophysics, Geodesy and Geography at Bulgarian academy of sciences, Sofia, Bulgaria

[2]South-West University „Neofit Rilski“, Blagoevgrad, Bulgaria

Corresponding author: ravnachka77@gmail.com

Abstract: In recent years, the phenomenon of the “working poor” has been the focus of scientific research, as well as an important element of national employment and social development policies. Two conditions are necessary for a person to be defined as a “working poor”: to be employed (full-time or part-time) and to be part of a household with an income below 60% of the median annual income. A complex of factors influence the impoverishment of the working population, which can be grouped as follows: the quality of employment and the respective wages, and on the other hand – the total household income, and the ratio between the number of persons and the working persons in that same household. The employed may earn more than the minimum wage, but their labour income, distributed among household members, may place each household member below the poverty line (determined based on EU criteria).

In recent years, the National Statistical Institute (NSI) has registered a trend of increasing number of working poor in Bulgaria, with their relative share also increasing from 8% in 2010 to 12% in 2023. In economic research, the low

labour income of the working poor is explained by low levels of productivity (Angelova, R. et al., 2020). According to NSI research on income and living conditions, the increasing number of working poor is usually associated with low labour remuneration in a number of economic activities producing goods and services with low added value. The overwhelming majority of the working poor are mainly engaged in the following classes of occupation: personnel engaged in public services, trade, and security; skilled workers in agriculture, forestry, hunting and fishing, and professions requiring no special qualifications (Angelova, R. et al., 2020). Education and professional qualifications of the employed, the quality of jobs, the productive employment, and the wages, are key factors in the formation of the "working poor" contingent.

Regional demographic and socio-economic differences determine regional differences in the quality of the workforce, the labour market, the type of jobs, wages, household size, etc. The spatial analysis of employment in the context of the working poor reveals the regional specifics, the dynamics of manifestation, and the scale of influence of the above-mentioned factors at different regional levels. The spatial analysis thus allows to determine and outline critical regions in the country.

This study aims to clarify the spatial differences of those employment characteristics that have a direct effect on the growth of the "working poor" contingent. The current state and trends in employment have been revealed, and a spatial analysis of the qualitative characteristics of employment and jobs at the regional level has been done. The obtained results are visualized using GIS.

Keywords: spatial analysis, employment, working poor, quality of jobs, wage.

Acknowledgements: Project "Regional Employment – Working Poor in Bulgaria"; Contract № КП-06-Н85/2024 NSF of Bulgaria – Ministry of Education and Science.

O-G-2 Health status and integration of the Roma into the healthcare system of Bulgaria

Boris Kazakov[1], Aleksandra Ravnachka[1,2], Velimira Stoyanova

[1]National Institute of Geophysics, Geodesy and Geography at Bulgarian academy of sciences, Sofia, Bulgaria
[2]South-West University „Neofit Rilski“, Blagoevgrad, Bulgaria
Corresponding author: boriskazakov1@gmail.com

Abstract: The paper focuses on some common issues concerning the health status and the access to healthcare services of the Roma in Bulgaria in general, as well as the results from a survey conducted among residents of the city of Plovdiv, Lom, Kyustendil, Straldzha, Ruse, Asenovgrad, Dobrich and Razlog. The survey is based on a general questionnaire designed to establish the level of social integration of the respondents, where part of the questions focuses on the respondents' health status and the access to healthcare. The main objective of the study is to assess the specific features of the health culture of Roma, as well as their integration into the healthcare system of the country. In order to do that, various national and international survey reports have been used, together with a field survey among the residents of a selected Roma community. The results show that the estimation of the number and share of Roma citizens with no health insurance is practically impossible, since no such data based on ethnicity is collected in Bulgaria. The most probable figure of uninsured Roma is around 1/3rd of all, although the discrepancies between the different sources are sometimes significant. The results show that the Roma health status is deteriorated, regardless of being the youngest population group in the country and the relatively easy access to a general practitioner . Cardio-vascular diseases, diabetes, hepatitis, and some parasitic diseases are the most common. Home self-treatment is common, which has to do with both health culture and lack of health insurance. The main issue remains the higher percentage of uninsured persons compared to the national average, as well as some cultural specific of the Roma, which hinder the improvement of their overall health culture.

Some serious contradictions have been established regarding the survey results on the one hand, and the opinion of health mediators and the GP interviewed for the purposes of the study. However, the overall health culture of the Roma in studied community is slowly improving.

The Roma in Bulgaria are different in terms of level of integration: subgroups; urban or rural; level of exposure to the macro-society; religion;

attained educational level; economic status, etc. Therefore, the solving of their problems requires a differentiated approach.

Keywords: Roma community, health, field survey, Harman Mahala quarter.

Acknowledgements: The study has been conducted as part of a project titled “Spatial models of the Roma ghettoized urban structures in Bulgaria”, funded by the National Scientific Research Fund of the Republic of Bulgaria, Grant №КП-06 Н65/7 – 12.12.2022.

O-G-3 Social policy and the working poor in the context of regional demographic characteristics in Bulgaria recently

Gergana Nikolova, Emilia Patarchanova, Alexandra Ravnachka, Miroslav Ivanov, Vasil Pandurski, Boris Kazakov

South-west university “Neofit Rilski” Blagoevgrad, Bulgaria

e-mail address of the corresponding author: gerganani kolova@swu.bg

Abstract: The management and solution of social issues and problems is directly related to the regulation of social relations arising and existing in connection with them. This regulation is implemented through the constitution and implementation of social policy. Social policies include complex social processes in themselves. They can be considered in two aspects. In the first aspect, social policies deal with the problems of satisfying the diverse needs of people, and in the second aspect, social policies are considered from the point of view of people's lifestyle, related to their quality of life. Social policies also contain a practical focus, which is expressed in improving the individual and collective lifestyle of people. Policies in the social sphere study the elements and track the processes taking place in it. A key interest for social policy is the study and regulation of social inequalities in a regional aspect. Poverty is one of the most significant social problems. This social problem leads to a sharp decrease in income, a decrease in purchasing power, a decrease in savings, a decrease in birth rates, an increase in mortality rates, and health problems. The level of poverty is directly correlated with the levels of socio-economic inequalities, which are also one of the main factors determining the deepening of poverty. Ensuring access to services, and above all – access to basic health, educationand

social services, is another key tool for overcoming the consequences of poverty. It is precisely access to education and health that is crucial for the prevention of social security. Low levels of education are one of the main factors determining poverty and social insecurity. Therefore, equal access to education for all children, regardless of their social status, ethnicity and specific needs, is of key importance for the prevention of social security. In this regard, the main challenges in this area are related to reducing early school leaving, ensuring equal access of vulnerable groups, including vulnerable ethnic groups and children with disabilities, to quality education in a general education environment.

Keywords: social sphere, social policy, regional policy, poverty, unemployment

Acknowledgements: Project "Regional Employment – Working Poor in Bulgaria"; Contract № КП-06-Н85/2024 NSF of Bulgaria – Ministry of Education and Science.

O-G-4 Mapping and spatial analysis of vertical relief reshaping in the landslide near the village of General Geshevo (Eastern Rhodopes)

Alexander Gikov[1], Stelian Dimitrov[2], Martin Iliev[2]

[1]Space Research and Technology Institute – Bulgarian academy of Sciences, Sofia, Bulgaria

[2]Sofia University "St. Kliment Ohridski", Sofia, Bulgaria

e-mail address of the corresponding author: gikov@abv.bg

Abstract: For the purpose of mapping and spatial assessment of vertical deformations of large-scale landslides structure (160 ha) located near the village of General Geshevo in the Eastern Rhodopes region, Bulgaria an integrated approach was used with the application of various geoinformation technologies. The evaluations and the mapping itself were carried out by means of different types of generated digital terrain models (DTMs), reflecting the dynamics in the development of the structure over a long period of time. Data from airborne laser scanning (LIDAR) based on an unmanned aerial vehicle platform have been

used to produce a very detailed modern DTM. The complex geospatial analysis of the different digital terrain models shows that as a result of the landslide, significant vertical deformations occurred in the study area. The results of the present study demonstrate the enormous possibilities of modern geoinformation technologies to integrate and analyze various data, approaches and methods, which provides the necessary tools for conducting long-term precise monitoring of territories affected by risk processes, including landslides.

Keywords: LiDAR, Unmanned aerial systems (UAS), Digital terrain models (DTM), Landslides.

O-G-5 Integrating GIS in Water Resources Governance for Regional Sustainability: A Case Study from Blagoevgrad Province, Bulgaria

Galina Bezinska, Siyka Keseva, Krasimir Stoyanov
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
e-mail address of the corresponding author: galinabezinska@swu.bg

Abstract: Effective governance of water resources is a cornerstone of long-term regional sustainability, particularly in territories characterised by complex geography, uneven resource distribution, and sectoral competition for limited supplies. The Blagoevgrad Province, located in south-western Bulgaria, is a region characterised by mountainous terrain, transboundary river basins, and fragmented infrastructure. Collectively, these geographical features pose significant governance challenges. In this context, Geographic Information Systems (GIS) offer an integrative framework for addressing spatial mismatches, enhancing institutional coordination, and supporting sustainable planning practices.

The present study proposes a GIS-based multi-criteria approach to assess and support water governance processes at the regional level. The objective of the research is to facilitate a more effective connection between hydrological realities and administrative decision-making through the utilisation of spatial analysis. The integration of multiple datasets was performed using ArcGIS Pro, encompassing digital elevation models, river networks, land cover (CORINE),

water abstraction and consumption statistics, and municipal boundaries. A Multi-Criteria Evaluation (MCE) framework was applied, incorporating indicators such as agricultural water demand, ecological sensitivity, infrastructure gaps, and exposure to hydrological hazards.

The results indicate that a number of municipalities encounter a significant discrepancy between water demand, notably for irrigation purposes, and supply. This is compounded by inadequate infrastructure and constrained monitoring capabilities. Furthermore, a significant proportion of urbanised areas are located within flood-prone zones, thereby increasing their vulnerability to climate-related risks.

Beyond delineating physical resource constraints, the study emphasises institutional fragmentation, characterised by misalignment between governance and hydrological boundaries, impeding effective coordination between municipalities, basin authorities, and other stakeholders. This underscores the significance of spatial analysis not only for environmental assessment but also for enhancing governance structures and collaborative planning.

The proposed GIS-based framework contributes to the operationalisation of Integrated Water Resources Management (IWRM) at the regional level. It is transferable to other regions facing similar ecological and administrative complexity. The enabling of spatial prioritisation, scenario development, and inter-institutional dialogue is indicative of GIS's potential to function not merely as a technical mapping tool, but as a platform for strategic governance, adaptive management, and sustainable regional development.

Keywords: GIS, water governance, multi-criteria analysis, regional sustainability, Blagoevgrad, environmental planning

O-G-6 GIS and Internet of Things

Matija Milić
Faculty of Sciences and Mathematics, Niš, Serbia
e-mail address of the corresponding author: matija.milic@pmf.edu.rs

Abstract: GIS (Geographic Information Systems) represents a powerful set of tools for collecting, storing, retrieving, transforming, and displaying

geospatial data. It consists of hardware, software, data, and personnel who manage GIS. The core purpose of GIS is to make spatial data usable, that is, to generate information from it that serves decision-making processes. GIS is applied in fields that deal with space in any form, such as geosciences, geodesy, forestry, agriculture, environmental protection, tourism, medicine, and others. The Internet of Things (IoT) refers to a system that connects a network of physical objects such as sensors, computing devices, and software, enabling the transfer of data to other systems without human-to-human or human-to-computer interaction. Empowered by the latest advancements in information and communication technologies (ICT), the Internet of Things is revolutionizing the world, opening new possibilities and offering solutions that were unimaginable just a few years ago. The IoT concept is multidisciplinary as it combines a wide range of technologies, protocols, applications, scenarios, and disciplines. The Internet of Things offers unlimited opportunities for both producers and service users. The connectivity between objects and the ability to collect vast amounts of data in real time have made the IoT extremely efficient. On the other hand, GIS contains a foundation of data collected through IoT devices and digital maps. This paper critically examines the connections between GIS and IoT systems, specifically their integration. The primary goal of the research is to highlight the nature of the relationship between GIS and the Internet of Things, as well as their joint applications in various areas of life, such as urban planning, environmental monitoring, disaster management, agriculture, transportation, healthcare, and more. The research is based on recent scientific literature concerning the interdependence of GIS and the Internet of Things. In this paper, descriptive, analytical-synthetic, and textual methods were applied.

Keywords: GIS, Internet of Things, convergence, crossbreeding, application

O-G-7 A socio-geographical analysis of demographic aging in Bulgaria and Italy at the nuts II level

Dimitar Simeonov

"St. Cyril and St. Methodius" University of Veliko Tarnovo, Department of Geography

e-mail address of the corresponding author: simeonov@abv.bg

Abstract: Demographic aging is among the most critical issues facing society in the coming decades, reflecting increased life expectancy, declining fertility rates, and the progression of large population cohorts into older age groups. Aging will thus become the dominant demographic trend of the 21st century, signaling profound health, social, and economic challenges. Addressing this globally significant issue should therefore be prioritized among political, economic, and academic stakeholders. The aim of this research is to perform a socio-geographical analysis of demographic aging comparing Bulgaria and Italy. The chosen methodological approach is comparative analysis, and the study covers spatial units at the NUTS II level in both countries. The foundation of the research integrates knowledge on spatial aging with the socio-geographical dimensions of demographic aging, seeking to provide an in-depth analysis and contribute solutions to the increasingly complex demographic challenges. Findings from classical and contemporary studies are complemented by insights from our previous demographic research on this topic. An international overview serves as a conceptual introduction, while the empirical section emphasizes specific characteristics of demographic aging. The study's applied focus is reflected in its effort to visualize contemporary trends in the regional aging profiles of Bulgaria and Italy.

Keywords: demographic aging; socio-geographical analysis; NUTS II spatial level; Bulgaria; Italy

O-G-8 Heavy metal content in bottom sediments of the Arda River basin upstream of the Kardzhali Dam

Zornitza Cholakova

Sofia University "St. Kliment Ohridski", Faculty of Geology and Geography, Sofia, Bulgaria

e-mail address of the corresponding author: cholakova@gea.uni-sofia.bg

Abstract: The paper highlights the importance of bottom sediments as a key indicator of the quality of water bodies in surface river basins. The focus of the study is the Arda River catchment basin, from its source to its confluence

into the Kardzhali Dam. The aim is to track the dynamics and spatial distribution of five elements—heavy metals and metalloids (potentially toxic elements): As, Cd, Zn, Cu, and Pb—in the bottom sediments of the catchment area.

Field sampling was conducted at a total of 30 locations along the main river and its primary tributaries up to the point of confluence with the Kardzhali Dam. The collected samples were air-dried, homogenized, and sieved through a 63 µm mesh. The concentrations of the chemical elements were determined using ICP-OES at the Central Research Laboratory of the University of Chemical Technology and Metallurgy in Sofia.

The concentrations of the studied potentially toxic elements varied within the following ranges:

- Arsenic (As): 0.1–244.1 ppm
- Cadmium (Cd): 0.6–126 ppm
- Zinc (Zn): 78–12,489.7 ppm
- Copper (Cu): 24.3–783.9 ppm
- Lead (Pb): 10.5–5,260 ppm

At six sampling points, Cu concentrations exceeded the Probable Effect Concentration (PEC) threshold of 149 ppm (US EPA, 2002), indicating a probable harmful effect on aquatic ecosystems. A particularly notable site is Golyama Reka before the town of Madan, where the Cu concentration is 2.7 times higher than the PEC.

Twelve locations exhibited Zn concentrations above the PEC threshold of 459 ppm. The same site before Madan shows the highest concentration coefficient—8.9 times above PEC. Other points with significantly elevated levels of Zn are located along the main Arda River (7 points), the Davidkovska River (2 points), the Ribnitsa River, and a small tributary flowing from a tailings pond near the town of Rudozem.

A total of 15 points exceeded the PEC for Pb (128 ppm). The most extreme case was a small tributary near Rudozem, with a lead concentration coefficient of 16.7. Elevated Pb concentrations were also recorded at 7 points along the Arda River, 2 points on the Davidkovska River, and all sampling points along the Elhovska, Ribnitsa, and Madanska rivers and their tributaries.

Arsenic levels at 8 locations exceeded the PEC threshold (33 ppm). The highest As concentration coefficient—7.4 times above PEC—was recorded in the small tributary near the Rudozem tailings pond. Other elevated As

concentrations were found at 3 points along the Arda River and in Byala Reka, Ribnitsa, Madanska, and their tributaries.

For cadmium, 11 sites exceeded the PEC of 4.98 ppm. The highest cadmium concentration (126 ppm) and coefficient (25.3 times above PEC) were recorded in Golyama Reka before Madan. Other significantly polluted sites included 6 points on the Arda River, and one point each on the Davidkovska, Madanska, and Ribnitsa rivers, as well as the tributary near Rudozem.

The highest levels of bottom sediment pollution with respect to all studied elements were observed in the catchment areas of the Golyama River (before the town of Madan), Malka River (which drains a tailings pond into the Arda River near Rudozem), Madanska River (near its mouth), and Ribnitsa River (before the town of Rudozem).

Keywords: Arda River, bottom sediments, heavy metals, pollution, mining activity

Acknowledgements: This work was carried out within the framework of the scientific project "Assessment of the Ecogeochemical State and the Provided Ecosystem/Landscape Services in Part of the Arda River Basin" (No. 80-10-164/16.04.2019), supported by the Scientific Research Fund of Sofia University "St. Kliment Ohridski" and the National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters," approved by Resolution No. 577/17.08.2018 of the Council of Ministers and funded by the Ministry of Education and Science (MES) of Bulgaria (Agreement No. Д01-27/06.02.2024).

O-G-9 Spatial and temporal analysis of the distribution of copper in soils affected by a long-term impact of copper smelter

Nadezhda Nikolova[1] Miglena Zhiyanski[2]

[1] Southt-West University "Neofit Rilski", 66 Ivan Mihaylov, Blvd., Blagoevgrad, Bulgaria,

[2] Forest Research Institute - Bulgarian Academy of Sciences, 132 “St. Kliment Ohridski” Blvd., 1756 Sofia, Bulgaria

e-mail address of the corresponding author:nin@swu.bg

Abstract: The paper aims at studying the spatial and temporal dynamics of concentrations of the acid-soluble copper in the humus horizon of soils affected by long-term contamination with toxic emissions from the largest copper smelting plant in Bulgaria "Aurubis". For this purpose, area and line profile studies were conducted, tracing the direction of prevailing winds in the eastern part of the Zlatishko-Pirdop valley, where the source of pollution is located. The content of the microelement copper in the superficial soil layers is compared with the average copper contents in the soils at different scales - world, European, regional (technogenic areas in Bulgaria), and the local geochemical backgrounds. The temporal aspect is studied by analyzing the distribution in three different years and compared respectively: 1973 - 1995, 1973-2021, and 1995 – 2021, calculated with an application of a time coefficient. The dependence of the copper concentration and the local atmospheric conditions, the lithogenic basis, the duration of the technogenic impact, the height of the chimney, the distance from the source of pollution, and the installed capacities and technologies are analyzed and discussions of improving the ecological situation have been provided. The results obtained showed that the copper content exceeds the regulated threshold values at all years of the study, which makes the copper a long-term soil contaminant in the study area. It could be concluded that strict control of emissions of the smelter is necessary to avoid further increase in the soil metal pollution in the study region.

Keywords: copper smelter, soils, long-term contamination, copper contents

O-G-10 Morphological and Hydrological Features of the Krajiste Region (Southeastern Serbia)

Milena Milenova; Krasimir Stoyanov; Galina Bezinska
South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria
e-mail address of the corresponding author: krasi_sto@swu.bg

Abstract: The Krajiste region, located in the south-eastern part of Serbia along the border with Bulgaria and North Macedonia, is a mountainous area of significant environmental and geostrategic importance. Despite the region's pronounced environmental diversity and geostrategic significance, it has received only limited academic attention. The Krajiste region is distinguished by a combination of karstic, fluvial, and tectonic landforms. Collectively, these landforms serve as a unique natural laboratory for studying the interactions between relief dynamics, surface water systems, and human activities within a transitional Balkan environment. The present study aims to address this lacuna by conducting a detailed geomorphometric and hydrological analysis using contemporary geospatial techniques.

Morphometric parameters such as elevation range, slope gradient, slope aspect, and drainage density were extracted from high-resolution Digital Elevation Models (DEMs) using GIS-based spatial analysis. These parameters were further used to delineate sub-basins and assess erosional susceptibility and watershed characteristics. A detailed examination was undertaken of hydrological features, including river network hierarchy, source distribution, intermittent stream dynamics, and karstic water phenomena.

The research methodology integrates spatial datasets (SRTM, Sentinel-2 imagery), topographic and geological maps, climatic records, and land use data. The analysis reveals a region characterised by pronounced vertical dissection, steep slopes (particularly in the central and southern parts), and considerable variation in drainage density driven by lithological and structural factors. The hydrological network is characterised by the prevalence of short, high-gradient streams, which are conducive to rapid surface runoff, particularly in deforested and degraded zones. The presence of karst features, including sinkholes and disappearing streams, serves to further complicate the processes of drainage and water retention.

The results of the study indicate that Krajiste is highly geomorphologically sensitive, especially to erosion and flash flooding, risks that are intensified by land abandonment and unsustainable use. This research contributes to the broader understanding of mountain basin dynamics in the Balkan Peninsula and provides a methodological basis for future studies in natural hazard assessment, cross-border watershed management, and sustainable development planning in marginal upland regions.

Keywords: Geomorphology; Hydrological Analysis; Mountain Watersheds; GIS and Remote Sensing

O-G-11 Climatic Characteristics of the Krajiste Region (South-east Serbia) and Their Impact on Relief and Geomorphological processes

Krasimir Stoyanov; Milena Milenova; Galina Bezinska
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
e-mail address of the corresponding author: krasi_sto@swu.bg

Abstract: The Krajiste region, located in the south-eastern part of Serbia, is a mountainous area of notable geospatial and climatological complexity, situated along the borders with Bulgaria and North Macedonia. The region is located within a transitional climatic zone, influenced by both continental and mountainous regimes. This results in diverse microclimatic conditions, shaped by variations in elevation, relief orientation, and land cover. Despite the region's pronounced geomorphic diversity and environmental sensitivity, its climatic characteristics and their implications for geomorphological processes have received relatively limited scholarly attention.

The present study integrates climatic, geomorphological, and spatial data to explore the interrelations between prevailing meteorological conditions and active landscape dynamics. Utilising long-term meteorological records from regional stations (Bosilegrad, Vlasina, Dimitrovgrad), the analysis encompasses average and extreme air temperatures, precipitation patterns, snow cover duration, and freeze–thaw cycles. The results indicate that the region is characterised by typical features of a moderately continental climate, including cold winters, frequent temperature inversions, and high frost potential. Minimum winter temperatures can, on occasion, be lower than -30°C, while freeze–thaw oscillations near 0°C are most evident during spring and autumn, thereby enhancing mechanical weathering processes.

The observed climatic patterns are closely linked to the region's geomorphology. The relief is characterised by fluvial incised valleys, karst depressions, and steep mountain slopes, which collectively engender conducive

conditions for periglacial processes. Prominent landforms include frost-induced features such as earth hummocks, cryoplanation terraces, solifluction lobes and stone rivers (kurums), especially prominent on Mt. Crnook. The combination of GIS-based spatial analysis with field observations has indicated that extreme weather events, including convective summer storms, have the potential to induce episodic erosion and sediment mobilisation, particularly within degraded or deforested catchments. Conversely, the presence of persistent snow cover, followed by rapid melting, contributes to shallow landslides and soil displacement on north-facing slopes.

Furthermore, the formation of some frost-related landforms at elevations below the expected periglacial threshold indicates anthropogenic influence. The area has been subject to significant historical mining activities and medieval deforestation, which have had a considerable effect on the thermal balance and surface hydrology, resulting in the creation of microenvironments conducive to periglacial activity at lower elevations. The aforementioned anthropogenic modifications have had a disruptive effect on ecological stability and have led to an intensification of natural geomorphic responses to climatic drivers.

This research contributes to the expanding corpus of literature on climate–geomorphology interactions in the Balkans. The study emphasises the necessity of incorporating both natural and human-induced drivers into the evaluation of landscape evolution, ecological vulnerability, and geomorphic hazards in marginal mountain environments. The findings indicate the necessity for integrated environmental monitoring and adaptive management strategies to address increasing climate variability and land degradation risks in the Krajiste region.

Keywords: Periglacial landforms; Climate–geomorphology interactions; Krajiste region; Freeze–thaw processes; Anthropogenic landscape change

O-G-12 An overview of European geographical research on natural borders and their effects

Marina Pehlivanova

Sofia University St. Kliment Ohridski, Faculty of Geology and Geography, Sofia, Bulgaria

e-mail address of the corresponding author: marina.ph@abv.bg

Abstract: The following overview covers the subject of the effects of naturally occurring geographical factors - rivers, mountain ranges, seas, etc. in the formation of European borders as we know them today.

It can be argued that nowadays, especially in the countries part of the EU(European union) and the Schengen area, borders are regarded as insignificant. However even in a historical moment with overwhelming globalisation trends it's important to look at the existing borders not only as study material but as an instrument in the process of understanding foreign politics and geopolitical relations. The focus of the following study would be naturally occurring obstacles that became part of or complete borders. Historically humans are drawn to water and natural security in the form of mountains, if available in the territory. However the same obstacles which could be looked at as secure could also be dangerous - natural disasters, animal activity and isolation are only a few of the factors that could be deemed not desirable when choosing territory to settle into. That is why it's not only important but also extremely interesting to try and understand the logic behind the decisions made and to determine how these decisions affect the communities near the borders, especially with the fast changing climate, the growing amount of conflict and the ongoing process of globalisation. For the purposes of this overview the countries regarded as "european" will be the ones currently accepted and named as such although throughout documents it seems like a challenge to be able to pinpoint what is seen as european and this has contributed to quite a few arguments over the decades.

The link to modern research lies in the undeniable links between geography, borders and geopolitical decisions. The way we see Europe's territories as countries relies on decisions made throughout history and their consequences. Another important detail is the fact that naturally occurring borders, which may have been named obstacles at one point in history, are now fundamental transportation and trade roads and that by itself dictates the way the economy of the whole continent, as well as the specific countries, works and evolves - ever since the continent first got human tribes settling in, resource has been a main moving point and it continues to be so. In that case a natural corder becomes a desirable asset as it doubles in its function and provides opportunities for foreign policies.

Keywords: border, geography, geopolitics, foreign policy

O-G-13 Virtual Tourism as a Tool for Enhancing Destination Accessibility and Sustainability

Vladimir Karadzhov, *Emilia Patarchanova*
Department of Geography, Ecology and Environmental Protection
Faculty of Mathematics and Natural Sciences
South-West University "Neofit Rilski" – Blagoevgrad, Bulgaria
e-mail address of the corresponding author: karadzhov@swu.bg

ABSTRACT: Virtual tourism is changing the way people explore the world, making destinations more accessible and supporting sustainable travel. This article looks at how technologies like Virtual Reality (VR) and Augmented Reality (AR) offer exciting and inclusive travel experiences, especially for people with physical challenges or limited budgets. It also shows how virtual tourism can help protect the environment by reducing the pressure on sensitive natural areas and cultural sites. By reviewing current examples and case studies, the paper highlights how virtual tourism can open up travel to more people while helping to meet global sustainability goals.

KEYWORDS: Virtual tourism, Accessible travel, Sustainable tourism, Virtual Reality (VR), Augmented Reality (AR), Digital tourism, Eco-friendly travel.

O-G-14 Contemporary tourism-geographical development of Karlovy Vary – a comprehensive model for sustainable development

Maria Nosikova
"St. Cyril and St. Methodius" University of Veliko Tarnovo, Department of Geography
e-mail address of the corresponding author: m.nosikova@bgschool.cz

Abstract: This report aims to analyze and discuss the tourism-geographical development of Karlovy Vary as a contemporary model for sustainable development. The focus is on the tourist destination of Karlovy Vary—a city known for its healing mineral springs and unique cultural heritage. The analysis encompasses the historical evolution of tourism, the geographical features, and

the natural resources that form the foundation of the city's attractiveness. Current trends in tourist flows, modern infrastructure, marketing strategies, and digitalization are identified. Based on fieldwork research, significant improvements in services and adaptation to the changing demands of the tourism market are highlighted.

By applying the STEAM approach, the report emphasizes a comprehensive model for sustainable development. The author argues that the implementation of new technologies offers the best solutions for the development of sustainable tourism and the improvement of destination image. Special attention is given to projects and start-up initiatives related to innovative spa services and health tourism. These initiatives not only enrich the tourist experience but also stimulate regional economic development by creating new jobs and attracting investments.

Keywords: sustainable tourism; tourist destination Karlovy Vary; STEAM approach; innovative spa services; health tourism

O-G-15 Geography of the transport system in the academic field of the Velikotarnovski geographical school

Emel Bilyalova

St. Ciril and St. Methodius University, Veliko Tarnovo, Bulgaria

e-mail address of the corresponding author: emelbilalova@gmail.com

Abstract: The focus of this article is on the academic development of transport geography in the Veliko Tarnovo geographical school. The occasion for writing this study is related to the 40th anniversary of the establishment of the Department of Geography at the Veliko Tarnovo University "St. St. Cyril and Methodius", celebrated in 2024. This anniversary makes us take a retrospective look at the development of scientific lines and research topics in the department. Among them, the study of the transport system stands out as an important part of geographical science, with its theoretical, applied and social dimensions.

