21-23
OCT, 2022
CRACOW

SD PAN
SAMORZĄD DOKTORANTÓW
POLSKIEJ AKADEMII NAUK

Book of abstracts

6TH CONFERENCE OF DOCTORAL STUDENTS OF THE PAS

CONFERENCE PROGRAMME

FRIDAY 21.10.2022

16:00 – 17:00 Start of the registration
17:00 – 17:20 Conference opening
17:20 – 18:30 Panel ” What to do after getting the PhD title? – many perspectives for the future”
19:00 Evening walk in the Old City of Kraków and integration

SATURDAY 21.10.2022

10:30 – 10:45 Start of the 2nd day
10:45 – 11:00 Presentation of the Relvo company
11:00 – 11:15 Mindfulness break with Mindy App
11:15 – 12:45 Presentations of the PhD students:
12:45 – 13:15 Coffee break
13:15 – 13:30 Mindfulness break with Mindy App
13:30 – 15:00 Presentations of the PhD students:
15:00 – 16:30 – Coffee break

FREE TIME

20:00 Integration dinner in the city

SUNDAY 21.10.2022

10:30 – 11:00 Start of the 3rd day
11:00 – 12:30 Panel “PhD Mental Health – summary of the results of the project”
12:30 – 13:00 Closing the conference

ORGANIZERS

The event is organized by the Doctoral Council of the Polish Academy of Sciences, teams operating at the Council and the Doctoral Council of the Institute of Nuclear Physics PAS

Doctoral Council of the Polish Academy of Sciences:

•President: Wiktoria Stańczyk, MSc Eng; Henryk Niewodniczański Institute of Nuclear Physics PAS
•Vice-President: Patrycja Uram, MSc; Institute of Psychology PAS
•Secretary: Hubert Kasprzak, MSc; Hirszfeld Institute of Immunology and Experimental Therapy PAS

Team for the Conference Organization:

•President: Wiktoria Stańczyk, MSc Eng; Henryk Niewodniczański Institute of Nuclear Physics PAS
•Marta Łukasik, MSc Eng; Institute of Metallurgy and Materials Science PAS
•Karolina Okoń, MSc; Institute of Agrophysics PAS
•Jenny Abi Nader, MSc; Institute of Bioorganic Chemistry PAS
•Katarzyna Mikołajczak, MSc; Institute of Plant Genetics PAS
•

Team for the Promotion of PAS Doctoral Students:

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•Marta Łukasik, MSc Eng; Institute of Metallurgy and Materials Science PAS
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•Aleksandra Pacanowska, MSc.
•Anna Nykiel, MSc.

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POROZUMIENIE DOKTORANTÓW UCZELNI KRAKOWSKICH

FORUM AKADEMICKIE

Mindy

FULBRIGHT
Poland

Program Fulbrighta to sztandarowy amerykański program wymiany edukacyjnej i kulturalnej, który działa na całym świecie od ponad 75 lat. Wśród znamienitych absolwentów Fulbrighta jest 61 laureatów Nagrody Nobla i 89 laureatów Nagrody Pulitzera. W Polsce Program Fulbrighta jest obecny od ponad 60 lat i skupia ponad 5000 polskich i amerykańskich absolwentów. Program wspiera współpracę między Polską a Stanami Zjednoczonymi, sprzyjając wymianie idei, wiedzy i kultury, a także rozwojowi badań naukowych oraz relacji międzyludzkich i międzyinstytucjonalnych.

The Fulbright Program is the flagship U.S. educational and cultural exchange program that has operated worldwide for over 75 years. Fulbright notable alumni include 61 Nobel Prize laureates and 89 winners of the Pulitzer Prize. In Poland, the Fulbright Program has been present for over 60 years and comprises a community of over 5000 Polish and American alumni. The Program has supported cooperation between Poland and the U.S. by fostering the exchange of ideas, knowledge and culture, as well as the development of research and interpersonal and inter-institutional relations.

Firma Relvo, jest naszym głównym partnerem i tak o sobie mówi: Od początku stawiamy na jakość i sprawdzonych dystrybutorów sprzętu diagnostycznego i analitycznego. Dostosowaliśmy naszą ofertę do potrzeb nie tylko placówek medycznych, ale również firm akademickich i prywatnych.

Oferujemy wysokiej jakości aparaturę laboratoryjną i materiały jednorazowe w atrakcyjnych cenach, co pozwala pokonać problem z zawyżonymi cenami produktów.

