Mathematical and Natural Sciences
Students Association
of Jagiellonian University

21st Mathematical and Natural Sciences Interdisciplinary Student Conference

SeMPowisko 2023

Book of abstracts

Kraków, 11–14 May 2023

Conference plan

Thursday, May 11th

14:45 – 15:30 *Registration*

Botanical Garden — 10:00

10:00 – 11:00 **Does being a pioneer pay off? How cryptogams colonize the moraines of Arctic glaciers**
prof. Michał Węgrzyn

11:00 – 12:00 *Botanical Garden tour*

Part I - Mixtures, Signals and Spacetime — 15:25

15:25 – 15:55 **The Dirty Job of Microbes - Microalgae in wastewater treatment**
Jakub Zięba

15:55 – 16:15 **Axiomatic construction of a flat spacetime model, a brief introduction**
Jan Wierzbicki

16:15 – 16:35 **About the relation of stellar oscillations and metallicities with TESS and Gaia**
Vázsony Varga

16:35 – 16:55 Influence of disorder on the electronic structure and superconductivity of $Co_{0.2}Ni_{0.1}Cu_{0.1}Rh_{0.3}Ir_{0.3}Zr_2$ high entropy alloy
Kacper Pryga

16:55 – 17:25 Non-invasive hazardous substances detection using neutron activation – the SABAT project
Karolina Klimek

17:25 – 17:55 Mixed signals: How do protein-lipid interactions affect signalling pathways?
Marta Luterek

17:55 – 18:15 *Co ee break*

Part II - Normal, Linear and Free — 18:15

18:15 – 18:35 Introducing Game Theory to Epidemic Models
Bartosz Żbik

18:35 – 18:55 Extending the cosmological distance ladder - circularity free measurements with Gamma-ray Bursts and Quasars
Aleksander Lenart

18:55 – 19:15 Interval graphs: when biologists invent mathematics
Magda Wójtowicz

19:15 – 19:35 Smith normal form - algorithm and applications
Magdalena Grabka & Piotr Domagała

Friday, May 12th

Museal tour — 10:00

10:00 – 12:00 *Tour to Computers Museum (WMiI) and Karol Olszewski exhibition (WCh)*

Part III - Inside the Cell Layer — 12:00

12:00 – 13:00 **Endothelial Cells – the Maestro of Circulation**
dr Aleksandra Kopacz

13:00 – 13:10 *Co ee break*

Part IV - Craters, Waves and Bisons — 13:15

13:15 – 13:35 **Landforms on Meridiani Planum, Mars**
Szymon Mol

13:35 – 13:55 **Conflict over nature conservation - Attitudes towards conservation of the transboundary Białowieża Forest**
Mikolaj Kowalewski

13:55 – 14:25 **Lamination methods applied in manufacturing composite components for solar boat Celka and proper resin infiltration in molds made of medium-density fiberboard (MDF).**
Magdalena Grodecka

14:25 – 15:25 *Pizza break*

Part V - Bioengineering Against Fear and Risk — 15:25

15:25 – 15:40 **Genetic circuits: Exploring biology through the lens of engineering**
Nina Kurowska

15:40 – 16:00 Modification of fibrous carbon substrates with biopolymers for cartilage tissue regeneration
Patrycja Poloczek

16:00 – 16:30 Genetic risk factors of Leber's hereditary optic neuropathy
Julia Sikorska

16:30 – 16:50 How to evoke fear and defense? Role of narrow-field cell types of the mice superior colliculus in triggering innate defensive behaviours - optogenetic approach
Martyna Pałys

16:50 – 17:10 *Co ee break*

Part VI - Unlucky Psychedelics — 17:10

17:10 – 17:30 Classic Psychedelics in the Treatment of 21st Century Mental Disorders
Zuzanna Kościuk

17:30 – 17:50 Should we use sunscreen?
Aleksandra Rzeczyc

17:50 – 18:10 Lucky Imaging by Jędrzej Jarosław Adaszek
Jędrzej Adaszek

18:10 – 18:30 *Co ee break*

Part VII - Microplastic Adsorption in Your Model — 18:30

18:30 – 18:50 Lorentz transformations as $\mathbb{C} \bigotimes \mathbb{H}$ algebra
Filip Kowalski

18:50 – 19:10 RSA model in the study of adsorption
Wiktor Zantowicz

19:10 – 19:30 Microplastic pollution – an overview of detection methods and consequences for the environment
Monika Rasz

Saturday, May 13th

Part VIII - Supernovae and Supercomputers — 10:00

10:00 – 11:00 Introduction to Stellar Physics and Supernova Explosions
prof. Shigehiro Nagataki

11:00 – 11:15 The quest for new correlations in the realm of the Gamma-Ray Burst - Supernova connection
Biagio De Simone

11:15 – 11:30 ODE as a residual neural network with infinite depth
Adam Kania

11:30 – 11:45 *Co ee break*

Part IX - Blazars and Neutron Stars — 11:45

11:45 – 12:05 Coffee, Chaos and Gravitational Waves
Syed Naqvi

12:05 – 12:35 Modeling structures and interiors of neutron stars
Julia Osęka

12:35 – 12:55 Differencing between quiescent and flaring states of blazars using threshold autoregressive models
Klaudia Kowalczyk

12:55 – 13:15 *Co ee break*

Part X - Biosciences At Our Commands — 13:15

13:15 – 13:35 Introduction to Biological Circuit Design
Joanna Doliwa

13:35 – 13:55 Fall-proofing Senior Care: How AI Takes a Step Up in Elderly Fall Detection
Mateusz Lickindorf

13:55 – 14:25 The more the merrier - biomolecular condensates
Artur Czajkowski

14:25 – 15:25 *Lunch break*

Part XI - Posters & Algorithms in Intervals — 15:25

15:25 – 16:15 *Poster session*

16:15 – 17:15 Algorithmic differentiation and its applications
dr hab. Daniel Wilczak, prof. UJ

17:15 – 17:35 Interval arithmetic for the rescue of mathematical proof
Igor Piechowiak

17:35 – 17:50 *Co ee break*

Part XII - Quanta of the Universe — 17:50

17:50 – 18:20 Research of radioactivity of the magnetar XTE J1810-197 in the 21 cm radio band
Weronika Puchalska

18:20 – 18:40 Microfluidics for Biomedical Research in Space
Gabriela Opiła

18:40 – 19:00 Quantum Phase Transitions: Uniform and Inhomogeneous Case. Ising Model in 1D
Ihor Sokolov