This article has a survey character, examining research on the transport system. Attention is paid to the main achievements, scientific approaches, and research perspectives of the lecturers of the department, who with their works significantly enrich the scientific discourse in this area.

The authors working on this topic have contributed both to the development of geographical science, while at the same time formulating applicable solutions to a number of practical issues related to the functioning of the transport system.

Research on the development of the transport system in the academic field of the Veliko Tarnovo geographical school continues to be relevant today, through the ongoing efforts of the new generation of researchers. It is this continuity that maintains the relevance of transport geographical research.

Keywords: transport geography, transport systems, school of geographical thought

O-G-16 Classification of Rural Areas in Southwest Planning Region in Bulgaria Based on Socioeconomic Development Criteria

Krasina Radomirska, Plamen Paratchanov
Sofia University "St. Kliment Ohridski", Sofia, Bulgaria
e-mail address of the corresponding author: radomirska@abv.bg

Abstract: Rural areas play a critical role in regional development, yet they are characterized by pronounced socioeconomic disparities that challenge the formulation of cohesive development strategies. This study focuses on the classification of rural areas within the Southwest Planning Region of Bulgaria, employing a comprehensive set of socioeconomic development criteria. The objective is to categorize rural municipalities into three distinct groups—developed, intermediate, and lagging—based on a multi-criteria analysis of economic, demographic, and infrastructural indicators.

The research methodology integrates quantitative data sourced from the Agricultural Census (2020), national statistical databases, and GIS-based spatial analysis. The selected indicators encompass variables such as employment rates, income levels, population dynamics, access to education and healthcare services, infrastructure development, and sectoral economic structure. This methodological framework allows for an objective and spatially informed

classification of rural territories, revealing patterns that are crucial for effective policy design and regional planning.

The results indicate a clear stratification of rural areas. Developed rural municipalities—such as Bansko, Goce Delchev, Sandanski, and Bozhurishte—exhibit high economic activity, robust infrastructure, and strong educational and institutional capacity. These areas benefit from diversified local economies, particularly in industry, logistics, and tourism, making them resilient to economic shocks and attractive for private investment. Intermediate municipalities, including Belitsa, Garmen, and Samokov, display moderate development levels, marked by a combination of growth potential and persistent structural limitations. While these areas show some signs of economic diversification, they continue to depend heavily on primary sectors and face gaps in access to key public services. In contrast, lagging rural municipalities—such as Yakoruda, Boboshevo, and Treklyano—are characterized by high unemployment, demographic decline, limited infrastructure, and underdeveloped public services. These factors contribute to ongoing outmigration and economic stagnation, posing significant challenges to regional cohesion and inclusive growth.

The classification highlights the need for differentiated, place-based policies to address rural disparities effectively. Policy recommendations emphasize the importance of targeted investments in education, healthcare, and infrastructure, particularly in intermediate and lagging areas. Strengthening local governance, enhancing human capital, and promoting economic diversification are essential steps toward reducing rural inequalities and fostering balanced territorial development.

This research contributes to the academic discourse on rural development and provides a practical tool for policymakers, planners, and stakeholders aiming to implement evidence-based interventions. By offering a structured classification of rural areas grounded in socioeconomic criteria, the study facilitates the identification of development priorities and supports strategic planning at both regional and national levels.

Keywords: Rural development, Socioeconomic classification, Regional disparities, Southwest Planning Region, Bulgaria, Spatial analysis

O-G-17 Social Processes in the Border Municipalities of the Southwest Region in Bulgaria

Vasil Pandurski
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
e-mail address of the corresponding author: vasil.pandurski@mail.bg

Abstract: Historically, borders have always had a dividing character—a place of concentrated military power aimed at protecting the sovereignty of states. As a result, border municipalities have been significantly disadvantaged from both a social and economic perspective. Things began to change after World War II, when organized cooperation between border regions started in Western Europe. In contrast, in Eastern Europe, borders continued to play a separating role until the late 1980s. The integration processes in Western Europe eventually extended to Eastern Europe, but the decades-long delay had a negative impact, particularly on social processes.

With the "opening" of borders, these processes became highly dynamic and difficult to predict. The labor market is in constant flux. A serious issue in some municipalities is the lack of job opportunities, leading to high unemployment rates. Even more pressing is the problem of long-term unemployment, which has an even more detrimental effect on the development of the local population.

This study includes municipalities that in recent years have faced similar problems—depopulation and aging populations, as well as difficulties in accessing quality public services such as healthcare and education. Special attention is given to the territorial distribution of these services, as there is a trend of centralization in some municipalities. Many of the reviewed municipalities have only one hospital, usually located in the municipal center. Larger municipalities are an exception to this. A similar situation exists with kindergartens and schools, which have mostly been preserved in the municipal centers.

The centralization of various public services in municipal centers leads to the depopulation of more remote villages and a concentration of the population either in the center or complete migration out of the municipality. These migration processes mainly affect the working-age population, resulting in a reduced labor force. Even targeted state efforts to support these regions

economically may not yield significant results due to the lack of human resources.

Some of these municipalities become economically dependent because social spending increases while municipal budget revenues remain insufficient. A large portion of the projects involving the border municipalities of the Southwest region are related to tourism and the agricultural sector. The local population needs support in developing modern business practices and in learning how to be competitive. In terms of tourism, a stronger marketing strategy is needed for the services offered and their promotion. Improving transport infrastructure to neighboring countries is also necessary in order to enhance the impact of cross-border cooperation.

Keywords: border municipalities, depopulation, social processes, employment, unemployment

O-G-18 Household well-being and the risk of poverty

Emilia Patarchanova1, Gergana Nikolova1, Aleksandra Ravnachka1,2 , Veselina Dalgacheva1, Vladimir Karadzhov1

1South-West University „Neofit Rilski“, Blagoevgrad, Bulgaria

2National Institute of Geophysics, Geodesy and Geography at Bulgarian academy of sciences, Sofia, Bulgaria

e-mail address of the corresponding author: emilia_patarchanova@swu.bg

Abstract: Society in Bulgaria is experiencing serious demographic, social, economic and other changes and transformations. They always reflect, more strongly or less clearly, on the family or household. Defined as the "smallest cell of society", it is also changing. For example, the number of households consisting of one person in different age groups is increasing: between 20 and 35 years; around 45-55 years; over 70-75 years. Households with two children are decreasing and those in which the couple does not seek to create a generation are increasing. Households with alternative forms of cohabitation to traditional family forms are emerging. Some of them also have children. Changes often occur before the state, as institutions, policies and legislation, is ready for them. Are these households at risk of poverty? What is the geographical framework of these transformations?

And the COVID-pandemic and the economic crisis it caused led to serious internal migrations. Many young couples with and without children gave up the advantages of the big city and lived in houses with a yard in villages with a very good ecological environment. How has their standard of living changed? In an upward or opposite direction? Are they at risk of poverty?

Many households in which one or both members lost their jobs also migrated to smaller settlements where they have so-called second homes. How has the well-being of these households changed?

Other households have merged, with younger people choosing to live with their parents or other relatives, creating shared households to have lower living costs. Is the risk of poverty a reason for these changes? Are these households more stable?

This study seeks answers to these and other questions. It aims to clarify the main reasons for the increase in the number of households at risk of poverty, as well as the spatial differences in the manifestation of this process. An analysis of the main factors influencing the well-being of households has been made. The differences in the resilience of different types of households with respect to the risk of poverty have been shown. The current state and trends have been revealed and a spatial analysis of the well-being of households at risk of poverty at the regional level has been made. The results obtained have been visualized using GIS.

Keywords: poverty risk, well-being, income, traditional households, new forms of households

Acknowledgements: Project “Regional Employment – Working Poor in Bulgaria”; Contract № КП-06-Н85/2024 NSF of Bulgaria – Ministry of Education and Science.

O-G-19 Foreign Direct Investment in the Trakia Economic Zone: Models and Economic Effects

Olga Gavrilova

South-West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences,

66 Ivan Mihaylov str. 2700, Blagoevgrad, Bulgaria

e-mail address of the corresponding author: olive_peneva@abv.bg

Abstract: Foreign direct investment (FDI) is a key element of international economic integration. It creates stable and sustainable relationships between economies, leads to increased labor productivity, improved product quality, and competitiveness. FDI promotes the creation of new jobs (increases employment and positively influences competition in the labor market), contributes to the transfer of knowledge, technology and know-how between countries, and stimulates consumption. As part of the global economy, FDI has a number of effects on the host country's economy - stimulating integration into global value chains, modernization of production, and increasing regional competitiveness. When implementing foreign investments, not only positive developments and favorable effects can be observed, but also negative ones. In the countries of Central and Eastern Europe, FDI is not only a source of financing for economic growth, but also a prerequisite for introducing new technologies, know-how and modern market management into production. It allows the host country to gain time in absorbing such technologies and shorten the duration of economic transformations. This study examines the processes of attracting FDI within the Trakia Economic Zone (TEZ) – one of the leading industrial zones in Bulgaria and Southeastern Europe. The TEZ is distinguished as the first and longest-standing industrial zone in Bulgaria, establishing itself as a leading model for successful development and investment attraction. Trakia Economic Zone is the first public-private partnership in Bulgaria, supported by the government and the Ministry of Economy. It is one of the largest industrial and logistics complexes in Bulgaria, encompassing several industrial zones located around the city of Plovdiv. Trakia Economic Zone is the first public-private partnership in Bulgaria, supported by the government and the Ministry of Economy. It is one of the largest industrial and logistics complexes in Bulgaria, encompassing several industrial zones located around the city of Plovdiv. The report analyzes investment patterns, the profile of foreign companies, as well as the economic effects of FDI on the socio-economic development of the region. The dynamics of globalization processes in recent decades and the increasingly intense movement of capital have led to an increasing influence of cross-border investments. Their importance as a key factor in improving the overall competitiveness of the economy is constantly growing, which leads to increasingly active policies by all countries to encourage foreign direct investment, at the expense of debt as the main source of financing.

Keywords: Foreign direct investment Foreign direct investment, Trakia economic zone, economic effects, investment models.

O-G-20 The Policy of the European Union for the Development of the Agricultural Sector in Rural Areas.

Valentin Shlyakov
South-west university "|Neofit Rilski", Blagoevgrad, Bulgaria
e-mail address of the corresponding author: shlqkovvalentin@gmail.com

Abstract: The report examines the European Union's policies for the development of the agricultural sector in rural areas of Bulgaria. It focuses on the implementation of measures aimed at modernizing the sector, enhancing the competitiveness of production, promoting organic farming, and fostering sustainable development. The impact of European programs on economic growth, social integration, and environmental sustainability is analyzed. The study pays particular attention to support measures for young farmers, the preservation of natural resources, and the development of local infrastructure. Through a review of strategic documents, official data, and best practices, the main outcomes and challenges in the implementation of sustainable rural development policies in Bulgaria are outlined.

Keywords: European Union (EU); agricultural sector; rural areas; sustainable development; competitiveness; organic farming

O-G-21 Conditions, factors and spatial organization of viticulture in Pazardzhik region

Doycho Vaklinov
Sofia University "St. Kliment Ohridski", Sofia, Bulgaria
e-mail address of the corresponding author: doychovaklinov83@gmail.com

Abstract: The main spatial characteristics of the geographical environment of the Pazardzhik region provide diverse opportunities for the development of a number of activities in the primary sector of the economy. In its central parts, viticulture plays a leading role in agricultural specialization, which has centuries-old traditions since antiquity.

The main focus of this study is aimed at studying the leading conditions and resources for the development of grape production and its modern spatial organization within the scope of the Pazardzhik region. Special attention is paid to the geographical scope and production specialization, of the formed viticultural microdistricts in the studied territory. The study concludes with defining the main challenges in the development of viticulture and the possibilities for overcoming them in the future.

Keywords: viticulture, conditions, resources, factors, spatial organization, specialization, microdistricts.

Section: Mathematics

O-M-1 An algebraic approach for construction of (t, s) – sequences

Vesna Dimitrievska-Ristovska[1], Vassil Grozdanov[2] and Petar Sekuloski[1]

[1] Faculty of Computer Science and Engineering, University ”SS. Cyril and Methodius”, 16 Rugjer Boshkovikj str., 1000 Skopje, Macedonia,

2 Department of Mathematics, Faculty of Natural Sciences and Mathematics, South-West University ”Neofit Rilski”, 66 Ivan Michailov str., 2700, Blagoevgrad, Bulgaria,

vassgrozdanov@yahoo.com

Abstract: In the present talk the authors use different monocyclic operators over an arbitrary finite field Z_b to propose an algebraic algorithm for construction of (t,s)-sequences. A special attention is devoted on the construction of (0,s)-sequences, practically in each dimension s. A special code, which give us the primitive polynomials of first degree over Z_b, is presented. Two codes, which practically realized the developed mathematical models for

construction of (t,s)-sequences and (0,s)-sequences, are offered. The obtained results are graphically illustrated.

Keywords: Monocyclic operators; (t,s)-sequences; (0,s)-sequences

O-M-2 Multidimensional Quasi-Monte Carlo integration in weighted anchored Sobolev spaces

Vassil Grozdanov[1] and Elmi Shabani[2]

[1]Department of Mathematics, Faculty of Natural Sciences and Mathematics, South West University "Neophit Rilski", 66 Ivan Mihailov, 2700 Blagoevgrad, Bulgaria

[2]Department of Business Management, Faculty of Business, University "Haxhi Zeka", 30000 Peje, Republic of Kosovo

e-mail: vassgrozdanov@yahoo.com

Abstract: In our lecture, an exact formula for the mean square worst-case error of the integration in the weighted anchored Sobolev spaces $H_{Sob,s,\gamma,w}$ presented in terms of the functions of the system Γ_{Bs} is delivered. The notion of the so-called weighted anchored diaphony is introduced and is shown that it is a quantitative measure for the irregularity of the distribution of sequences. The relationship that exists between the mean square worst-case error and this type of the diaphony is established.

Keywords: Weighted anchored Sobolev spaces, the function system ΓBs , mean square worst-case error, weighted anchored diaphony

O-M-3 The Erdös-Turàn-Koksma inequality in Cantor systems

Atidzhe Hodzhova and Vassil Grozdanov,

Department of Mathematics, Faculty of Natural Sciences and Mathematics, South West university "Neofit Rilski", 2700 Blagoevgrad, Bulgaria

vassgrozdanov@yahoo.com

ati567@mail.bg

Abstract: Uniformly distributed series are important mathematical objects, and the interest in them is determined by their numerous applications in various fields of human knowledge. The main results in the theory of uniformly distributed sequences, as well as in quasi-Monte Carlo integration, have been obtained using functions from some complete orthonormal functional systems as a research tool. The main thing in this direction is the definition and properties of the functions from the functional system Γ_{B_s}. The Erdős–Túran–Koksma inequality is a fundamental result of the quantitative theory of uniformly distributed sequences. In practice, it is an upper bound on the extreme discrepancy, quadratic discrepancy in terms of functions from some classes of complete orthonormal functional systems. In the our lecture, the Erdős–Túran–Koksma's inequality for the $(\Gamma_{B_s}; \alpha; \gamma)$ - diaphony of an arbitrary s-dimensional sequence will be presented. This result is convenient for creating a computer model of the $(\Gamma_{B_s}; \alpha; \gamma)$ - diaphony of an arbitrary s-dimensional sequence. In this model, the error is estimated, and it is shown that it is an infinitesimal quantity.

Keywords*:* $(\Gamma_{B_s}; \alpha; \gamma)$ – diaphony, Erdős–Túran–Koksma' s inequality

O-M-4 About a new view on the golden ratio

Stanislava Stoilova, Mikhail Kolev

University of architecture, civil engineering and geodesy, Sofia, Bulgaria

Abstract: In our presentation we discuss some new ideas related to a mathematical problem faced during the preparation of students for the National Student Olympiads in Mathematics. These ideas are related to analogies found in solving a certain class of integrals and the "golden ratio". The first mention of the golden ratio dates from Ancient Greece. It can be found in Euclid's Elements, the Classical Greek work on mathematics and geometry. Later it was studied and used in many areas of science and art.

Keywords: competitions in mathematics; golden proportion; solving mathematical problems

O-M-5 On some methods of calculation of specific types of integrals

Stanislava Stoilova[1], *Yana Vasileva*[2], *Mikhail Kolev*[1]
[1]University of architecture, civil engineering and geodesy, Sofia, Bulgaria
[2]Sofia University "St. Kl. Ohridski", Sofia, Bulgaria

Abstract: Calculating integrals is not always an easy task to solve. Often interesting such problems are given to solve in student mathematics competitions. In our report we consider some such integrals and possible methods for their solution.

Keywords: competitions in mathematics; integral calculation; integration methods

O-M-6 Criterion of Connectedness by Clopen Coverings

Zoran Misajleski
Faculty of Civil Engineering, Ss. Cyril and Methodius University, Skopje, Macedonia
misajleski@gf.ukim.edu.mk

Abstract: In this talk a new criterion of connectedness is given. The topological space X is connected if and only if for every clopen covering (i.e. a covering consisting of closed and open sets) $\mathcal{U}$ of X in X and every $x, y \in X$, there exists a chain in $\mathcal{U}$ that connects x and y. And by a chain in $\mathcal{U}$ that connects points x and y we understand a finite sequence of elements of $\mathcal{U}$ such that x belongs to the first element, y to the last, and the intersection of every two consecutive elements of the sequence is not empty. The advantage of this definition is that it is given in a positive sentence, in contrast to the standard definition which is given in a negative sentence. Moreover, by this definition, we prove the properties of connected sets. The advantage of the definition can be seen from the proofs of the theorems, which are short and elegant.

Keywords: Connectedness, coverings, clopen sets, chain

O-M-7 On sequence convergence in (3,j)-metric spaces, j∈{1,2}

Dončo Dimovski[1], Pavel Dimovski[2], Tomi Dimovski[3]
[1]Macedonian Academy of Sciences and Arts, Skopje, North Macedonia
[2]Ss. Cyril and Methodius University, Faculty of Technology and Metallurgy, Skopje, North Macedonia
[3]Ss. Cyril and Methodius University, Faculty of Mechanical Engineering, Skopje, North Macedonia
tomi.dimovski@gmail.com

Abstract: In this article, we show that a convergent sequence in (3,2)-metric spaces has a unique limit. We give several examples in (3,1,ρ)-metric spaces and (3,1)-metric paces in which a convergent sequence has more than one limit. We obtain sufficient conditions for a sequence in (3,1)-metric space to have a unique limit.

Keywords: (3,1,ρ)-metric space, (3,2,ρ)-metric space, (3,1)-metric space, (3,2)-metric space

O-M-8 Some asymptotic results for the generalized directional short-time Fourier transform with fixed direction

Jasmina Veta Buralieva
Faculty of Computer Science,
Goce Delcev University, Stip, North Macedonia,
jasmina.buralieva@ugd.edu.mk

Abstract: Several Abelian- and Tauberian-type results characterizing the quasiasymptotic behavior of tempered distributions in terms of their generalized directional short-time Fourier transform (DSTFT) with fixed direction, with respect to one or two variables, are proven. An Abelian-type result relating the quasiasymptotic boundedness of tempered distributions to the asymptotics of their generalized DSTFT with fixed direction is given. Also, an

asymptotic result for the generalized DSTFT with fixed direction is obtained using the S-asymptotic behavior of distributions of exponential type.

Keywords: Directional short-time Fourier transform, distributions, quasiasimptotics, S-asymptotics, Abelian- and Tauberian-type results.

O-M-9 Simulations of Electoral Systems: How Different Methods of Vote Allocation Affect Political Representation

Georgi Bratkov, Boyana Garkova[1]
South-West University, Blagoevgrad, Bulgaria
[1]big@swu.bg

Abstract: This study presents a simulation-based comparative analysis of different electoral systems with a focus on how vote allocation methods affect political representation. We propose a new method for allocating seats based on radical operation and a dynamic threshold to collect in order to gain a seat in the legislative assembly. Using mathematical models and algorithmic implementations, we simulate electoral outcomes obtained from the proposed method and the largest remainder method (Hare-Niemeyer). We compare and analyze the results obtained by the two methods. The results highlight the importance of mathematical modeling for understanding electoral justice and provide practical guidance for electoral reform and political decision making.

Keywords: electoral systems, elections, vote allocation methods, mathematical modeling, simulation analysis

O-M-10 On Some Applications of Second-Order Linear Differential Equations in Economy

Sashka Kandilarova
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
sashkakandilarova@gmail.com

Abstract: We consider some mathematical models in economy. The theoretical background is reviewed, with particular focus on a market model with price expectations, as well as the interaction between inflation and unemployment, commonly known as the Phillips relation. Both models are based on the second-order linear differential equations with constant coefficients and constant term. Specific economic problems have been solved and discussed.

Keywords: mathematical models, a market model with price expectations, the interaction between inflation and unemployment.

O-M-11 Estimation of the difference between continuous and impulsive models

Saba Iftikhar[1], Tzanko Donchev[2], Dimitar Kolev[1],
Nikolay Kitanov[3], Boyana Garkova[3]
[1]Abdus Salam School of Mathematical Sciences, Lahore, Pakistan
[2]University of architecture, civil engineering and geodesy, Sofia, Bulgaria
[3]South-West University, Blagoevgrad, Bulgaria
nkitanov@swu.bg

Abstract: In this presentation we consider an evolution process modeled by two ways: by an impulsive ordinary differential equation (IODE) and by ODE with continuous variables. It is clearly that solutions of the IODE is discontinuous, and at the second case the solution is continuous (or smooth). In the case of Cauchy problem it is obviosly that there exist a grait difference between solutions id both cases. The qualitative analysis allows us to estimate that difference when investigate some properties as the stability, blow-up, periodicity and more. Some examples illustrate the stated difference. This difference can be assosiated to corresponding dynamical systems. The estimated difference is very important when one analyzes some real physical process.

Keywords: impulsive ODE, stability, ODE with continuous variables

Acknowledgements - It work was supported by the Bulgarian National Science Fund under Project KP-06-PN62/1.

O-M-12 Existence and stability for a parabolic initial and boundary value problem

Saba Iftikhar[1], Tzanko Donchev[2], Dimitar Kolev[1],
Nikolay Kitanov[3], Boyana Garkova[3]
[1]Abdus Salam School of Mathematical Sciences, Lahore, Pakistan
[2]University of architecture, civil engineering and geodesy, Sofia, Bulgaria
[3]South-West University, Blagoevgrad, Bulgaria
big@swu.bg

Abstract: This presentation is devoted to an initial and boundary value problem IBVP for a parabolic equation of second order w.r.t. the space variable x and with some nonlinearities in the reaction part. We discuss the sufficient conditions for existence of asymptotically stable solutions. To this end we show existence of upper and lower solutions which guarantee the existence, uniqueness and stability. Moreover, it turns out that there exists exponentially and asymptotically stable solution as the time t tends to infinity. The stated parabolic IBVP is applicable in Physics and Biology. There exist lots of applications in contemporary technologies as well.

Keywords: parabolic equations, existence, stability

Acknowledgements - It work was supported by the Bulgarian National Science Fund under Project KP-06-PN62/1.

O-M-13 Attractors of M-Dissipative Evolution Inclusions

Tzanko Donchev[1], Nikolay Kitanov[2], Alina I. Lazu[3], Iveta Nikolova[1]
[1]University of architecture, civil engineering and geodesy, Sofia, Bulgaria
[2]South-West University, Blagoevgrad, Bulgaria
[3]"Gh. Asachi" Technical University, Iasi, Romania

tzankodd@gmail.com

Abstract: Let E be a real Banach space and let $A: D(A) \to E$ be a m-dissipative operator, generating compact semigroup.

We study the following autonomous evolution inclusion:

$$\begin{cases} \dot{x}(t) \in Ax(t) + f_x(t), \ \ a.e. \ \ t \in (0, \infty), \\ f_x(t) \in F\big(x(t)\big), \ x(t_0) = x_0. \end{cases} \tag{1}$$

We study the existence of limit solutions (quasitrajectories) when $F(\cdot)$ satisfies forward Lipschitz condition with negative constant. First existence of solutions on $[t_0, \infty)$ is proved. Then the existense of limit of the reachable set as *t* tends to infinity is shown. This liit is a forward atractor.

We consider different cases of conditions w.r.t. geometry of E and prove existence of the limit of reachable set, which appears to be the forward attractor. When A is of complete continuous type and $F(t, x)$ is a subset of weakly compact the limit solutions appears to be integral solutions of (1).

Keywords: attractor, evolution inclusion

Acknowledgements - It work was supported by the Bulgarian National Science Fund under Project KP-06-PN62/1.

O-M-14 Mixed Semicontinuous Riemann-Liouville Evolution Inclusions

Tzanko Donchev[1], Boyana Garkova[2], Alina I. Lazu[3], Iveta Nikolova[1]

[1]University of architecture, civil engineering and geodesy, Sofia, Bulgaria

[2]South-West University, Blagoevgrad, Bulgaria

[3]"Gh. Asachi" Technical University, Iasi, Romania

iveta.nikolova@abv.bg

Abstract: Let $(E, |\cdot|)$ be a real Banach space and let $A: D(A) \to E$ be a densely defined linear operator, generating C_0 semigroup.

In this paper we study the following nonlocal multivalued fractional evolution equation

$$\begin{cases} ({}^{L}D_{0+}^{q}x)(t) = Ax(t) + f_x(t), \;\; a.e. \;\; t \in I' = (0,T], \\ f_x(t) \in F\big(t, x(t)\big), \\ \big(I_{0+}^{1-q}x\big)(t) = g\big(x(\cdot)\big)(:= x_0). \end{cases} \quad (1)$$

Here $({}^{L}D_{0+}^{q}\,\cdot)$ is the Riemann-Liouville fractional derivative of order q, $0 < q < 1$, with the lower limit zero, I_{0+}^{1-q} is Riemann-Liouville integral of order $1 - q$ and $T > 0$.

We study the existence of solutions for nonlocal semilinear Riemann-Liouville fractional evolution inclusions in a general Banach space under mixed semicontinuity conditions, i.e. $F(\cdot,\cdot)$ is almost lower semicontinuous (LSC) with closed nonempty values on an open set and almost upper semicontinuous (USC) with nonempty closed convex values elsewhere. First almost USC case is considered. Afterward Fryszkowski's type selection theorem is used to investigate almost LSC case. Then existence of solution to system with mixed type semicontinuous right hand is proved.

Keywords: nonlocal multivalued fractional evolution equation

Acknowledgements - It work was supported by the Bulgarian National Science Fund under Project KP-06-PN62/1.

O-M-15 Tolerance and Interval Graphs for Strategic Planning During Health Crises

Limonka Lazarova, Natasa Stojkovik, Aleksandra Ilievska, Marija Miteva, Dusan Bikov

Faculty of Computer Science, Goce Delcev University, Stip, Republic of North Macedonia

limonka.lazarova@ugd.edu.mk

Abstract: This paper explores the use of tolerance and interval graphs for strategic planning during health crises, focusing on COVID-19. These graphs model overlapping intervals with defined tolerance, aiding in resource optimization for classrooms, hospital beds, and airport gates. Applications include contact tracing, risk prediction, and scheduling. The approach supports efficient, flexible decision-making in managing limited resources.

Keywords: tolerance graphs, interval graphs, graphs models, optimization.

Acknowledgements - name/number of the project supported financially the research work.

O-M-16 Graph Theory Applications in Investment Analysis and Risk Modeling

Limonka Lazarova, Anastasija Antova, Natasa Stojkovik, Aleksandra Ilievska, Vasko Kokalanov

Faculty of Computer Science, Goce Delcev University, Stip, Republic of North Macedonia

limonka.lazarova@ugd.edu.mk

Abstract: This paper explores the application of graph theory in investments and financial modeling. It presents key graph types, representations, and algorithms, with a focus on their use in Python to assess risk, model markets, and optimize portfolios. Graph-based methods help investors better understand risks and select optimal investment strategies.

Keywords: graphs, mathematical model, risk, asset.

O-M-17 One More Result on Products of Distributions in Colombeau Algebra

Marija Miteva, Limonka Lazarova, Biljana Zlatanovska

Goce Delcev University, Stip, North Macedonia

marija.miteva@ugd.edu.mk

Abstract: Theory of distributions (generalized functions) generalizes the notion of a function by providing rigorous mathematical meaning to various concepts that were previously considered heuristically. Due to its properties, the theory of distributions is widely applicable in science and engineering.

However, it encounters a problem with multiplication of distributions: the product of two arbitrary distributions is not defined within this theory. To overcome this problem, Colombeau algebra was constructed and Colombeau theory of generalized functions was introduced as generalization of the existing theory of distributions. The products of distributions in the Colombeau algebra are consistent with the products in classical theory, but also many products that cannot be evaluated in classical theory, can be evaluated within Colombeau theory of generalized functions. In this paper, we evaluate product of distributions using the Colombeau theory of generalized functions.

Keywords: distributions, Colombeau algebra, Colombeau generalized functions, multiplication of distributions

Acknowledgements – supported by Goce Delcev University, Stip, North Macedonia.