The company, Relvo, is our main partner and says so about itself: From the beginning, we focus on quality and proven distributors of diagnostic and analysis equipment. We have adapted our offer to the needs of not only medical institutions, but also academic and private companies.

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Mindy

Mindy – zrozum myśli, emocje i uczucia

To aplikacja mobilna z praktycznymi ćwiczeniami i wiedzą wspierającą nasze zdrowie psychiczne. Znajduje się tutaj ponad 700 nagrań od 40 certyfikowanych trenerów i ekspertów. Dzięki nim zdobędziesz umiejętności, których nie uczono Cię w szkole, obniżysz poziom stresu i zrelaksujesz się przed snem.

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Deutscher Akademischer Austauschdienst
Niemiecka Centrala Wymiany Akademickiej

Niemiecka Centrala Wymiany Akademickiej (DAAD) jest największą na świecie organizacją stypendialną. Od momentu powstania w 1925 roku z DAAD skorzystało około 2,8 mln studentów i pracowników naukowych, zarówno w Niemczech, jak i za granicą. Dla polskich kandydatów DAAD oferuje stypendia na kursy językowe oraz pobyty studyjne i badawcze w Niemczech. Oprócz działalności stypendialnej DAAD aktywnie angażuje się w umiędzynarodowienie niemieckich uczelni, wspiera inicjatywy promujące germanistykę i język niemiecki za granicą, współpracuje z krajami rozwijającymi się oraz pełni funkcję doradczą wobec najważniejszych decydentów politycznych w dziedzinie nauki, edukacji i rozwoju.

The German Academic Exchange Service (DAAD) is the world's largest scholarship organization. Since its inception in 1925, around 2.8 million students and academics in Germany and abroad have benefited from DAAD. For Polish candidates, DAAD offers scholarships for language courses as well as study and research stays in Germany. In addition to scholarship activities, DAAD is actively involved in the internationalization of German universities, supports initiatives promoting German studies and the German language abroad, cooperates with developing countries, and has an advisory function to major political decision-makers in the field of science, education, and development.

Porozumienie Doktorantów Uczelni Krakowskich (PDUK) jest organem reprezentującym interesy doktorantów wszystkich krakowskich uczelni. Zrzesza młodych naukowców z różnych dziedzin, zarówno tych o specjalności technicznej, jak i tych o wykształceniu akademickim, których misją jest zabieranie głosu w sprawach dotyczących wszystkich doktorantów krakowskich uczelni. Flagowym wydarzeniem organizowanym przez PDUK jest Krakowski Bal Doktorantów, który zawsze jest okazją do spotkania, integracji środowiska i zacieśnienia interdyscyplinarnej współpracy naukowej. W 2021 roku PDUK był również organizatorem pierwszego Krakowskiego Salonu Naukowego, wydarzenia, które przyciągnęło wielu młodych naukowców chętnych do popularyzacji swoich badań. PDUK jest otwarty na wszelkie nowe inicjatywy i zachęca wszystkie jednostki oraz doktorantów zainteresowanych współpracą do kontaktu.

The Union of Doctoral Candidates at Cracow Universities (PDUK) is the body representing the interests of doctoral candidates from all the universities in Kraków. It brings together young researchers from various fields of interest, those with a technical specialty and those of academic background as well, whose mission is to speak out on matters concerning all doctoral students from Kraków universities. The flagship event organized by PDUK is the Kraków Doctoral Student Ball, which is always an opportunity to meet, integrate the community and strengthen interdisciplinary scientific cooperation. In 2021, PDUK was also the organizer of the first Kraków Science Salon, an event that attracted many young scientists eager to popularize their research. PDUK is open to all new initiatives and encourages any entity and any doctoral candidate interested in collaborative cooperation to get in touch.

Kraków Miastem Startupów jako Fundacja non-profit istnieje od 2015 roku. Działa na rzecz rozwoju przedsiębiorczości, innowacyjności i kondycji krakowskiego ekosystemu startupowego. Ponadto, budując połączenie pomiędzy startupami, uczelniami, władzami publicznymi i organizacjami pozarządowymi, pomaga stawiać pierwsze kroki w świecie innowacyjnego biznesu. Ponadto Kraków Miastem Startupów wspiera środowisko akademickie, dostarczając młodym naukowcom i innowatorom wiedzy i umiejętności biznesowych, a także umożliwiając transfer technologii z krakowskich uczelni do biznesu. Jest organizatorem wydarzeń networkingowych, konferencji naukowo-biznesowych, hackathonów oraz kilkudziesięciu warsztatów rocznie. Dodatkowo rekrutuje startupy na wczesnym etapie rozwoju do programu preakceleracyjnego. Goszcząc projekty młodzieżowe, umożliwia poszerzanie wiedzy zdobytej na lekcjach przedsiębiorczości.