19:00 – 19:20 About active galactic nuclei and relativistic jets
Julia Sierzputowska

Sunday, May 14th

Part XIII - Molecular Technology — 10:00

10:00 – 11:00 Let's take an even closer look: probing individual electrons on Surfaces
dr Dominik Wrana

11:00 – 11:20 How can theoretical chemistry improve your phone screen?
Jakub Firlej

11:20 – 11:40 Metal-organic frameworks - the multifunctional superheroes
Gabriela Kowacz

11:40 – 11:55 *Co ee break*

Part XIV - Copper, Cerium and Molecules — 11:55

11:55 – 12:15 Transition metals NPs CeO2-supported catalysts for soot oxidation
Andrzej Wójtowicz

12:15 – 12:35 Simultaneous determination of copper(II) and zinc(II) concentrations
Aleksandra Jucha

12:35 – 12:55 Into the world of molecular materials
Kinga Szczecińska

12:55 – 13:15 *Co ee break*

Part XV - Magnets, Fluorescence and Energy Storage — 13:15

13:15 – 13:35 Quick introduction to luminescent materials
Marta Niemiec

13:35 – 13:55 Alkaline metal salts of redox-active polydioxothiadiazoles as potential energy storing materials
Dominik Dzierżek

13:55 – 14:15 One molecule, numerous opportunities. Single molecule magnets based on chiral complexes.
Katarzyna Rzepka

14:15 – 15:15 *Lunch break*

Part XVI - Groups, Spaces and Slices — 15:15

15:15 – 15:45 Automatic groups
Mateusz Kandybo

15:45 – 16:05 Slice rank as a tool for combinatorial problems
Jakub Kamiński

16:05 – 16:25 The structure of moduli space of Riemann Surfaces
Mykhailo Hontarenko

Abstracts

Thursday, May 11th

15:25 – 15:55 — The Dirty Job of Microbes - Microalgae in wastewater treatment

Jakub Zięba, KNSB Mygen, WBBiB UJ, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Poland

With the development of human population and industry, wastewater quickly becomes more and more pressing issue. The main concern is nitrogen and phosphorus contamination, responsible for eutrophication of water bodies and toxic blooms. Another problem is heavy metal, pharmaceutics and pathogen content. All of these matters are often resolved by heterotrophic and chemical processes, but more recently there is a growing interest in natural microalgae-based approaches. The rationale behind this is potential for cultivation of algal biomass. This biomass can be a rich source of fertilizers, secondary metabolites and can be used in fermentation resulting in biofuel. In this ways, waste could be transformed into a source of wealth as well as clean water.

15:55 – 16:15 — Axiomatic construction of a flat spacetime model, a brief introduction

Jan Wierzbicki, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

I will try to present how modern physical theories are made from scratch based on the example of axiomatic construction of a flat spacetime model in special relativity. Talk is also aimed at non-physicist and non-

mathematicians, as I will try to explain mathematical structures from ground up and give physical meaning to them on the go.

16:15 – 16:35 — About the relation of stellar oscillations and metallicities with TESS and Gaia

Vázsony Varga, CSFK, ELTE, (1) Konkoly Observatory, CSFK, Hungary (2) Eötvös Loránd University, Hungary

The old yellow giant RR Lyrae type pulsating variable stars are unique in multiple ways. One of their really interesting features is that instead of performing resource-consuming spectroscopy, their metallicity can be estimated based solely on photometric measurements, which are available for numerous stars thanks to large-scale surveys such as the Gaia mission. Furthermore, some of them show interesting additional modes, whose cause and physics are not fully understood yet, to which examining their metallicity dependence might help to have a deeper look into.

The empirical relation used for deriving the so-called photometric metallicities should be fitted separately for different photometric passbands. However, to this day, a relation calibrated for the Kepler space telescope is being used for the Gaia G band, despite the differences of the passbands and the small parameter space covered in case of the RRab subtype. For the TESS space telescope, which provides accurate enough light curves to perform a frequency analysis of additional modes, such a formula for photometric metallicities has not been established at all yet.

In my talk, I will show how we have recalibrated the method both for the RRab and RRc subtypes in case of the Gaia space telescope, and used the hence derived values to examine the metallicity distribution on the Gaia Bailey diagram and that of the Large Magellanic Cloud.

I will also show my work regarding the calibration for TESS, give a short introduction to the phenomena of the RRc stars' additional modes, and show how the metallicity seems to influence their incidence rates.

16:35 – 16:55 — Influence of disorder on the electronic structure and superconductivity of $Co_{0.2}Ni_{0.1}Cu_{0.1}Rh_{0.3}Ir_{0.3}Zr_2$ high entropy alloy

Kacper Pryga, WFiIS AGH, Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Kraków, Poland

High entropy alloys are a class of novel intermetallic compounds that consist of at least five elements and despite complex composition crystallize in rather simple crystal structures. Some of them possess exceptional mechanical properties, meaning that applications in extreme conditions are possible. HEAs can also exhibit superconductivity and recently a new such HEA was discovered: $Co_{0.2}Ni_{0.1}Cu_{0.1}Rh_{0.3}Ir_{0.3}Zr_2$ with a HEA-type transition metal site. As of today, no detailed study of its mechanism of superconductivity can be found.

We performed DFT calculations of the electronic structure of this HEA and related binary compounds using a number of complementary methods, i.e. KKR-CPA, LAPW and pseudopotential. By using determined electronic and phonon structure we were able to investigate the significance of disorder, local distortions and spin-orbit coupling effects on the properties of the material. Obtained value of electron-phonon coupling parameters suggests conventional character of pairing interactions, while electronic structure is strongly correlated to the constituent binary structures due to key role of the ordered Zn crystallographic site.

16:55 – 17:25 — Non-invasive hazardous substances detection using neutron activation – the SABAT project

Karolina Klimek, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

After World War II about 250 000 tons of munition, including up to 65 000 tons of chemical agents, were sunk in the Baltic Sea. The main areas, where the munition was sunk, are Bornholm Deep and Gotland Deep. There is also an unknown amount of munition spread over the whole Baltic. These remnants of war equipment and munitions are also serious sailing hazards. Moreover, some of the projectiles are already corroding and because of that, gases which they contain, such as mustard gas and tabun, are infiltrating into the sea.

Thus, searching for new illicit substances detection methods is necessary for the protection of the water environment and also in view of civil protection.

In my presentation, I will talk about a non-invasive device, which will use Neutron Activation Analysis (NAA) for detecting hazardous materials in water which is currently in development at the Jagiellonian University wi-

thin the framework of the SABAT project. Analysis of energy spectra, which come from neutron activation of different substances in laboratory conditions will be also presented.