O-M-18 Persistent Homology-Based Regime Detection for Time Series Forecasting

Petar Sekuloski, Vesna Dimitrievska Ristovska
Faculty of Computer Science and Engineering, Skopje, Macedonia
petar.sekuloski@finki.ukim.mk

Abstract: Financial markets don't follow simple rules—they shift between calm and chaos, trends and reversals, often without clear warning. These shifts, known as regime changes, pose a major challenge for forecasting models. A method that works well during stable periods may completely fail during high volatility. In this paper, we present a new approach to time series forecasting that adapts to such changes by combining machine learning with tools from Topological Data Analysis (TDA)—a branch of mathematics focused on the shape and structure of data. Our method relies on persistent homology, a technique in TDA that helps detect patterns like loops, clusters, or voids in high-dimensional data. We begin by transforming the original time series into a multi-dimensional space using delay embeddings, allowing us to study the geometric structure of its evolution. From this structure, we extract topological features and summarize them using metrics such as persistence entropy and Betti curves, which capture how the shape of the system evolves over time. These

topological summaries are then used to detect regime shifts in the data. For example, the appearance of a persistent loop may indicate the beginning of a new cycle or oscillatory behavior. Once a regime shift is detected, the forecasting framework automatically switches to a model more appropriate for that regime. Simpler models like ARIMA are used during trend-following phases, while more flexible models like LSTM or XGBoost are employed when the data becomes more complex or volatile. We tested this adaptive framework on financial time series, including the S&P 500 index and Bitcoin prices. The results show that our topology-guided switching model outperforms traditional forecasting methods, especially during periods of high uncertainty. Metrics like Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE) improved significantly compared to static models that use a single approach throughout. Our work demonstrates that topological features offer a powerful new lens for understanding time series dynamics. By recognizing changes in the underlying structure of the data, forecasting models can become more responsive and accurate. This opens the door to more robust forecasting systems not only for financial markets, but also for areas like weather prediction, healthcare monitoring, and network traffic analysis. Future research will explore real-time extensions, multivariate data, and additional topological tools.

Keywords: Topological data analysis, financial forecasting, regression;

Section: Informatics

O-I-1 Integrating Exon–Gene Structure into Neural Architectures for RNAseq Classification

Aleksandar Jovanović[1], Michael Sammeth[1,2]

[1]Department of Applied Sciences and Health, Coburg University, Coburg, Germany;

[2]Department of Anesthesiology, Intensive Care, Emergency and Pain Medicine, University Hospital Würzburg, Würzburg, Germany;

aleksandar.jovanovic@hs-coburg.de

Abstract: RNA sequencing (RNAseq) is a high-throughput technique used to quantify the transcriptional activity of genes across biological samples. By measuring RNA molecules present in a cell or tissue, RNAseq provides a detailed snapshot of gene expression patterns, offering insight into cellular identity, function, and disease states. RNAseq-based studies improve over DNAseq by capturing the functional impact of DNA mutations on biomolecules, allowing for the quantification of both the expressed genes and their components (exons). As a result, RNAseq has become a cornerstone of modern biomedical research, enabling tasks such as tissue classification, cancer subtyping, and disease diagnosis based on gene expression profiles.A typical RNAseq dataset captures expression values that typically span tens of thousands of genes and hundreds of thousands of exons, while rarely having more than a few hundred samples - which makes it a high-dimensional, structured, and noisy input space. Despite this, most computational models treat RNAseq data as unstructured input vectors, ignoring both the biological relationships between features and the compositional nature of transcriptomic data. In particular, traditional dense neural networks process each exon or gene as an independent input feature, without modeling the known hierarchical structure where exons group into genes.

In this work, we propose a biologically motivated neural network architecture for RNAseq-based classification that explicitly reflects the underlying exon–gene hierarchy. The model is composed of two levels: (1) exon-level inputs are first encoded into latent vectors and aggregated within each gene; (2) these gene-level representations are then used for downstream classification. This structure reflects biological intuition—capturing variation within genes while preserving gene-level semantics—and introduces inductive biases that improve learning in low-sample, high-dimensional regimes.

We propose a structured input representation that integrates relative exon usage—common in splicing analysis—with gene-level expression scaling, tailored for use in neural models. Each exon is represented by its relative usage within the gene (i.e., its fraction of total gene expression), which captures local splicing patterns. This relative value is then scaled by the gene's overall expression level (e.g., in reads per million), preserving global abundance information. This dual encoding disentangles intra-gene regulatory patterns from overall transcriptional activity, providing a richer signal for classification tasks.

We evaluate our approach on multiple RNAseq-based phenotyping tasks using publicly available datasets. The proposed hierarchical model consistently outperforms baseline dense architectures across metrics such as classification accuracy, convergence speed, and generalization to unseen samples. Ablation studies confirm the importance of both the architectural hierarchy and the structured input representation. We also observe improved feature disentanglement and gradient locality, which contribute to more robust and interpretable learning dynamics.

Our results show that embedding biological structure into both model architecture and input representation can lead to substantial improvements in RNAseq-based classification. This work contributes to the broader effort of aligning machine learning models with domain-specific structure, particularly in computational biology where the data is rich, structured, and semantically meaningful.

Keywords: RNA sequencing, Neural networks, Hierarchical modeling, Transcriptomics, Exon–gene structure, Structured input representation

Acknowledgements - Funded by a DFG grant to MS (project number 439797931)

O-I-2 Applications of Machine Learning Algorithms

Eyal Sadeh

Department of Computer Science, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria.

Email: eyal1983@gmail.com

Abstract: Machine learning (ML), an intelligent type of data analysis and learning, has become a transforming technology today, which has become capable of improving the performance of several industries by automating and predicting. In this paper, a comprehensive review of ML applications in key sectors like healthcare, finance, manufacturing, retail, and autonomous systems have been presented. ML is changing how disease is diagnosed, prognosis can be predicted, and drugs can be discovered in healthcare to enhance patient outcomes and treatment strategies by using huge amounts of medical data. One example of the wide use of ML in modern medicine is predictive modelling for

chronic diseases and the analysis of electronic health records, as well as diagnostic imaging. Also, ML algorithms have been of great use to the financial sector, mostly in fraud detection, credit risk assessment, and stock forecasting. For instance, in the financial sector, ML is used to detect fraudulent transactions in real time using ML-based anomaly detection techniques and to build better investment decisions using predictive analytics. ML is also very important in manufacturing and industrial automation, as it allows predictive maintenance, process optimization, and quality control. ML models can use sensor data to predict equipment failures so that downtime can be reduced and production efficiency optimized. Just for example, recommendation systems fuelled by ML are used in retail and e-commerce industries to make the shopping experience more personalized and interesting for the customers. Demand forecasting using ML improves inventory management, preventing unnecessary inventory costs, including carrying costs and shortage costs. The emergence of autonomous systems, particularly self-driving vehicles, highlights another ground-breaking ML application. With machine learning, autonomous vehicles are able to interpret sensor data, understand items, and make real-time driving choices, which will increase safety on the road and road navigation abilities. In addition to those applications, the paper goes on to explore the areas of current ML TRENDS, such as deep learning, reinforcement learning, and generative models. However, these advancements have enabled these types of performance to be achieved in areas like computer vision, natural language processing, and decision-making. Besides becoming an integral part of the Internet of Things (IoT), quantum computing, and blockchain, the adoption of ML is being extended in various industries. Some of the huge challenges to the adoption of ML are ethical concerns, bias in AI models, data privacy issues, and the requirement for explainable AI. These challenges have to be addressed if you want the ML applications to be fair, transparent, and responsible. This literature review covers all the state of ML applications in respective domains with their benefits and fuelling challenges to their growth. It is a useful tool for researchers, industry professionals, and policymakers who are seeking to study and establish the use of ML innovations. In all, becoming more of an interdisciplinary lab meant that we needed to become more mature regarding ethical AI frameworks as ML technology continues to develop.

Keywords: Machine Learning Applications, Predictive Analytics, Healthcare Innovation, Industrial Automation, Autonomous Systems, and Ethical AI

O-I-3 Comparative Analysis of Classification Algorithms on Big Datasets using WEKA

Aleksandar Stoimenovski, Irena Atanasova
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
stoimenovski@swu.bg

Abstract: This paper presents a comparative analysis of several classification algorithms implemented in the WEKA (Waikato Environment for Knowledge Analysis) software, focusing on their performance on seven publicly available big datasets, each containing a minimum of 10,000 instances. Six classification algorithms such as Decision Trees, k-Nearest Neighbors (KNN), and Support Vector Machines (SVM), Naive Bayes, Random Tree, and Logistic Regression were applied to large-scale datasets chosen from UCI Machine Learning Repository. The growth of big data requires effective and accurate classification methods, and this study meets that need by assessing how well these algorithms perform and scale on datasets larger than those typically managed by standard methods. For each dataset, we employed a 10-fold cross-validation strategy to ensure a thorough and dependable performance evaluation. In some cases, we also utilized a different testing method, specifically 66% split, a model created from two-thirds of the dataset and tested on the remaining one-third. Afterward, a final model is built using the entire dataset for reporting and any additional classification tasks. This approach is primarily applied to the SVM (Support Vector Machine) and Naïve Bayes algorithms. Our assessment metrics include several essential measures, such as accuracy, precision, recall, F1-score, area under the ROC curve (AUC), and processing time. The findings indicate notable differences in the performance of these algorithms when applied to various datasets. Although algorithms such as Decision Trees and Random Trees showed high accuracy on certain datasets, they also faced challenges when dealing with high-dimensional

data or imbalanced classes.On the other hand, algorithms such as SVM and Logistic Regression performed better in specific situations but typically required more computational resources. Naive Bayes, recognized for its simplicity and efficiency, provided a strong alternative, especially for datasets with distinct feature independence. KNN, although fairly simple, exhibited inconsistent performance based on the selected distance metric and the number of neighbors taken into account. We examine how the characteristics of datasets affect the performance of each algorithm, highlighting their strengths and weaknesses in different scenarios. This comparative study provides important insights into which algorithm is best suited for various big data classification tasks, helping practitioners choose the most suitable technique based on dataset features and desired performance outcomes. Furthermore, we address the scalability issues each algorithm faces when working with very large datasets, proposing potential optimization strategies to enhance efficiency and resource use. Our findings deepen the understanding of algorithm performance in the realm of big data and offer practical guidance for selecting the most effective classification method for specific applications.

Keywords: Big Data, Data mining, WEKA, Classification

O-I-4 The Accessibility Impact from Changing Existing Schools into Experimental Schools without the Establishment of New Schools: Analyzing Kindergarten and Primary Schools of Florina, Greece, a Case Study with QGIS.

Ilias Solakis, Irena Atanasova
South West University "Neofit Rilski", Blagoevgrad, Bulgaria
solakis84@yahoo.gr

Abstract: In this study, the spatial and accessibility effects of converting current kindergarten and primary schools of Florina, Greece, into model and experimental schools without building new educational facilities are investigated. We present a thorough analysis of the effects of such conversions on student travel times, accessibility trends, and educational equity throughout

the region using Geographic Information Systems (GIS) as the main analytical tool. Changes in school catchment areas before and after conversion are measured using transportation analysis, which includes walking distance. We identify regions that are significantly more difficult to reach and have longer trip times using isochrone mapping, network analysis, and spatial statistics. The spatial analysis using QGIS reveals that the area of the conversion of an existing facility to an experimental school experiences disproportionate increases in travel times, with some areas seeing journey times double after conversion. Particularly concerning is the impact on kindergarten students, whose limited mobility options and need for adult accompaniment amplify accessibility challenges.

The conversion of the 4th Primary School and the 7th Kindergarten of Florina into experimental schools in 2012 created "school deserts," where students living in specific areas are forced to walk longer distances than expected. Specifically, students who previously walked 5-10 minutes to reach their school now need up to 30 minutes, even crossing areas of other school units to reach the new school in their region. The attendance data for the 2022-2023 school year indicate that there are viable alternatives that could correct the accessibility problems by transforming a co-located school into an experimental one. Specifically, the conversion of the 1st Primary School to Experimental and the reinstatement of the 4th Primary School as a regular school would restore balance in school planning and reduce pressure on the 1st and 2nd Primary Schools. Similarly, the conversion of the 9th Kindergarten to Experimental and the reinstatement of the 7th Kindergarten to its original state would significantly improve the accessibility. Thus, the travel time isochrones demonstrate that all the student population would be inside the 15-minute travel threshold that educational authorities consider optimal. The proposed changes lead to equal access of students to their neighborhood schools, a reduction in transportation, and a rationalization of the distribution of the student population, without sacrificing the institution of experimental schools.

Based on our GIS analysis of school accessibility in Florina, we conclude that the conversion of existing kindergarten and elementary schools into experimental schools without establishing new facilities creates significant accessibility disparities across the region. Finally, future school conversion initiatives should incorporate accessibility impact assessments prior to

implementation, with particular attention to the unique mobility constraints of young children.

Keywords: Geographic Information System, GIS, QGIS, school mapping, experimental schools, school desert.

O-I-5 Some Robotic Process Automation (RPA) Use Cases and Applications in Financial Industry

Vladislav Yurukov, Irena Atanasova
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
vyurukov@pliak.com

Abstract: Robotic Process Automation (RPA) has gained significant traction in the financial industry due to its ability to enhance efficiency through the automation of repetitive tasks. Doing the right automation at the right time might be challenging because of various considerations like cost, capacity, adoption readiness, maintainability, scalability etc.

This paper outlines several typical use cases for RPA within the finance sector, drawing from a variety of scholarly sources and blending them with our personal experiences from running an RPA program in leading financial companies.

RPA is a technology that uses software robots, or "bots," to automate repetitive, rule-based tasks that are typically performed by human workers. These tasks can include data entry, transaction processing, responding to customer inquiries, translations, optical character recognition. RPA bots interact with digital systems and software in the same way that humans do, using the user interface to capture data and manipulate applications.

According to IBM, RPA combines APIs and user interface (UI) interactions to integrate and perform repetitive tasks across enterprise and productivity applications. This form of automation uses rule-based software to perform business process activities at a high volume, freeing up human resources to prioritize more complex tasks. RPA tools complete autonomous execution of various activities and transactions across unrelated software systems.

RPA lives within the ecosystem of a company by integrating with various business processes and systems. It can be found in departments such as finance, human resources, customer service, and IT. By automating repetitive tasks, RPA helps companies improve efficiency, reduce costs, and minimize errors. Additionally, RPA can be combined with artificial intelligence (AI) to handle more complex use cases and enhance decision-making processes.

One prominent application of RPA in finance is the automation of data entry and processing. This capability allows financial institutions to focus on core business activities while bots handle high-volume, rule-based tasks, leading to improved efficiency and consistency in operations. Furthermore, the use of RPA for tax compliance is particularly noteworthy. Big Four firms have leveraged RPA to scrape data from multiple Enterprise Resource Planning (ERP) systems and consolidate it for tax preparation. This automated approach not only speeds up the tax reporting process but also ensures accuracy by reducing human error.

Fraud detection and compliance operations are also significantly enhanced through RPA. By automating routine checks and monitoring activities, RPA provides the ability to analyse vast volumes of data for discrepancies that may indicate fraudulent behaviour. RPA can enable auditors to focus on more complex tasks by automating preliminary data collection and analysis, thereby enhancing overall audit quality. The integration of RPA with advanced analytics can also facilitate proactive fraud detection, although the nuances of its effectiveness in other sectors like healthcare have been highlighted in related studies.

Keywords: rpa, automation, artificial intelligence, business process, data scraping.

O-I-6 Data mining - based predicting of students' evaluation and students' acceptance of Distance E-learning. Case study: South-West university "Neofit Rilski"

Irena Atanasova, Aleksandar Stoimenovski
South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria
irenatm@swu.bg

Abstract: Data Mining is a process that enables the extraction of hidden, valid, and useful knowledge from large datasets, supporting forecasting and decision-making processes in critical moments. Data Mining analyzes data to discover implicit relationships and patterns that were not previously anticipated, using methods from various fields such as statistics, machine learning, neural networks, database systems, and genetic algorithms. In the study, research, and analysis of the described data in this article (the data was collected through a survey of students studying at SWU during the period 2017-2024), intermediate results from the steps in the data mining process are presented: Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Mining, Pattern Evaluation, and Knowledge Representation.

In the education sector, Educational Data Mining is emerging as a new and rapidly growing practice aimed at identifying and extracting new and valuable knowledge from educational data. The primary goal is to address issues in educational research areas and improve the overall learning process by utilizing various statistical techniques, machine learning algorithms and technics.

This article presents the results of a data mining study conducted at a Bulgarian university, primarily aiming to reveal the high potential of data mining applications for university management and to contribute to more effective student education. The research focuses on developing data mining models to predict students' acceptance of one of the learning formats —distance e-learning and remote learning in an electronic environment—to ensure effective and sustainable education. Distance learning is considered equivalent to full-time and part-time education, while force majeure circumstances such as epidemics and pandemics (e.g., COVID-19) have forced educational institutions to transition to remote learning in an electronic environment. Both types of learning (distance learning and remote learning) are conducted in an online environment. Predicting the acceptance of these two learning formats and student behavior presents potential benefits for universities.

The dataset used for the study includes data collected from a student survey published on the Blackboard e-learning platform. Students enrolled in distance learning complete the survey at the end of each semester, while full-time and part-time students completed the survey between 2020-2022 (due to university closures caused by the COVID-19 pandemic). Several well-known data classification algorithms are applied to the dataset, including rule-based

learners, decision tree classifiers, and nearest neighbor classifiers. The effectiveness of these algorithms is analyzed and compared. Challenges such as data quality, availability, incompleteness, and inconsistency complicate the Data Mining process.

The focus of this article is on developing a model for discovering hidden knowledge and relationships in the data regarding the positioning of distance learning and remote learning in the educational space. For this purpose, a case study approach is used, and Data Mining techniques are applied to predict the acceptance of distance learning and remote learning. The CRISP-DM methodology is used for this research. The study demonstrates that data from a conducted survey can be used to predict student behavior, addressing issues related to the effectiveness and sustainability of distance learning and remote learning.

Keywords: Data mining, Distance E-learning, Students' behavior, Predicting perfomans

O-I-7 Collaborative mindset and AI empowered Knowledge Management

Vladislav Yurukov, Irena Atanasova
FMNS South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
vyurukov@pliak.com

Abstract: The integration of a collaborative mindset with AI-empowered knowledge management presents unique opportunities for organizations to enhance innovation, efficiency, and collaborative practices. A collaborative mindset—characterized by an inclination to work together—fosters improved relationships and shared goals within teams (Edgren & Barnard, 2015). This mindset is crucial for effective knowledge management (KM), as it facilitates the acquisition, sharing, and synthesis of knowledge across organizational boundaries (Guo, 2019)(Liu, 2022). For instance, the combination of collaboration in knowledge management and ecological responsibility creates a framework where enterprises can learn from one another, integrating knowledge and technology to overcome sector-specific challenges (Guo, 2019).

Artificial Intelligence (AI) has become a transformative force in KM by enabling seamless sharing and learning within organizations. AI technologies facilitate the management of vast amounts of knowledge, enhancing the roles of knowledge workers and streamlining processes related to knowledge acquisition and application (Sundaresan & Zhang, 2021). The collaborative effects of AI, particularly in knowledge innovation management, indicate that AI can effectively identify and integrate cross-border knowledge through advanced data analytics (Liu, 2022). Moreover, the establishment of AI-enabled systems allows organizations to redesign their KM roles, leading to more efficient knowledge sharing and innovation processes (Sundaresan & Zhang, 2021).

Furthermore, the notion of a "growth mindset," which encompasses openness to learning and collaborative growth among individuals, aligns closely with effective KM practices. Managers who foster a growth mindset are more inclined to trust their team members and promote collaborative decision-making, enriching the organizational culture and facilitating knowledge transfer (Kouzes & Posner, 2019). This correlation between mindset and collaborative behavior can transform how teams approach challenges, creating environments where team members share ideas and insights more freely, thus enhancing overall organizational performance.

In the educational sector, achieving a collaborative mindset can significantly change the dynamics of knowledge sharing among faculty and students. For example, peer collaboration and mentorship can lead to a shared vision for educational enhancement, mutually enriching the learning environment (Klingenberg & Rothberg, 2022). Universities and industries can leverage AI-driven initiatives to improve collaboration in KM processes, thus promoting innovation and bridging gaps in knowledge transfer (Ankrah & Al-Tabbaa, 2015).

In summary, a collaborative mindset, when empowered by AI, creates a fertile environment for enhanced knowledge management. It promotes effective collaboration, encourages a culture of growth and innovation, and leverages advanced technologies to manage knowledge more efficiently. Organizations that cultivate these elements are better equipped to adapt to changing landscapes and achieve sustainable success.

Keywords: knowledge management, artificial intelligence, collaboration, organizational culture,

O-I-8 Numerical solution of some facility location and inventory control problems

Stefan Stefanov
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
e-mail address: stefm@swu.bg

Abstract: In this paper, some facility location and inventory control problems are considered, in particular, the problem of instantaneous order replenishment, no shortage, and given maximum storage area for all items. A version of this problem with bounded variables (box constraints) is also studied. A necessary and sufficient condition (characterization theorem) that describes the optimal solution of the considered inventory control problem with bounded variables is stated and proved. An efficient algorithm of polynomial computational complexity, based on the characterization theorem, is proposed for solving this problem, and convergence of the algorithm is proved. Some numerical examples that illustrate the proposed approach and the efficiency of the proposed algorithm are presented. An open problem for future research is to study other facility location and inventory control problems and to develop convergent polynomial algorithms for solving the corresponding optimization problems.

Keywords: Convex programming, separable programming, inventory control problems, necessary and sufficient condition, Wilson's economic lot size formulas.

O-I-9 Analysis of data mining algorithms for predicting physical activity of urban populations

Svetoslav Petkov, Irena Atanasova
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
irenatm@swu.bg

Abstract: Modern human science proves that one of the powerful means of preventing diseases in the urban population is increasing physical activity.

The decrease in people's physical activity is a widespread phenomenon, leading to a number of adverse consequences, with the urban population being particularly sensitive to insufficient physical activity. Active physical activities in optimal conditions have a beneficial effect on all human functions.

The main goal of this article is to demonstrate the applicability of various Data mining algorithms, such as classification rules, association rules and decision trees in the field of public health, focusing on the studying the physical activity of the population in large cities. This article shows that the concepts of association rule extraction, classification rule extraction and decision trees can be successfully used to encourage higher physical activity, as a regular human activity. To build and evaluate the models, the authors use the WEKA data mining tools for preprocessing, building association rules, and classification of the data. WEKA is a machine learning workbench that supports many activities of machine learning practitioners and it can be easily extended or customized with new classifiers, clusters, attribute selection methods, and other components.

The scientific research presented in this article was conducted on a set of data collected through a questionnaire, for the population of several regional cities in Bulgaria. The scientific results for the data were obtained using the methodology described above. The questionnaire was distributed in various ways, using different information technologies. The survey itself was implemented using Microsoft forms. The following types of data were collected through the questionnaire: Demographic data (gender, age), Health status, Dietary regimen, Social status and work, and Recreation, sports, and physical activity during free time. The duration of data collection was about six months, the reason for this relatively long period is that the authors wanted to survey people living in different large cities in Bulgaria, with different social and health status.

This study uses machine learning methods to discover hidden knowledge and relationships between the physical activity of the urban population and the health and social status of people living in large cities. The different generated models (decision trees, classification rules and association rules) effectively captured the relationship between physical performance, health and the balance between physical activities during work and leisure. These findings contribute to the existing literature on the topic and provide insights for public

health practitioners to prevent and improve the health status of the urban population.

Ethics statement: Participants in this study voluntarily provided data on their health status, dietary habits and physical activity. All requirements for the protection of personal data were met.

Keywords: Data mining algorithms, Weka, Physical activity, Urban populations

O-I-10 Enhancing Computational Thinking and Code Comprehension through Advanced Parsons Puzzles

Ivo Damyanov, Martin Madzhov
South-West University, Blagoevgrad, Bulgaria
damianov@swu.bg

Abstract: Parsons Puzzles are simplified code-construction exercises where students build programs by selecting and rearranging provided lines of code. As well-established tools in programming education, they promote computational thinking and code comprehension by focusing on code structure rather than syntax. By supplying syntactically correct fragments, Parsons Puzzles reduce cognitive load, enabling students to concentrate on the logical flow and meaning of the code.

Although many implementations of Parsons Puzzles exist today, most offer only standard functionality. They typically support a single language or those with similar syntax and are generally limited to languages following the imperative programming paradigm. To overcome these constraints and expand the variety of puzzles that can be generated, this paper presents an advanced Parsons Puzzles solution. It introduces innovative features designed to enhance applicability across diverse courses and languages, improving the overall learning experience.

This paper explores how a new Parsons Puzzles application can enhance computational thinking and code comprehension among students. The application incorporates several key enhancements: (1) Support for multiple languages and paradigms, including C, C++, C#, Java, JavaScript, Python, and

SQL, covering various programming paradigms. (2) Support for multi-line code blocks to facilitate more complex and realistic coding scenarios. (3) Automatic processing of nested code blocks to aid visualization and comprehension. (4) Introduction of mini-blocks for detailed construction, allowing tasks to be divided into manageable segments targeting specific concepts.

Together, these features enable the creation of customizable, visually intuitive tasks that meet a broad range of educational needs, setting this solution apart from existing implementations. By breaking down complex problems into smaller, focused components, the application supports a step-by-step learning approach, enhancing comprehension. All of this significantly strengthen the fundamental elements of computational thinking—decomposition, pattern recognition, and algorithmic reasoning—through engaging, structured exercises.

The application's development extends beyond traditional programming to support students studying databases and data analysis. Flexible constructs accommodate the nuances of SQL across its various dialects, enabling puzzle-based tasks in this domain. This innovation allows learners to explore database queries and data manipulation interactively—an advancement not currently known to be offered by other Parsons Puzzles platforms.

The authors regard Parsons Puzzles as a vital tool for bridging the gap between block-based programming (e.g., Scratch) and text-based programming with modern, general-purpose languages such as C#, Java, and JavaScript. For students familiar with block-based environments, the ability to manipulate blocks controlling sequences of code text is especially valuable. This approach facilitates the transition to more complex programming paradigms, reinforcing foundational skills while introducing the syntax and logic of versatile languages. Consequently, the application serves as an essential resource for both novice learners and programmers shifting from visual to text-based coding environments.

Keywords: Parsons puzzles, computational thinking, code comprehension

Section: Methodology in Education

O-ME-1 STEAM: learning content development, how to use it, difficulties

Ginka Exner
Department of Physics, Faculty of Physics and Technology, Plovdiv University
Paisii Hilendarski, Plovdiv, Bulgaria
ginka.exner@gmail.com

Abstract: The introduction of innovative practices in school education is a continuous trend in Bulgarian education. One such practice is STEAM (science-technology-engineering-art-mathematics) approach. STEAM centers are being built in almost all schools across the country. The challenge is how to organize and conduct the lessons so that they achieve the targeted positive effect. This report presents an attempt to develop learning content (a cycle of lessons) named "Light, Colors and Our Vision - Brain Games", where physics, biology, chemistry, mathematics and engineering intertwined and complement each other. The concept of developing learning resources (easy to be implemented by teachers and students and using cost-effective materials) and their particular use (free choice of some of them and omitting others, depending on the students' interests) will be presented. The difficulties during the resources development will be discussed, main of which has been the lack of synchronization between school subjects.

Keywords: STEAM, education, innovative educational practices, secondary and higher education

O-ME-2 Distance and Independent Learning Contents in a Digital Environment

Boboyev A.X., Jo'raqulova Z.I., Toshniyozova F.B.
Tashkent Institute of Chemical Technology, Uzbekistan
toshniyozovafarangiz@gmail.com

Abstract: This article analyzes the role of distance and independent learning contents in a digital environment, their significance in modern education, their effectiveness, and the specific features of their development. Special attention is paid to methodological approaches in creating digital content, its application, and increasing student engagement in independent learning.

Education in the 21st century is unimaginable without digital technologies. In particular, the development of distance and independent learning formats has necessitated the formation of educational content in new directions. The digital environment is a new learning space built on interactive, multimedia, and freely accessible resources.

What was once considered a futuristic concept — learning through digital technologies — has now become an integral part of the modern education process. E-learning is gradually replacing traditional seminars, lectures, and conferences, enhancing the effectiveness of the education system. One of the primary reasons is the adaptability of e-learning to modern conditions. Distance learning is a form of education in which the learning process is organized without physical interaction between teacher and student, using modern information and communication technologies. In such a process, compared to traditional education, the structure of the academic workload has unique characteristics and is divided into contact hours and independent study sessions.

Independent Study Sessions:

Independent learning allows students to acquire necessary knowledge without direct instructor involvement, in a timely and self-regulated manner. These sessions include:

- Studying lecture texts, textbooks, and manuals;
- Completing homework, essays, and term papers;
- Participating in online tests and assignments;
- Working on course or project work;
- Completing tasks through Learning Management Systems (e.g., Moodle).

Distance Learning Content:

Distance learning content refers to educational materials delivered via the Internet, including:

- Video lectures
- Presentations

- E-textbooks
- Online tests and assessment tools
- Forums and discussion groups

Independent Learning Content:

Independent learning content comprises resources that can be acquired at the learner's own pace and presented flexibly, such as:

- Self-assessment tests
- Educational modules
- Digital projects
- Archives of video lessons
- Virtual laboratories

The Role in Student Learning:

Digital and distance learning content offers students:

- The ability to learn at their own pace,
- Improved digital literacy,
- Enhanced critical thinking and independent decision-making skills,
- Opportunities for self-assessment.

This research highlights the effectiveness of distance and independent learning content in a digital environment, student demand for these resources, and their advantages in educational settings. The findings show that student interest and engagement in independent learning largely depend on the quality and interactivity of the digital content used.

Content delivered in a distance learning format offers students flexibility, self-assessment opportunities, and autonomy over their learning pace. Particularly, visual and interactive materials — video lectures, quizzes, interactive presentations — were highly rated among students.

Moreover, the educational value, technical quality, and user-friendliness of content play a crucial role in content development. Digital content should not only convey knowledge but also motivate students to engage actively in the learning process.