Kraków Miastem Startupów (Cracow the City of Startups) is one of the most active startup organizations in Małopolska. KMS as a non-profit Foundation has existed since 2015. It works at developing entrepreneurship, innovation and the condition of the Cracovian start-up ecosystem. Furthermore, by building the connection between start-ups, universities, public authorities and non-governmental organizations, it helps to take the first steps in the world of innovative business.

In addition, Kraków Miastem Startupów supports the academic community by providing young scientists and innovators knowledge and business skills as well as enabling the transfer of technology from Cracovian universities to business. It is the organizer of networking events, scientific/business conferences, hackathons and several dozen workshops a year. Additionally, it recruits startups at the early stage of development for the pre-acceleration program. By hosting youth projects, it allows extending the knowledge acquired from entrepreneurship lessons.

FORUM AKADEMICKIE

Forum Akademickie - ogólnopolski miesięcznik informacyjno-publicystyczny (wcześniej pod nazwą "Przegląd Akademicki"), wydawany od 1991 roku. Czasopismo zajmuje się problematyką badań naukowych i szkolnictwa wyższego.

Forum Akademickie – the nationwide information and journalistic monthly (previously called “Przegląd Akademicki”), published since 1991. The journal deals with the issues of research and higher education.

kobietynauki.org

Naszym kolejnym patronatem została Polska Sieć Kobiet Nauki/Polish Women Scientists Network. Ideą Portalu Kobiety Nauki jest stworzenie pierwszej w Polsce sieci łączącej kobiety naukowczynie oraz polskie uczone.

Women of Science Network has become our next patron. The idea of the Women of Science Website is to create the first network in Poland connecting women scientists and Polish scholars.

SPIS TREŚCI

Probing nanostructures using synchrotron light – a brief overvie

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Nanostructures are a broad class of materials, nowadays being widely studied by researchers around the world in disciplines like physics, materials science or nanotechnology. In general, any material having at least one of its dimensions in the range 1 – 100nm can be called a nanostructure. Nanoscopic sizes and the ability to engineer structures on molecular level directly imply a variety of extraordinary macroscopic features that they possess, e.g. high magnetic and electric performance, mechanical endurance and many more. That is why nanotechnology and nanomaterials are seemed to inevitably going to play a great role in improving world's technology, industry and medicine in the nearest future.

There are plenty of methods that scientist can use to examine nanostructures, but currently one of the most powerful and reliable tools is synchrotron light.

Synchrotrons are factories of light. They are building-sized, circular machines that accelerate charged particles to velocities comparable to the velocity of light, to produce radiation way brighter than the Sun's. Acceleration of particles is done by using synchronized electric and magnetic fields provided by hundreds of massive electromagnetic devices comprising the synchrotron's primary linear accelerator and storage ring. Charged particles while making turns in the storage ring change their velocity vector, which leads to converting their kinetic energy into a synchrotron light, which can be used by teams of researchers for examining their materials' samples. Radiation produced by synchrotrons have many advantages: it's extremely bright, consists of wavelengths ranging from infrared to hard X-rays, can be polarized in any direction and is highly collimated (all of its energy is focused onto a tiny surface ~1 mm). Beacuse of those features, synchrotrons create possibility for scientists to study their materials in a deepened, more profound way, unachievable by means of any other experimental techniques.

The presentation will cover a brief overview on nanostructures and examining them by synchrotron light, giving example of lecturer's recent measurements done on the ASTRA beamline of Cracow's SOLARIS Synchrotron Center, examining silica nanospheres and mesoporous silica material functionalized with copper ions.

