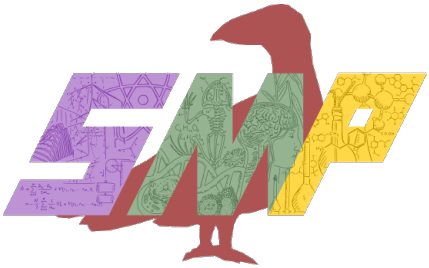
Mathematical and Natural Sciences
Students Association
of Jagiellonian University

20th Matematical and Natural Sciences Interdisciplinary Student Conference

SeMPowisko 2022

Conference program and talks abstracts



Kraków, 20–22 May 2022

Conference plan

Friday, May 20th – room A-1-13

14:00 – 14:30 *Registration — ground floor hall*

Inauguration — 14:00

Part I - Black and Fluorescent — 14:45

14:45 – 15:30 **Modeling matter around black holes**
Prof. Patryk Mach

15:45 – 16:00 **In silico design of novel fluorescent, translation-controlling riboswitches based on the Broccoli aptamer**
Marta Luterek

16:10 – 16:30 *Break*

Part II - Nutrients and Pollutants — 16:30

16:30 – 17:00 **Modulating TOR signaling regulates lifespan in various organisms**
Szymon Biela

17:10 – 17:40 **Ants Co-Occurring with Predatory Antlions Show Unsuccessful Rescue Behavior towards Captured Nestmates**
Kacper Drożdżak

17:50 – 18:05 **Bioremediation - the degradation of pollutants by microorganism.**
Maria Rybak

18:15 – 18:30 *Break*

Ending Lecture — 18:30

18:30 – 19:15 How vibrational motion can recognize the pathological state of cells and diseases of affluence?
Prof. Kamilla Małek

Saturday, May 21st – room A-1-06

09:45 – 10:10 *Registration — ground floor hall*

Second day opening — 10:10

Part III - Machine Learning and Projecting — 10:10

10:10 – 10:55 **Hierarchical correlation reconstruction - between statistics and ML**
Dr. Jarosław Duda

11:10 – 11:20 **A quick overview of Cauchy's Suface Area formula for three-dimensional convex bodies**
Igor Piechowiak

11:30 – 12:00 *Coffee break*

Part IV - Measuring and Error Detection — 12:00

12:00 – 12:30 **Tropical higher dimensions**
Maciej Żurawski

12:40 – 13:10 **(Im)possible puzzle**
Izabela Mandla

13:20 – 13:35 *Break*

Part V - Knots and Folds — 13:35

13:35 – 14:00 **What is possible to knit? Results from topology**
Marta Lotka

14:10 – 14:25 MoUSE - how to read rodents' minds
Weronika Ormaniec, Adam Kania, Dmytro Zhylko

14:35 – 15:20 *Lunch break*

Part VI - Infected Chemistry — 15:20

15:20 – 15:35 SARS-CoV-2 infection in light of the circadian clock
Joanna Doliwa

15:45 – 15:55 Stimulated Raman Scattering Microscopy – Basics, Development and Perspectives
Jakub Firlej

16:05 – 16:20 Lanthanide-Based Luminescent Thermometers
Paweł Bonarek

16:30 – 16:55 *Coffee break*

Part VII - Craters, Waves and Rats — 16:55

16:55 – 17:05 What can go wrong during rodent surgery: GCaMP6 and epileptiform events
Martyna Pałys

17:10 – 17:25 The evolution of craters on Meridiani Planum, Mars
Szymon Mol

17:35 – 17:50 The concept of Standing Waves in Gravity
Syed Naqvi

18:00 – 18:10 *Break*

Part VIII - Radiophysics — 18:10

18:10 – 18:20 Searching for supermassive black holes with radio eyes
Arpita Misra