Keywords: Digital environment, Distance learning content, Independent learning resources, Interactive educational materials, E-learning technologies, Students' digital activity

References*:*

1. Usmonov B.Sh., Khabibullaev R.A. “Digitalization of the educational process in a credit-module system through Google Sheets.” Human Capital Scientific-Practical Journal. 5(161)-2022, Vol. 2, pp. 12–20.

O-ME-3 Application of Metacognitive Strategies and Artificial Intelligence in the Learning Process

Lyuba Petrova
Konstantin Preslavsky University of Shumen, Shumen, Bulgaria
lyubap237@gmail.com

Abstract: In this article, the application of metacognitive strategies in the learning process of rational inequalities in 9th grade is examined, as part of the mathematics curriculum for general education. The study integrates the use of artificial intelligence (AI) applications to support students' self-reflection and self-regulation. It is conducted over 12 lessons, during which students use various platforms and tools to solve problems related to rational inequalities. The aim is to explore how combining metacognitive strategies with AI can enhance students' understanding and increase their confidence in solving mathematical problems.

Metacognitive strategies involve awareness and control over the cognitive processes students use when solving problems. These strategies cover three main stages: planning the approach to problem-solving, monitoring the process while solving, and evaluating the outcome after solving the problem. The goal is for students to be able to reflect on their thought processes and regulate their actions while solving problems, thereby improving both their understanding and problem-solving skills on the topic..

AI applications can be easily integrated into the learning process, allowing students to visualize solutions to inequalities, verify calculations, and receive additional explanations for complex questions. AI-based systems offer personalized learning opportunities, adapting the process to meet students' individual needs. This enables students to receive real-time feedback, facilitating the quick identification and correction of errors. AI chatbots, as well as specialized calculators, also assist students in developing various problem-

solving strategies by offering different perspectives and approaches to problems.

The study does not involve pre-assessments, and progress is evaluated through real-time observations of participation and problem-solving. Individual progress and difficulties are monitored for each student. A post-test is conducted at the end of the learning period to assess the effectiveness of the strategies and AI tools used.

The findings of the study indicate that the integration of AI applications into learning enhances students' metacognitive skills, boosts their confidence in mathematical abilities, and improves their problem-solving strategies. The study provides valuable insights into the effectiveness of various AI tools and their role in developing students' self-regulation and self-reflection.

Keywords: Metacognitive strategies, Artificial intelligence, Personalized learning, Problem-solving strategies

Acknowledgements to Scientific Research Fund of South-West University "Neofit Rilski" – Blagoevgrad and Project “Synergy between Robotics and AI in Mathematics and Information Technology Education”, RD-08-76 /31.01.2025

O-ME-4 Continuity issues in the content of the chemistry course between secondary school and university

A.B. Toibazarova, N.O. Appazov

Korkyt Ata Kyzylorda University, Kyzylorda, Republic of Kazakhstan

Abstract: This study addresses the continuity challenges in chemistry education between secondary schools and universities. The gap between university expectations and the actual preparedness of high school graduates in chemistry presents ongoing challenges. The article highlights inconsistencies in curriculum content, teaching methods, and assessment standards. A pedagogical experiment was conducted to examine the impact of introducing the topic "Analytical Research Methods" in Grade 10 chemistry, including practical applications such as paper chromatography. The experiment involved school students and undergraduate chemistry students, resulting in a measurable improvement in research skills. The study suggests integrating physical and chemical analysis methods into the training of future teachers. A

specialized course was developed to address these requirements, aiming to foster experimental and analytical skills through consistent lab work. Based on the results, methodological guidelines were proposed to enhance the transition from school to university education. The study emphasizes collaboration between schools and universities, highlighting that systematic inclusion of analytical methods enhances student preparedness and motivation. Improving continuity in chemistry education is essential for forming competent professionals ready to meet modern academic and labor market demands.

Keywords: chemistry education, continuity, secondary school, higher education, transition, laboratory skills

Acknowledgment: Supported by the scientific project under the National Plan “100 concrete steps”.

O-ME-5 Cross curricular relationships in teaching mathematics and informatics in lower secondary school

Mediha Topalova, Daniela Tuparova
South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria
medihatopalova@swu.bg

Abstract: Mathematics and Computer Science, while often taught as separate subjects, are fundamentally intertwined due to their shared reliance on logical reasoning and precise problem-solving. This inherent connection presents a valuable opportunity to enhance student learning by integrating the two disciplines.

The core idea is that computer sciences can serve as a practical, hands-on tool to reinforce and deepen mathematical understanding. By providing concrete applications of some mathematical concepts, computer science can make these concepts more accessible and intuitive for students, particularly in lower secondary education.

The theory behind this integration rests on the principle that learning is most effective when students can see the relevance and application of abstract concepts. Computer Science, with its emphasis on problem-solving, algorithms, and data manipulation, offers a tangible context for applying mathematical

principles. This practical application can bridge the gap between abstract mathematical theory and real-world understanding.

Specifically, the article proposes that by leveraging the computational (and as a whole – mathematical) aspects of Computer Science, educators can enhance students' comprehension of key mathematical areas. For example, the concept of variables, which can be abstract in mathematics, becomes concrete when students manipulate variables in a computer program. Similarly, the process of developing algorithms reinforces logical thinking and problem-solving skills, which are essential in mathematics. This way the knowledge of a student deepens and the chances of understanding how to deal with such variables in both sciences are presumably higher.

The article gives specific examples of realizing the cross-curricular relationships between mathematics and computer sciences while teaching the latter of them. Some of the tasks are using visual block programming (5^{th} grade) for improving the logical thinking of the students. Others are oriented towards using spreadsheet software (like MS Excel) so that it can be seen how a lot of mathematical tasks can be solved by such program. Some examples include creating images while using known or about to be studied geometry figures and also drawing developments of three-dimensional figures. And also, another great opportunity is showing some mathematical tasks while coding with scripting programming language – such as using decimals or negative numbers, or as stated above by variables.

The final goal is to explore whether incorporating computer sciences into the curriculum can positively impact a student's grasp of mathematical knowledge. The argument is that by illustrating mathematical concepts through practical computational applications, students can develop a deeper and more meaningful understanding of both disciplines. This integrated approach aims to make learning more engaging and effective, ultimately fostering stronger mathematical and computational skills.

Keywords: teaching mathematics, teaching informatics (computer sciences), cross curricular relationships, lower secondary school

O-ME-6 Methods for Introducing Optimization Algorithms and Mathematical Modeling into the High School Mathematics Curriculum (Grades 8–10) through Interactive Platforms – Wolfram Alpha and Matlab

Elitsa Atanasova, Feim Musankov
South-West University „Neofit Rilski", Blagoevgrad, Bulgaria
eliatanasova@swu.bg musankov@swu.bg

Abstract: In contemporary school education, the need to explore new methods and activities to engage students' interest in studying mathematics as an academic subject is becoming increasingly important and essential for achieving future results. In this context, new combinatory methods are being applied more frequently, combining traditional teaching approaches with innovative strategies, incorporating the use of digital technologies. **The main motivation and goal** of the study is to spark students' interest and help them develop motivation for learning by combining the following method of teaching mathematics at the lower secondary education level: working with a textbook during a lesson introducing new material in the "Optimization" section, which is then further developed in a computer lab using mathematical modeling software – Matlab or Wolfram Alpha.

A school club titled "Optimize Easily with Mathematical Software" will be established. During the respective sessions, students who voluntarily join the club will be introduced to new methods and approaches for solving everyday problems in various fields (such as economics, agriculture, tourism, sports, etc.) through mathematical tasks and models in a computer lab, using specialized software for solving optimization problems in mathematics – Matlab and Wolfram Alpha. The study also includes an examination of the capabilities of these software products when working with optimization algorithms and mathematical modeling—topics that can enhance logical thinking and data analysis skills among the younger generation.

The subject of the study is the educational and cognitive activity of students from the first stage of secondary education (grades 8–10) within an interactive learning environment during lessons introducing new material and practice exercises, as well as during self-directed extracurricular activities—interest-based clubs. This study focuses on the use of software tools in modeling

and solving optimization problems, with the transportation problem, as part of linear programming, along with the process of constructing a mathematical model.

The research methodology is based on conducting practice-oriented lessons with students from the first stage of secondary education, where each student has access to a computer and uses software to solve specific tasks and visualize the answers/solutions. This is followed by student surveys aimed at testing the hypotheses regarding preferred problem-solving methods. The survey data is analyzed quantitatively, and the results are presented in graphical form. Through the evaluation and analysis of students' practical activities in an interactive environment, and by applying the discussion method, the qualitative results achieved by the participating students are also assessed.

The first hypothesis is that teaching in a traditional classroom using a textbook, whiteboard, and marker for lessons introducing new content, combined with the use of software in a computer lab during practice lessons on the topic of "Optimization," will increase students' interest in studying mathematics as a school subject in secondary education.

The second hypothesis is that the classical model of teaching students in grades 8–10 remains the preferred method among students when learning mathematics—that is, using chalk and a blackboard without the integration of technology in the learning process.

Keywords: optimization algorithms, mathematical modeling, computer lab, optimization problems, mathematical problem modeling software.

O-ME-7 Trakya University STEM Innovation Lab: Philosophy, Structure, Projects, and Future Vision

Sertaç Arabacioğlu, Eylem Bayir
Trakya University, Faculty of Education, Edirne, Türkiye
sertacarabacioglu@trakya.edu.tr

Abstract: Established within the Faculty of Education at Trakya University, the STEM Innovation LAB is a project-based and interdisciplinary space for learning, designing, and research. The lab's primary goals are to provide

preservice teachers with innovative learning opportunities that integrate technology, pedagogy, and content knowledge, and to guide researchers in the process of incorporating current technologies into educational settings. This study aims to introduce the lab's core philosophy—one that goes beyond traditional approaches—its working model, sub-units, projects, and future vision. The philosophy of the STEM Innovation LAB is grounded in an authentic understanding of STEM education. With a focus on design and engineering processes, the lab aims to develop unique educational tools and contents. The activities are designed to help students understand concepts in mathematics, science, engineering, and technology through innovative methods. The lab adopts a data-driven approach, using data to assess designs and improve engineering processes. With a process-oriented perspective, the skills and insights students gain through experience, knowledge, and inspiration are valued just as highly as the final products itself. All activities align with current educational curricula and international standards. This dynamic structure positions the lab as a continually evolving, "living organism" and instills a mindset of continuous improvement in its participants. The lab includes specialized sub-laboratories such as the 3D modeling and printing lab, digital tools lab, video production lab, augmented reality (AR) and digital futures lab, 3D digital design and scanning lab, Metaverse (META) digital learning lab, artificial intelligence and coding lab, artificial intelligence and robotics lab, and the green STEM lab. The STEM Innovation LAB hosts a wide range of projects, including international, national, student-centered, and social responsibility initiatives. It also maintains active collaborations with various institutions and organizations in the city of Edirne. The lab's funding primarily comes from these projects and scientific activities. With its flexible, production-focused structure that adapts to project and design needs, the lab stands out as a model of best practices in its field. Looking ahead, the lab aims to serve as a project-based guidance and mentoring hub for other university departments and researchers.

Keywords: STEM Education, Learning & Teaching Space, STEM Innovation Lab

O-ME-8 Modeling with scratch for solving movement problems at the lower gymnasium level

Rositsa Georgieva
Department of Mathematics, South-West University "Neofit Rilski"
Blagoevgrad, Bulgaria
r_georgieva@swu.bg

Abstract: The focus of the article is an exemplary Scratch project, implementing cross-curricular connections and aiming to assist teachers in teaching and students in solving text-based movement problems at the lower secondary level. Methodological guidelines for using the project in mathematics education are given. The terminology related to cross-curricular connections and their place in teaching various academic disciplines is presented. The conclusion discusses the possibilities for applying Scratch projects to implement cross-curricular connections in teaching at the lower secondary level.

Keywords: cross-curricular connections, teaching approaches, modeling.

O-ME-9 Interactive Learning with Virtual Reality and 3D Printing

Damyana Grancharova
Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
damyanat@yahoo.com

Abstract: Modern education is changing due to technological progress, and thus educators are now able to approach students differently. VR and 3D printing, along with the most creative inventions, make possible the use of interactive and immersive learning experiences in the classroom. These wonderous gadgets do not only help the students stay interested, in addition, they provide a much deeper experience by allowing them to be involved in the learning process through the use of virtual 3D animation. This article goes on to

discuss the role of VR and 3D printing in education, their impacts, and the ways they might change the course of traditional teaching.

The use of VR allows the students to reach the 3D rendering of the human body, make virtual chemical experiments without a danger, and to travel through space and time. Encouraging students in their everyday life to be more creative, VR helps them to gain insights, thus improving both engagement and knowledge retention. In addition to that, VR promotes active learning, saving the students from the role of passive information consumption, which is the soul of an educational setting.

3D printing brings revolution in education by linking the gap between theory and practice. This creates the opportunity for students to fully understand the concepts by making physical models of science diagrams, geometric designs, historical sculptures, and engineering prototypes. By using 3D printing in STEM education, the students can create realistic prototypes which will help them develop different abilities to understand and pursue engineering, science and design.

The integration of VR and 3D printing into education does not only personalize learning but also is suitable for different learning styles and abilities. For those students who prefer to see or touch materials during the learning process, the two mentioned technologies are particularly beneficial as they can create a more interesting approach than conventional lectures and textbooks. In addition to that, they enable inclusive education by means of customized strategies, which are highly appropriate for the individual differences exhibited by students with disabilities. For example, students with visual disabilities can "touch" 3D printed models and teachers can produce VR to imitate a school setting with the freedom to customize it according to the student's need.

In conclusion, VR and 3D printing have an impact on education by allowing students to participate in the learning process by using interactive and engaging methods. These technologies make sure that students get more involved, understand the concepts better, and learn to work and think out of the box. The educational institutions now include more digital transformation therefore the future of learning is associated with the appropriate using of VR and 3D technology, which makes education more immersive, reachable, and customizable.

Keywords: Virtual reality, 3D printing, education, interactive learning

O-ME-10 Non-formal style in mathematics teaching

Nataliya Pavlova
Konstantin Preslavsky University of Shumen, Bulgaria
n.pavlova@shu.bg

Abstract: This paper presents some possibilities for inserting an informal style of learning into the classical mathematics lesson. The concepts used are clarified – formal, non-formal and informal learning and the characteristic communication style in informal learning. Some studies are presented, aimed at the benefits and possibilities of non-formal and informal learning for increasing mathematics achievements in formal learning. Various examples are given, in an informal style, which can be implemented in the classical mathematics lesson. In the article, the focus is on the application of elements (dialogues, texts, images and videos), atypical for the classical mathematics lesson and distinguished by an informal style of communication and presentation of information. The main idea of this approach is for the teacher to enter the surrounding environment in a non-formal way, as a bearer of a non-standard view of mathematics. The goal is for the student to have internal motivation to have fun with humor with mathematical subtext. Specific examples are given and methodological guidelines for their application in formal learning are described.

The needs of the alpha generation suggest the use of a number of visual elements. Along with the classic ideas for presenting mathematical material through non-formal expression and the use of funny images, proposed by Shporer, Gardner, Steinhaus etc., some modern options for presenting humorous ideas, such as memes, are also presented.

The Internet is full of such examples that can be used in a ready-made form, modified according to the goals of the lesson, or created independently by teachers and students. By using such memes in a classic mathematics lesson, the teacher can provoke students' internal motivations for informal mathematics learning by creating and sharing mathematical memes on social networks. It should be noted that such a desire is rarely manifested in the mass student.

The requirements and characteristics of each new generation change and it is often difficult to cover all aspects of the organization of the learning process. The global trend is for training to be directed in a practical and applied direction.

For this purpose, work is being done on the implementation of STEM training and the application of the competency approach. At this stage, it is important to use not only methodological techniques to stimulate interest and motivation for studying mathematics, but also psychological techniques that increase interest and a positive attitude towards the subject. The insertion of humorous elements and the use of a non-formal style in certain lessons is applied by teachers and leads to a lightening of the atmosphere and a reduction in stress among students, but it is important when applying this style to ensure compliance with the principle of scientificity and purposeful and conscious insertion of such fragments.

Keywords: informal learning, non-formal learning, mathematics, images, humor

O-ME-11 Integrating Sudoku into 5th grade mathematics classes

Ivayla Gergova, Boyana Garkova
South-West University, Blagoevgrad, Bulgaria
iv.iv.gergova@gmail.com

Abstract: The transition from primary to lower secondary education presents challenges for many students, especially those from Generation Alpha. On one hand, they have strong technological skills, but on the other, they often lack soft skills such as effective communication, teamwork, and problem-solving. Supporting students through this critical stage of development requires creative, student-centered pedagogical approaches that go beyond traditional methods. This paper explores the integration of sudoku puzzles as an innovative educational tool in mathematics education for 5th-grade students.

Sudoku is widely recognized not only as an entertaining puzzle but also as a tool that develops logical thinking, concentration, and error-checking skills. Modern variations of sudoku differ from the classical version by introducing additional constraints, symbolic representations, and thematic connections. These adaptations allow puzzles to be linked with mathematical concepts as

well as real-world contexts, making them more engaging and relevant for students.

As part of this work, educational materials have been created to support the integration of Sudoku-based activities in the classroom. These resources include printable worksheets, online puzzles, interactive presentations, and augmented reality visualizations. Each puzzle is presented through storytelling, creating an inclusive and motivating learning environment that encourages active participation and student creativity. The materials are aligned with the 5th-grade curriculum, addressing topics such as prime and composite numbers, fractions and decimals, parts of a whole and percentages, and three-dimensional shapes like rectangular prisms and cubes. The main goal is to develop key mathematical skills such as pattern recognition, understanding sequences, exploring logical connections, and spatial reasoning. These competencies are essential not only for academic success but also for developing critical thinking and lifelong learning.

The integration of game-based learning through Sudoku enriches mathematics education. It supports both the cognitive development and the social-emotional growth of students. By offering meaningful, interactive challenges, sudoku empowers students to become active participants in their own learning journeys.

Keywords: sudoku, mathematics, education, game-based learning, soft skills, 5th grade

O-ME-12 Prospective Teachers' Demographic Characteristics and Their Beliefs about Their Preparedness to Teach Mathematics

Metodi Glavche
Ss Cyril and Methodius University, Faculty of Pedagogy in Skopje, Macedonia
mglavche@gmail.com

Abstract: An empirical study examining whether a set of demographic characteristics of prospective primary school teachers and pre-school teachers influence reports of their beliefs about their personal preparedness to teach mathematics was conducted on a sample of university students within the

framework of a larger national study, “The beliefs of future primary school teachers and preschool teachers about the nature of knowledge, about learning and about teaching mother tongue and mathematics”. The sample consists of students in their fourth year of university study programs for primary school teachers, for pre-school teachers, and for pedagogy, from all four Macedonian universities offering these study programs (N=161). The basic data collecting tool was a questionnaire consisting of items taken and adjusted from the TEDS-M study. The data analysis was conducted using Mann-Whitney U and Kruskal-Wallis H nonparametric tests (IBM SPSS 20).

The results suggests that gender, language of instruction (Macedonian, Albanian or Turkish), educational levels of parents, as well as respondents’ secondary education type (general or vocational) and secondary education average grades to a various degree influence certain aspects of prospective teachers’ reported beliefs regarding their theoretical and practical preparedness to teach mathematics. Conclusions are deduced and some recommendations are considered with respect to the future teachers’ demographic characteristics which have to be taken into account when designing and implementing mathematics methods courses within initial teacher education with the goal of developing the required professional knowledge and beliefs. School based practice needs to be set in place in manners which support a cohesive integration of theoretical knowledge and effective practical approaches to classroom challenges which await the new teachers in their induction years. Adequate opportunities for reflections on one’s own teaching practices and the associated professional beliefs have to be developed with the aim of equipping prospective teachers with appropriates tools for self-evaluation and lifelong learning skills.

Keywords: teacher education, mathematics methods courses, gender, language of instruction, study program

O-ME-13 The role of the competency-based approach in stem education

Krasimir Harizanov
Konstantin Preslavsky University of Shumen, Shumen, Bulgaria
kr.harizanov@shu.bg

Abstract: STEM education (science, technology, engineering and mathematics) is gaining increasing importance in the modern world, preparing students for the challenges of the future. In this context, the competency approach plays a key role, as it places emphasis not only on the acquisition of knowledge, but also on the development of skills, attitudes and abilities that are applicable in the real world. The competency approach differs from other approaches by emphasizing the practical application of knowledge. In STEM education, this means that students do not simply memorize theoretical information, but use it to solve real problems using scientific methods, engineering thinking and technological solutions.

STEM environment, develops critical thinking, creativity, teamwork, problem-solving skills and technological literacy. These skills are essential for the personal and professional development of students in the dynamic world of the 21st century. The competency-based approach includes integrated learning through projects in which students apply knowledge from different disciplines simultaneously. This creates conditions for deeper understanding, engagement and active participation in the learning process. This approach takes into account the individual progress and learning style of each student. The competency-based model places emphasis on the outcome of learning and the acquisition of skills, which allows for more flexible and effective learning.

The purpose of this article is to present the role of the competency-based approach in STEM education, emphasizing its importance for developing key skills and preparing students for the challenges of modern society. Attention is paid to the teacher and his role in the learning process. His important task in STEM education is to connect knowledge from different subject areas and show how it is applied to solving real problems. This requires flexibility, creativity and the ability to work in a team with colleagues from other disciplines. The teacher plays a central role in developing key skills in students - such as critical thinking, communication, collaboration and the use of technology. He must not only master technology, but also integrate it effectively in education. It is necessary to create a culture of curiosity, to show these benefits of science and technology in practice, as well as to support students.

STEM education with the application of a competency-based approach prepares students for the professions of the future, building them capable of adaptation, independent learning and solving emerging challenges. This is to form responsible and proactive individuals. The competency-based approach to

STEM education is a modern and effective model that combines knowledge, skills, and attitudes into a unified learning process. It is key to shaping future professionals, innovators, and responsible citizens capable of addressing the challenges of the global world.

Keywords: STEM education, competency-based approach, Project-based learning

Acknowledgements: This paper is (partially) supported by Scientific Research Grant of RD РД-08-76/31.01.2025 of the Scientific Research Fund of Shumen University "Bishop Konstantin Preslavski"

O-ME-14 Creative Activity in Food Industry Engineering

Rano Mirsamikova, Botir Usmonov
"Languages" Department, Tashkent Chemical-Technological Institute
irrb@tkti.uz

Abstract: The activities of food industry engineers represent a complex and multifaceted process, encompassing theoretical and practical work, study, understanding, generalizing and sharing experiences, and exploring research data and findings. Knowledge of the fundamentals of psychology enables an engineer to influence their creative activities. The article outlines the foundations of engineering creativity psychology and demonstrates their connection with various concepts.

O-ME-15 The implementation of stem education in the higher education system

Gulnora Aripova, Abror Boboev, Mahmuda Tadjibaeva
Tashkent Institute of Chemical Technology, Uzbekistan
shuhgul711@gmail.com

Abstract: This article analyzes the relevance, practical application, and prospects of implementing and developing the STEM (Science, Technology, Engineering, Mathematics) education system in the Republic of Uzbekistan. In

the era of globalization and digital technologies, the STEM approach has become one of the key priorities in the global education system, and Uzbekistan's higher education system is also actively supporting this direction. The article highlights the importance of the STEM approach in training competitive, innovative, and practically skilled specialists, as well as its role in fostering 21st-century skills such as interdisciplinary integration, creativity, and critical thinking.

Based on available statistics from the Republic of Uzbekistan, the implementation of STEM education at various levels (preschool, general secondary, and higher education) has been examined. Specifically, out of 2.9 million children aged 3 to 7, 74% attend preschool, yet only 0.02% of them receive education based on the STEM model. Similarly, it is noted that more than 6.5 million students are enrolled in general secondary education institutions, over 1.5 million children attend preschool institutions, and more than 300,000 students are studying in higher education institutions. According to 2020 data, there are 420 specialized schools in Uzbekistan, but the STEM model has been implemented in only a few of them, covering just 0.03% of the total number of students.

The article also provides information about initiatives to introduce specialized courses, academic programs, and laboratories in the field of STEM at higher education institutions in Uzbekistan. Project-based learning, the integration of art and design elements with engineering disciplines, and practice-oriented approaches are described as some of the key advantages of the STEM education system.

The necessity of the STEM approach is emphasized in order to develop students' creative and technical skills, foster innovative thinking, and prepare them for new technologies and scientific research within higher education institutions. At the same time, the lack of STEM laboratories, the limited number of methodological resources, and the incomplete implementation of modern educational technologies at all levels are identified as existing challenges in the country.

In conclusion, the article analyzes the current state and future prospects of STEM education in Uzbekistan, substantiating its role in the country's scientific, technological, and economic development. The STEM approach is regarded as a key tool for modernizing Uzbekistan's education system, fostering

an innovative society, and preparing specialists who meet international standards.

The STEM system emphasizes the adaptation of students to modern professions, the development of innovative thinking, and the transformation of students into competitive specialists with practical knowledge. Unlike traditional education, STEM education does not limit itself to theoretical knowledge but focuses on developing students' practical and creative skills. Thus, this system is seen as a key factor in the scientific, technological, and economic development of Uzbekistan.

Keywords: STEM, educational methods, competitiveness, innovation, integration, creative thinking

O-ME-16 Application of a research approach in stem education

Sevinch Mustan
Konstantin Preslavsky University of Shumen, Shumen, Bulgaria
s.mustan@shu.bg

Abstract: In modern education, increasing importance is given to approaches that develop various qualities in students, such as active learning, critical thinking, real-world problem solving, etc. One such innovative approach is STEM education, which unites the four main subjects of science, technology, engineering, and mathematics. It is relatively new for Bulgarian teachers and the challenges surrounding its teaching are diverse. The lack of literature and sufficient skills to work with the various devices and components makes it difficult for teachers, but with the establishment of STEM centers in schools, teachers will have greater freedom to experiment and develop their skills. On the other hand, there are training courses, groups on social networks where teachers exchange experiences and ideas, as well as mobile applications to be used during classes. With this approach to learning, students are presented with real-world problems that they must solve. One of the most effective methods for implementing this type of learning is the inquiry-based approach, which

plays a key role in STEM education by encouraging students to analyze a problem, experiment, and discover new solutions.

One way to present these problems or challenges is through STEM cards. They are a tool for developing key competencies in students. STEM cards are an interesting way to present a challenge and can be used both during classes and in extracurricular forms. They enable easier learning of more complex concepts for individual work or teamwork, and thanks to them, students not only acquire important knowledge and skills, but also learn to work in a team. The most interesting part of these cards is that they allow students to experiment with different devices and components. This increases their interest in science and technology. Using such cards during training has other advantages, namely, they show the direct connection between theory and practice. Also, in this way, learning in the relevant subject becomes more interesting and useful for students.

This article presents several basic aspects of STEM education. It examines the importance of STEM education for modern education and how it can be implemented in the classroom. Then, STEM cards are examined and analyzed, presenting their structure, purpose and advantages. Another aspect is the methodology of working with STEM cards. Here, the ways of creating and working with STEM cards are presented, as well as the different approaches to including them in the classroom. The article also presents specific projects that have been implemented using STEM cards, the results obtained from their application, as well as the impressions of the students.

In conclusion, some recommendations for the successful integration of the research approach into education are discussed, emphasizing its importance for shaping future STEM professions.

Keywords: STEM education, STEM challenges, STEM cards, challenge cards, project-based learning

Acknowledgement: This paper is (partially) supported by Scientific Research Grant of RD-08-76/31.01.2025

O-ME-17 Challenges in Informatics Education: Analysis and Improvement Proposals

Samuil Zherev, Elena Karashtranova

Department of Informatics, Faculty of Mathematics and Natural Sciences,
South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
e-mail: sjerev@gmail.com

Abstract: In today's information society, informatics education holds a strategic place within the educational system, preparing students for active participation in the digital society. However, in Bulgaria and many other countries, there are significant challenges related to curriculum content, organizational structure, and resource provision for this subject.

This study presents an overview of the state of informatics education at national level. A critical analysis of current curricula and teaching strategies is conducted, identifying key difficulties encountered by both students and educators. In the context of Bulgaria, the subject is primarily taught at lower and upper secondary levels, with higher quality observed in specialized tracks, although access and scope remain limited.

A survey was conducted among informatics teachers working in specialized secondary classes. The analysis of the collected data reveals several major problems: outdated curricula, lack of practical and interactive resources, limited access to modern technology, and the need for additional teacher training. Difficulties in motivating students to actively engage in the learning process were also reported.

The study highlights the need for a comprehensive and integrated approach to the transformation of informatics education, with a focus on practicality, innovation, and cross-sector collaboration.

Keywords: informatics education, survey research, pedagogical model

POSTER SESSION

Chemistry

P-C-1 Could an Aurophilicity play a role in dimeric Au (III) Diiminoisoindole Complexes? The Group 11 Complexes for the 11th FMNS!

Stanislava Majerova, Zdenka Ruzickova, Ales Ruzicka
Department of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Pardubice, Czech Republic
zdenka.ruzickova@upce.cz

Abstract: A group of unsymmetrically substituted diiminoisoindoles was prepared and the coordination abilities of these ligands were systematically investigated. A significant group of prepared compounds are coinage metal complexes. These dimeric complexes contain unusually short metallophilic interactions between metal atoms in solid structure, as confirmed by X-ray crystallography. Their structure, properties and possible uses were investigated. Counterintuitively, unusually short metal-metal distances have also been observed also in the case of Au (III) complexes. Does similar phenomenon exist even in these complexes? And what about in solution?

Keywords: diiminoisoindole, Group 11 elements, metallophilicity

Acknowledgement: The work was supported by the Czech Science Foundation (No. 25-17434S).