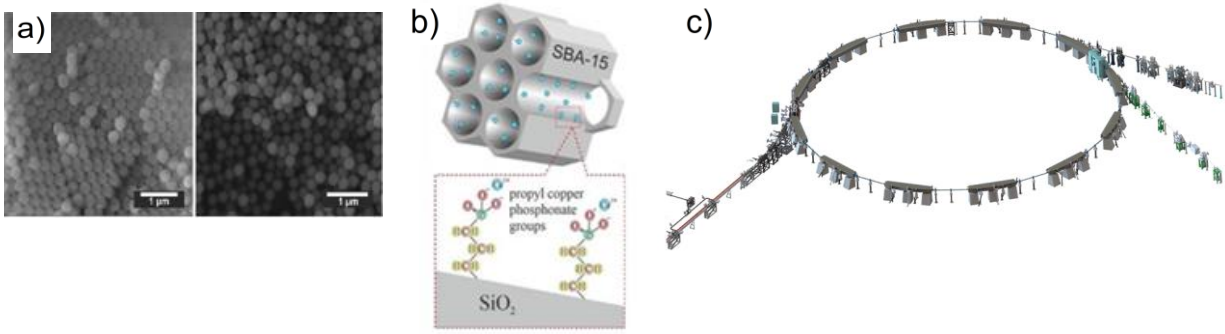

Fig. a) Silica nanospheres under the scanning electron microscope, **b)** schematic representation of mesoporous silica SBA-15 functionalized with Cu ions, **c)** schematic representation of SOLARIS' synchrotron device [*source: www.synchrotron.uj.edu.pl*]

Direct Dark Matter Search in Liquid Argon Detectors

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Dark Matter hypothesis has emerged as the most favoured explanation for otherwise unexplained motion of celestial bodies at galactic scales and beyond. It proposes that the motion of such bodies can be explained by presence of a not yet discovered form of matter which predominantly interacts with ordinary matter via gravitational interaction. Based on observations of Cosmic Microwave Background, cosmological models predict Dark Matter to outweigh ordinary matter by a factor of 5. For the past 4 decades efforts to detect dark matter candidate particles, known as Weakly Interacting Massive Particles (WIMP), have not yielded any credible detection. Though the probable parameter space for such particles has been shrinking, to further constrain it we will need to build even more sensitive detectors which present various technological challenges. One strategy to directly detect WIMPs is to use Liquid Argon as target material in the detector. A particle colliding with the Ar nucleus can result in Scintillation light with wavelength in Vacuum Ultra-Violet (VUV) region. Photon detection devices have relatively poor efficiencies in VUV. To boost the detection efficiency, one can cover internal surfaces with a Wavelength Shifting material[1]. Since the next generation detectors[2] will have large surface areas, it becomes quite challenging to cover the entire surface with Wavelength Shifters (WLS). Starting with a high-level overview of Liquid Argon (LAr) detectors, I will present our ongoing efforts to mitigate these challenges[3, 4].

This research was in part made possible with funding from European Union's Horizon 2020 research and innovation programme under grant agreement No. 952480.

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Layered methylhydrazinium lead halide perovskites

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Hybrid Organic-Inorganic Perovskites (HOIPs) have been intensively investigated in recent decade due to remarkable physiochemical properties. The three-dimensional (3D, formula ABX_3, mostly of centrosymmetric *Pm*-3*m* structure) HOIPs are built of corner-sharing BX_6 octahedra network with voids filled by "A" cations [1]. The most popular 3D HOIPs consist of small organic "A" cations, e.g., methylammonium (MA^+), formamidinium (FA^+) and PbX_6 (X = Br, Cl, I) octahedra. Multiple properties, e.g., high photoluminescence quantum yields (PLQY), broad tunability of emission colors, unprecedented mobility of charge carriers and so on, place them as strong candidates for revolutionary photovoltaic and light-emitting devices, as well as photodetectors or systems for photodynamic therapy [2-4]. However, these materials possess meaningful drawbacks, i.e., poor resistance to moisture and chemicals. One of the ways to overcome these issues is to reduce structural dimensionality to the layered (2D) HOIPs (formula A_2BX_4), where the octahedra layers are separated by organic cations.
The dimensionality reduction to 2D HOIPs allows not only to improve stability and certain properties (e.g., PLQY) [5], but also to incorporate larger organic cations, such as methylhydrazinium (MHy^+). Indeed, our group have developed the HOIPs comprising MHy^+, with many unique properties and larger stability when compared to the most popular analogues. MHy_2PbBr_4 crystallizes at room temperature in noncentrosymmetric $Pmn2_1$ space group and reveals ferroelectric behavior and second harmonic generation (SHG) activity [6]. In MHy_2PbCl_4 the sequence of temperature-controlled phases (centrosymmetric *Pmmn*, modulated $Pmmn(00\gamma)s00$ and noncentrosymmetric $P2_1$) is very rare for this family of materials [7]. In the last presented representative, i.e., MHy_2PbI_4 the unique octahedra tilt system is observed with only centrosymmetric crystal phases [8]. All the layered MHy_2PbX_4 (X = Br, Cl, I) systems exhibit thermochromism and demonstrate the record-low interlayer spacing among layered hybrid compounds. The second feature is crucial in terms of diminishing the negative influence of dimensionality reduction on the electrical properties [6–8]. Development of HOIPs with MHy^+ opens up new vistas of applications, especially in optoelectronics.