17:25 – 17:55 — Mixed signals: How do protein-lipid interactions affect signalling pathways?

Marta Luterek, KMPS UJ, KNSB Mygen; WBBiB, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Poland

All cells must respond to changes in their environment and send out messages to each other. Cell signalling is a fundamental property of all cells, from bacteria searching for food to neuronal activity in our brains. A basic signal transduction mechanism involves receptors that sense the signal and trigger a response inside of the cell. One of the most important mechanisms of signal transduction is signalling through GPCRs (G-protein coupled receptors). Most elements comprising signal transduction systems are bound to lipid membranes – however, lipids have been demonstrated to not only provide the environment, but also to regulate proper signal transduction. I will present insights into how lipid modifications of G-proteins might affect GPCR-mediated signalling.

18:15 – 18:35 — Introducing Game Theory to Epidemic Models

Bartosz Żbik, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Since the outbreak of Covid-19, epidemic modeling become a popular topic not only among scientist.

Picking correct strategies to control the disease is usually based on mathematical models.

The standard approach for modeling epidemics is to use compartmental models based on differential equations.

The majority of such models assume that people are willing to cooperate, which isn't necessarily true.

The problem whether to cooperate with or betray other people, may be described by game theory through the prisoner's dilemma game.

Introducing the process of decision making to epidemic models may lead to new interesting behaviours.

18:35 – 18:55 — Extending the cosmological distance ladder - circularity free measurements with Gamma-ray Bursts and Quasars

Aleksander Lenart, KMPS UJ, WFAIS, Astronomical Observatory, Jagiellonian University in Kraków, Poland

Nowadays cosmological measurements lead to significant discrepancies between values of cosmological parameters obtained in low and high redshift observations. Those discrepancies can be explained either by observational issues or by the new physics. In this talk, I will present a general method for the circularity-free elimination of the impact of selection biases and redshift evolution. This work is an extension of the so-called Efron & Petrosian (1992) method. A permutation-type test for the correlation estimate, which is widely used in the literature. Our improvement enables the circularity-free application of this method in cosmological measurements. This provided us with the most reliable high-redshift cosmological measurements involving Quasars and Gamma-ray Bursts.

18:55 – 19:15 — Interval graphs: when biologists invent mathematics

Magda Wójtowicz, KMS UJ, WMiI, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

In the late 1950s, while studying the structure of genes, Seymour Benzer posed a question: was certain fragment overlap data on the DNA consistent with the gene having linear structure? His article on the subject was probably the first to discuss interval graphs - undirected graphs whose vertices are identified with intervals on the real line and two vertices are adjacent if and only if their corresponding intervals intersect. In my talk I will provide an overview of interval graphs, some of their properties and applications, focusing on applications in biology.

19:15 – 19:35 — Smith normal form - algorithm and applications

Magdalena Grabka, KMPS UJ, WMiI, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

Piotr Domagała, WMiI, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

We will introduce Smith normal form of matrices and talk about its most important applications, in particular, we'll cover its usage in topology for computing homologies of finite simplicial complexes or cellular complexes over the integers. We will also show the algorithm which lets us transform any integer matrix into Smith normal form.

Friday, May 12th

13:15 – 13:35 — Landforms on Meridiani Planum, Mars

Szymon Mol, KMPS UJ, WGiG, Faculty of Geography and Geology, Jagiellonian University in Kraków, Poland

In January 2004 the Opportunity rover landed on the surface of Mars and for 14 years she traversed more than 46 km exploring an equatorial region of Mars called Meridiani Planum. This scientific investigation provided ground-truth verification of working hypotheses and information about the Martian geological history and ongoing surface and atmospheric processes. The images acquired by various rover instruments (e.g. PANCAM) showed landforms typical of the desert environment. Some of these Meridiani Planum landforms have analogs on Earth and some of them are extremely difficult to find on Earth. These landforms were formed by wind, tectonic, impact and/or other processes. There exists also a further diversity of landforms on Meridiani Planum. There are for example tall, inactive very coarse sand ripples, accompanied by small, active very fine sand ripples. All in all, Meridiani Planum is a plain which surface is shaped by wind related processes and impact cratering.

13:35 – 13:55 — Conflict over nature conservation - Attitudes towards conservation of the transboundary Białowieża Forest

Mikolaj Kowalewski, oikos Copenhagen, IFRO KU, Faculty of Science, Department of Food and Resource Economics, University of Copenhagen, Denmark

The Białowieża Forest is a contested transboundary forest massif in Poland and Belarus. Reflecting transitions from value chains built on sustained yield forestry to ecotourism, we pioneer documentation of how country-specific legacies shape preferences towards increased forest protection at the expense of wood production. For both countries we used a quantitative ordered logit model based on questionnaires to Polish and Belarusian ecotourism business owners to study drivers of preferences towards the Białowieża Forest, and qualitative data to identify attitudes towards the expansion of protected areas in the Białowieża Forest. While Belarusian ecotourism business owners supported increased area protection, the opposite was true for their Polish counterparts. The qualitative data revealed that narratives against extended area protection were spread in Poland but not in Belarus. The conflict over the conservation of the Polish part of the Białowieża Forest involves actors and stakeholders with competing interests. A solution is that this remnant massif of the once wide-spread European temperate lowland forest becomes subject to a regional planning and zoning perspective.

13:55 – 14:25 — Lamination methods applied in manufacturing composite components for solar boat Celka and proper resin infiltration in molds made of medium-density fiberboard (MDF).

Magdalena Grodecka, AGH Solar Boat Team, WIMiC, Faculty of Materials Science and Ceramics, AGH University of Science and Technology, Kraków, Poland

AGH Solar Boat Team project goal is to build racing solar boats. Composite materials made of carbon fiber and epoxy resin offers light weight and good mechanical properties crucial in such constructions. Each composite element demands individual production approach. Different lamination methods and mold materials result in diverse final effects. The system of hydrofoils and struts, allowing to raise the boat's hull above the water surface, requires a mold of complicated geometry. One of the most convenient materials for making such a mold is MDF board, due to its availability and ease of

machining. Preparing it for lamination is done by covering the milled surface with resin to harden the outer layer of the board. That allows obtaining the desired smoothness, prevents absorption of the resin intended for lamination and protects the mold from moisture. A frequent problem is insufficient resin absorption by the MDF, which in further processing of the mold results in a surface unsuitable for work. The subject of this talk is to present and compare various lamination methods, their usefulness in particular situations and the techniques used to provide optimal MDF mold surface quality.