P-C-2 Positively charged heteroboranes: Synthesis and reactivity

Vlastimil Němec, Josef Holub, Maksim Samsonov, Jan Vrána, Aleš Růžička
University of Pardubice, Pardubice, Czech Republic
Institute of Inorganic Chemistry, Czech Academy of Sciences, Czech Republic
vlastimil.nemec@student.upce.cz

Abstract: The polyhedral boranes and heteroboranes appear almost exclusively in neutral or anionic forms, while the cationic bear the positive charge at exoskeletal heteroatoms. The cationic boranes remained elusive until 2020, when Spokoyny[1] published closo-B_{12}(O-3-methylbutyl)$_{12}^{+}$ radical cation, which decomposes at - 30 °C. In 2021, we published the first thermally robust cationic heteroboranes[2] derived from the electron-rich 10-vertex carboranes supported by *N*-heterocyclic carbenes. In this work, the synthesis of new positively charged heteroboranes will be presented. The reactivity of electron-rich carboranes can be modified by the change of the donor base (various *N*-heterocyclic or mesoionic carbenes), which has crutial impact of their reactivity. New types of positively charged carboranes were prepared by the reaction with these clusters. These compounds are also suitable for coordination of metal cations ranging from lithium to bismuth including also transition metal compounds.

Keywords: 10-vertex carboranes, *N*-heterocyclic carbenes, Coordination chemistry

P-C-3 Biosorption of industrial dyes by the dried and inactivated lichen Usnea barbata

Katarina Stepić, Radomir Ljupković, Jovana Ickovski, Slobodan Ćirić, Aleksandra Đorđević, Tijana Jovanović, Aleksandra Zarubica

Department of Chemistry, Faculty of Science and Mathematics, Niš, Serbia

aleksandra.djordjevic1@pmf.edu.rs

Abstract: The significant expansion of industrial activities on a global scale has greatly contributed to water pollution, primarily due to the discharge of wastewater containing a wide range of organic contaminants, among which synthetic dyes are particularly problematic. These compounds exhibit high chemical stability and low biodegradability, enabling their prolonged environmental persistence and posing a threat to aquatic ecosystems and human health due to their potential toxicity, mutagenicity, and carcinogenicity. Bio-based materials are attracting growing scientific attention due to their notable biosorption capabilities, which play a significant role in enhancing the removal efficiency of various contaminants from aqueous environments. This

study investigates the potential application of *Usnea barbata*, a lichen species, as a biosorbent for the removal of three structurally distinct dyes: Methylene Blue (MB), Crystal Violet (CV), and Acid Red 183 (AR 183). Methylene Blue and Crystal Violet are cationic dyes, whereas Acid Red 183 is an anionic azo dye, which allowed for a comparative analysis of biosorption efficiency based on dye charge and structure. The biomass was dried to room temperature, ground into fine powder, sieved to uniform particle size, and utilized in its inactivated form without further chemical treatment. Sorption tests were conducted in batch mode with 50 cm^3 of dye solution (initial concentrations were 20 mg dm^{-3}) and 50 mg of biosorbent and stirred on a magnetic stirrer at 400 RPM in the dark. Aliquots are taken after 2 hours, and concentrations of dyes were determined by a UV-Vis spectrophotometer. Experimental results showed high removal efficiency for cationic dyes, with MB reaching 93.8% and CV 71.4%, under unmodified conditions. In contrast, the biosorption of the anionic dye AR 183 was minimal, with only 11.7% removal, which is likely due to the acidic native pH (4.30) of the lichen suspension, resulting in electrostatic repulsion between the negatively charged dye molecules and the negatively charged biosorbent surface. The higher affinity toward MB compared to CV can be explained by structural differences: MB is a phenothiazine derivative with a nearly planar geometry, promoting stronger interactions, while CV is a bulkier triarylmethane compound. The research highlights the promising potential of *Usnea barbata* lichen as a cost-effective and eco-friendly material for cationic dye removal, though additional optimization is required to improve its efficiency. Further optimization of parameters such as pH and temperature adjustments, surface modification, and contact time may significantly improve the removal performance. This work contributes to the scientific knowledge on natural biosorbents and supports the advancement of green technologies for wastewater treatment.

Keywords: Biosorption, *Usnea barbata*, Methylene Blue, Crystal Violet, Acid Red 183.

Acknowledgements - This research is supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, grant numbers 451-03-136/2025-03/200124 and 451-03-137/2025-03/200124.

P-C-4 Ethnopharmacological applications of *Salvia officinalis* L. in the Niš district: Traditional use in oral health disorders

Jovana Ickovski[1], Slobodan Ćirić[1], Aleksandra Đorđević[1], Katarina Stepić[1], Radomir Ljupković[1], Marija Marković[2], Vesna Stankov Jovanović[1]

[1] University of Niš, Faculty of Sciences and Mathematics, Niš, Republic of Serbia

[2] Institute of Forestry, Belgrade, Republic of Serbia

aleksandra.djordjevic1@pmf.edu.rs

Abstract: *Salvia officinalis* L., commonly known as sage, is a well-known medicinal plant traditionally employed across various cultures for its antiseptic, anti-inflammatory, and antimicrobial properties. In the Balkan region, particularly in southeastern Serbia, sage holds a prominent place in traditional medicine. Despite its widespread use, there is limited ethnopharmacological documentation specific to local regions such as the district of Niš. This study aims to investigate the traditional uses of *S. officinalis* in Niš, focusing on its role in treating oral and throat conditions.

A cross-sectional ethnobotanical survey was conducted among 47 residents of the Niš district using online survey. Respondents were asked about their use of *S. officinalis*, including the parts of the plant used, preparation methods, and specific health conditions treated. Use Report (UR) was used as a reflection of how frequently a condition is associated with a particular treatment or remedy in the dataset by participants. Among the 47 respondents, 14 (29.8%) reported using *S. officinalis* primarily for the treatment of oral and throat-related ailments. The most frequently cited conditions included oral infections (UR = 10) and sore throat (UR = 9), followed by gum disease, toothache, and mouth ulcers (each with UR = 1). In all cases, the aerial parts of the plant were utilized, typically prepared as an infusion (tea), either for gargling or oral consumption. It is interesting to note that the majority of respondents (76.6%) do not think that the taste of tea is pleasant but despite of that they still use it regularly for the aforementioned medical conditions. That together with the frequency of citation highlights a culturally significant role of sage in folk remedies for maintaining oral hygiene and managing infections. The high incidence of reported use for oral and throat conditions aligns with existing

pharmacological studies confirming the antimicrobial and anti-inflammatory properties of *S. officinalis*. The local preference for using aerial parts of the plant as tea suggests both practical knowledge and potential consistency with pharmacognostic data. Moreover, the congruence between traditional applications and modern biomedical evidence underscores the potential value of sage in integrative therapeutic approaches, especially in rural or medically underserved communities. This ethnopharmacological assessment confirms the cultural importance of *S. officinalis* in the Niš district, particularly in the management of oral and throat ailments. The findings support further phytochemical and clinical studies to validate traditional knowledge and explore potential for incorporation into evidence-based health practices. Documenting such regional uses contributes to the broader understanding of medicinal plant heritage in Serbia and the Balkan Peninsula.

Keywords: *Salvia officinalis*, ethnopharmacology, Niš district, traditional medicine, oral health, herbal tea.

Acknowledgements - This research is part of the project "Ethnopharmacological Study of the Region of Southeastern Serbia", O-02-17, supported by the Serbian Academy of Sciences and Arts. It was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contracts No. 451-03-136/2025-03/200124, No. 451-03-137/2025-03/200124, and No. 451-03-136/2025-03/200027).

P-C-5 Antimicrobial activity of *Hypericum barbatum* Jacq. essential oil

Aleksandra Đorđević[1], Goran Petrović[1], Jovana Ickovski[1], Radomir Ljupković[1], Jelena Stamenković[2], Slobodan Ćirić[1], Katarina Stepić[1]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Niš, Niš, Serbia,

[2]Department of Chemistry, Faculty of Medicine, University of Niš, *Niš, Serbia*

aleksandra.djordjevic1@pmf.edu.rs

Abstract: Essential oils have been used since ancient times as important medicinal remedies. Today, they are widely applied in various branches of medicine, including pharmacy, balneology, massage therapy, and homeopathy.

In recent years, the growing interest in essential oils as biocidal and insect-repellent agents has prompted further investigation into their antimicrobial properties. The genus *Hypericum* L. (Hypericaceae) comprises over 480 species, which are distributed across all continents except Antarctica. Species within this genus have long been valued as medicinal plants. The extracts, as well as the oils of *Hypericum* species have demonstrated notable antiviral, antimicrobial, antioxidant, wound-healing, and antidepressant activities. *Hypericum barbatum* is no exception in this respect. The present study aimed to assess the antimicrobial potential of *H. barbatum* essential oil. Antibacterial activity was evaluated using a broth microdilution assay against *Bacillus subtilis* ATCC 6633, *Staphylococcus aureus* ATCC 6538, *Escherichia coli* ATCC 8739, *Pseudomonas aeruginosa* ATCC 9027 and *Salmonella abony* NCTC 6017. Antifungal activity was tested against *Aspergillus niger* ATCC 16404 and *Candida albicans* ATCC 10231. The essential oil showed moderate activity against all tested strains. Minimum inhibitory concentrations (MICs) ranged from 0.78 and 12.50 mg/ml, while minimum bactericidal and fungicidal concentrations (MBCs and MFCs) ranged from 3.13 and 25.00 mg/ml and 6.25 and 12.50 mg/ml, respectively. The oil was more effective against Gram-positive than Gram-negative bacteria. Indeed, the most susceptible strains to the essential oil were *S. aureus* and *B. subtilis*, both exhibiting a MIC of 0.78 mg/ml, with MBCs values of 3.13 and 6.25 mg/ml, respectively. Among the fungi, *C. albicans* was more sensitive (MIC = MFC = 6.25 mg/ml) than *A. niger* (MIC = MFC = 12.50 mg/ml). Nevertheless, the antimicrobial efficacy of the essential oil was lower compared to the reference standards (doxycycline and nystatin) against all microorganisms tested. Our findings suggest that *H. barbatum* essential oil exhibits considerable antimicrobial activity, potentially validating the traditional use of Hypericum species in medicine.

Keywords: *Hypericum barbatum*, essential oil, antimicrobial activity, broth microdilution assay.

Acknowledgment. The authors gratefully acknowledge the Ministry of Science, Technological Development and Innovation of the Republic of Serbia for financial support through Projects No. 451-03-136/2025-03/200124 and 451-03-137/2025-03/200124.

P-C-6 Using innovative USB sensors in chemistry

Aleksandra Tencheva [1], *Elitsa Chorbadzhiyska* [1,2]

[1]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

al.tencheva@swu.bg

Abstract: The use of innovative sensors in chemistry leads to an increase in the quality of scientific research. They can be aimed at reducing effort and increasing the speed of obtaining results, increasing the productivity of scientific experiments, meeting new needs and requirements of modern scientific achievements, etc. The interactivity of innovative sensors leads to improvements, change and is the basis of innovative practices. Through chemistry education, students are engaged in integrated science learning, emphasizing finding effective robotic solutions to real-life problems. With the help of sensors SWR PACKAGE putative applications, data collection, analysis can be performed.

Using the sensors, measurements and interpretation of data related to light intensity, nitrate and carbon dioxide measurements, etc. can be performed. Through the graphical programming environment, a robot can collect data using sensors. The sensors have been designed to enable low-cost data collection in laboratory courses. Data are collected by a computer and can be displayed or plotted in nearly real time. While this work describes only an initial implementation of the concept, the pakets sensors SWR may ultimately be a powerful mechanism to improve laboratory instruction or serve for administering learning laboratory courses.

Sensor technologies have improved the everyday life of human beings through their applications in almost all fields. Sensors are devices that detect changes in the source/environment and collect signals, and accordingly, the reaction is designed. There is a range of sources, including light, temperature, movements, and pressure etc., which may be used. A wide range of applications is utilised using innovative sensor technologies in lifestyle, healthcare, fitness, manufacturing, and daily life. In the medical field, the difficulty to take medicine is eased by drug donors fitted with sensors [*Javaid, M., Haleem, A., Rab, S.,*

Singh, R. P., & Suman, R. (2021). Sensors for daily life: A review. Sensors International, 2, 100121].

Keywords: sensors, chemistry education, innovation

Acknowledgements - This study was supported by the project RP-A2/25.

P-C-7 Characterization of electrocatalysts for cathodes in a microbial electrolysis cell

Katerina Angelova[1], Yordan Angelov[1], Elitsa Chorbadzhiyska[1,2]

[1]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

elli_e1@swu.bg

Abstract: Meeting energy needs today is an extremely important and topical problem against the background of depleting fossil fuels and in view of environmental protection. It is believed that hydrogen will be the energy source of the future and, in combination with fuel cells, will provide an environmentally friendly and safe way to meet global energy needs. The only product of hydrogen combustion is water, no harmful gases are released, the environment is not polluted, and at the same time, hydrogen has several times higher energy density than fossil fuels. However, obtaining pure hydrogen is still expensive and this hinders its widespread production. This has recently necessitated more and more work in the field of obtaining hydrogen.

One of the newest methods in this direction is biocatalyzed electrolysis, in which, along with obtaining hydrogen, simultaneous purification of biodegradable waste products is carried out. Unlike traditional electrolyzers, the oxidation of the substrate is carried out with the help of specific microorganisms capable of transferring extracellular electrons generated by their catabolite processes to the anode of bioelectrochemical systems. One of the most important advantages of MES is that they use substrates from renewable sources and are characterized by high efficiency. The reaction in which hydrogen is released at the cathode is inherent in a number of industrial electrolysis processes with aqueous electrolytes. The choice of cathode material has a

strong influence on the rate of hydrogen release. A crucial factor for the practical implementation of MES is to find effective cathode materials for operation at neutral pH, since electrogenic microorganisms are used.

This paper reviews the basic principles of microbial electrolysis cell, as well as various methods for physicochemical and electrochemical characterization of potential cathode materials for bioelectrochemical hydrogen production.

Keywords: electrocatalysts, microbial electrolysis cell, cathode material, linear voltammetry

Acknowledgements - This study was supported by the project RP-A2/25.

P-C-8 Quantitative determination of calcium in the chicken eggshell by ICP-OES method

Emilija Pecev-Marinković[1], Aleksandra Pavlović[1], Jelena Mrmošanin[1], Ivana Rašić Mišić[1], Enisa Selimović[2], Katarina Milenković[1], Stefan Petrović[1], Denis Mitov[1]

[1]Faculty of Natural Sciences and Matematics, Department of Chemistry, University of Niš, Niš, Serbia

[2]Department of Sciences and Mathematics, State University of Novi Pazar, Novi Pazar, Serbia

emilija.pecev@pmf.edu.rs

Abstract: Calcium is an important trace element in the human body. Calcium can promote the activities of some enzymes in the body, participate in the activities of the nerves, muscles, and the release of neurotransmitters. Calcium deficiency leads to osteoporosis, hyper-osteogeny, rickets in children, spasm of the hand and foot, hypertension, kidney stones, colon cancer, dementia, and other diseases. The required daily doses of calcium depend on age, gender, pregnancy, breastfeeding, etc. Eggshell powder is a natural source of calcium which may have a positive effect on bone metabolism. Experimental and clinical studies have shown that using eggshell powder have positive properties on bones density, in prevention and treatment of osteoporosis. Throwing out eggshells without using them depreciates a vital source of calcium. As an eggshell contains twice the amount of calcium a person needs a day, it is considered as the richest source of calcium of natural origin. Eggshells

have been traditionally and widely used in medicine, beauty science and food production for decades. The aim of this paper was quantitative determination of calcium in samples of chicken eggshells using ICP-OES method. As beneficial component, the eggshell structure and mineral elements, were determined in samples of domestic and industrial eggs: Leghorns eggs, Australorps eggs, and Lohmann Brown eggs. The samples were prepared in microwave oven according procedure described by Szeleszczuk. The eggshell samples were washed with water, then the membranes were removed and finally the eggshells were dried in air and powdered. 500 mg of each sample was weighted and placed in a digestion PTFE vessel, then 6 mL of nitric acid (conc.) and 1 mL H_2O_2 were added and the samples were digested. The validation of the ICP-OES method which includes linearity, precision, accuracy, the detection and quantification limits was done. The linearity of the method was tested in the concentration levels from 0 μg/g to 100 μg/g. Calibration curves for all elements demonstrated good linearity with correlation coefficients greater than 0.999. The limit of detection (LOD) and the limit of quantification (LOQ) were calculated using 3σ and 10σ criterion, respectively. The precision of the method expressed as relative standard deviation (RSD) of three independent analyses ranges from 0.41 to 7.33%. The results showed that eggshells contain a large percentage of calcium, ranges from 348 to 426 mg/g, followed by Mg, P, Na and K.

Keywords: eggshell, calcium, ICP-OES method, optimization, validation

Acknowledgements - This research was supported by the Serbian Ministry of Education, Science and Technological Development (Agreement number 451-03-137/2025-03/200124; 451-03-136/2025-03/200124). The authors are grateful for the financial support provided by this Ministry.

P-C-9 DFT Study of the Thermodynamic Aspects of Lutein Oxidative Transformations

V. Staykov[1], Zh. Velkov[2]

[1]Resbiomed Eye Clinic, Zone B-19, Sofia, Bulgaria

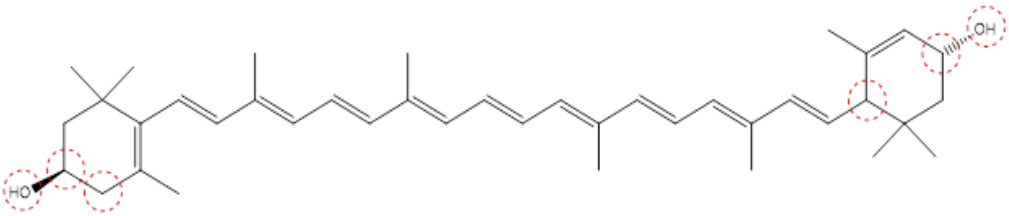
[2]South-West University "Neofit Rilski" Blagoevgrad 2700, Department of Chemistry

jivko_av@swu.bg

Abstract: Lutein is an exogenous carotenoid[1] that accumulates in the retina and the epithelial layer of the human lens, where it protects against UV radiation and undesirable chemical reactions involving highly reactive oxygen-containing species (ROS) such as singlet oxygen and lipid peroxides[2]. Increased consumption of fruits and vegetables — resulting in elevated lutein (and zeaxanthin) levels — has been shown to delay age-related cataracts and macular degeneration, thereby reducing the risk of vision loss[3].

Using density functional theory (DFT) with a high-level orbital basis set (B3LYP/6-311++G**)[4], we have calculated the enthalpies of lutein and its most likely derivatives formed in reactions with ROS. This approach enables the prediction of the most energetically favorable pathways for interconversion among carotenoids and allows assessment of their radical-scavenging potential.

The obtained results will contribute to a better understanding of the mechanisms of action and the role of these compounds in the protection and treatment of the human eye.



Keywords: thermodynamic aspects, lutein oxidative transformations, density functional theory (DFT), radical-scavenging potential

References:

1. A.Perry, H.Rasmussen, and E. J. Johnson, “Xanthophyll (lutein, zeaxanthin) content in fruits, vegetables and corn and egg products,” Journal of Food Composition and Analysis, vol. 22, no.1, pp. 9–15, 2009.

2. R. Edge, D. J. McGarvey, and T. G. Truscott, “The carotenoids as anti-oxidants—a review,” Journal of Photochemistry and Photobiology B: Biology, vol. 41, no. 3, pp. 189–200, 1997.

3. Joan E. Roberts and Jessica Dennison, The Photobiology of Lutein and Zeaxanthin in the Eye, Journal of Ophthalmology Volume 2015, Article ID 687173.

4. A. D. Becke, Density-functional exchange-energy approximation with correct asymptotic behavior, Phys. Rev. A 38, 6, 1988, 3098-3100.

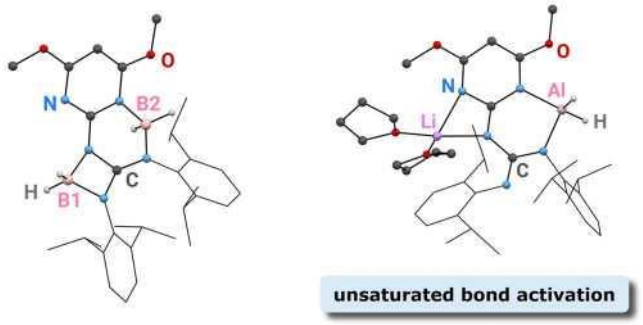
P-C-10 Boron and Aluminum Complexes of Electronically Diverse Biguanide Ligand: Synthesis and Reactivity

Alena Hoffmannova, Lukas Vlk, Tomas Chlupaty, Zdenka Ruzickova, Ales Ruzicka

Department of General and Inorganic Chemistry, Faculty of Chemical Technology, University of Pardubice, Pardubice, Czech Republic

Alena.Hoffmannova@student.upce.cz

Abstract: Biguanides, known for their superbasicity, n-π conjugation of C-N moiety, and deprotonation possibility, exhibited remarkable flexibility as ligands for coordination chemistry.[1] In our group, we synthesized a series of mono- and dianionic biguanidinate complexes of group 13 elements, particularly aluminum and boron, and examined their structural features. Their ability to reduce various unsaturated bonds as well as promote catalytically driven hydroelementation reactions of these bonds will be also reported.



Keywords: biguanide, 13 group elements, homogeneous catalysis

Acknowledgement: The work was supported by the Czech Science Foundation (No. 25-17434S).

References: [1] Peddarao, T.; Baishya, A.; Sarkar, N.; Acharya, R.; Nembenna,

S. Eur. J. Inorg. Chem., **2021**, 2021(21), 2034-2046.

P-C-11 Evaluation of Antioxidant Activity and Total Phenolic Content of Red and Green Pepper (*Capsicum annuum* L.)

Jelena Nikolić, Violeta Mitić, Milica D. Nikolić, Milijana Zlatković, Mihajlo Halilović, Milan Mitić, Vesna Stankov Jovanović

Department of Chemistry, Faculty of Science and Mathematics, University of Nis, 18000 Niš, Serbia

jelena.cvetkovic@pmf.edu.rs

Abstract: Peppers (*Capsicum annuum* L.) are widely recognized for their rich phytochemical composition and potential health benefits, particularly due to its antioxidant properties. They are rich in bioactive compounds such as phenolic acids, flavonoids, carotenoids, and vitamin C, which contribute to their strong antioxidant properties. Regular consumption of peppers has been associated with reduced oxidative stress and a lower risk of chronic diseases, including cardiovascular disorders and certain cancers. Red peppers generally contain higher levels of phytochemicals and antioxidants compared to green peppers, due to their advanced ripening stage. They are particularly richer in carotenoids such as beta-carotene and capsanthin, as well as vitamin C and total phenolic compounds. In contrast, green peppers have lower antioxidant capacity but still provide beneficial nutrients, making both stages valuable, though red peppers are considered more potent in terms of health-promoting properties. In this study, the antioxidant activity of red and green peppers was evaluated using a series of complementary in vitro assays: DPPH and ABTS radical scavenging activity, total reducing power (TRP), ferric reducing antioxidant power (FRAP), and cupric ion reducing antioxidant capacity (CUPRAC). Additionally, total phenolic content (TPC) was determined using the Folin–Ciocalteu method. According to DPPH assay, antioxidant activity of red pepper was higher (5.36 ± 0.07 μg TE / mg FW) compared to green ones (3.56 ± 0.06 μg TE / mg FW. Same trend was observed for all antioxidant activity assays, with the most significant difference for FRAP assay, where red pepper showed four times higher antioxidant activity, compared to the green one. On the other hand, total phenolic content does not differ significantly (889 ± 7 μg GAE / mg FW for red peppers and 711 ± 6 μg GAE / mg FW for green pepper). Strong correlations are observed between TPC and the radical scavenging/reducing

capacities. The strongest correlation was recorded between CUPRAC and TPC, for red peppers extract. Red peppers exhibit significantly stronger antioxidant activity than green peppers, primarily due to their higher concentrations of carotenoids, phenolic compounds, and vitamin C developed during ripening. These findings suggest that red pepper is a potent source of natural antioxidants and highlight the importance of using multiple analytical methods to comprehensively assess antioxidant potential.

Keywords: peppers, antioxidant activity, total phenolic content, correlation

Acknowledgements - This research was supported by the Ministry of Science, Technological Development and Innovation under grant number 451-03-137/2025-03/200124 and 451-03-136/2025-03/ 200124.

P-C-12 Assessment of the chemical composition and biological activity of essential oil from Bulgarian yarrow (*Achillea millefolium*)

Krastena Nikolova[1], Natalina Panova[1], Anelia Gerasimova[2], Yulian Tumbarski[3], Ivan Ivanov[4], Ivayla Dincheva[5], Christina Tzvetkova[6], Galia Gentscheva[6,7]

[1]Department of Physics and Biophysics, Faculty of Pharmacy, Medical University of Varna, Varna, Bulgaria

[2]Department of Chemistry, Faculty of Pharmacy, Medical University of Varna, Varna, Bulgaria

[3]Department of Microbiology and Biotechnology, Technological Faculty, University of Food Technologies, Plovdiv, Bulgaria

[4]Department of Organic Chemistry and Inorganic Chemistry, University of Food Technologies, Plovdiv, Bulgaria

[5]Department of Agrobiotechnologies, AgroBioInstitute, Agricultural Academy

[6]Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria

[7]Department of Chemistry and Biochemistry, Medical University-Pleven, Pleven, Bulgaria

kr.nikolova@abv.bg

Abstract: *Achillea millefolium* L., commonly known as yarrow, is a perennial herbaceous plant of the Asteraceae family, native to temperate regions of Europe, Asia, and North America. Traditional folk medicine has used the plant for its anti-inflammatory, antispasmodic, and antiseptic properties. Its aerial parts contain essential oils, flavonoids, and other biologically active compounds.

The present study aimed to investigate the chemical composition and biological activity of yarrow essential oil *(*Achillea millefolium) from Bulgaria. Gas chromatography–mass spectrometry (GC–MS) analysis, total reflectance X-ray fluorescence (TXRF) technique, antioxidant activity (ABTS and DPPH methods), antimicrobial activity was used.

Through an optimized procedure with Ga as an internal standard, thirteen elements—S, Cl, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Se, and Br—were quantified. The highest concentrations were observed for S, Ca, and Fe (12.35 – 7.26 mg kg^{-1}), followed by Cl, K, Ti, Cu, and Zn (2.23 – 0.53 mg kg^{-1}).

The dominant compounds identified by GC-MS analysis were oxidated monoterpenes (66.88%), followed by Hydrocarbon monoterpenes (13.81%). The predominant chemical components in the essential oil were α-pinene (5.67%), Eucalyptol (16.89%), and linalool (4.89%).

The ABTS method showed a high degree of radical neutralization with an IC_{50} value of 9.15±0.01 μg/mL, while the DPPH method had a significantly lower IC_{50} of 205.00±0.03 μg/mL, indicating selective antioxidant activity depending on the type of radicals. The maximum inhibition observed at 100 μg/mL reached 95.13% with the ABTS method and 29.82% with the DPPH method.

Keywords: antioxidant activity, chemical composition, yarrow, *Achillea millefolium,* antimicrobial activity, essential oil.

Acknowledgements - The authors are thankful to MU-Varna, project No. 23003 “"Investigation of antitumor, anti-inflammatory and antibacterial activity of plant extracts and antitumor agents using lipid model systems and in vitro cell models”.

P-C-13 Determination of Cd, Cu, and Zn in White, Integral, and Red Rice Varieties Using ICP-OES

Stefan Petrović[1], Snežana Tošić[1], Milica Marković[1], Ava Amideina[2], Violeta Mitić[1], Jelena Nikolić[1], Vesna Stankov Jovanović[1]

[1]Department of Chemistry, Faculty of Science and Mathematics, University of Nis, Niš, Serbia

[2]Faculty of Mathematics and Natural Sciences South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

jelena.cvetkovic@pmf.edu.rs

Abstract: Rice is a popular food consumed globally and represents a major dietary source of essential and non-essential trace elements. This study aimed to evaluate the concentrations of cadmium (Cd), copper (Cu), and zinc (Zn) in three commonly consumed rice types—white, integral (brown), and red rice—using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Samples were subjected to microwave-assisted acid digestion prior to elemental analysis to ensure efficient extraction of the target metals. Samples were digested using nitric acid and hydrogen peroxide mixture. Prior analysis, method optimization and validation were performed. The application of ICP-OES provided high sensitivity and accuracy for the simultaneous determination of these metals, demonstrating its reliability in food safety and nutritional quality assessments.

The results showed significant variation in metal content among the different rice types. Cadmium, a toxic heavy metal, was present in integral and white rice, but at levels below the maximum limits established by international food safety guidelines (0.3 μg g^{-1}). Regarding cadmium content, the highest concentration was recorded in white rice (0.149 ± 0.000 μg g^{-1}), whereas Cd concentration was below limit of detection in red rice. Red and integral rice varieties generally exhibited higher concentrations of Cu and Zn compared to white rice, reflecting the retention of the outer grain layers, which are typically removed during the polishing process of white rice. Zn concentrations were highest in red rice (11.81 ± 0.01 μg g^{-1}), followed by integral (9.87 ± 0.02 μg g^{-1}) and white rice (4.99 ± 0.01 μg g^{-1}), indicating its potential as a superior dietary source of this essential micronutrient. Cu followed a similar trend, at lower overall concentrations. Red and integral rice showed similar Cu content (1.26 ± 0.02 μg g^{-1} and 1.29 ± 0.04 μg g^{-1}, respectively).