This research was funded by the Polish National Science Centre (project No 2019/35/B/ST5/00043.).

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Anti-smog resolution vs presence of radioisotopes in the atmosphere

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Air pollution severely impacts air quality, public health, and the economy in the world. Hence, reducing smog is one of the most critical challenges for contemporary societies. The first step in this process is understanding the phenomena responsible for smog formation. Natural and artificial radioisotopes emitted from the ground or produced in the atmosphere can help this research. In periods when they do not occur for natural reasons, e.g. in winter (limited resuspension), they can be used as markers of the anthropogenic sources of pollutant emissions to the atmosphere. Here we used samples of total atmospheric precipitation as storage of isotopes presented in the atmosphere above Krakow to study smog. Krakow is an example of a city where both anthropogenic processes (dust production and emission to the atmosphere) and natural conditions (geographical location, meteorological conditions) are conducive to retaining pollutants in the air. Data analysis concerning the variability of radioisotopes in the atmosphere between 2017 - 2020 provided information on the impact of the anti-smog resolution in Krakow on air quality [1]. Our research can also help predict and understand the presence of radioisotopes in the atmosphere and processes of smog formation when unstable situations in the energy sector will cause the return to coal and wood as a heat source in the nearest future.

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Beauty and the Charm (Study of beauty to charm hadron decays and proton-proton collision reconstruction at LHCb experiment)

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The European Organisation for Nuclear Research (CERN) is famous for standing at the technology frontier in the field of particle physics studies. One of the four main experiments at the Large Hadron Collider (LHC) at CERN with the name of LHCb is designed to chart the unknowns of the so-called "beauty physics" which concerns the particles with a *b*-quark. In my talk, I will briefly describe the reasons why such studies, including my PhD thesis from the title of this talk, are being conducted, what we can possibly deduce about the nature of our universe from them and in what manner I have been contributing to LHCb analyses so far. The soon-to-be-published study "First observation and branching fraction measurement of the Lb→Dsp decay" that I have been working on with the AGH and the NIKHEF groups will be mentioned.

Studying light flavour resonances in $\pi^+ \pi^-$ photoproduction

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In our work we focused on the double pion photoproduction process to study the interference of meson resonance production and meson-baryon rescattering effects. We used Deck model [1] to describe the essential features of diffractive $\pi^+ \pi^-$ photoproduction, assuming that it is dominated by virtual pion exchange.
Aiming at the description of the latest data collected at CLAS12 and GlueX experiments, we computed the moments of the $\pi^+ \pi^-$ angular distribution for different beam energies in the helicity frame i.e the rest frame of the $\pi\ \pi$ system where the z-axis is defined in the opposite direction of the recoil nucleon. We also computed the prediction for the P-wave projected differential cross section and compared it the ones performed by the CLAS collaboration in order to validate our theoretical model.

This research was funded by the Polish National Science Centre (project No. 2018/29/B/ST2/02576).

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Genomic diversity of invasive raccoon populations and its pathogen diversity – importance for the invasion success

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Invasive alien species are in interest of many researchers, as there is an increase in introductions and intense spread of alien species. Biological invasions have negative impact on native biodiversity. Understanding mechanisms of successful invasion is crucial to mitigate existing and prevent future invasions [1]. Despite the global scale of invasion, mechanisms underlying the successful invasion are still unknown.

Introduction of little number of individuals decrease genetic variability, whereas low genetic diversity decreases ability to adapt to new environment [2]. However, in case of some alien species, the number of individuals may be big enough, or there were multiple separate introductions from highly diversed source populations [3] what determine higher genetic diversity [4]. Learning the level of genetic diversity and pointing genes linked to successful invasion is necessary to predict spread of invasive populations. Apart from the role of adaptation in process of successful invasion, there are important environmental factors such as pathogens pressure. According to enemy release hypothesis, alien species after introduction to new environment lose pathogens which decrease their fitness in native range. Thanks to that, they may increase their fitness in new invasive range, especially in comparison to native species. My model organism is common raccoon which is invasive in Europe. First introductions took place in Germany from where they have spread to different European countries [5]. Research showed that genetic diversity of invasive populations is high, despite of the founder effect. The aim of my studies is to learn genetic mechanisms responsible for local adaptations which determine the success of invasive species, what will be done by comparing genomic diversity of native and invasive populations. Second aim is verification of enemy release hypothesis. To do so, pathogens composition will be compared between native and invasive populations of raccoon.