18:30 – 18:40 Radioactive watches
Karolina Klimek

Sunday, May 22nd – room A-1-13

09:45 – 10:10 *Registration — ground floor hall*

Third day opening — 10:10

Part IX - High-Speed Physics — 10:10

10:10 – 10:55 My own little virtual LHC
Prof. Andrzej Siódmok

11:10 – 11:25 The Hubble constant tension: still a mistery
Biagio De Simone

11:35 – 12:00 *Coffee break*

Part X - Rocks Tricked Into Thinking — 12:00

12:00 – 12:30 Quantum Wasserstein Generative Adversarial Networks and how to buid them
Rafał Bistroń

12:40 – 13:10 Sea-level fall and orbital cycles recorded by changes of magnetic susceptibility and calcium carbonate content
Agata Kuźma

13:20 – 13:35 *Break*

Part XI - Infrared Quants — 13:35

13:35 – 13:50 Investigation of Physical Properties of LIRGs using Spectral Energy Distribution Modelling
Subhrata Dey

14:00 – 14:30 Quantum Key Distribution
Mateusz Stępniak

14:35 – 15:20 *Lunch break*

Part XII - Cosmological Predictions — 15:20

15:20 – 15:35 Predicting the redshift of gamma ray loud AGNs using machine learning
Aditya Narendra

15:45 – 15:55 Crisis in cosmology and how to solve it
Aleksander Lenart

16:05 – 16:20 How to predict particles masses? – the χQSM model
Maciej Kucab

16:30 – 16:55 *Coffee break*

Part XIII - Scattered and Condensed — 16:55

16:55 – 17:10 Positronium annihilation - how can it be used in different studies?
Ksymena Poradzisz

17:20 – 17:35 Kibble–Zurek Mechanism – Defect formation in condensed matter
Jakub Mazur

17:45 – 17:55 *Break*

Part XIV - Outside and Inside — 17:55

17:55 – 18:10 LOFAR
Weronika Puchalska

18:20 – 18:35 Your inner amoeba
Piotr Balwierz

18:45 – 18:55 *Ending*

Abstracts

Friday, May 20th

14:45 – 15:30 — Modeling matter around black holes

Prof. Patryk Mach, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

How do physicists model matter around black holes? What are the main ways to model the dynamics of gases in strong gravitational fields and how to take into account the self-gravity of the gas? I will try to answer these questions, assuming a perspective of a theoretical physicist. I will explain differences between the Vlasov gas and the hydrodynamical or magnetohydrodynamical approach. I will also show what geometrical (spacetime) effects are to be expected in systems consisting of a black hole and a gas with a sufficiently high mass fraction.

15:45 – 16:00 — In silico design of novel fluorescent, translation-controlling riboswitches based on the Broccoli aptamer

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

Riboswitches are fragments of mRNA molecules that act as regulators of gene expression. This regulation occurs due to the binding of small chemical molecules (ligands). Riboswitches occur naturally in the genomes of e.g. bacteria, for which they are an important part of the regulation of their metabolism. It is also possible to design synthetic riboswitches. Of particular interest is the design of fluorophore-binding riboswitches.

The aim of my project was to design in silico two complete riboswitch molecules capable of regulating the translation process, based

on the sequence of a fluorescent synthetic aptamer called Broccoli. The designed molecules were also subjected to experimental analyses. Based on bioinformatic analyses and preliminary experimental analyses, further modifications were made to the sequences of the constructs, and further bioinformatic analyses were performed.

The riboswitches, after additional modifications, may, among other things, facilitate scientific research on interactions and actions of selected proteins in bacterial cells.

16:30 – 17:00 — Modulating TOR signaling regulates lifespan in various organisms

Szymon Biela, KNBM UW, Faculty of Biology, University of Warsaw, Poland

Studies in multiple model organisms prove that nutrient signaling has a strong influence on aging. With easy access to nutrients organisms grow, develop and age very fast. In case of nutrients deficiency the pace of growth and development of the organisms is slower, what results in longer lifespan. Up to date there are many studies concerning molecular mechanisms of aging. Among several signal transduction pathways concerning this process, TOR (target of rapamycin) pathway is of great significance. TOR is a widely conserved serine/threonine kinase, which by sensing nutrients regulates for example metabolism and cell growth. Multiple metabolites, such as alfa-ketoglutarate and diacylglycerol can inversely modulate TOR pathway and, as a consequence, extend lifespan.