These findings highlight the nutritional advantages of less processed rice types in terms of essential trace elements, while also emphasizing the importance of monitoring toxic metal contamination, especially in whole grain varieties. This study contributes to a better understanding of the elemental composition of different rice types and supports informed dietary choices based on nutritional and safety considerations.

Keywords: ICP OES, rice, Cd, Cu, Zn

Acknowledgements - This research was supported by the Ministry of Science, Technological Development and Innovation under grant number BROJ.

P-C-14 Impact of Wildfire on the Antioxidant Potential of *Doronicum columnae*: A Biochemical Assessment of Methanolic Extracts from Fire-Affected and Control Sites

Vesna Stankov Jovanović[a], Jelena Nikolić[a], Marija Marković[b], Marija Ilić[c], Marija Dimitrijević[d], Milan Mitić[a], Violeta Mitić[a]

a Department of Chemistry, Faculty of Science and Mathematics, University of Nis, 18000 Niš, Serbia

b Institut of Forestry,11000 Belgrade, Serbia

c Veterinary specialized institute Niš, 18000 Niš, Serbia

d Department of Pharmacy, Faculty of Medicine, University of Niš, 18000 Niš, Serbia

jelena.cvetkovic@pmf.edu.rs

Abstract: This study examines the antioxidant activity of methanolic extracts from the plant *Doronicum columnae* (commonly known as Leopard's bane), collected from wildfire-affected areas, to assess the impact of fire as an ecological stressor on the plant's antioxidant potential. Belonging to the Asteraceae family, *D. columnae* is known in folk medicine, though its chemical composition remains insufficiently studied. Members of this family often contain both beneficial bioactive compounds and potential toxins.

Methanolic extracts were obtained from the aerial parts of the plant, collected one year (2008) and two years (2009) after a major wildfire on Mount Vidlič in 2007. Control samples were collected from untouched beech forests.

Antioxidant activity was evaluated using five methods: total reducing power, DPPH free radical scavenging capacity, total flavonoid content, total polyphenolic content via the Folin–Ciocalteu method, and the ABTS radical cation decolorization assay.

Results indicated that extracts from fire-affected areas had a higher total reducing power than control samples, with the highest values observed in 2009. This suggests that fire may stimulate the synthesis of certain antioxidants, especially during the regeneration phase. However, the contents of flavonoids and polyphenols were lower in burned-area plants, particularly in 2008, indicating an inhibitory effect of fire on the synthesis of these compounds.

DPPH assay results showed increased free radical scavenging activity in plants from fire-affected areas compared to controls, with 2008 samples showing higher activity than those from 2009. Conversely, the ABTS assay revealed lower antioxidant activity in fire-affected plants, highlighting the complex biochemical response to stress. These differing results may stem from the distinct antioxidant compounds each method targets.

Overall, wildfire exerted a contrasting influence on various aspects of *D. columnae*'s antioxidant profile. While total reducing power increased, the levels of flavonoids and polyphenols, as well as the ABTS assay results, decreased in fire-affected plants. This suggests that fire suppressed the synthesis of some antioxidant compounds while possibly enhancing alternative defense mechanisms.

This research sheds light on how plants like *Doronicum columnae* biochemically adapt to ecological stressors such as wildfire. The findings highlight the complexity of secondary metabolite responses and suggest the species as a promising subject for further study as a potential natural antioxidant source, particularly in the context of increasing ecological disturbances caused by climate change and wildfires.

Keywords: *Doronicum columnae*, wildfire, antioxidant activity

Acknowledgements - This work was supported by the Ministry of Science, Technological Development and Innovation of Republic of Serbia, grant number 451-03-137/2025-03/ 200124 and SASA, grant number O-02-17.

P-C-15 Argan shell-derived carbon material as an efficient sorbent for water treatment

Petranka Petrova[1], Elitsa Chorbadzhiyska[1,2], Maya Chochkova[1], Tarik Chafik[3], Katerina Angelova[1], Jordan Angelov[1], Georgios Uzunis[1]

[1]South-West University, Faculty of Mathematics and Natural Sciences, Blagoevgrad, Bulgaria [2]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[3]Faculty of Sciences and Techniques, University Abdelmalek Essaadi, Tangier, Morocco

ppd@swu.bg

Abstract: Carbon-based materials derived from waste biomass have attracted significant attention in water treatment applications due to their porous structure and high surface area. In this study, a carbonaceous sorbent was synthesized from argan shells biomass—an abundant, low-cost, and sustainable byproduct of the Moroccan Argania spinosa tree. The prepared material was evaluated for its efficiency in removing toxic metals from wastewater. Key sorption parameters, including pH, temperature, contact time, and sorbent dosage, were systematically optimized. The findings demonstrate that the argan shells derived carbon material is an effective and promising candidate for the removal of inorganic contaminants under optimal conditions.

Keywords: carbon-based material, argan shell, toxic metals, water treatment

Acknowledgements: This research was funded by the project RP-A2/25 from South-West University "Neofit Rilski," Blagoevgrad.

P-C-16 Design and multifunctional performance of a novel zinc-based MOF constructed from TCPT ligand

Rusi Rusew[1], Hristina Lazarova[1], Magdalena Angelova[1], Vanya Kurteva[2], Rositsa Nikolova[1], Boris Shivachev[1]

[1] Institute of Mineralogy and Crystallography "Acad. Ivan Kostov", Bulgarian Academy of Sciences, Sofia, Bulgaria

[2] Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Sofia, Bulgaria
r.rusev93@gmail.com

Abstract: A novel metal–organic framework (MOF), designated MOF-S1, was synthesized by a solvothermal reaction between zinc nitrate hexahydrate and the tritopic ligand 2,4,6-tris-(4-carboxyphenoxy)-1,3,5-triazine (TCPT). The resulting crystalline material formed hexagonal rod-shaped crystals with a trigonal space group (P-31c) and a two-fold interpenetrated 3D network architecture composed of zinc paddle-wheel secondary building units (SBUs). The framework is stabilized through hydroxyl bridges and exhibits ultramicroporosity. Single-crystal and powder X-ray diffraction confirmed structural integrity and phase purity, while thermogravimetric analysis demonstrated thermal stability up to ~300 °C. Nitrogen adsorption studies revealed a Langmuir surface area of 711 m^2/g and a median pore width of ~6.5 Å. The framework's pore structure and connectivity make it ideal for selective adsorption processes. Diffuse reflectance spectroscopy and Kubelka–Munk analysis indicated a wide band gap of 4.24 eV, confirming its potential for UV-light-driven applications. The adsorption performance of MOF-S1 was tested using a range of dyes, including Congo Red, Methylene Blue, Methyl Orange, and Rhodamine B. The material demonstrated strong and rapid uptake of all dyes, with equilibrium reached within minutes for most. Kinetic modeling supported pseudo-second-order behavior, indicative of chemisorption. Langmuir isotherm analysis showed monolayer adsorption dominance, especially for Congo Red and Methylene Blue, suggesting a high-affinity surface. Photocatalytic degradation experiments were performed under UV irradiation. MOF-S1 achieved degradation efficiencies of ~93% for Methyl Orange and ~74% for Rhodamine B. The process followed mixed kinetic models, indicating contributions from both chemosorption and physisorption pathways. Comparative literature analysis highlighted that MOF-S1 outperformed several reported MOFs in terms of photodegradation efficiency and dye removal rates. Structural comparisons with related TCPT-based MOFs—such as Zn_2(TCPT)OH and SNU-100—revealed that synthesis conditions significantly influence framework architecture and performance. The use of DMF/H_2O without acidic additives and optimized reaction time contributed to the formation of a robust, highly porous material with enhanced functional properties. In conclusion,

MOF-S1 combines high surface area, thermal stability, and efficient UV-responsive behavior, making it a strong candidate for applications in wastewater treatment, photocatalysis, and environmental remediation technologies.

Keywords: MOF, TCPT, dye adsorption, UV photocatalysis, zinc coordination, wastewater treatment

Acknowledgements: This research was funded by the Bulgarian National Science Fund (BNSF), grant number KP-06-COST/3.

P-C-17 Mineral resource base of Uzbekistan for obtaining modern geopolymers

Zebo Babakhanova, Shokhnoza Ruzimova
Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
zebo.babakhanova@gmail.com

Abstract: "Geopolymers" widely used in construction industry as a lightweight heat-resistant and thermal insulation materials. Study of mineral resource base of Uzbekistan shows several potencial types of raw materials to obtain porous geoplymer ceramic materials.

Opoka-like rocks and clays deposit present in Navoi and Tashkent regions. The occurrences of opoka characterized by their location, composition, and properties.

"Changi" complex deposit in Tashkent Region consists of diatomite, glauconite, kaolinite, bentonite and other mineral formations. To obtain lightweight and thermal stable compositions, a method of chemical and thermal treatment of clay mineral resources, in particular kaolin, glauconite, bentonite of the Changi deposit, was chosen.

The use of glauconite and other mineral formations of the Changi deposit as lightweight and heat-resistant materials has not been studied before and is of great scientific, technical and applied interest. The chemical composition of mineral formations of the Changi deposit is as follows (wt. %): glauconite - 61.33 SiO_2, 0.36 TiO_2, 12.24 Al_2O_3, 6.55 Fe_2O_3, 4.62 FeO, 0.20 MgO, 0.64 CaO, 0.97 Na_2O, 3.45 K_2O, 8.82 H_2O; bentonite – 62.54 SiO_2, 0.20 TiO_2, 21.26 Al_2O_3, 2.57 Fe_2O_3, 0.42 FeO, 1.01 MgO, 1.86 CaO, 1.02 Na_2O, 0.99 K_2O, 4.02 H_2O; kaolin –

72.87 SiO_2, 0.18 TiO_2, 20.33 Al_2O_3, 0.97 Fe_2O_3, 0.62 FeO, 0.42 MgO, 0.86 CaO, 0.21 Na_2O, 0.40 K_2O, 1.24 H_2O.

Glauconite silts and sands are easily distinguished from cores mainly by their characteristic green colour (in most cases, various shades of green). The density of such greenery is observed when the amount of glauconite exceeds 1.0÷1.5%. Due to the composition of glauconite, it is widely used as a mineral fertilizer, in the production of sorbents and green dyes. However, the production of porous ceramic materials based on glauconite requires further study of mineral raw materials.

The chemical process of treating the original mineral clay resources includes dissolution of clay component particles followed by initial polymerization of dissolved types of aluminium oxide and silicate, which leads to further polymerization into bound amorphous gels. The geopolymerization process and reaction products characterized using methods such as X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (NMR).

As a result of the conducted research, the prospects for further study of raw materials of the Changi deposit in Tashkent region for obtaining lightweight porous, heat-resistant ceramic materials have been established. At present, the structure and process of pore formation are being studied using various initial components and heat treatment processes.

Keywords: sustainable, clay, kaolin, glauconite, bentonite, geopolymer

P-C-18 New cysteine derivatives with amantadine, rimantadine and memantine and evaluation of their chemical stability

Antoniya Stoymirska[1], Kiril Chuchkov[1], Radoslav Chayrov[1] and Ivanka Stankova[1]

[1]South-West University "Neofit Rilski", Department of Chemistry, Blagoevgrad, Bulgaria

ivastankova@abv.bg

Abstract: The importance, of the stability of the compounds used as prodrugs is to help the cell membranes transport or lipid barriers of the active fragment. In the search for new and effective prodrugs against the coronavirus SARS-CoV-2, a series of aminoadamantanes analogues (amantadine, rimantadine and memantine) with the amino acide cysteine has been investigated. The chemical stability of the compounds containing different residues was studied at pH 1 and pH 7.4 at a temperature of 37°C. UV-VIS spectrophotometric method was applied in the kinetic studies for quantification of the concentrations of unchanged compounds on a Spectrophotometer Agilent Technologies.

Keywords: Cysteine, Prodrug, Aminoadamantanes, Chemical Stability, Biological Activities

Acknowledgements - This work was supported by the Bulgarian National Science Fund, № КП-06-Н79/7/ 15.12.2023г.

P-C-19 Chemical stability of new aminoadamantane analogues with N-acetylcysteine

Antoniya Stoymirska[1], Kiril Chuchkov[1], Radoslav Chayrov[1] and Ivanka Stankova[1]

[1]South-West University "Neofit Rilski", Department of Chemistry, Blagoevgrad, Bulgaria

ivastankova@abv.bg

Abstract: N-Acetylcysteine (NAC) is a drug that has been used since 1963, mainly as a mucolytic agent. Over the years, a number of studies have been conducted with acetylcysteine and its derivatives and many other biological activities and applications have been discovered, such as paracetamol intoxication, doxorubicin cardiotoxicity, ischemia–reperfusion cardiac injury, acute respiratory distress syndrome, bronchitis, chemotherapy-induced toxicity, HIV/AIDS, heavy metal toxicity and psychiatric disorders [1]. In recent years, after the covid-19 pandemic the possibility of using it for coronavirus SARS-CoV-2 treatment has been investigated. In the present study, we decided to modify the adamantane derivatives - amantadine, rimantadine and

memantine with N-acetylcysteine and evaluate their chemical stability at pH 1.0 and pH 7.4 and temperature of 37°C simulate human fluids. The chemical stability of the aminoadamantane derivatives Am-NAC, Rim-NAC and Mem-NAC was examined at 37°C at pH 1.0 (0.1M HCl) and pH 7.4 (phosphate buffer) on an Agilent 8453 UV/Vis Spectrophotometer Agilent Technologies. Specially developed UV-VIS spectrophotometric method for quantification of the concentrations of the compounds was applied in the kinetic studies. The result of the examination will show us, if the newly synthesized analogues are quite enough stable in order to pass in the blood circulation and to be tested for other biological activities.

Keywords: N-Acetylcysteine, Aminoadamantanes, Chemical Stability, Biological Activities

Acknowledgements - This work was supported by the Bulgarian National Science Fund, № КП-06-Н79/7/ 15.12.2023г.

References:

[1]. Yuval Samuni, Sara Goldstein, Olivia M. Dean, Michael Berk, The chemistry and biological activities of N-acetylcysteine, Biochimica et Biophysica Acta (BBA) - General Subjects, Volume 1830, Issue 8, 2013, Pages 4117-4129, ISSN0304-4165.
https://doi.org/10.1016/j.bbagen.2013.04.016.(https://www.sciencedirect.com/science/article/pii/S030441651300144X).

.

P-C-20 Double-layer leather handcraft belt: Design, Technology and Chemistry

M. Stoev [1], *D. Zheleva* [2], *N. Spasova* [2],

[1]Dept. of Chemistry, Faculty of Mathematics and Natural Sciences, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Dept. of Textile, Leather and Fuels, Faculty of Chemical Technology, University of Chemical Technology and Metallurgy, Sofia, Bulgaria

mstoev@mail.bg

Abstract: The aim of this work is to produce a strong, ecological, long-lasting leather belt from natural materials, using green chemistry approaches, resistant to loads and atmospheric influences. The tasks are: (i) selection of

leather and materials, (ii) selection of natural products for leather processing, (iii) selection of anti-allergic metal buckles and rivets, (iv) making the product using green energy with a minimal carbon footprint and (v) durability of the product and recycling. The design, the technological stages of hand-crafting belt and the use of natural products for the finishing processes, and chemical processes are presented. The structural features and properties of natural and artificial leathers are discussed. For the hand-crafting of the leather belt, Italian natural leathers of the type vegetable-tanned calfskin (the croup part of the leather was used) were selected for: the front part of the belt with thicknesses of 4 mm, main and for stamping, and 1.4 mm for lining. A leather strip with a width of 38 mm and a length along the length of the leather was cut in order to avoid its stretching. A rubber adhesive resistant to deformation and aging was selected for gluing the two leather strips. A hand-stitched seam with a knot was made, with the holes for the thread being 5 mm apart. Polyester thread with a thickness of 0.8 mm with a pre-applied wax coating was used. The belt was treated with three spray-applied iridescent aniline dyes, which were fixed by heat-treated linseed bio-oil. The edges were treated with liquid rubber and protected with beeswax. The collagen fibers in the leather were lubricated with Fiebing's Neatsfoot Oil. The finishes of mink fat wax and shellac were applied, giving the product a final shine. An anti-allergic buckle and stainless steel rivets have been selected. Green energy and environmental protection are used for the product, and it has a minimal carbon footprint.

Keywords: leather, belt design and technology, natural finishes, green energy and recycling

P-C-21 Substrates with natural zeolites and fertilizers for smart orchid cultivation

Mitko Stoev[1], Elitsa Chorbadzhiyska[1,2]

[1]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

mstoev@mail.bg

Abstract: The aim is to prepare drought-resistant substrates containing natural, modified zeolites, mineral and biodegradable fertilizers for smart cultivation of orchids with green energy. The tasks are: (i) preparation of a substrate containing natural, modified zeolites, mineral and biodegradable fertilizers, (ii) development of a monitoring system for growing orchids with the prepared substrates in Smart home, (iii) remote control of growing orchids with green energy and minimal water consumption. A remote system for growing orchids has been developed, consisting of two modules: (i) a chemical laboratory and (ii) an orchid stand in Smart home. In the chemical laboratory, substrates containing birch bark, natural modified and activated zeolites, solid and liquid fertilizers containing N, P, K and trace elements for growing orchids are prepared. Zeolite is chemically modified by acid treatment, graphene oxide and is thermally activated. Changes in the structure, morphology and adsorption of zeolites were observed with X-ray, SEM-EDS and BET analyses. For an acidic environment in the substrate the lemon extract in acidic water from a reverse osmosis system is used. The garlic extract is used for natural disinfection and development of the root system. The leaves of the orchid are treated with bioethanol for disinfection. The substrate with the orchids is placed in a transparent flowerpot for the photosynthesis of the root system with visual color control of the moisture content of the zeolite. The remote orchid stand is in Smart Home managed with a Home Assistant Green server and ZigBee hub to control LEDs lighting, HD video camera, humidity sensors, temperature, mineral fertilizers, humidity and CO2 sensors on the air, a sensor for mineral fertilizers in the substrate and green energy from a photovoltaic generator. The results obtained are a model for efficient plant cultivation by combining the use of natural products, green chemistry, green energy and smart control and management systems.

Keywords: orchids, substrates, natural zeolites, biodegradable fertilizers, green energy, smart monitoring system

P-C-22 A Direct Microwave-Accelerated Wittig reaction for synthesis of substituted cinnamates

Maya Chochkova[1], Ernst Lankmayr, Petranka Petrova[1], Tsenka Milkova[1]*

[1] South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2] University of Technology, Institute for Analytical Chemistry, Micro- and Radiochemistry, Graz, Austria
mayachochkova@swu.bg

Abstract: Substituted cinnamates, such as esters of caffeic, ferulic, sinapic and coumaric acids are derived from phenylpropanoid pathway and are common constituents of honeybee propolis [1]. However, despite the extensive evidence of their health-promoting properties, the low quantities of such secondary metabolites retain their further biological investigations. Therefore, in our study we were provoked to find a method for their synthesis. Amongst the known methods for formation of a double bond, the Wittig olefination method provides stereocontrolled synthesis.

Herein, a series of cinnamates were accomplished under multimode microwave activation reaction between benzene carbaldehydes and corresponding phosphonium salts, in the presence of K_2CO_3, without isolation of the phosphonium ylides. The desired products were isolated by preparative thin-layer chromatography in moderate to high yields, and then were compared with those cinnamates, previously obtained by Wittig reaction using domestic microwave oven [2].

Keywords: cinnamates, microwave activation, Wittig reaction, phosphonium salts

Acknowledgements: This research was funded by the project RP-A2/25 from South-West University "Neofit Rilski," Blagoevgrad.

References:

[1] Bankova, V., & Popova, M. (2023). Propolis: Harnessing Nature's Hidden Treasure for Sustainable Agriculture. Agrochemicals, 2(4), 581-597.

[2] Spasova, M., Bankova, V., Ivanova, G., Pajpanova, T., & Milkova, T. (2006). Synthesis of esters of substituted phenolic acids by microwave assisted wittig reaction. Oxidation Communications, 29(1), 172-75.

P-C-23 Synthesis, hydrolytic stability and antiviral studies of Sulfur-based anti-influenza drugs

Maya Chochkova[1], Boyka Stoykova[1], Petranka Petrova[1], Nejc Petek[2], Martin Štícha[3], Jurij Svete[2], Lubomira Nikolaeva-Glomb[4], Yuhuan Li[5]*

[1] South-West University “Neofit Rilski”, Blagoevgrad, Bulgaria
[2] University of Ljubljana, Ljubljana, Slovenia
[3] Charles University, Prague 2, Czech Republic
[4] The Stephan Angeloff Institute of Microbiology Bulgarian Academy of Sciences, Sofia, Bulgaria
[5] Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, P. R. China
mayachochkova@swu.bg

Abstract: Sulfur-containing building blocks represent highly favored scaffolds in various natural or synthetically obtained pharmacologically active molecules. Their diverse functionalities, including thioether, sulfonamide, sulfoxide, and others are often linked with the possibility to inhibit microbial growth and to regulate immune responses. Nowadays, approximately 25% of all utilized small-molecule pharmaceuticals have been approved as organosulfur drugs or are clinical candidates. Herein, inspired by the medicinal power of such compounds, a series of potential sulfur-based ligands against influenza A viruses was obtained by modification of amino group of anti-influenza drugs (rimantadine, amantadine and oseltamivir) and memantine. Furthermore, the structures of novel derivatives bearing versatile sulfur-containing acyl moieties (cysteinyl-, thienyl-) were established by spectroscopic methods (^{1}H NMR, ^{13}C NMR, (ATR)u_{max}, and HRMS). The newly synthesized amides were tested in vitro for antiviral activity against influenza viruses A/Aichi/2/68 (H3N2), A/Wuhan/359/1995 and B/Jinfang/13/1997. Moreover the hydrolytic stability of desired amides was monitored in three model pH systems that mimic conditions in the stomach, blood plasma and small intestine, including pH 2.0, 7.4 and 9.0, respectively.

Keywords: sulfur-containing drugs, hydrolytic stability, anti-influenza drugs, amide synthesis

Acknowledgements - This research is supported by the Bulgarian National Science Fund project № КР-06-Н79/7 (15.12.2023).

P-C-24 Residual Deviations Analysis – A Powerful Calibration Linearity Criterion. Visual Test or Reliable Statistical Tool?

Ava Amideina[1], Petko Mandjukov[1]*
Department of Chemistry, South-West University "Neofit Rilski", 66 Ivan Mihajlov Str., 2700 Blagoevgrad, Bulgaria
*a_amideina@abv.bg

Abstract: The main objective of every analytical measurement is to obtain unbiased result with as low as possible measurement uncertainty and ensured metrological traceability. Crucially important stage of an instrumental analytical procedure is the calibration. Usually, the calibration function is suggested as linear which in most of the cases holds true. However, the selection of the calibration function is not always a trivial task, especially in cases of nonlinear model which is very close to the linearity. One of the most sensitive and simple criteria for linearity / nonlinearity decision is the residual deviations analysis, always described and applied as a visual test. A key role for the interpretation of ($e\ vs.\ x$) data is the distribution profile of the estimated residuals around the zero line.

Since the residual deviations plot visual test applied to verify the quality of calibration model is subjective in nature, the main aim of the present study is to transform it into an objective (operator independent) statistical test based on statistical analysis of the $e = b_0 + b_1x + b_2x^2$ regression function.

When the calibration function is properly selected, considering the data set, the residual deviations are scattered randomly in a narrow band around the zero level ($y_i \approx \hat{y}_i$). In such a case the regression ($e_i vs.\ x_i$) trends to insignificant. Thus, objectively proved significance of the function could be accepted as evidence for wrongly selected linear model.

As a simplest significance criterion, the correlation coefficient for the regression function $e = f(x)$ can be evaluated.

When the calibration data is nonlinear but a linear model is selected a specific shape (convex or concave) of the residuals' distribution is observed. In this case the regression coefficients of the function $e = b_0 + b_1x + b_2x^2$ can be used as a decision tool for the significance of the dependence of e on x. A key role for the decision is the significance of the regression coefficient (b_2)

associated with the nonlinear term x^2. A test for significance of the regression coefficients (Student's t- test) can be applied as a prove for the correctness of calibration model selected. If b_1 is significant that is an indication for a concentration-dependent trend and possibly wrong regression calculations.

Calculation of the standard deviations of the regression coefficients in case of nonlinear functions are seldomly discussed in the statistical literature. An algorithm for their evaluation is also presented. All calculations are performed using Microsoft EXCEL.

Keywords: validation of the calibration model, visual test, linearity criterion, residual deviations, matrix notation, standard deviations of regression coefficients.

Physics

P-P-1 Electron beam welding of titanium and aluminum alloys with a vanadium filler

Darina Kaisheva[1,2], Georgi Kotlarski[1,6], Maria Ormanova[1,3,6], Vladimir Dunchev[4,6], Angel Anchev[4,6], Borislav Stoyanov[5,6], Stefan Valkov[1,3,6]

[1]Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria

[2]Department of Mathematics and Physics, Neofit Rilski South-West University, Blagoevgrad, Bulgaria

[3]Department of Mathematics, Informatics and Natural Sciences, Technical University of Gabrovo, Gabrovo, Bulgaria

[4]Department of Material Science and Mechanics of Materials, Technical University of Gabrovo, Gabrovo, Bulgaria

[5]Department of Industrial Design and Textile Engineering, Technical University of Gabrovo, Gabrovo, Bulgaria

[6]Center of competence "Smart mechatronic, eco-and energy-saving systems and technologies"

darinakaisheva@abv.bg

Abstract: In an era where the requirements for utilization of materials increase the possibility of combining them becomes more and more attractive.

There are a vast number of techniques used for the joining of dissimilar materials, and one of the most prominent and essential is welding. An array of welding techniques exists such as friction stir welding, laser beam welding, gas metal arc welding, and more, which all have their advantages and disadvantages. A very highly technologically advanced method is electron beam welding. This technique provides high precision, high controllability, good efficiency, and high purity of the welds due to the vacuum environment the welding process takes place in. A big disadvantage, however, is the formation of brittle joints with low ductility when welding some dissimilar metals. This is attributed to the rapid formation of intermetallics, their uneven distribution in the weld seam, and the formation of cracks along the length of the joint. In order to moderate the microstructure of dissimilar weld seams fillers are commonly used. This work demonstrates the influence of applying a vanadium filler as an intermediate layer between Ti64 and Al6082-T6 plates on the resultant microstructure, and some mechanical properties of the formed weld seams. The microstructure of the obtained specimens was investigated by means of X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) analyses. A high titanium rich weld seam was formed, as a result of which the presence of the γ-TiAl ($L1_0$) and α_2-Ti_3Al ($D0_{19}$) intermetallic phases was detected. The XRD experiments also suggested that some quantity of the $TiAl_3$ phase may be present in the fusion zones, however, this was not confirmed by EDS. Some mechanical properties were determined, namely the microhardness and the ultimate tensile strength (UTS). As a result of employing the V interlayer, the formation and distribution of Ti-Al intermetallics was unified. Cracks and pores were detected in the structure of the weld seam. The microhardness did not change substantially at either of the five studied zones – aluminum plate, aluminum heat affected zone (HAZ), fusion zone (FZ), Ti64 HAZ, and Ti plate. The average microhardness in the fusion zones of the samples prepared without a filler and with a V one was 537 ±43 $HV_{0.05}$, and 548 ±50 $HV_{0.05}$, respectively. Despite the presence of pores and cracks, the ultimate tensile strength (UTS) of the sample prepared with the V filler increased near twofold compared to the sample prepared without a filler (from 45 ±6 MPa without a filler to 70 ±10 MPa with a filler). This is attributed to the more homogeneous distribution of the Ti-Al binary intermetallic compounds along the volume of the weld seam.

Keywords: electron-beam welding, titanium alloys, aluminum alloys, vanadium, filler

Acknowledgements - This research was funded by the European Regional Development Fund within the OP "Research, Innovation and Digitalization Programme for Intelligent Transformation 2021-2027", Project No. BG16RFPR002-1.014-0005 Center of competence "Smart Mechatronics, Eco- and Energy Saving Systems and Technologies".

P-P-2 Investigation of laser produced noble metal-semiconductor nanostructures

Mihaela Koleva [1,2], Anna Dikovska [1], Nikolay Nedyalkov [1], Tsanislava Genova [1]

[1]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee blvd., Sofia 1784, Bulgaria

[2]South-West University "Neofit Rilski", 66 Ivan Mihailov Str., Blagoevgrad, 2700, Bulgaria

mihaela_ek@yahoo.com , mihaela_ek@swu.bg

Abstract: In the recent years, there has been many efforts for producing new materials for transparent electronics. Zinc oxide (ZnO), as a semiconductor with a wide band gap and a high-exciton binding energy is the most promising candidate for a wide amount of optoelectronic applications. Laser synthesis of composite nanoparticle-based nanostructures at atmospheric pressure results in formation of a complex porous structure. Tailoring the properties of metal oxide semiconductors by noble metal nanoparticles is beneficial to enhance the photoluminescence (PL) UV emission of ZnO. The formation of ZnO/noble metal (Ag, Pd, Ag/Pd) nanostructures is carried out by ps-pulsed laser deposition in the air at room temperature. The effect of post deposition ns-laser annealing on the optical properties of the nanostructures is studied. The contribution of laser modifications to the change of a surface plasmon resonance (SPR) absorption band, and respectively, to the near-band-edge and deep level photoluminescence emission, is investigated.