Learning mechanisms underlying adaptation and successful invasion of alien species is crucial in biodiversity conservation and decreasing negative consequences of invasion.

This research was funded by the Polish National Science Centre (project No. 2020/37/B/NZ8/03801).

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Nutrition enhancement using CRISPR-Cas9 Genome Editing tool in Plant

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Raffinose family of oligosaccharides (*RFOs*) are known as the most widespread D-galactose containing oligosaccharides in higher plants. Raffinose and other *RFOs* such as stachyose, verbascose, and ajugose are synthesized from sucrose by the subsequent addition of activated galactose moieties donated by galactinol. Two enzymatic steps are regulated by galactinol synthase (*GolS*) and raffinose synthase (*RS*) as key regulators in *RFOs* synthesis. *GolS* serves as a crosslink between myo-inositol metabolism and RFO biosynthesis, and also controls entry of myo-inositol into the *RFOs* pathway.

The *RFOs* predicted to be involved in biotic and abiotic stresses related response in plants. However, the loss-of-function mutants reported so far fail to show any perturbation in those biological functions. Hence, the role of *RFOs* in biotic and abiotic stress is still in debate [1]. It was further reported that the dietary food rich in *RFOs* creates stomach discomfort, flatulence and diarrhoea in human and monogastric animals due to lack of a hydrolyzing enzyme needed for RFO breakdown [2]. RFO when consumed in lower concentration are considered as prebiotic, supporting growth of beneficial intestinal microflora [3]. Therefore, in this joint project, we propose the development of a strategy to reduce seed *RFOs* concentration by CRISPR/Cas9 mediated targeted editing of *GolS* and *RS* genes in an important leguminous crop pea (*Pisum sativum* L.). It will prove to be a step forward in the direction to develop more healthy food crop for human diet.

This research was funded by the Polish National Agency for Academic Exchang, Poland (project No. PPN / BIN / 2019/1/00142) and Department of Science and Technology, India (project No. DST/INT/POL/P-45 /2020) .

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Lichens – a source of substances with biological activities

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Lichens are defined as a self-sustaining micro-ecosystem. According to the novel definition from 2020, this ecosystem is formed by the interaction of an exhibiting fungus and an extracellular arrangement of one or more photosynthetic partners, and an indeterminate number of other microscopic organisms [1]. Lichen secondary metabolites are of fungal origin [2]. These substances play a specific role in the lichen thalli, which includes protecting lichens from being overgrown, eaten by animals, or from exhibition to UV light [3–5]. Since ancient times, secondary metabolites of lichens have been used in traditional medicine. Many lichens are sources of critical secondary metabolites for the pharmaceutical industry [6]. Moreover, these substances are still of great interest as alternative medical treatments in various parts of the world [7]. Lichen secondary metabolites can be a potential source of pharmaceutically valuable compounds as they exhibit many important properties, i.e., antimicrobial, antioxidant, anti-inflammatory, cytotoxic, and antiviral. One of the most extensively studied secondary metabolites is usnic acid. The species of *Usnea* contains a high amount of these compounds. Usnic acid is an active substance used as a tumor inhibitor and an analgesic [8]. In addition to usnic acid, other lichen secondary metabolites, e.g., atranorin, fumarprotocetraric acid, gyrophoric acid, lecanoric acid, physodic acid, protocetraric acid and stictic acid indicate relatively antimicrobial solid effects against numerous bacteria and fungi, including human pathogens [9]. Other substances of lichen origin, e.g., evernic acid, norstictic acid, salazinic acid, protocetraric acid or zeorin, are comparatively strong antimicrobial agents but also show antioxidant and anticancer activity [10]. The potential of lichen secondary metabolites is unpredictable. Many studies are currently ongoing to characterize the activity of these compounds against pathogens and tumor cells with the hope of developing effective therapeutics.

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Application of nanowires in today's world

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Nanotechnology is currently one of the most dynamically developing branches of physics. Among many nanostructures, the crucial role is played by nanowires, which are one-dimensional objects with a length of a few micrometers and diameters of the order of nanometers. Especially magnetic nanowires, which have been gaining popularity in recent years, are materials of great importance in fundamental research and innovative applications.