15:25 – 15:40 — Genetic circuits: Exploring biology through the lens of engineering

Nina Kurowska, WBBiB UJ, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Poland

Synthetic biology applies knowledge from established engineering fields to biological systems by using genetic components to create new functionalities. Genetic circuits play a major role in this process. Such circuits can be designed to exhibit specific behaviors and allow for programmable control of biological processes. Genetic circuits have numerous applications, including metabolic network modulation, gene regulation and biological containment methods. Like every new technology, genetic circuit design faces many obstacles, but its potential is virtually limitless.

15:40 – 16:00 — Modification of fibrous carbon substrates with biopolymers for cartilage tissue regeneration

Patrycja Poloczek, SKN Nucleus, WIMiC AGH, Faculty of Materials Science and Ceramics, AGH University of Science and Technology, Kraków, Poland

The aim of the work was to use fibrous carbon substrates with an active surface as a filling of a cartilage tissue damage (caused by focal inflammation or chondromalacia) stimulating the process of its regeneration. The fibrous substrate provides a good scaffold for cartilage cells and its active surface can stimulate chondrocyte proliferation. A fiber form is optimal from the point of view of the substrate morphology, density and mechanical strength. Low-modulus carbon fibers are used in medicine due to their

high biocompatibility and safe degradation products removed by the organism during the process of phagocytosis . To increase the cell proliferation potential, carbon fibers are modified with nanoparticles or biopolymers such as chitosan. Chitosan is well known in literature as a polycationic biopolymer with high absorbency and antibacterial properties. Due to the presence of numerous amide groups in the chain, brittle glycosidic bonds was used in our work to produce biomimetic carbon – chitosane substrates mimiking of ECM (extracellular matrix) cartilage tissue.

As a result of the research, the material and its modification method was selected which is the most suitable.

16:00 – 16:30 — Genetic risk factors of Leber's hereditary optic neuropathy

Julia Sikorska, MISMaP UW, Inter-faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Poland

In the vast majority of cases, Leber's hereditary optic neuropathy (LHON) is caused by the primary pathogenic mitochondrial DNA (mtDNA) variant m.11778G>A in MT-ND4 gene. Its presence is indispensable for the disease to occur, but not sufficient to precipitate the onset of symptoms, which is visual loss.

One of the possible causes behind its incomplete penetrance might be the variation of mtDNA copy number, observed within different populations. The aim of this work was to determine the variability of mtDNA copy number in peripheral blood of Polish carriers of m.11778G>A and its impact on loss of vision. The absolute copy number of mtDNA, determined as the mtDNA/nDNA ratio, was measured with the use of qPCR in three groups: amongst m.11778G>A carriers who have lost their sight (N1=83), amongst people with m.11778G>A showing no symptoms of LHON (N2=37) and amongst completely healthy people (N3=68).

Contrary to the research conducted on other populations, the results showed no difference in mtDNA copy number between any of the examined groups. The follow-up of this work will focus on examing the presence of PRICKLE3 variant c.157C>T and its impact on visual loss due to LHON.

16:30 – 16:50 — How to evoke fear and defense? Role of narrow-field cell types of the mice superior colliculus in triggering innate defensive behaviours - optogenetic approach

Martyna Pałys, Psychosexology Students Club, WPsych UW, Inter-faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Poland

The animals' survival hugely depends on their successful reaction to avoid danger. In mice these reactions are roughly represented by the animal's ability to escape or freeze when facing a threatening situation. It has been established, that such defensive behaviors can be reliably triggered in the lab by exposing animals to visual threats or by artificially stimulating specific neurons with light (optogenetics). The superior colliculus (SC) is a midbrain structure that plays an important role in triggering such behaviors, and there is evidence for a strong relationship between neurons in the superior colliculus and different components of defensive behaviors. However, the extent to which a behavior can be triggered by a specific cell type remains elusive. In this study we focused one genetically targetable cell type of the SC - the narrow-field neurons - and aim to establish their importance for triggering defensive behaviors.

17:10 – 17:30 — Classic Psychedelics in the Treatment of 21st Century Mental Disorders

Zuzanna Kościuk, KNN Neuronus, WB UJ, Faculty of Biology, Jagiellonian University in Kraków, Poland

The prevalence of mental disorders has increased dramatically in recent decades, with depression and anxiety being among the most common conditions affecting individuals of all ages. The rise in mental disorders has been linked to a range of factors, including urbanization, social isolation, economic instability, and exposure to environmental toxins.

The use of classic psychedelics, such as LSD and psilocybin, in the treatment of mental disorders has been the subject of renewed interest in recent years. Studies have shown that both substances have the potential to alleviate treatment-resistant depression, anxiety, and other mental health disorders. Furthermore, psychedelics have been found to enhance creativity and increase well-being.

This presentation will provide an overview of the potential role of classic psychedelics in the treatment of 21st-century mental disorders. We will

explore the history of LSD and psilocybin use in therapy, current research on the effectiveness and safety of these substances, and the potential benefits and risks of using classic psychedelics in mental health treatment. We will also discuss the mechanism of action and their effects on the brain.

17:30 – 17:50 — Should we use sunscreen?

Aleksandra Rzeczyc, KMPS UJ, WBBiB, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Krakow, Poland

Many people use UV filters without considering their purpose. Currently, it is known that UV light interacts with molecules, leading to the formation of new products. In particular, UV light can cause several significant forms of damage to DNA, such as thymidine dimers. Additionally, all molecules vibrate, resulting in the spontaneous disintegration of biological macromolecules. These changes can lead to nucleotide mismatching and ultimately the development of genetic diseases.

17:50 – 18:10 — Lucky Imaging by Jędrzej Jarosław Adaszek

Jędrzej Adaszek, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

I would like to present the lucky imaging method, which allows us to improve the quality of photos taken with the amateur, low-budget telescopes as well as large professional observatories. The work was based on my experience as an astrophotographer as well as other astronomy enthusiasts and the work entitled: "Lucky Imaging: High Angular Resolution Imaging in the Visible from the Ground" by N.M. Law, C.D. Mackay, and J.E. Baldwin. This method allows us to decrease the influence of atmospheric fluctuations and tracking quality on image sharpness, which allows us to obtain much better angular resolution. This method has been known for years in the circles of planetary astrophotographers, however, for technological reasons, it hasn't been used for deep space astrophotography. After years, thanks to technological development, we have recently been able to use this method for deep space imaging. An application of this method allowed for significant improvements

18:30 – 18:50 — Lorentz transformations as $\mathbb{C} \otimes \mathbb{H}$ algebra

Filip Kowalski, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Some particular representations of Standard Model can be described in language of normed division algebras. We are going to take a look at complex quaternions which can conveniently describe Lorentz algebra and its associated group, accommodate it in the Standard Model and see how to obtain some of well known facts from Lorentz group representation theory.