17:10 – 17:40 — Ants Co-Occurring with Predatory Antlions Show Unsuccessful Rescue Behavior towards Captured Nestmates

Kacper Drożdżak, KMPS UJ, WB, Faculty of Biology, Biology, Jagiellonian University in Kraków, Poland

The interaction of antlions and ants is postulated to be a predator-prey interaction in which the involved parties coevolve. Here, we investigated two issues of potential significance in terms of antlions and ants imposing selective pressures on one another. First, we determined whether trap-building antlions and sand-dwelling ants closely co-occurred in an area inhabited by both. In the field, we found that ants were the main potential prey items in artificial traps placed inside aggregation zones of antlions and that Formica cinerea workers comprised the majority of these ants. Second, we checked whether rescue behavior, a type of prosocial behavior displayed by F. cinerea workers and performed towards nestmates captured by antlions, reduced the hunting success of the latter. In the laboratory, we found that rescue attempts were very rarely successful. Overall, caution must be used when considering the coevolution of antlions and ants. Clearly, even though these two organisms can closely co-occur, the rescue behavior of ants seems to be unrelated to the predatory threat from antlions.

17:50 – 18:05 — Bioremediation - the degradation of pollutants by microorganism.

Maria Rybak, KMPS UJ, WFAIS, Faculty of Biochemistry, Biophysics and Biotechnology

In my short presentation I'd like to introduce the topic of bioremediation. It is very significant matter nowadays which can be for example used to remove the pollutions of soils or water. My talk will briefly explain what is bioremediation, what techniques of bioremediation are used recently and how it can be conducted using micriobiology (especially bacteria and fungi). I am also going to say a little bit about future perspective of bioremediation.

18:30 – 19:15 — How vibrational motion can recognize the pathological state of cells and diseases of affluence?

Prof. Kamilla Małek, WChemUJ, Faculty of Chemistry, Jagiellonian University, Kraków

Fourier Transform Infrared and Raman spectroscopic imaging is set to become a true independent modality for the diagnosis of diseases. The spectroscopic advantage of those techniques lies in the fact that the chemical change must precede or accompany any morphological change that is symptomatic of the disease. The ability to spectroscopically analyze and/or spatially locate macromolecules within single cells, tissues, and bodily fluids offers a platform to investigate, diagnose and monitor the treatment of several diseases of affluence like cancer and its metastasis, cardiovascular pathologies, and others.

This lecture provides an overview of our latest achievements in the field of FTIR and Raman imaging applied to studies of a plethora of biological specimens derived from in vitro and murine models of civilization diseases and clinical samples. These studies are mainly based on searching for "IR and Raman biomarkers" within the complex vibrational spectra that are indicative of a pathological, physiological, or biological state, which can be used to discriminate statistically classes of samples. Very often, this approach is accompanied by attempts of understanding the biochemical information delivered by spectra and their correlation with the existing diagnostic methods.

Saturday, May 21th

10:10 – 10:55 — Hierarchical correlation reconstruction - between statistics and ML

Dr. Jarosław Duda, KMPS UJ, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

While machine learning techniques are very powerful, they have some weaknesses, like iterative optimization with many local minimums, large freedom of parameters, lack of their interpretability and accuracy control. From the other side we have classical statistics based on moments not having these issues, but providing only a rough description. I will talk about approach which combines their advantages: with MSE-optimal moment-like coefficients, but designed such that we can directly translate them into probability density. For multivariate case such basis of mixed moments asymptotically allows to accurately reconstruct any joint distribution, each coefficient can be independently and cheaply estimated, has a clear interpretation, and we have some control of its accuracy. I will also present its two applications: systematic enhancement of ARMA/ARCH-like modeling for any mixed moments and non-stationary time series, and for credibility evaluation of income data: modeling continuous conditional probability distribution from a large number of variables of various types.

11:10 – 11:20 — A quick overview of Cauchy's Surface Area formula for three-dimensional convex bodies

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

This talk with swiftly introduce primarily the intuition and possible applications of Cauchy's surface area formula, stating that for an n-dimensional solid S the surface area can be calculated as exactly $\frac{1}{4} \cdot A_p$, where A_p is the average of areas of all possible projections of S onto a fixed plane.