The wide range of potential applications of nanowires includes biomedicine, environmental protection, consumer electronics, and many other fields. Due to their biocompatibility, Fe-based nanowires, are used in biomedicine for example in cancer therapy or drug delivery. In the hyperthermia process, also known as overheating, an applied AC magnetic field, which makes the nanowires vibrate, causes a local temperature increase. When these nanowires are introduced in the immediate vicinity of the cancer cells, they induce their death, because diseased cells are less resistant to temperature changes than their healthy counterparts. In the case of drug delivery, the properly functionalized nanowires can act as remote drug carriers that can be manipulated by an external magnetic field to provide the drug through the microchannels to living cells. One of the methods to release the drug is the temperature action, which results in the swelling or contraction of the gel, in which nanowires are embedded, leading to absorbing or release of the medicaments.

Nanowires are also used as various types of sensors. For example, Ni-based nanowires, due to their magnetostriction effect, can act as acoustic sensors in the inner ear, just like ciliary cells. Another example concerts the corrosion monitors, in which oxidation of Fe-based nanowires changes their magnetic saturation, which can be easily controlled by magnetic measurements. Nanowires can be also used as magnetic field sensors. In this case, the multilayered nanowires, which show a giant magnetoresistance effect, demonstrate an abrupt change in resistivity when a magnetic field is applied. The nanowires with a specially modified surface can be also used to absorb, with high selectivity, toxic substances such as Hg, Cr (VII), or other heavy metals, contributing to the protection of the environment. Additionally, nanowires placed in flexible membranes can serve as flexible permanent magnets.

Nanowires may also be used in electronic components, such as high-density magnetic recording media, especially next-generation data storage devices like 3D magnetic memory units. In the 3D approach, multilayered nanowires composed of magnetic segments separated by nonmagnetic spacers are required. These hybrid nanowires made of magnetic segments will increase the recording density to several dozen terabits per square inch. In our laboratory, we are working on the production of nanowires with properties that make them good candidates for use as 3D magnetic memory modules.

Such a wide range of applications of nanowires necessitates the production of nanowires with various properties, tailored to specific requirements. This can be achieved by modifying their morphology, structure and magnetic properties, which justifies the need to continue intensive research on nanowires.

This research was supported by a French Government Scholarship.

Prediction of particle energies accelerated in a region of the Buneman instability using neural networks

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Cosmic ray (CR) acceleration processes can be studied by using a fully-kinetic treatment for plasma simulations, e.g., particle-in-cell (PIC) simulations, that allow us to describe a detailed microphysics responsible for CR acceleration. Particle tracing implemented in many PIC codes is able to store full datasets for selected high-energy particles. However, the by-eye inspection of particle trajectories includes a high level of bias and uncertainty, and pinpointing the specific acceleration mechanisms is very difficult. Therefore, we propose a method to predict the energy of particles by using Neural Networks (NN). The dataset consists of 210000 particles with 3 different variables traced from our recent PIC simulations of non-relativistic shocks [1], each associated with a time series of 1200 time steps long. These particles cross a region affected by the Buneman instability, a type of electrostatic instability, upon which a few percentages of them reach high energies. We perform regression and anomaly detecion on the dataset by using a Convolutional NN. Regression is able to predict real particle energies with high precision, despite the noisy and imbalanced dataset whereas anomaly detection is able to distinguish energetic and non-energetic particles without previous knowledge of the energy of the particle. Proposed methodology may considerably simplify particle classification in large-scale PIC and hybrid simulations.

This research has been supported by Narodowe Centrum Nauki through research project 2019/33/B/ ST9/02569. This research was supported by PLGrid Infrastructure. The numerical experiments were conducted at ACC Cyfronet AGH and also on the North German Supercomputing Alliance (HLRN) under the project bbp00033..

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Extended Budyko-based approach for analysing annual water balance dynamics using the concept of effective precipitation parameter

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Fluctuations in the annual water balance caused by natural and/or human factors lead to hydrologically unstable conditions. Studies have attempted to extend the Budyko hypothesis to provide an estimate of annual water balance components under such hydrologically conditions [1-3]. However, our knowledge of extended Budyko-based (BB) models under unsteady-state hydrological conditions is largely based on very limited data, including soil moisture and net groundwater inflow/outflow. Therefore, the main objective of the study was to extend the current knowledge on the application of the BB model under such conditions by introducing a new effective precipitation parameter concept and further compare the results with the original parametric Budyko-based models. The results showed that the effective precipitation-based approach improved the performance of the models in predicting the annual water balance in most of the Vistula River basin. Estimating the dynamics of the water balance considering environmental changes is important to understand the changes in hydrological processes.