18:50 – 19:10 — RSA model in the study of adsorption

Wiktor Zantowicz, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Adsorption is a process widely used in various fields, from medicine to nanotechnology and air filters. The effectiveness of adsorption depends on several factors, including the shape of particles, the materials used, and the process conditions. To optimize this process, researchers require a thorough understanding of these factors.

One such tool used for studying adsorption is the Random Sequential Adsorption (RSA) model. RSA allows researchers to simulate random packings and analyze the effects of particle shape on the adsorption process, providing valuable insights for understanding the process.

Saturday, May 13th

19:10 – 19:30 — Microplastic pollution – an overview of detection methods and consequences for the environment

Monika Rasz, KMPS UJ, NKF UJ; WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Microplastic pollution is a rising issue in the modern world, the consequences of which are yet to be fully understood. In this presentation I will

discuss some of the threats posed by the ubiquity and increasing fragmentation of plastic debris as well as the challenges and perspectives of microplastic research. This includes the principles of operation of the most commonly used detection methods, their limitations and emerging alternative approaches, focusing on those which can be applied to identify the plastic present in water environments.

11:45 – 12:05 — Coffee, Chaos and Gravitational Waves

Syed Naqvi, WFAIS UJ, Astronomical Observatory, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Chaos is an interesting phenomenon that occurs in many areas of science. We are surrounded by chaos, from unpredictable weather to population dynamics to the rise and fall of stock markets. Certain systems described by differential equations show chaotic behavior. Einstein's general theory of relativity is a set of nonlinear differential equations. They have been shown to allow chaotic behavior in various situations. We study a standing gravitational wave solution to Einstein's equations. We have found chaotic geodesics for the standing Einstein-Rosen gravitational waves. Investigation of the phase space of this system revealed a fractal structure. Poincare maps were studied to visualize the hyperbolic and elliptical fixed points. The heteroclinic network found for our system is similar to that studied in biological systems.

12:05 – 12:35 — Modeling structures and interiors of neutron stars

Julia Osęka, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Neutron stars provide us with extraordinary opportunity to test currently known laws of physics in extreme conditions, which are not available in labolatories. Although, it is not well understood what are the properties of neutron stars' matter, a wide variety of models has been discussed in the literature through the last century. I will present a brief overview of modeling interiors of these exotic objects. This requires an application of a broad range of physic's domains: from general relativity to quantum chromodynamics. At

the end I will confornt the theoretical results with some exemplary observational data.

12:35 – 12:55 — Differencing between quiescent and flaring states of blazars using threshold autoregressive models

Klaudia Kowalczyk, KNSA UMK, WFAiIS, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University in Toruń, Poland

Blazars are a peculiar class of active galactic nuclei (AGNs) hosting relativistic jets oriented at a very small angle, pointing almost directly at the observer. They can be further subdivided into flat spectrum radio quasars (FSRQs) and BL Lacertae (BL Lac). The first type displays strong, broad emission lines and high accretion rates, while the latter's spectra are featureless or show at most weak emission lines, sometimes exhibiting absorption features, and have low accretion rates. Many of these blazars' light curves (LCs) display variability. Differentiating between quiescent and flaring states is a key to probing the inner regions of AGNs. In my work, I am using novel methods that weren't commonly used in astronomy before, but proved to be successful, e.g., in econometrics. Threshold autoregressive models constitute a promising opportunity for distinguishing quiescent states from flares in blazars' LCs, which is of importance when it comes to modeling the emission.

13:15 – 13:35 — Introduction to Biological Circuit Design

Joanna Doliwa, KMPS UJ, WB, Faculty of Biology, Jagiellonian University in Kraków, Poland

Biological circuits are sets of interacting biological components which govern certain phenomena or behaviors. The molecular circuits consist of molecular species such as genes, proteins, or protein kinases that regulate, and interact with one another in specific ways. For example, transcription factor proteins bind to promoter regions of their target genes which initiates their transcription. That is, the process of rewriting the information from the format of DNA to that of mRNA. On a slightly more general level, cell circuits are composed of individual cells which signal, controlling processes such as each other's growth, death or neurotransmitter release. Interactions within

both circuit types may be modelled using mass action kinetics and differential equations. In gene regulatory network design, the equation terms characterizing protein and mRNA production and removal are some of the key features describing the dynamics of a system. To discover and depict the characteristics of a biological circuit dynamical system, analyses such as linear stability analysis are often performed. I illustrate them using the example of the repressilator gene regulatory network motif.

13:35 – 13:55 — Fall-proofing Senior Care: How AI Takes a Step Up in Elderly Fall Detection

Mateusz Lickindorf, SKN Sztucznej Inteligencji w Medycynie, WL UMW, Faculty of Medicine, Wrocław Medical University, Poland

According to the World Health Organization (WHO), falls among the elderly are a major health concern that can result in serious injuries, hospitalizations, and even death, with falls being the second leading cause of unintentional injury deaths worldwide. AI has emerged as a promising approach to enhance fall detection and response, leveraging machine learning algorithms to analyze sensor data from cameras, accelerometers, and wearables. AI-powered fall detection systems can identify falls accurately and detect changes in mobility patterns, enabling early identification of individuals at risk of falling. However, the implementation of AI-powered fall detection systems presents challenges, including privacy and ethical considerations, algorithm bias, and interoperability. This talk will explore whether a mathematical description of a fall is possible, entertain state of the art in AI-powered fall detection and discuss the technical and ethical challenges and opportunities of integrating these systems with existing healthcare.

13:55 – 14:25 — The more the merrier - biomolecular condensates

Artur Czajkowski, KMPS UJ, TU Dresden, Physics of Life Cluster of Excellence, Technische Universität Dresden

Over the last decade a new phenomenon has risen to prominence in the field of biophysics. It was shown that some proteins have the capability of forming a separate liquid phase in which they are highly concentrated. It allows the cell to create within itself highly dynamic organelles that are not

bound by membranes. Such condensates can regulate the kinetics of enzymatic reactions, sequester certain molecules, or serve as signaling hubs. This talk will try to tell you about the physical basis of condensate formation, some interesting phenomena involving condensates shown in vitro, and give a brief overview of their possible roles in vivo.