12:00 – 12:30 — Tropical higher dimensions

Maciej Żurawski, KMPS UJ, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland

Concept of fidelity is greatly important in Quantum Information Theory. I would like to present classical and quantum approach to this measure and with the use of measure theory explain the results obtained by simulations. One of the results is that in higher dimensions most of the surface of the sphere is covered by tropical zones.

12:40 – 13:10 — (Im)possible puzzle

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

Two prisoners and one guard who loves logic. It may sound like the beginning of many puzzles that we are familiar with. This time, to gain freedom, prisoners will have to solve a problem that is connected to the chessboard. The problem that may seem impossible to solve. But is it really so? And how does any of this have anything to do with error detection and correction?

13:35 – 14:00 — What is possible to knit? Results from topology

Marta Lotka, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

The issue of knittability as a topological property can be considered from two perspectives: 1) knittability of stitches understood as knots, and 2) possibility of representing topological surfaces (or rather their immersions in 3-dimensional space) with knitted fabric. This talk will review crucial results in both fields, in particular the framework by [1] for representing knitted stitches, and the proof by [2] that all topological surfaces can be represented using techniques intrinsic to the craft of knitting. Connection of these results to biomedical engineering will also be briefly discussed.

14:10 – 14:25 — MoUSE - how to read rodents' minds

Weronika Ormaniec, Adam Kania, Faculty of Mathematics and Computer Science, Jagiellonian University in Kraków, Poland; Dmytro Zhylko, BIT AGH, WIET, Faculty of Computer Science, Electronics and Telecommunications, AGH Univercity of Science and Technology, Poland

We present the project that aims to address the issue of manual analysis of recordings from experiments on rodents (mainly for pharmacological purposes) by introducing automatic methods of ultrasonic vocalization (USV) detection and classification. The solution supports two methods of USV classification and detection. Algorithms were tested on real world data, which presents additional obstacles like noise from mice cage or mice in nearby cages. That's why we also present a few denoising algorithms to facilitate automatic detection.

We are planning to make our work publicly available under open source license in the form of Python packages and desktop applications.

15:20 – 15:35 — SARS-CoV-2 infection in light of the circadian clock

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

Circadian clock is an endogenous biochemical oscillator that cycles with a stable phase, is synchronised by solar light, and runs with a period of approximately 24 hours. It is known to play an important role in regulating various aspects of viral infections such as viral replication and host responses. Standing in the midst of the COVID-19 pandemic, one may wonder what the specific interplays between the SARS-CoV-2 infection and the human circadian clock are. Here I review the role of circadian clock proteins in SARS-CoV-2 entry and replication, as well as the possibility of perturbation of host circadian rythms due to the infection. Based on this information, I evaluate possible candidates for

antiviral drugs. I then look at how timing of SARS-CoV-2 vaccination and drug dosing may affect their efficacy. Finally, I explain the effect of circadian disruption, which affects for example night shift workers, on the severity of developed COVID-19 symptoms.

15:45 – 15:55 — Stimulated Raman Scattering Microscopy – Basics, Development and Perspectives

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

Stimulated Raman Scattering (SRS), a part of set of modern microscopic techniques called SRS microscopy, has a profound impact on fields like chemistry, biology or biomedicine. For example, there has been pilot studies conducted in quick intraoperative brain tumour histopathology based on AI supported SRS microscopy.

Two pulsed laser beams which frequency difference matches the molecular vibrational frequency is required to observe SRS phenomenon. Although it sounds like a simple idea, construction of efficiently working SRS microscope is far from easy.

In this speech, basics of SRS phenomenon will be discussed. Furthermore, construction of SRS microscope used by Raman Imaging Group at Jagiellonian University will be shown. Last but not least, perspectives on SRS microscopy usage will be proposed.