Keywords: nanostructures, composites, pulsed laser deposition, PL, SPR

Acknowledgements - The authors acknowledge the financial support of the bilateral project IC-CZ/03/2025-2026 between the Bulgarian Academy of Sciences and the Czech Academy of Sciences.

P-P-3 All-optical characterization of the magnetic properties of nanocomposite bulk samples

Elena Taskova[1], Svetoslav Kolev[1,2] and Tatyana Koutzarova[1]

[1]Academician Emil Djakov Institute of Electronics, Bulgarian Academy of Sciences

72 Tzarigradsko Chaussee, 1784 Sofia, Bulgaria

[2]Neofit Rilski South-Western University, 66 Ivan Mihailov Str., 2700 Blagoevgrad, Bulgaria

taskova@ie.bas.bg

Abstract: In the recent years, the nanosized magnetic oxides and magnetic nanocomposites are widely used in microwave components, for example for shielding microwave radiation in medical applications. Their magnetic properties are important for these applications.

The object of this work is to investigate the magnetic properties of nanocomposite bulk samples. All-optical scheme have been used to characterize these properties. It consists of two contra-propagating laser beams with mutually orthogonal linear polarization, serving as pump and probe. The fine magnetic fields created by two samples: (i) the magnetite (Fe_3O_4) nanoparticles, and (ii) Z-type hexaferrite (CoZ) are measured using the method based on high-contrast magneto-optical electromagnetically induced absorption resonances [1].

Keywords: coherent spectroscopy, electromagnetically induced absorption, magnetometry, nanoparticles, magnetite, Z-type hexaferrite

Acknowledgements - The work was supported by the Bulgarian National Science Fund under contract KP-06-N48/5.

References:

[1] E. Taskova, E. Alipieva, S. Kolev, T. Koutzarova and D. Brazhnikov, Coherent optical spectroscopy characterization of the magnetic properties of

oriented Fe_3O_4 nanoparticles, *J. Phys.: Conf. Ser.* **2240**(1), 2022, 012022.

C P-P-4 rystallography and electrical impedance spectroscopy of TiO_2 thin films deposited on Al substrates

Daniela Stoeva[1], Georgi Kotlarski[1], Dimitar Dechev[1], Nikolay Ivanov[1], Stefan Valkov[1,2], Maria Ormanova[1,2], Valentin Mateev[3], Iliana Marinova[4]*

[1] Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee, 1784 Sofia, Bulgaria

[2] Faculty of Mathematics, Informatics, and Natural Sciences, Technical University of Gabrovo, 4 H Dimitar Str., 5300 Gabrovo, Bulgaria

[3] Faculty of Electrical Engineering, Technical University of Sofia, 8 Kliment Ohridski blvd., 1000 Sofia, Bulgaria

[4] Institute of Robotics, Bulgarian Academy of Sciences, Acad. Georgi Bonchev Str., 1113 Sofia, Bulgaria

*danyela.stoeva@gmail.com

Abstract: In this study, titanium oxide thin films were synthesized on Al substrates by the direct current reactive magnetron sputtering technique. During the experiments, a pure Ti interlayer on aluminum substrates was deposited. Part of the formed samples were heated to a temperature of 180 °C for 120 minutes. The TiO_2 thin films were deposited on heated and unheated Al substrates with Ti interlayer. Important crystallographic parameters of samples, like phase composition, formation of preferred crystallographic orientation, and lattice parameters were studied using X-ray diffraction analysis (XRD). Other surface characteristics, such as surface roughness, and distribution of the measured heights were determined using Atomic force microscopy (AFM). Electrical impedance spectroscopy (EIS) was used to determine the electrical characteristics of specimens. The results obtained for the electrical properties of the modified surfaces were discussed in relation to the investigated structure of the samples. The results showed that the applied preliminary heating of the deposited Ti interlayer on the Al substrate significantly influenced the electrical impedance of the Ti/TiO_2 coating.

Keywords: Al substrates, TiO_2 coatings, structure, electrical properties.

Acknowledgements: The financial support of the Bulgarian National Science Fund, project #KP-06-N67/10 (2022) is highly appreciated.

P-P-5 Influence of diffusion on the propagation of optical beams in alkali metal vapors

Nikola Nikolov, Stoyan Tsvetkov, Sanka Gateva
Institute of Electronics, Bulgarian Academy of Sciences 72, Tsarigradsko Chaussee blvd., Sofia, Bulgaria
ninikolov@ie.bas.bg

Abstract: Spatial effects such as self-lensing (self-focusing for blue detuned or self-defocusing for red-detuned resonant laser beams), self-trapping and others have been of constant interest for a long time [1-7]. It was shown that nonlocal response of the nonlinear medium can lead to stabilization of transverse bright solitary beams in the self-focusing case of sodium vapor [2]. Different nonlinear mechanisms for self-lensing in atomic vapors [5], and two different mechanisms that contribute to nonlocality of the nonlinearity, i.e. atomic(thermal) and radiation diffusion [4] have been studied. Propagation of spatial dark solitons (dark solitary beams) in atomic vapors has been observed experimentally, but only as a dark soliton stripes, that form vortex solitons due to optical instability in self-defocusing nonlinear medium [9]. In the provided model in [9], atomic or radiation diffusion and thus nonlocality of the nonlinearity are not included. We go one step further and include the diffusion equation to model the atomic diffusion and solve it simultaneously with the Nonlinear Srödinger Equation to model the dark light beam propagation in nonlocal (due to diffusion) nonlinear atomic vapor media.

We step on the model used for dark light beam propagation in nonlinear nonlocal self-defocusing media due to thermal optical nonlinearity in liquid paraffin oil doped with iodine. In this case propagation of spatial dark solitons is proved both experimentally and numerically. The model used in [10] is mathematically identical to the model used in our work. That let us to investigate for now numerically, appropriate parameters of alkali vapors for stable spatial dark soliton propagation.

Keywords: dark solitons nonlocal atomic vapor nonlinearity

Refferences:

[1] cw Self-Focusing and Self-Trapping of Light in Sodium Vapor, J. E. Bjorkholm and A. A. Ashkin, Phys. Rev. Lett. Volume 32, 129 – Published 28 January (1974)

[2] Stabilization of transverse solitary waves by a nonlocal response of the nonlinear medium, D. Suter, T. Blasberg, Phys. Rev. A 48 (1993) 4583.

[3] Spatial effects of radiation trapping in an optically thick atomic vapor excited by a laser beam, T. Scholz, M. Schiffer, J. Welzel, D. Cysarz, and W. Lange, Phys. Rev. A 53, 2169 – Published 1 April (1996)

[4] Self-lensing in sodium vapor: influence of saturation, atomic diffusion and radiation trapping, T. Ackemann, T. Scholz, Ch. Vorgerd, J. Nalik, L.M. Hoffer, G.L. Lippi, Optics Communications, Volume 147, Issues 4–6, pages 411-428, 15 February (1998)

[5] Nonlinear lensing mechanisms in a cloud of cold atoms, G. Labeyrie, G. L. Gattobigio, T. Chanelière, G. L. Lippi, T. Ackemann & R. Kaiser, Nonlinear Dynamics Volume 41, pages 337–348, (2007)

[6] Highly nonlocal optical nonlinearities in atoms trapped near a waveguide, E. Shahmoon, P. Grišins, P. H. Stimming, I. Mazets, G. Kurizki, Optica, Volume 3, Issue 7, page 725 (2016)

[7] Atomic vapor as a source of tunable, non-Gaussian self-reconstructing optical modes, J. D. Swaim, K. N. David, E. M. Knutson, C. Rios, O. Danaci & R. T. Glasser, Scientific Reports Volume 7, Article number: 42311 (2017)

[8] Hot atomic vapors for nonlinear and quantum optics, Q. Glorieux, T. Aladjidi, P. D. Lett and R. Kaiser, New Journal of Physics, Volume 25, May (2023)

[9] Observation of vortex solitons created by the instability of dark soliton stripes, V. Tikhonenko, J. Christon, B. Luther-Davies, and Y. S. Kivshar, Opt. Lett. Volume 21, No. 15, page 1129, August 1, (1996)

[10] Observation of Attraction between Dark Solitons, Phys. Rev. Lett. Volume 96, 043901 – Published 3 February, (2006)

P-P-6 Analysis of the decay of the ^{9}B nucleus in the dissociation of the ^{10}C nucleus

Ralitsa Stanoeva[1,2]

[1]South-West University “Neofit Rilski”, 66 Ivan Mihaylov St., Blagoevgrad, 2700, Bulgaria
[2]Institute of Electronics, Bulgarian Academy of Sciences, 72 Tsarigradsko Chaussee Blvd., Sofia, 1784, Bulgaria
rstanoeva@swu.bg

Abstract: The creation of beams of radioactive nuclei opens up qualitatively new opportunities for studying their structural features and excited states.

In the study of interactions at high energies, a significant role is played by the nuclear photoemulsion method, which is characterized by unique capabilities. Due to its extremely good spatial resolution (0.5 μm) compared to other methods and depending on the primary impulse, an angular accuracy of the tracks of relativistic fragments of about 10^{-3} radians can be obtained. This provides complete observation of all possible fragmentation decays of relativistic nuclei.

The nuclear emulsion technique remains an effective research method, in particular allowing to study the cluster dissociation of a wide variety of light relativistic nuclei in a unified approach. Despite the fact that the possibilities of relativistic fragmentation for studying nuclear clustering have been known for a long time, modern experiments have not been able to come close to a comprehensive analysis of the ensemble of relativistic fragments.

Of particular interest are the peripheral interactions of nuclei at energies above 1 A GeV as optimal for measurement and interpretation. The most significant for clustering studies are the interactions of relativistic nuclei, occurring with minimal mutual excitation of the colliding nuclei without the formation of charged mesons. In this case, an accurate separation of the products by momentum is achieved during fragmentation of the projectile nuclei and the target nuclei. The main criterion for selecting such events is the condition for preserving the electric charge and mass number of the impinging nucleus in a narrow angular fragmentation cone.

At the present time, an analysis of peripheral interactions of the relativistic isotopes beryllium, boron, carbon and nitrogen, including radioactive ones, with nuclei from the composition of the emulsion has been performed, which allows us to present a picture of clustering in an entire family of light nuclei. In the present paper results of an analysis of decay of the ^{9}B nucleus in

dissociation of ^{10}C nuclei are presented and a comparative analysis of the experimental data with the Monte Carlo model calculations is made.

Keywords: Monte Carlo modelling, radioactive beams, nuclear track emulsion technique, peripheral interactions of nuclei

P-P-7 Modeling in electrochemical characterization of electrode materials

Pavel Chorbadzhiyski[1], Metodi Popstoilov[2], Elitsa Chorbadzhiyska[3,4]

[1]Department of Mathematics and Physics, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Department of Communication and Computer Engineering, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[3]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[4]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

pavel_3010@abv.bg

Abstract: Modeling in the electrochemical characterization of electrode materials is an essential tool for understanding, analyzing, and optimizing their properties and behavior in various electrochemical systems such as fuel cells and microbial electrolyzers. This process combines experimental data with mathematical and physical models in order to describe and predict the behavior of electrodes in the corresponding environment, the reactions that occur at the interface between the electrode and the electrolyte.

The main goal of electrochemical modeling is to understand how the structure, composition, and morphology of the electrode material affect its electrochemical characteristics. The study of the electrochemical behavior of a given electrochemical system consists of maintaining certain characteristic quantities for the electrochemical system constant and observing how other variables (current, potential, and concentration) vary when the controlled quantities change. In electrochemical research, the change in the potential of the electrodes is monitored using reference electrodes. Information about a

given electrode reaction is most often obtained by determining the current as a function of potential. Electrochemical modeling in this research is focused on the hydrogen evolution reaction. The quantities obtained as a result of the linear voltammetric tests in the cathodic direction are: the potential at which hydrogen evolution begins, which corresponds to the overpotential of the reaction (V_e) and the slope of the first linear section of the corresponding voltammogram, which is a measure of the rate of the hydrogen evolution reaction (V_h). The more positive the potential at which hydrogen evolution is observed, the smaller the overpotential of the reduction process on the given electrode surface. At the same time, the greater the value of the exchange current of the reaction, the greater the rate of hydrogen reduction.

Chronopotentiometric methods are based on measuring the dependence of the potential on time at given current values or when the current changes in a certain way. The change in the potential with time can be used both for quantitative analytical determinations and for studying the kinetics of the processes occurring on the surface of the working electrode. The corrosion resistance of materials is also essential. It can be determined electrochemically by linear voltammetry conducted in the anodic direction. Another frequently used modeling approach is Electrochemical Impedance Spectroscopy, which is used to estimate resistances and capacitances in the system through equivalent electrical circuits.

With the help of modeling, key parameters are optimized. Modeling allows not only to validate experimental results, but also to predict the behavior of new materials before their physical synthesis. Electrochemical modeling is a powerful approach that contributes to the rational design and development of new high-performance electrode materials. It supports a faster transition from laboratory research to real-world applications, while reducing the cost and time to develop innovative energy technologies.

Keywords: modeling, electrochemical characterization, electrode materials

Acknowledgements - This study was supported by the project RP-A2/25.

P-P-8 Modeling in energy efficiency - autonomously powered systems

Pavel Chorbadzhiyski[1], *Metodi Popstoilov*[2], *Elitsa Chorbadzhiyska*[3,4]

[1]Department of Mathematics and Physics, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Department of Communication and Computer Engineering, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[3]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[4]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

pavel_3010@abv.bg

Abstract: Modeling of autonomous power supply, energy management and energy efficiency plays a key role in the design and optimization of modern energy systems, especially in the context of the increasing use of renewable sources and the need for sustainable development. Autonomous power systems are used in remote areas, smart buildings and electric vehicles, and their goal is to provide reliable electricity independent of the central power grid. Modeling of autonomous energy systems includes the simulation of various energy sources such as photovoltaic panels, wind turbines and micro-hydro generators, as well as energy storage devices - batteries, supercapacitors or hydrogen cells. An important part of this process is the consideration of the variable performance of renewable sources according to weather conditions and time of day, as well as the behavior of consumer loads. Energy management is a software or hardware component that manages the balance between energy production, storage and consumption. Its main goal is to increase efficiency, reduce operating costs and extend the life of system components. Energy management models include demand and supply forecasting, dynamic load distribution and selection of the optimal source according to the current situation. Energy efficiency refers to the ability of a system to convert energy into the most useful form possible with minimal losses. Modeling in this area covers the assessment of thermal and electrical losses, increasing the efficiency of individual devices. Energy efficiency is important not only for reducing costs, but also for reducing the carbon footprint.

Integrated modeling of autonomous power supply, energy management and energy efficiency is crucial for creating sustainable, intelligent and self-sufficient energy systems. It allows for simulation, analysis and optimization at the design stage, leading to more reliable and efficient energy solutions.

Keywords: modeling, energy management, energy efficiency, autonomous systems

Acknowledgements - This study was supported by the project RP-A2/25.

P-P-9 Stimulated Raman Scattering in quartz fibers around the point of zero dispersion

Lyuben Ivanov
South West University "Neofit Rilski", Blagoevgrad, Bulgaria
and
Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria
e-mail: mihovli@abv.bg

Abstract: The process of occurrence of Stimulated Raman scattering in a medium with inhomogeneous vibrational resonances when pumped with laser radiation at different pulse durations was investigated. In this particular case, an optical light guide based on fused quartz was used as a nonlinear medium. The influence of the group velocities dispersion on the effective interaction length of the pump and Stokes waves is evaluated. The studies were carried out in the spectral range 1.17-1.35 μm, which is around the point of zero of group velocities dispersion in fused quartz. It is shown that changing the wavelength of the pump pulses in the region of positive dispersion of the group velocities of the medium effectively excites the Stokes component of the Stimulated Raman scattering with a wavelength in the region of negative group velocities dispersion. At the same time, its frequency shift from the pumping wave can vary practically from 0 to 1000 cm^{-1} and does not coincide with the maximum in the amplification line of the spontaneous Raman scattering.

Keywords: optical fibers, Stimulated Raman scattering

P-P-10 Applicability of quartz for dosimetric purposes

Ivana Fabijanikj Sandeva, Aleksandar Krleski, Lihnida Stojanovska-Georgievska, Margarita Ginovska, Hristina Spasevska
Ss. Cyril and Methodius University in Skopje, Faculty of Electrical Engineering and Information Technologies, Skopje, Macedonia
ivana@feit.ukim.edu.mk

Abstract: When exposed to ionizing radiation, minerals accumulate energy by which some electrons move to excited energy states. When returning to the ground state, some of these electrons may become trapped in the crystal structure. Optical or thermal stimulation gives energy to trapped electrons and they can be released and recombined with holes, resulting in emission of photons. This process begins with absorption of radiation energy by trapping of charge carriers in the defects of crystal structure, continues with absorption of energy from the optical or thermal stimulation that releases trapped charge, and at the end, there is loss of energy by diffusion of charge across the crystal lattice, followed by recombination that forms photons. Detection of these photons gives the opportunity to detect and measure a luminescence signal.

Quartz is one of the most abundant minerals in the crust of the Earth. Even though it has a simple chemical composition as SiO_2, even the pure quartz crystals contain point defects in their structure. Observed luminescence from quartz is complex because of the variety of these defects. Quartz is very suitable for luminescence measurements, as it has the ability to record the amount of ionizing radiation it has been exposed to, making it a good natural dosimeter. The aim of this study was to observe luminescence characteristics of quartz and to propose a model for dose determination.

Experiments were performed on RISO TL/OSL Reader DA-20, which has a built-in beta irradiation source, in the Radiation Physics Laboratory (RAD-LAB) in Skopje. Measurements were done on quartz samples in the form of 180-250 μm grains. Initially, samples were unirradiated. For the purposes of this study, quartz grains were exposed to beta irradiation from Sr-90 for different periods of time, by which the absorbed dose could be controlled. After the irradiation, samples were exposed to thermal stimulation in nitrogen atmosphere, with a heating rate of 2 °C/s. This makes it possible to know the temperature of the sample in every second during the measurement period. Measurements gave glow curves, representing the dependence of thermoluminescence (TL)

intensity on temperature. Glow curves of irradiated quartz samples exhibit different maxima than glow curves of unirradiated samples, showing that the irradiation process induces changes in the structure of quartz. It is important to distinguish between maxima that occur due to natural radioactivity and maxima that are due to the beta irradiation. Obtained results were compared for quartz samples exposed to different doses of ionizing radiation, giving information on the dependence of the TL intensity on absorbed dose.

Obtained glow curves showed good dependence of the TL intensity on the absorbed dose, meaning that performed measurements gave promising results that quartz can be used as a natural dosimeter. Further studies are needed for quartz to be used as an accurate dosimeter, including better understanding of the physical processes that occur in quartz during irradiation, as well as deeper knowledge about lattice defects.

Keywords: quartz, thermoluminescence, dosimetry

Geography

P-G-1 Anthropophysiological characteristics of the contemporary Bulgarian population in Northeastern Bulgaria

Nadezhda Paraskova[1], *Magdalena Pirinska – Apostolu*[1]

[1] Department of Zoology and Anthropology, Faculty Of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov Blv., Sofia, Bulgaria

e-mail address of the corresponding author: nadjia_para@yahoo.com

Abstract: Anthropophysiological tests are genetically encoded and are under the regulation of the central nervous system. The studied group is from a region with complex ethnogenesis in historical terms. Some tests have been studied among the population of Northeastern Bulgaria. The results obtained were compared with data for the country as a whole. The effectiveness of the anthropophysiological tests Hand clasping, Arm folding and Clapping has been studied. to persons from the cities: Balchik, Dobrich, Popovo, Targovishte, General Toshevo, Ruse, Shabla and Kubrat. Generally accepted methodologies

have been applied (Luby, 1908; Weyrer,1932; Blincoe, 1962). Hand clasping. In the contingent of the test, the left type of the test is most often detected, followed by the right type. Arm folding. In the studied population, the left-handed type dominates over the right-handed type: Clapping. In this test, the neutral type is the most common in the sample examined. The hand clasping test is characterized by almost identical values of the type of left hand and the type of right hand and by a relatively high percentage of individuals indifferent to the test. For the arm folding test the data shows more frequent left-wing characteristics. In the clapping test, the order of the typical values differs from the normal distribution in the Bulgarian population. The similar presentation of the left and right hands and the high percentage of the neutral type are regional specifics of the hand clasping test. The neutral type prevails in the clapping test with almost equal values of the left-hand type and significantly lower values of the right-hand type.

Key words: Hand clasping, Arm folding, Clapping.

P-G-2 Presence of wormian bones in adult human skulls from Late Roman period - Salona, Dalmatia

Ralitsa Bogdanova[1], Magdalena Pirinska-Apostolu[2]

[1]National Museum of Natural History, Bulgarian Academy of Sciences, Sofia, Bulgaria

[2]Department of Zoology and anthropology, Faculty of Biology, Sofia University "St.Kliment Ohridski", Sofia, Bulgaria

e-mail address of the corresponding author*:* rbogdanova@nmnhs.com

Abstract: About 300 descriptive features of the human skeleton have been identified and classified in the scientific literature (Mann & Hunt 2019). Anatomical variations are often defined based on their frequency of expression or presence in an osteological collection or in a particular geographic group. Wormian bones located along the cranial sutures and fontanelles may develop from independent ossification centers, or by separation from the primary centers. (Sanchez-Lara et al. 2007; Basnet et al. 2018). Also called ossicles, suture, intra-sutural bones, their number, shape, and size can vary (El-Najjar & Dawson 1977; Kaur et al 2013; Baa et al. 2018; Goyal et al. 2019).

There is no consensus in the scientific literature regarding the formation of the wormian bones, and to this day their etiology remains still unclear (Kaur et al. 2013; Natsis et al. 2019; Vishali et al. 2014).

However, the most common and accepted view is that they are related to both population genetics and external environmental factors. (Burrows et al. 2007; White 1996). Many authors have identified the frequency of accessory bones as appropriate anthropological features for comparative population studies. (Hanihara and Ishida 2001, Barberini et al. 2008).

The aim of this work is to investigate different type and incidence of Wormian bones in adult skulls from the Early Christian necropolis of the Late Antique site Salona, Dalmatia (IV-VI AD) in the European population. For the present study 232 human skulls (147 male and 85 female) were differentiated by sex, age and macroscopically observed for presence of wormian bones.

From 232 skulls presence of wormian bones was found in 165 skulls (71.12%). The different types of wormian bones was found in 58 (35.15%) female and 107 (64.84%) male skulls. The most frequently wormian bones were observed in the lamboid suture 121 (52.15%), asterionic 50 (21.55%), apical 41 (17.67%) epipteric 36 (15.51%) parietal notch bone 25 (10.77%). In the males the established frequency of wormian bones is as follows: lamboid 124 (53.44%) and asterion 52 (22.41%) followed by epipteric 26 (11.20%), apical 25 (10.775), parietal notch bone 23 (9.91%), coronal 7 (3.01), mastoid 4 (1.72%). For females the most observed wormian bones are lamboid 68 (29.31%) and asterion 18 (7.75%) followed by apical 16 (6.89%), parietal notch bone 15 (6.46%), epipteric 12 (5.17%), mastoid 3 (1.29%), coronal 2 (0.86%).

The present study investigate the presence and incidence of wormian bones in adult dry skulls from the early Christian necropolis in Salona site, Dalmatia. The knowledge of the presence and variation of the wormian bones are important for neurosurgeons, forensic, and anthropological point of view.

Keywords: skull, wormian bones, variation

P-G-3 The influence of social factors on the physical development and maturation of girls (12-16 years old) from Sliven district - Bulgaria

Pirinska - Apostolu Magdalena[1], *Nadezhda Paraskova*[1], *Ralitsa Bogdanova*[2]

[1]Department of Zoology and Anthropology, Faculty of Biology, Sofia University "St. Kliment Ohridski", 8 Dragan Tsankov Blv., Sofia, Bulgaria,

[2] National Museum of Natural History, Bulgarian Academy of Sciences, Sofia, Bulgaria

e-mail address of the corresponding author: mpirinska@abv.bg

Abstract: Human physical development is a biosocial process, subject to the influence of interconnected groups of factors - ontogenetic and social, which have a complex impact on each individual. One of the most notable events during the period of puberty in girls is the appearance of the first menstruation - menarche. Menarche is a sign of maturation and fertility in young women. The growth and development of children are reliable markers of the general health and nutritional habits of society. In addition, changes in children's growth and development reflect the different socio-economic status of each specific population.

The present study was carried out in schools in the territory of the Sliven district (the city of Sliven and the city of Nova Zagora) on 9 somatometric signs (weight, height, height in a sitting position, length to the tragion, trunk length, length of the lower and upper limbs, biacromial and bicrystalline diameter); the age of appearance of the first menarche was noted, as well. Based on the measurements taken, 11 indices were calculated. 167 girls aged 12 to 16 were studied, of whom 148 were living in a family environment and 19 - in social institutions. During the study, a standard anthropological methodology of Martin & Saller was used.

The greatest change in the body of girls (regarded as one group) from Sliven District is observed in the period 13-14 years of age, concerning four of the examined traits: weight, height, height in a sitting position, and length of the lower limbs. The same trend is maintained in girls living in a family environment, as this complex of traits also includes the length of the upper limbs. The biacromial and bicristaline diameters increase smoothly throughout the entire period from 12 to 16 years of age for the group as a whole and

separately for the two groups. Due to the small number of the contingent from social institutions distributed by age groups, reliable conclusions cannot be made regarding their physical development.

In general, for girls from Sliven District, the average age of first menarche is 12.29 years. When comparing the two social groups in terms of the onset of first menstruation, it was found that in girls living with their families, it occurs earlier (12.25 years) than in girls living in social institutions (12.6 years). This indicator of sexual maturation gives reason to conclude, that girls living in social institutions mature later than those living in a family environment.

Keywords: physical anthropology, somatometric traits, schoolgirls, Sliven region, Bulgaria

P-G-4 Geographical studies of urbanization processes and their spatial organization in Bulgaria

Evelina Filatova, Emilia Patarchanova,
SWU "Neofit Rilski", Blagoevgrad, Blagoevgrad, Bulgaria
e-mail address of the corresponding author
emilia_patarchanova@swu.bg

Abstract: Cities have always been drivers of culture and social progress. They are centers of socio-economic life, concentrating not only population, but also infrastructure, services, and others on their territory. Urban change is most often characterized by two main units of measurement: the degree of urbanization and the rate of growth of the urban population. Intensive urbanization in conditions of rapid population growth and its activity is a basic prerequisite for the need to create scientifically based concepts for the city and settlement formations. The development of settlements is an essential part of the development of society. Historical and geographical knowledge is necessary to clarify the genesis of settlements and understand modern settlement processes. From their formation as a geographical feature with an increasing concentration of functions and population on a limited territory to their current state of a complex and dynamic social organism, the development of cities gives rise to significant research interest. The settlement type of the city is relatively young, if compared to villages. The city is the result of the division of labor, the

differentiation and concentration of non-agricultural activities. The emergence and development of certain cities must be linked to their place and contribution to public life during different periods. The growing industrialization since the middle of the last century has led to strong urbanization, which poses many challenges to cities, both in Europe and Bulgaria, and around the world. The growth of cities leads to serious demographic and economic changes, which modern cities have difficulty coping with. Therefore, they need research for the purpose of planning and good management in the name of citizens and business.

Keywords: city development, urbanization, urban population, spatial organization

Acknowledgements - Contract №КП-06-МНФ/57/19.12.2024

P-G-5 Evaluating Urban Expansion Using a City-Scale Dasymetric Population Map: A Case Study of Bursa, Türkiye

Mustafa Köse[1], Nilanchal Patel[2], Galina Bezinska[3]

[1]Afyon Kocatepe University, Afyon, Türkiye

[2]Birla Institute of Technology, Mesra, India

[3]South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

e-mail address of the corresponding author: galinabezinska@swu.bg

Abstract: Urban expansion has become a defining feature of rapidly growing cities, particularly in developing countries, where population growth and rural-to-urban migration are driving complex spatial transformations. Effective urban planning requires detailed, high-resolution data on how populations are distributed and how urban areas evolve over time. Traditional population mapping techniques, such as choropleth maps based on administrative boundaries, often fail to capture the heterogeneity of urban development and may misrepresent the true spatial patterns of population density.

This study investigates urban expansion in Bursa, Türkiye, using a city-scale dasymetric population mapping approach. Bursa, one of Türkiye's major

metropolitan areas, has experienced significant urban growth in recent decades due to industrialisation and increased migration. Between 2000 and 2025, the city's urban footprint expanded considerably, resulting in land use fragmentation, increased pressure on green spaces, and mounting environmental concerns. This research uses a dasymetric mapping technique that integrates satellite imagery, land use/land cover data, and official population statistics to more accurately redistribute population across the urban landscape. Unlike traditional methods, dasymetric mapping disaggregates population data using additional geographic information, providing a more realistic spatial representation of population density. The study examines the spatial and temporal dynamics of urban expansion by integrating remote sensing data, population modelling, and environmental indices.

Landsat imagery enabled the analysis of changes in land surface temperature (LST), vegetation cover, and surface barrenness. The analytical framework included key indicators such as the Normalized Difference Vegetation Index (NDVI), the Normalized Difference Bareness Index (NDBaI), and a modified Summer Simmer Index (SSI), which was designed to better capture urban thermal discomfort during periods of high temperature.

To achieve a more accurate representation of urban population distribution, a high-resolution dasymetric population map was developed. This facilitated stronger spatial correlations between demographic pressures and environmental conditions. Furthermore, a new Composite Urban Environmental Stress Index (CUESI) was developed by integrating geospatial and demographic layers. This synthetic index combines critical parameters – LST, vegetation, barrenness, thermal comfort, and population density – into a unified metric, that allows the identification of areas of experiencing heightened environmental stress.