17:15 – 17:35 — Interval arithmetic for the rescue of mathematical proof

Igor Piechowiak, KMPS UJ, WMiI, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

The talk will focus on over-viewing the basic concepts of interval analysis, beginning with the definitions, fundamental notions and theorems of the field. Then the advantages of interval arithmetic in conducting computer-assisted proofs will be shown, as well as some analogies between numerical and interval algorithms useful in computing.

17:50 – 18:20 — Research of radioactivity of the magnetar XTE J1810-197 in the 21 cm radio band

Weronika Puchalska, KNSA UMK, WFAiIS, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University in Toruń

For centuries, people have been looking for scarce and unknown objects in the Universe. Among these objects, we can distinguish magnetars, on which I mainly focus in my master's thesis. They belong to the group of isolated neutron stars with extremely strong magnetic fields ($\approx 10^{14-15}$ G) and long rotation periods (> 2 s).

Magnetars are believed to make up at least 10% of the population of young neutron stars and are primarily powered by the decay of their enormous magnetic fields, which serves as an energy source for their transient emission behavior. It is also thought that magnetars are the source of FRBs (fast radio bursts).

During my presentation, I will explain the origin of these unique objects and focus on their connection to FRB.

18:20 – 18:40 — Microfluidics for Biomedical Research in Space

Gabriela Opiła, NKSA UJ, WFAIS, Faculty of Physics and Applied Computer Science, AGH, Kraków, Poland/Faculty of Physics, Astronomy and Applied Computer Science, UJ, Kraków, Poland

Microfluidics is an interdisciplinary field of science, based on physical and chemical principles, with a wide range of possible applications. This includes diagnosis of certain medical conditions, as well as conducting biomedical experiments, even in extreme conditions, such as on satellites.

Lab-on-a-chip microfluidic systems can also be utilized in experiments in which effects of microgravity are studied with laboratory-based methods, such as diamagnetic levitation, clinostat, etc. Measurements involving this kind of systems exhibit high sensitivity and require only minuscule amounts of sample. Microfluidic systems are also easy to load on micro- and nanosatellites, as they have compact size. Owing to these features, microfluidics is an attractive solution to overcome economic and technological challenges in biomedical research, such as the high cost and lengthy duration of organizing such missions on a space station.

In this talk, I will demonstrate the crucial ideas behind microfluidic research, present a sample microfluidic system, as well as discuss examples of space research and missions involving microfluidic devices carried out so far.

18:40 – 19:00 — Quantum Phase Transitions: Uniform and Inhomogeneous Case. Ising Model in 1D

Ihor Sokolov, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Phase transition is a change in a state of a system when one of parameters of the system goes through its critical point. The difference between homogeneous and inhomogeneous change of this parameter can make a big difference in the final state od the system. It will be demonstrated on the example of 1D Ising model.

19:00 – 19:20 — About active galactic nuclei and relativistic jets

Julia Sierzputowska, KNSA UMK, WFAiIS, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University

Active galaxies are a type of galaxies whose emission does not result, as in the case of classical galaxies, from the stars, but from an accretion disk that falls on the supermassive black hole in its core. Such a central region is called AGN - active galactic nuclei. Since the core is the main emission region, the names AGN and active galaxies are used interchangeably. The fall of such an accretion disk can cause two oppositely directed ejections of matter - relativistic jets. In my lecture, I will briefly introduce the nature of active galaxies, and also present what role jets may have played in the epoch of reionization.

Sunday, May 14th

11:00 – 11:20 — How can theoretical chemistry improve your phone screen?

Jakub Firlej, KMPS UJ, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

In the 21. century we are ruled by our smartphones. We work in front of the screen, keep the screen in our pocket the entire day and then relax by the screen in the evening. How wonderful would it be if the glowing rectangle we stare at all day could show us images of startling quality. Pondering about that issue we should take notice of a seemingly petty and easy to ignore element of the screen, namely - the polarizing filter. Why it is there? Would we want to get rid of it? Could and should we seek alternatives? And, most importantly, how could these alternatives be derived? The answer, surprisingly, may be theoretical chemistry.

11:20 – 11:40 — Metal-organic frameworks - the multifunctional superheroes

Gabriela Kowacz, KMPS UJ, WCh, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Metal-organic frameworks (MOFs) are a subset of porous coordination polymers which contain organic linkers in their structure. Initially, MOFs were used for gas storage and separation, but the continuous research led them to be applied, for instance, in catalysis, proton-conductive membrane construction, and drug delivery. Their functionality is promising for their development and application in many fields of science and industry, including engineering and medicine.

While for gas storage, the main restriction is for the material to be porous, for other applications it must fulfil more specific requirements. For example, to exhibit proton conductivity, the material must have Brønsted acidic groups to create a conduction path. Focusing mainly on proton-conductive materials, the structure and applications of MOFs will be presented. Both de novo synthesis and post-synthetic functional groups insertion into existing materials will be covered.

11:55 – 12:15 — Transition metals NPs CeO2-supported catalysts for soot oxidation

Andrzej Wójtowicz, KMPS UJ, WCh, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Soot particles are formed in Diesel engines working in oxygen shortage and emitted to the atmosphere. Due to their small size they become a part of particulate matter (PM) suspended in air, causing detrimental effects both on the environment and on human's health. Employing catalytic systems for soot oxidation can significantly reduce solid particles emission. Currently used commercial catalysts are based on noble metals (Ag, Au, Pt), but due to their high price various other systems are being investigated. Among the most interesting there are CeO2-based catalysts. In this work transition metals NPs CeO2-supported catalysts were synthesised using hydrothermal method. Obtained results of model soot oxidationd in the presence of 5%O2/He in tight contact mode demonstrate that 1%Co1%Cu/CeO2 and 2%Co2%Cu/CeO2 catalysts exhibit highest activity in the investigated reaction (50% soot conversion below 400°C).

12:15 – 12:35 — Simultaneous determination of copper(II) and zinc(II) concentrations

Aleksandra Jucha, KMPS UJ, WCh, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Some heavy metals such as copper and zinc are essential in many biochemical processes, however their excessive concentration in water and soil can become toxic to the environment, and surplus consumption can lead to a number of diseases. The aim of the presented research was develop a spectrophotometric method for simultaneous determination of copper(II) and zinc(II) ions in environmental samples. The method based on the reaction between this analytes and 1-(2-Pyridylazo)-2-naphthol (PAN) to form a coloured complex in pH = 10 and pH = 12,4. In addition for this method the possibility of using Digital Imaging System as the detector system was tested.