16:05 – 16:20 — Lanthanide-Based Luminescent Thermometers

Paweł Bonarek, KMPS UJ, WChUJ, Faculty of Chemistry, Jagiellonian University in Kraków, Poland

Lanthanide MOFs showing temperature dependence of luminescence are a promising source of sensitive nanothermometers. They

allow for contactless temperature scan with heigh spatial resolution and may find utilization in nanomedicine, polymer composite preparation, or inkjet printable films. In this presentation, I would like to introduce the subject of lanthanide-based luminescent thermometers by succinctly explaining how they work, how to they are synthesized and what can be done to improve their performance. It will be illustrated with some examples, and comments about potential uses will be added. Finally, I will mention future challenges in the field.

16:55 – 17:05 — What can go wrong during rodent surgery: GCaMP6 and epileptiform events

Martyna Pałys, Neuroinformatics Student Club, Faculty of Physics, University of Warsaw, Inter-faculty Individual Studies in Mathematics and Natural Sciences, University of Warsaw, Poland

GCaMP6 is a genetically encoded calcium indicatior which is used in biological research to measure intracellular Ca2+ levels in nerve cells. It is observed that in experiments with using GCaMP increases the numer of epileptiform events in hippocampal CA1 area. The causes of this phenonenon remain still unclear.

17:10 – 17:25 — The evolution of craters on Meridiani Planum, Mars

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

Impacts are the most common geologic processes in the Solar System. Even though their effects are rarely visible on Earth, craters might be easily observed on other planetary bodies. Meridiani Planum is a playa-type plain in the equatorial areas of Mars. It was visited and explored by the Opportunity rover in 2004-2018. Along her traverse there are a couple of hundreds impact craters. They vary in size, shape,

age and the level of erosion. In my talk I will present how craters are being modified by degradational processes based on data from the rover cameras, HiRISE experiment and digital terrain model prepared in collaboration with scientists from Warsaw University of Technology. The work was funded by the Anthropocene Priority Research Area budget under the program "Excellence Initiative – Research University" at the Jagiellonian University.

17:35 – 17:50 — The concept of Standing Waves in Gravity

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

Standing waves are a very interesting phenomenon in Physics. When two waves meet, there are regions of maximum and minimum displacements. These regions, known as, antinodes and nodes, lead to many interesting phenomena from wiggly patterns you can make on a string tied on one end to a guitar string or flute producing music to trapping particles by lasers. We study the concept of standing waves in Einstein's theory of gravity. Einstein's theory, known as the general theory of relativity predicted the existence of gravitational waves which were experimental discovered recently. So it is interesting to probe the question of whether two interacting gravitational waves form standing waves? This study of standing gravitational waves provides a glimpse into the complexities involved in Einstein's equations and will throw light into their non-linear nature.

18:10 – 18:20 — Searching for supermassive black holes with radio eyes

Arpita Misra, Astronomical Observatory of Jagiellonian University, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

How do you see something that emits no light? How do you measure the mass and size of such an object? With the advent of radio telescopes, we can now peer directly into the heart of a galaxy that often hides a supermassive black hole. In this talk, I intend to explain how we image massive black holes and what we can understand from them. I will discuss about the recent radio observations of SagA* by the Event Horizon Telescope and briefly talk about other supermassive black holes that we observe in distant galaxies.

18:30 – 18:40 — Radioactive watches

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

After Maria and Pierre Curie had discovered a chemical element radium, it became wildely used in everyday life. Radium was added for example to chocolate, toothpaste, bread and lots of different things. It was also used to produce luminescent watches. In factories, which produced such watches, were working usually young women. They had to paint dials and hands of the watches with paint, which included radium and zinc sulfide (ZnS). This combination caused, that watches emitted light. This work was quite easy and well-paid. Young girls were not aware of dangerous radiation emitted by radium. Over time they got sick and started dying...

In my presentation I will tell more about history of this luminescent watches. I will also explain, why accually such watches were emitting light. Additionally I will show the analysis of energy spectrum emitted by two old watches available at the Faculty of Physics at Jagiellonian University. During my presentation you could see identification of radioactive elements included in that watches. Will it be radium?