This research was funded by the Polish National Science Centre (project No. 2018/30/Q/ST10/00654).

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Moths over the ocean – Long Distance Dispersal shaping the global distribution of Tiger Moths (Lepidoptera: Erebidae: Arctiinae)

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Since the validation of the continent drift theory in the mid-20th century, the general patterns of fauna and flora distribution on Earth have been "ultimately" explained by so called vicariance, i.e. deriving from the common ancestors occurring once e.g. on the former super-continent Gondwana, that broke up around 180 million years ago (mya) [1]. However, when we consider the dating of divergence times based on so called "molecular clock", it appears that some groups of organisms are evolutionary far too young to explain their distribution with vicariance, and thus in the last few decades the Long Distance Dispersal (LDD) over ocean has its "renaissance" in biogeography [1]. One of such young, albeit already highly diverse groups are Tiger Moths (subfamily Arctiinae), belonging to family Erebidae, that started to diversify around 50 mya [2]. In my presentation I will focus on two groups of Tiger Moths: Madagascan lineage of the tribe Syntomini, and tropical genus *Euchromia* Hübner, [1819]. Long Distance Dispersal is crucial to explain their current, intriguing pattern of distribution. The Madagascan Syntomini not only colonized the island in two separate episodes [3] and then diversified into almost 100 species, many of them very local [4]. This evolutionary lineage also gave rise to two independent out-of-Madagascar dispersal events, leading up to Asia and Europe, including the area of Poland [5]. The genus *Euchromia* occurs in the tropical area of the Old World, from Africa to Fiji, but certainly derives from South America [6]. Thus, its current distribution must be an effect of LDD, perhaps with later vicariance. These results show, that in biogeography there is no one, ultimate explanation of organisms' distribution, but rather the current patterns of occurrence of plants and animals result from many processes that have been interacting in time.

This research was funded by the Polish National Science Centre (OPUS 15, project No. UMO-2018/29/B/NZ8/00186 and PRELUDIUM 20, project No. UMO-2021/41/N/NZ8/03334).

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Changes in the physicochemical behavior of (1,1,1-trimethylhydrazinium)PbI_3 perovskitoid driven by temperature- and pressure-induced phase transitions

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Hybrid organic-inorganic perovskites (HOIPs) are well-known for their unusual physicochemical properties, which make them potentially useful in a wide range of optoelectronic applications [1]. Depending on the mutual dependence of the ionic radii of the structural components, HOIPs are predestined to adopt diverse structures with varying dimensionalities. Lead halides, for example, can form a three-dimensional (3D) perovskite lattice when templated by relatively small organic cations such as methylammonium, formamidinium or methylhydrazinium [2]. Using protonated bulky amines, on the other hand, favors the formation of two- (2D) or one-dimensional (1D) structures [3]. In recent years, the attention of researchers has been drawn to 1D hybrids, known as perovskitoids, because of their significantly different properties from archetypical 3D perovskites, such as greater intrinsic stability, which allows them to be used to expand the application potential of perovskite solar cells [3-5].

Detailed physicochemical analysis of (1,1,1-trimethylhydrazinium)PbI_3 in a wide range of temperatures and pressures will be presented. The studied compound crystallizes in hexagonal $P6_3/m$ symmetry and undergoes two phase transitions (PTs) during heating (cooling) at 322 (320) and 207 (202) K. The second-order PT to the high-temperature $P6_3/mmc$ phase is associated with a weak change in entropy and is related to weak structural changes and different confinement of cations in the available space. The second, first-order PT, to the low-temperature (LT) orthorhombic *Pbca* phase, which corresponds to the high change in entropy and dielectric switching, is associated with the ordering of the trimethylhydrazinium cations, re-arrangement, and strengthening of hydrogen bonds, and slightly shifted lead-iodide octahedral chains. The LT phase exhibits a reddish-orange excitonic emission with an activation energy of 65 meV. The high-pressure Raman data revealed two additional PTs, one between 2.8 and 3.2 GPa, related to the symmetry decrease, ordering of the cations, and inorganic chain distortion, and the other in the 6.4-6.8 GPa range related to the partial and reversible amorphization.

This research was funded by the Polish National Science Centre (project No. 2020/37/N/ST5/02257).

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