12:35 – 12:55 — Into the world of molecular materials

Kinga Szczecińska, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Molecular materials have been attracting considerable attention for several years. The possibility of replacing already existing, oftentimes unsustainable materials, with tunable ones, exhibiting fascinating properties and multifunctional to their structural core, has engrossed a wide array of scientists. Ideas for functionalising are almost endless, from the incorporation of different metals, through changing the reaction conditions, to even crossing the borders of seemingly distant areas of chemistry. In order to fully understand the topic of multifunctional materials, it is necessary to understand how they can be created in order to impose desired properties on a coordination network, e.g. to make it sensitive to various environmental stimuli. More importantly still, it is fundamental to inspect what processes stand behind the materials' response.

The talk will introduce the basic ideas behind the creation of functional materials, as well as cover state-of-the-art advancements in their applications, including the underlying ideas for the design of compounds acting as chemical or physical sensors and actuators.

13:15 – 13:35 — Quick introduction to luminescent materials

Marta Niemiec, KMPS UJ, WCh, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

In this talk, I will introduce the broad subject of luminescence, focusing on luminescent materials. The talk will include the elementary definitions, followed by the description of the current scientific approach, possible directions of research and applications. It will focus on the main idea, so no advanced knowledge of chemistry is required.

13:35 – 13:55 — Alkaline metal salts of redox-active polydioxothiadiazoles as potential energy storing materials

Dominik Dzierżek, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

The ever-rising demand for alternative methods of energy storage led to a very interesting field of research – design of rechargeable batteries based on organic-based electrode materials. Main advantages of such batteries are: high charge and discharge current density, capacity, which is retained even after many charge-discharge cycles, as well as an eco-friendly nature.

Availability of multiple oxidation states within a single molecule is directly correlated with its energy storage capabilities. This idea was exploited by the design and synthesis of tripak - an organic molecule comprising three fused dioxothiadiazole groups which shows six accessible oxidation states according to cyclic voltammetry.

The next step towards a modern cathode material based on tripak was the preparation of its alkaline metal salts. Li2tripak·3H2O, Na2tripak·3H2O, Cs2tripak, Mgtripak·2MeCN·3H2O were obtained and characterised by sc-XRD, PXRD, TGA, IR.

The idea of using tripak-based cathode materials in construction of a secondary battery cell was inspired by molecules with an analogous geometry showing record-breaking, key parameters characterising batteries.

13:55 – 14:15 — One molecule, numerous opportunities. Single molecule magnets based on chiral complexes.

Katarzyna Rzepka, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Development of new technologies results in the growing amount of data to be stored. This issue leads to the increasing interest in constructing materials for ultra-high-density data storage and studies targeting small, inconspicuous molecules showing magnetic memory effect coupled with multiple physical properties e.g. chirality.

Precise molecular design allows to obtain optically active complexes with slow magnetic relaxation of the magnetisation. Merging chirality and magnetism in a single molecular compound allows to explore second order properties such as magneto-chiral dichroism (MChD). In the field of single molecule magnets, lathanide-based complexes seem to be the most promising candidates due to their significant magnetic anisotropy. Adding chirality to these complexes can be realized by coordinating optically pure helicenes to the metal centre.

The MChD phenomenon became an inspiration for studies on complexes with the smallest helicene-type ligand, 1,10-phenanthroline-N,N'-dioxide. Using the chiral resolution methods, we have obtained a series of optically pure lanthanide compounds and studied them by scXRD, SQUID magnetometry and CD spectroscopy.

15:15 – 15:45 — Automatic groups

Mateusz Kandybo, KNMT, WMI UWr, Faculty of Mathematics and Computer Science, University of Wrocław, Poland

Study of automatic groups is an important topic in modern geometric group theory. During the talk we will briefly introduce the definitions of automatic and biautomatic groups. Then we will discuss main properties of those types of groups. At the end we will talk about some open problems related to the topic.

15:45 – 16:05 — Slice rank as a tool for combinatorial problems

Jakub Kamiński, KNMT, WMI UWr, Faculty of Mathematics and Computer Science, University of Wrocław, Poland

An n-argument function is called a slice when it can be written as a product of a single-argument function with an (n-1)-argument function. Intuitively, this means that one of the arguments can be "separated" or "sliced off". We can then define the slice rank of a function as the least number of slices it can be decomposed into. It turns out that this notion can be used to produce some very strong bounds for certain classes of combinatorial problems, in particular ones where we want to know the size of the biggest set that doesn't contain a certain structure. In the talk I'll show how to use this method for two plainly defined (but difficult) problems.

16:05 – 16:25 — The structure of moduli space of Riemann Surfaces

Mykhailo Hontarenko, NKF UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

I would like to introduce some notions of genus g Riemann Surfaces with n marked points.

Riemann surfaces is very highly known topics for mathematicians and physicists because of complex analysis, hyperelliptic curves and string theories.

Riemann surfaces by definition are complex manifolds, which are very useful in different mathematical and physics problems. Somehow we want to have classification of Riemann surfaces, so we would like to provide a moduli space of the genus g Riemann surfaces with n marked points $\overline{\mathcal{M}}_{g,n}$. The moduli space also has orbifold structure. The motivation of moduli space is to parametrize objects of some fixed kind, or different types of isomorphisms. Moduli space of Riemann surfacers has not just mathematical, but also physics motivation, for example in string theories and in topological quantum field theory they are highly used.

Posters

Raman spectroscopy as a tool for effective differentiation between leukemic cells and normal B lymphocytes.

Kacper Stawoski, NKChMiŚ UJ, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Raman spectroscopy is based on inelastic scattering of photons on the sample and it allows to determine molecular markers of carcinogenesis. In this study, our aim was to determine the spectroscopic markers of acute lymphoblastic leukemia, represented by TANOUE cell line and normal B-cells from healthy donors. An in-depth analysis with the use of chemometrics showed increased content of lipidic structures and a decrease in nucleic acids content in cancer cells compared to their normal counterparts. The „Label-free and rapid optical imaging, detection and sorting of leukemia cells" project is carried out within the Team-Net programme of the Foundation for Polish Science co-financed by the EU.

Appendage Regeneration in Vertebrates: What Makes This Possible?

Iga Czechowska, KNSB Mygen, WBBiB UJ, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Poland

The ability to regenerate amputated or injured tissues and organs is a fascinating property shared by several invertebrates and some vertebrates. The current availability of new experimental tools, facilitating the comparative study of models with high regenerative ability, provides a powerful instrument to unveil what is needed for a successful regeneration. The presented review provides an updated overview of multiple aspects of appendage regeneration in three vertebrates: lizard, salamander, and zebrafish. The deep

investigation of this process points to common mechanisms for the restoration of a functional appendage.