The results reveal substantial increases in surface temperature and bare areas, as well as a noticeable decline in vegetation, particularly in densely populated neighbourhoods. The CUESI proved to be a valuable tool for identifying areas of acute ecological vulnerability, highlighting the need for targeted regeneration strategies and the expansion of green infrastructure. This study proposes a multi-dimensional approach that links physical landscape change with human presence, providing urban planners with a practical tool to

support sustainable growth and improve liveability in rapidly developing cities such as Bursa, Türkiye.

Keywords: Urban Expansion, Remote Sensing, Dasymetric Mapping, Environmental Stress Index, Land Surface Temperature (LST)

Section: Ecology and Environmental Protection

P-EEP-1 First and confirmative records of four mayflies (Insecta: Ephemeroptera) from the Republic of North Macedonia

Biljana Rimcheska[1], Yanka Vidinova[1]

[1]Department of Aquatic Ecosystems, Institute of Biodiversity and Ecosystem Research,
Bulgarian Academy of Sciences,
vidinova@yahoo.com

Abstract: The mayfly fauna of Republic of North Macedonia was intensively studied in the 50-60's years from the past century. Since then, only a few data records are published, which comprise several newly reported species. However, there is still need for future research that should be done to complete and actualize the check list of the North Macedonian mayflies. Bearing in mind to reveal the current state of the mayfly fauna, we focus our work on selected semi-mountainous and mountainous rivers from the 7th Ecoregion, covering the easternmost part of the country. Sixteen sites were sampled twice – in autumn 2017 and in spring 2018. Among the 42 mayfly taxa found in total, we established four species new for the country: *Baetis (Baetis) melanonyx* (F.J. Pictet, 1843), *Procloeon pulchrum* (Eaton, 1885), *Habrophlebia eldae* Jakob & Sartori, 1984 and *Ecdyonurus (Ecdyonurus) macani* Thomas & Sowa, 1970. Apart from *B. (B.) melanonyx*, which was recorded at seven sites (№№ 3, 5, 6, 9, 14, 15 and 16), the other species are known only from a single site and in small numbers: *H. eldae* (site 9, 4 individuals), *P. (P.) pulchrum* (site 15, 1 ind.) and *E. macani* (site 6, 3 ind.) at. Among the other mayflies *Baetis* (*Rhodobaetis*) *rhodani* (F.J. Pictet, 1843) and *Alainites muticus* (Linnaeus, 1758) were the most

abundant species, which we found at all 16 studied sites. The following species were recorded only at one site as well: *Metreletus balcanicus* (Ulmer, 1920), *B.* (*B.*) *lutheri* Müller-Liebenau, 1967, *B.* (*B.*) *vernus* Curtis 1834, *Ecdyonurus* (*Helvetoraeticus*) *picteti* (Meyer-Dür, 1864), *Epeorus* (*Ironopsis*) *yougoslavicus* (Šamal, 1935), *Caenis macrura* Stephens, 1836 and *Serratella ignita* (Poda, 1761). Further, we emphasize the rarity of some of the listed species implying because of the hydromorphological degradation present at some of the sampled sites, as maybe one of the most important factors for recorded absence of most of the species at other ecologically similar sites. In general, this work summarizes the first records of mayfly species, both faunistic and ecological data, as well as the degree of vulnerability to offer an effective tool for the proper river management of semi-mountainous and mountainous rivers from 7th Ecoregion.

Keywords: Ephemeroptera, diversity, new records, rare species, ecological preferences, Eastern Balkans.

Acknowledgements: This study was supported by project № DFNP-17-108/28.07.2017 "Implementation of biotic indices BMWP and ASPT in order to evaluate the ecological status of mountain and semi-mountain rivers from the 7th Ecoregion (Eastern Balkans)", funded by Bulgarian Academy of Science.

P-EEP-2 Optimizing nitrogen retention through novel magnesium-urea complexes: monitoring ammonia emissions in soil environments

Gergana Velyanova
Institute of Mineralogy and Crystallography,
Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria
gergana315@gmail.com

Abstract: The efficient delivery and prolonged retention of nitrogen in agricultural systems remain critical challenges in fertilizer development. This study explores the formation and behavior of a novel magnesium-urea compound designed to minimize nitrogen volatilization and enhance nutrient stability in soil environments. A tribochemical route was applied to synthesize a crystalline complex combining magnesium sulphate monohydrate and urea. The

product exhibits high nitrogen content and improved physicochemical stability, tailored to support sustainable nutrient management strategies. The mechanochemical preparation method, devoid of solvents and performed at low energy input, yielded a distinct compound with the empirical formula $MgSO_4 \bullet 6[OC(NH_2)_2] \bullet 0.5H_2O$. This phase was confirmed through powder diffraction techniques and characterized by its low hygroscopicity, enhanced storage potential, and high crystallinity. Controlled synthesis was achieved using specific reagent ratios and milling conditions. The resulting product demonstrated clear advantages over traditional urea, notably in reducing volatilization losses when introduced into organic soil substrates. A custom-designed static chamber system was used to evaluate the ammonia release profile of the synthesized fertilizer compared to conventional urea. Both formulations were incorporated into a standardized organic substrate under identical moisture and environmental conditions. Ammonia concentration was measured daily using a calibrated electrochemical gas detector over an extended period. Results revealed a significant decrease in nitrogen loss from the magnesium-urea complex, affirming the hypothesis that structural stabilization of urea molecules in the presence of divalent magnesium reduces the rapid release of nitrogen into the atmosphere.

The implications of this approach are twofold. First, it demonstrates a viable strategy to mitigate one of the most persistent inefficiencies in nitrogen fertilization – gaseous losses due to ammonification and volatilization. Second, the method aligns with environmentally conscious production protocols by eliminating solvent use and by-products, supporting the development of cleaner agrochemical formulations. Future research should focus on field-scale validation of the fertilizer's performance and the potential synergistic effects when combined with other nutrient carriers. Long-term soil interaction studies will further clarify the compound's agronomic value and its role in circular nutrient economy models.

Keywords: nitrogen retention, urea complex, magnesium sulphate, mechanochemistry, ammonia emission, sustainable fertilizers.

Acknowledgements: This research was financially supported by the Bulgarian National Science Fund, grant agreement КП-06-Н64/4, 15.12.2022.

P-EEP-3 Some aspects of the chemical pollution from CFPPs of Razmetanitsa and Sokolitsa rivers

Vanina Mitseva[1], Elena Karashtranova[1], Emilia Varadinova[1,2]

[1]South-West University "Neofit Rilski", Faculty of Mathematics and Natural Sciences, 66 Ivan Mihaylov Street, 2700 Blagoevgrad, Bulgaria

[2]Department of Aquatic Ecosystems, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences,

vanim@abv.bg

Abstract: Aim: The study aims to establish the origin, type and impact of chemical pollutants entered in the rivers as a result of discharges from existing Coal Fire Power Plants (CFPPs) in two of most affected river catchments in Bulgaria - Razmetanitsa and Sokolitsa rivers

Materials and methods: In 2023 and 2024 monitoring was carried out before and after discharges of waste water from CFPP “Bobov dol” and CFPP “Contour Global Maritsa East 3” in the affected Razmetanitsa and Sokolitsa river catchments. Water and sediment samples were taken to measure the concentrations of specific pollutants, priority substances and other substances, which are indicative for water pollution from CFPPs. Comparisons of the received values with official monitoring data for previous periods, as well with current standards and regulatory documents were made.

Results: A relation between the high values of the analyzed pollutants in sites situated after the CFPPs and the deterioration of the ecological and chemical status of the studed rivers in the sections after discharge was established.

Conclusion: The CFPPs activities in both studied river catchments cause deterioration of the ecological and chemical status in the studied aquatic ecosystems. The conducted study confirmed necessity of expansion of the list of obligatory aquatic pollutants, which are objects of permission and control regime according to the requirements of the Bulgarian water legislation.

Keywords: coal fired power plants, surface/running water pollutants, ecological status, chemical status.

P-EEP-4 Monitoring European beech phenology in two long-term ecological research sites by remote sensing

Svetoslav Anev [1], *Sonya Damyanova* [2]

[1]Department of Dendrology, Faculty of Forestry, University of Forestry, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria

[2]Department of Plant Pathology and Chemistry, Faculty of Ecology and Landscape Architecture, University of Forestry, 10 Kliment Ohridski Blvd., 1797 Sofia, Bulgaria

svetoslav.anev@ltu.bg

Abstract: Latitude and altitude's impact on phenological rhythms were studied from 2017 to 2023 at two European beech forest sites in western Bulgaria, Petrohan and Belasitsa. These sites are part of the European Long-Term Ecological Research Network. We used products from the Copernicus program's 'High-Resolution Vegetation Plant Productivity' to extract the main phenological events: start-of-season date, max-of-season date, end-of-season date, and length of season. Our findings indicate that the spring phenology of European beech is closely linked to altitude, while autumn events are more significantly affected by latitude. Spring phenological events were delayed by 2.9 days per 100 m at Petrohan and 2.3 days per 100 m at Belasitsa. This relationship weakens in summer and almost disappears in autumn when latitude becomes a leading factor. The average difference in the end-of-season date between Belasitsa and Petrohan is 10.8 days, which means 5.4 days per degree of latitude. Although the end of the season has been occurring later each year, the relationship is still insignificant; however, this is likely due to the short duration of the study. The dynamics of individual phenological events in different years, at various altitudes and latitudes, show that European beech has good potential for acclimating to current climate conditions in the western Bulgarian mountains, Further research is needed on the influence of longitude, considering the uneven transition between Mediterranean and temperate-continental climates in the southeastern part of the specie's range.

Keywords: Belasitsa, LTER forest sites, Petrohan, phenology

Acknowledgements - Bulgarian Long-Term Ecosystem Research Network (LTER-BG) – TO1-320/30.11.2023; Damages and recovery assessment of the

icestorm-affected forests in the Petrohan using remote sensing methods – NIS-B-1292/2023.

P-EEP-5 Microbiological status of soils within the scope of the site Petrohan, LTER-BG

Bilyana Grigorova-Pesheva, Sonya Damyanova, Pavel Pavlov
University of Forestry, Sofia, Bulgaria
e-mail: b.pesheva@ltu.bg

Abstract: The microbiological status of forest soils can serve as a basis for assessing the condition of the soil and, respectively, the condition of tree stands. The present study aimed to investigate the microbiological status of soils within the scope of the Petrohan site, part of LTER-BG. The study includes the analysis of five soil profiles, of Cambisols at altitudes from 620 to 1420 m. For the purpose of the study, basic soil parameters relevant to soil microflora were determined - pH (H2O), Humus, organic carbon, total nitrogen, C/N ratio, phosphorus, temperature and soil moisture. From the microbiological indicators, the quantities of the main microbiological groups (bacteria, micromycetes and actinomycetes) were determined, as well as the total microbial number was reported, as an expression of the biogenicity of the studied soils. Correlations between individual soil characteristics and its microbiological parameters were sought. In all soils studied, microbial abundance decreased with depth in the soil profile. Microbial abundance moved from 8.6 x 10^4 CFU/ g soil to 12.6 x 10^4 CFU/ g soil for A horizon and from 1.45 x 10^4 CFU/ g soil to 2.60 x 10^4 CFU/ g soil for B horizon. With a greater amount of microorganisms, soils at higher altitudes stand out. The dominant group is the bacteria. The statistical analysis of the results shows different dependencies in the individual horizons. Thus, in the A horizon, with increasing pH values, the microbial abundance decreases (r=-75). The microbial communities of the A horizon of the studied soils show a positive correlation when analyzing the data on the content of organic and total nitrogen and phosphorus. The correlation is inversely proportional when taking into account the impact of temperature and moisture. The influence of environmental

factors on the microbial abundance of the studied soils increases in the depth of the soil profile. Thus, when analyzing the relationship between the biogenicity of the soil in the B horizon and the content of organic carbon, the correlation coefficient reaches to r=.99. Similar data show the dynamics of microbial communities in different soil horizons and reflect the degree of impact of environmental factors on soil microorganisms. The present study and the results generated can serve as a basis for future studies in assessing soil health in forest areas.

Keywords: microorganisms, Cambisols, soil biogenicity

Acknowledgements - The research that led to these results was carried out with the help of infrastructure LTER-BG (Agreement № TO1-320/30.11.2023), purchased under the National Roadmap for Scientific Infrastructure, financially coordinated by the Ministry of Education and Science. The collection and processing of the primary data started with implementing the project NIS-B-1292/2023 at the University of Forestry, Bulgaria.

P-EEP-6 Data Fusion for Ecosystem Services Assessment: a Case Study in Bulgarian South-western Rila Mountains

Kostadin Katrandzhiev, Kremena Gocheva, Radka Fikova, Svetla Doncheva
Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria
kmkatrandjiev@gmail.com

Abstract: We assess the provision capacity of three cultural ecosystem services: 3112 Physical use of land-/seascapes in different environmental settings, 3123 Heritage, Cultural and 3222 Bequest on a local level in a study area in Rila Mountain. They are incorporated in the Methodological framework for assessment and mapping of ecosystem condition and ecosystem services in Bulgaria (Clorind, 2017) on a national level; however, national level parameters are not immediately usable for local assessments. Adapting the assessment of selected cultural services to the local level through defining key parameters is the subject of our study. We furthermore build upon previously obtained results on condition and functioning of the high - mountain ecosystems (HME) in the

same study area (Katrandzhiev et al. 2022) to explore the connection between ecosystem condition and the provision of cultural ecosystem services through the Whole System approach adopted in the Methodological framework.

We develop calculation algorithms for each parameter of the selected services. For identified gaps in the calculation of some parameters we develop calculation algorithms appropriate to the study area. We then collect available local scale data such as visitor numbers for local cultural heritage sites, calibrate the assessment scale by developing parameter level scales as necessary (e.g. for protected area type, access method type, ecosystem condition based on satellite observations), and calculate the numeric values for the score of provision capacity for the three cultural ecosystem services using the same scale as in the national assessment – between 1 for lowest and 5 for highest capacity. We found a high provision capacity (4,4 for 3112, 3,65 for 3123 and 3,87 for 3222) for all assessed services in the studied HME. The presented assessment is both a contribution to the localisation of the Methodological framework, and to assigning semi-quantitative values to abstract ecosystem services.

Keywords: Ecosystem services assessment, Data fusion, High- mountain ecosystems, Expert- based approach

Acknowledgements: The study has been carried out in the framework of the National Science Program "Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters" approved by the Resolution of the Council of Ministers № 577/17.08.2018 and supported by the Ministry of Education and Science of Bulgaria (Agreement DO-230/06-12-2018) and the LTER-BG infrastructure financially coordinated by the Ministry of Education and Science (Agreement DO1-320/30.11.2023). and eLTER PLUS (No 871128) Horizon 2020 project.

Mathematics

P-M-1 Obtaining an Analytical Solution of First-Order Differential Equations with ChatGPT

Biljana Zlatanovska, Marija Miteva, Natasa Koceska, Saso Koceski, Limonka Lazarova, Mirjana Kocaleva

Goce Delcev University, Stip, North Macedonia
biljana.zlatanovska@ugd.edu.mk

Abstract: ChatGPT is a part of the artificial intelligence developed by OpenAI, which was officially launched in 2022. It is a tool that enables interactive conversations and provides explanations, guidance and information across various fields related to everyday life, education and professional work. On the other hand, differential equations are deeply connected to nature and the laws of physics, playing an essential role in the mathematical modeling of real-world phenomena. Therefore, in this paper we analyze ChatGPT's capability to solve first order ordinary differential equations, with a focus on obtaining accurate analytical solutions. Our focus will include the following types of equations: equations with separable variables, linear and Bernoulli differential equations, as well as some nonlinear differential equations. Our goal is, through analysis of various examples to conclude the accuracy and applicability of ChatGPT in solving this type of mathematical problem.

Keywords: differential equation, ChatGPT, solution of differential equation

Acknowledgements - This work is financially supported by Goce Delcev University, Stip.

Informatics

P-I-1 Application of Computer Visualizations in Scientific Data Analysis

Radoslav Mavrevski[1], Miglena Trencheva[1], Metodi Traykov[3], Tereza Trencheva[2], Ivan Trenchev[1,2]
[1]South-West University "Neofit Rilski", Blagoevgrad, Bulgaria
[2]University of Library Studies and Information Technologies, Sofia, Bulgaria
[3]New Bulgarian University, Sofia, Bulgaria
email: i.trenchev@unibit.bg

Abstract: The advancement of computer visualization and its application in bioinformatics represents significant progress in the analysis of complex biological data. This paper explores the integration of mixed reality (MR) and artificial intelligence (AI) as powerful tools for the visualization and interpretation of data in bioinformatics. By utilizing immersive MR environments combined with AI-driven machine learning algorithms, new opportunities emerge for the exploration of large-scale biological datasets. For instance, in the analysis of genomic sequences, MR enables researchers to visualize and interact with 3D models of DNA structures, while AI algorithms identify mutations or regulatory elements with high precision. In proteomic studies, the combination of MR and AI facilitates the visualization of protein-protein interactions, enhancing the understanding of their functionality and potential therapeutic targets. Furthermore, in structural bioinformatics, MR-AI systems allow for interactive modeling of 3D protein structures, accelerating the drug discovery process by identifying potential binding sites. The paper also presents examples from metagenomic analysis, where the visualization of microbial community data through MR-AI aids in understanding complex ecosystems and their role in human health. The findings emphasize that the combined use of mixed reality and artificial intelligence not only improves the efficiency of bioinformatics research but also provides novel ways to interpret and communicate complex biological data, thereby contributing to advancements in biomedical sciences.

Keywords: mixed reality, artificial intelligence, bioinformatics, data visualization, genomics, proteomics

Acknowledgements - This study is financed by the European Union-NextGenerationEU through the National Recovery and Resilience Plan of the Republic of Bulgaria project № BG-RRP-2.005-0003.

P-I-2 Adaptive Learning in Mixed Reality: New Horizons for Personalized Education

Ivan Trenchev [1.2] , Vladimir Angelov[2], Yana Karshiyska[2], Kamelia Shumanova[2], Borislav Zashev[1]

1 South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

2 University of Library Studies and Information Technologies, Sofia, Bulgaria

i.trenchev@unibit.bg

Abstract: The integration of artificial intelligence (AI) and mixed reality (MR) in education is revolutionizing the way learners interact with digital content. This paper explores how AI-powered adaptive learning systems, combined with Unreal Engine 5 (UE5), can enhance immersive educational experiences. UE5 provides high-fidelity virtual environments, enabling interactive and engaging simulations that respond dynamically to learners' needs. AI algorithms analyze user interactions, preferences, and cognitive load to personalize content in real-time, fostering deeper engagement and improved knowledge retention. The study examines key applications, including gesture recognition, voice interaction, and real-time adaptation of virtual learning environments. Challenges such as optimization for real-time performance, ethical considerations, and user accessibility are also discussed. The findings highlight the potential of AI-driven MR experiences in reshaping education, making learning more accessible, interactive, and personalized..

Keywords: Mixed Reality, Artificial Intelligence, Unreal Engine 5, Adaptive Learning, Immersive Education, Virtual Environments

Acknowledgements - This research was conducted as part of the project "Mathematical Modeling and Artificial Intelligence for Adaptive Learning in Mixed Reality" at the University of Library Studies and Information Technologies (ULSIT). We extend our gratitude to the university for providing the necessary resources and support for the development of this study. Special thanks to all contributors and collaborators who played a crucial role in the research and implementation of innovative solutions in adaptive learning environments..

P-I-3 Construction and optimization of the seventh-order polynomial convolutional interpolation 2P kernel

Zoran N. Milivojević[1,], Nataša Savić[1], Bojan Prlinčević[2], Violeta Stojanović[1], Dijana Kostić[1]*

[1]Academy of Applied Technical and Preschool Studies, Niš, Serbia

[2]Kosovo and Metohija Academy of Appl. Studies, Leposavić, Serbia ERBIA

*e-mail: zoran.milivojevic@akademijanis.edu.rs

Abstract: This paper presents the construction of the convolutional, seventh-order polynomial (n = 7), two-parameter (2P), interpolation kernel. The 2P kernel is defined on the interval (-5, 5) and approximates the ideal *sinc* interpolation kernel. The 2P kernel is composed of piecewise seventh-order polynomials, which are defined on the subintervals. In order to fulfill the conditions that the convolutional interpolation kernel should satisfy, a system of 38 equations with 40 unknown coefficients of the piecewise seventh-order polynomials was created. In order to achieve an unambiguous solution, two unknowns are replaced with parameters α and β, and, in this way, the parameterization of the 2P kernel is performed. Time and spectral characteristics of the 2P kernel are dependent on the kernel parameters, and, thanks to that, the kernel can be optimized to solve a specific problem. In the second part of this paper, the optimization of the kernel parameters, in accordance with the criteria of similarity with the ideal *sinc* kernel, was performed. Based on the criteria that the slope of the spectral characteristic of 2P kernel should be equal to the slope *sinc* in node x = 1, the kernel parameters were determined ($\alpha_{opt} = \alpha_{\zeta,} = 217/3496$, $\beta_{opt} = \beta_{\zeta} = 49/43620$). Based on the criterion that the (n-1)th-order derivative of the spectral characteristics of 2P kernel should be continuous at x = 1, the kernel parameters were determined ($\alpha_{opt} = \alpha_{\xi,} = 145/4468$, $\beta_{opt} = \beta_{\xi} = 30/50087$). The effect of optimization of the kernel parameters on the spectral characteristic of the 2P kernel, in relation to the ideal box characteristic, using total square error ET, was analyzed. Based on the results, which are presented using tables and graphs, it is concluded that the ET of the 2P kernel is less compared to the ET of the seventh-order 1P kernel. Therefore, the precision of interpolation, when the seventh-order 2P kernel is applied, is higher. Based on these facts, the implementation of the interpolation convolutional seventh-order 2P kernel, in real-time systems, can be recommended.

Keywords: Convolution, Interpolation, Polynomial kernel, Taylor series

P-ME-1 Robots and Reassurance: Teacher Insights into a New Curriculum for Anxiety-Free Math Learning

Nadezhda Borisova [1], Elena Karashtranova [1], Ineta Helmane [2], Linda Daniela [2], Hasan Arslan [3], Yasemin Abalı Öztürk [3], Kadir Tunçer [3], Danguole Rutkauskiene [4], Kornelia Daukintyte [4], Aleksandra Zając [5]

[1] Department of Informatics, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2] University of Latvia, Latvia

[3] Canakkale Onsekiz Mart University, Turkey

[4] Baltic Institute of Educational Technologies, Lithuania

[5] Cardinal Stefan Wyszyński University in Warsaw, Poland

email: nborisova@swu.bg

Abstract: Integrating robotics into mathematics education is a promising strategy for reducing student anxiety and building confidence. This innovative curriculum combines technology with supportive pedagogical strategies to create an engaging, low-stress learning environment. This study examined in-service and pre-service teachers' perceptions regarding the application of robotics in primary mathematics education. These findings underscore the potential of robotics to augment hands-on learning, creativity, and problem-solving skills among young learners. Data were collected through online surveys and interviews. The results indicate that while educators recognize the significant pedagogical value of robotics, successful implementation is contingent upon targeted professional development and curricular alignment. These insights highlight the necessity for the early, meaningful integration of technology to facilitate anxiety-free mathematics learning in primary classrooms.

Keywords: Mathematics Education, Robotics in Education, Math Anxiety, Primary Education, Teacher Perceptions, STEM Education

Acknowledgments: This study was done with the support of the Erasmus+ programme of the European Union, project name Anxiety Free Mathematics Education with Robotic Applications in Blended Learning, 2023-1-LV01-KA220-HED-000153826. The European Commission support for the production of this

publication does not constitute an endorsement of the contents that reflects the views only of the authors, and the Commission cannot be held responsible for any use that may be made of the information contained therein.

P-ME-2 Chemistry - fun and interesting using STEM approaches

Aleksandra Tencheva[1], *Elitsa Chorbadzhiyska*[1,2]

[1]Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

[2]Innovative Center for Eco Energy Technologies, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

al.tencheva@swu.bg

Abstract: Chemistry, as a science, is often perceived as a difficult and abstract discipline that requires serious attention and effort. However, when chemistry is viewed through the prism of STEM (Science, Technology, Engineering and Mathematics), it takes on a new dimension – fun and interactive. The STEM approach provides opportunities for experimentation, discoveries and application of chemical principles in the real world, while stimulating curiosity and creative thinking. In this article, we will look at how, through STEM approaches, we can make chemistry not only more accessible, but also extremely fascinating for students and students who are looking for new ways to understand and fall in love with this amazing science.

Chemistry is considered to be a complex and difficult science, but using STEM methods in its teaching, chemistry can become an extremely interesting and attractive subject for students. The use of various STEM methods in teaching chemistry on the one hand leads to provoking interest, and on the other hand to increasing motivation to learn. This makes learning fun, the learner learns not because he "has to", but because he wants to learn and obtain certain knowledge, to acquire certain competencies.

At the center of STEM education is the student. He must be maximally engaged, both in class and outside of it. Active participation of the learner and learning through practical application, experiencing what has been learned, are the main principles underlying STEM education. Teachers turn students into

discoverers, researchers, experimenters who successfully understand and apply their knowledge in real situations, as well as in everyday life.

Teaching through STEM methods develops critical thinking, creativity and problem solving, teamwork skills, digital literacy, independent thinking, assessment and self-evaluation - skills that are necessary for successful implementation in the labor market, and even more so for successful and correct coping with the challenges of life and social realization.

This publication presents various STEM approaches that can be successfully used in chemistry teaching with a view to increasing interest and motivation for studying the science of chemistry, revealing the fun side of chemistry, easy and more effective perception and understanding of the studied material, obtaining long-lasting knowledge and forming key competencies in students necessary for achieving personal, social and professional fulfillment.

Keywords: chemical experiment, STEM learning, STEM approaches, STEM in chemistry

Acknowledgements - This study was supported by the project RP-A2/25.

P-ME-3 How Important is STEM Integration in Modern Teaching: Survey Insights

Damyana Grancharova

Department of Chemistry, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria

damyanat@yahoo.com

Abstract: STEM (Science, Technology, Engineering, and Mathematics) is one of the most significant parts of education that is heavily practiced in the school systems and has become popular over the last decade. Students are now equipped with necessary skills that they need to succeed in the future job market due to the full implementation of the STEM educational curriculum. A survey was conducted among teachers, evaluating the situation with the STEM education in the educational system to provide valuable evidence of the importance of STEM integration as well as the challenges and opportunities of its implementation.

Survey outcomes are indicative of strong support for STEM integration where more than 90% of those questioned have found it to be a key factor in the academic progress of students. Most of the respondents think that STEM methodologies are seriously tied to student's participation, critical thinking, and career preparation. Moreover, the study shows that teachers are very keen on developing professionally and more than half of them are passionate about furthering their studies in the field of STEM education.

Despite the excitement generated by STEM, the questionnaire also mentions some issues which educators are facing. The lack of resources, limited access to modern laboratory equipment, and lack of professional training are the most common reasons for these issues. Over 40% of respondents said that a practical training and mentorship program should be the main focus in order to have a better incorporation of STEM principles into their teaching.

The survey has also revealed another important aspect of the current state of STEM which is the need for improvements in the organization of the STEM education sector. According to the respondents, the main crucial necessities were the well-equipped STEM classrooms, setting up STEM hubs at schools, and integrating entrepreneurship education into STEM curricula. All the participants agreed with the initiative to increase the international exchange programs, thus indicating the significance of cooperation on an international stage in relation to scientific and technological advancements.

Aside from that, the inquiry explained the STEM education role in natural sciences, with almost all of the people interviewed agreeing that the STEM methods are better for science education. In fact, a large number of teachers are convinced that the incorporation of STEM approaches into teaching promotes critical thinking and also helps students to form a better realization of the scientific theories. The results show that STEM is not merely a secondary education model but an essential and most meaningful part of the teaching process.

In conclusion, the research shows how important to integrate STEM in the modern education is. Indeed, while the benefits are commonly recognized, the results show that certain improvements are still needed in order to maximize its potential. The allocation of funds for digital tools, laboratory resources, professional training, and structural improvements is one way to guarantee the seamless functioning of the STEM program.

Keywords: STEM integration, modern teaching, survey insights

Acknowledgement*:* This study was supported by the project "Master Degree in Integrating Innovative STEM Strategies in Higher Education", 2024-1-BG01-KA220-HED-000253761.

O-M-19 Applications of LLM in geometry teaching

Petar Sokoloski
Ss. Cyril and Methodius University of Skopje, Skopje, N. Macedonia
petar@pmf.ukim.mk

Abstract: Large Language Models (LLMs) have demonstrated remarkable capabilities in solving a variety of mathematical problems, including those in geometry. The most popular LLMs are ChatGPT-4, Gemini and Deepseek which are updated every few months but there are many new others showing up in very short time intervals. Their abilities to process natural language, interpret diagrams (when combined with multimodal models), and apply logical reasoning makes them valuable tools for geometry problem-solving. In this article I am going to present the key applications of LLMs in teaching geometry at the high school and university levels that I have used. Some of this applications are: Text-Based Problem Solving, Diagram Interpretation (Multimodal Models), and Educational Assistance. I am also going to discuss the limitations and the challenges in using this tools and some of the obstacles that I have faced and how to overcome them.

In conclusion, while LLMs show promise in solving geometry problems, their effectiveness depends on combining language understanding with structured reasoning and visual interpretation. As technology advances, they are likely to become even more reliable assistants in mathematical education and problem-solving and we must adapt them for best student practices as soon as possible.

Keywords: Geometry teaching, LLMs, Educational assistance.

Index