CDK4/6 - function, inhibition and perspectives

Konrad Barnowski, NKChMiŚ UJ, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

The cell cycle is a highly conserved process that consists of four sequential phases: G1 (pre-DNA synthesis), S (DNA synthesis), G2 (pre-division), and M (cell division). The transition from one phase to the next phase is regulated by different CDKs (Cyclin-Dependent Kinases) to ensure the normal progression through the entire cell cycle.

CDK4 and CDK6 are key initiators of the G1 to S phase transition. What's more, the dysregulation of CDK4/6 in multiple pathways results in the uncontrolled proliferation of cancer cells through different mechanisms. Thus, CDK4/6 are valuable and promising therapeutic targets in the development of anticancer drugs.

Raman markers of acute myeloblastic leukemia: preliminary studies

Wiktoria Korona, WCh UJ, Faculty of Chemistry, Raman Imaging Group, Jagiellonian University in Kraków, Poland

Leukemia is a blood cancer caused by genetic alterations occurring in stem cells. In this study Raman imaging is considered a promising diagnostic tool for molecular characterization of leukemia cells [1]. The purpose of the investigation was to distinguish cells of acute myeloid leukemia (AML) of the THP-1 cell line from normal peripheral blood mononuclear cells (PBMCs), constituting the control group, using Raman imaging combined with chemometric methods. The spectral differences are observed mainly in the intensity of the bands assigned to nucleic acids and lipids. These observations are promising for the development of Raman imaging towards leukemia diagnosis in clinical practice.

Hippocampus – regional functional and anatomical differentiation

Gabriela Czerniak, KNN Neuronus, ZNiCh WB UJ, Department of Neurophysiology and Chronobiology, Institute of Zoology and Biomedical Research, Jagiellonian University in Kraków, Poland

The hippocampal formation is important for cognitive and emotional processing. Most researchers treat the hippocampus as a functionally homogeneous structure. However, new data shows its differentiation into dorsal, intermediate and ventral parts. Many studies have confirmed the separation of these regions in molecular and functional terms and the diversity of input and output connections.

The main distinction is between the dorsal and ventral areas of the hippocampus, where functional differentiation is particularly noticeable. The dorsal hippocampus is responsible for learning, memory, exploration and navigation thanks to the presence of place cells. In humans, it is also involved in the recall of verbal memory. The ventral hippocampus regulates emotional responses, motivated behaviour, reward circuity, and affective states. Interestingly, in the ventral CA1 field are present anxiety cells, they are activated in an anxious environment, and their increased frequency contributes to evasive behaviour.

Understanding the functional differentiation of the ventral and dorsal hippocampus will provide better and more accurate targeting in future molecular and behavioural research.

Spectroscopic Examination of Biochemical Changes in Cancer Cells Resulting From Fatty Acids Uptake

Kacper Siąkała, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Incubation of lipid acids by cancer cells results in a change of its biochemical profile. These changes can be tracked by Raman spectroscopy. In our work, we highlighted the spectral differences between control and HL-60 cells incubated with fatty acids (FA). As a result of FA uptake, we observed molecular changes in nucleic acids, hemoproteins, and lipids content.

The „Label-free and rapid optical imaging, detection and sorting of leukemia cells" project is carried out within the Team-Net programme of the Foundation for Polish Science co-financed by the EU. This work was cofunded within the "Excellence Initiative - Research University" program at the Jagiellonian University in Krakow.

Investigation of reaction mechanisms of formation and degradation of thiol derivatives macrocyclic cobalt(III) complexes

Natalia Walas, WCh UJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

In addition to the well-known properties of vitamin B12, its role in methionine synthase (MS) deserves special recognition. Methionine synthase is the enzyme responsible for the conversion of homocysteine to methionine, where vitamin B12 is an essential cofactor. The aim of this study is to test the effect of the macrocyclic ligand on the reactivity of the cobalt(III) ion toward thiol ligands involved in the MS catalytic cycle. Spectroscopic and kinetic analysis of the reaction of aquacobalamin and cobalt(III) protoporphyrin IX with methionine and homocysteine were carried out under physiological conditions. In addition, DFT molecular modelling was carried out to determine changes in geometry and electron density distribution in the complexes formed. The results indicate that porphyrin is particularly reactive toward methionine compared to vitamin B12, and there are clear differences in the course of porphyrin's reaction with both thiols. These studies may help to better understand the molecular basis of the mechanisms of biological activity of methionine synthase.

Licorice root's licochalcone A: undiscovered potential for asthma treatment

Anna Cieślik, KNSB Mygen, WBBiB UJ, Faculty of Biochemistry, Biophysics and Biotechnology, Jagiellonian University in Kraków, Poland

Asthma is a chronic inflammatory disease that affects one in ten people. Its symptoms are due to the narrowing of the airways caused by remodeling of the bronchial wall, mainly subepithelial fibrosis. The increased number of myofibroblasts plays a crucial role in these processes. Currently, asthma treatment is mostly symptomatic, highlighting the need for a drug that targets the underlying molecular processes.

Licochalcone A is a flavonoid that naturally occurs in the root of licorice Glycyrrhiza glabra that has shown anti-inflammatory and antifibrotic properties.

We hypothesized that licochalcone A may inhibit the key event in subepithelial fibrosis, TGF-β induced fibroblast-to-myofibroblast transition (FMT). Viability and proliferation assays, immunofluorescence and immunoblotting were performed on human bronchial fibroblasts derived from asthmatic patients. The results showed that licochalcone A significantly reduces the FMT efficiency by affecting the TGF-β signaling pathways.

It is concluded that licochalcone A could be a potential candidate for preventive therapy for subepithelial fibrosis in asthma, however, further research is needed on this topic.

Elements of the potential theory of transient Markov chains

Łukasz Gorczyca, KMS UJ, WMiI, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

Starting from the Laplace equation, we will look at the Dirichlet problem. We will define harmonic and subharmonic functions. We will write down the Dirichlet problem in the language of Markov chains. The formulation of the Maximum Principle will allow us to prove what the solution of the Dirichlet problem is. Describing such a branch of probability calculus requires a large number of concepts, so the poster will explain the most important ones. From Green's Functions, through ivariant and excessive measures to induced markov chains. We will deal with Riesz's Decomposition Theorem and the Approximation Theorem. We will define the balayee of function and by collecting all the information we will formulate and prove the Domination Principle.

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