Niedziela, 21 V

10:10 – 10:55 — My own little virtual LHC

Prof. Andrzej Siódmok, KMPS UJ, WFAIS, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

11:10 – 11:25 — The Hubble constant tension: still a mistery

Biagio De Simone, Astrophysics, (1) Department of Physics "E.R. Caianiello", University of Salerno (Italy); (2) INFN

The difference from 4 to 6 σ in the Hubble constant (H_0) between the values observed with the local (Cepheids and Supernovae Ia, SNe Ia) and the high-z probes (CMB obtained by the Planck data) still challenges the astrophysics and cosmology community. Previous analysis has shown that there is an evolution in the Hubble constant that scales as $f(z) = H_0'/(1+z)^\eta$, where H_0' is $H_0(z=0)$ and η is the evolutionary parameter. Here, we investigate if this evolution still holds by using the SNe Ia gathered in the Pantheon sample and the Baryon Acoustic Oscillations (BAOs). We assume $H_0 = 70\, kms^{-1}Mpc^{-1}$ as the local value and divide the Pantheon into 3 bins ordered in increasing values of redshift. Similar to our previous analysis but varying two cosmological parameters contemporaneously (H_0, Ω_{0m} in the ΛCDM model and H_0, w_a in the w_0w_aCDM model), for each bin we implement a MCMC analysis obtaining the value of H_0. Subsequently, the values of H_0 are fitted with the model $f(z)$. Our results show that a decreasing trend with $\eta \sim 10^{-2}$ is still visible in this sample.

12:00 – 12:30 — Quantum Wasserstein Generative Adversarial Networks and how to buid them

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

Quantum Computing and Machine Learning are the fastest-growing fields in science. The idea to merge them comes as no surprise. One of the motivations to do so is the efficient generation of arbitrary (approximate) quantum states of complicated systems, for example in quantum chemistry. A natural candidate for the solution of such a problem would be a quantum analogue of Generative Adversarial Networks. However, current studies strongly suggest that they share many of the obstacles of the 'original' GANs, especially the instability in the learning process.

To deal with these problems several modifications of GANs were proposed e.g. Wasserstein GAN, which experience much more stable training for the cost of a fixed Discriminator structure build to calculate the Wasserstein distance. In my talk, we will discuss the basic ingredients of the first successful design of quantum Wasserstein Generative Adversarial Networks (qWGAN), which has been shown to improve the robustness and the scalability of the adversarial training of quantum generative models even on noisy quantum hardware.

12:40 – 13:10 — Sea-level fall and orbital cycles recorded by changes of magnetic susceptibility and calcium carbonate content

Agata Kuźma, KNGS UJ, WGiG, Faculty of Geography and Geology, Institute of Geological Sciences, Jagiellonian University, Gronostajowa 3a; 30-387 Kraków, Poland

Agata Kuźma, Krzysztof Ninard, Łukasz Weryński, Agata Biała, Julia Dziewońska, Julia Krzyżowska

The siliceous marl succession exposed in the Piotrawin quarry (Eastern Poland) is macroscopically monotonous. Our contribution is aimed at the extraction of trends and cyclicity from the sedimentary record based on a quantitative approach. For the first time, we provide a high-resolution record of magnetic susceptibility (MS) and calcium carbonate content changes from the Piotrawin site. A set of

complementary statistical, multivariate, and time series analysis methods was used to investigate the interrelation of measured variables and detect patterns in them. Orbital cyclicities are identified by the means of Multi-taper Method-based spectral analysis and multivariate Singular Spectrum Analysis (SSA). The short eccentricity cycles recorded in the whole rock succession were reconstructed using the gap-filling SSA technique. An average sedimentation rate is statistically determined at 1.5-2 cm/kyr. The time span of its deposition is estimated at 1.3-1.7 Myr, based on both sedimentation rate estimates and the counts of short eccentricity cycles identified.

13:35 – 13:50 — Investigation of Physical Properties of LIRGs using Spectral Energy Distribution Modelling

Subhrata Dey, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian /university in Kraków

Luminous Infrared Galaxies (LIRGS) offer unique laboratories to understand various physical processes which drive the evolution of galaxies across cosmic times as they form a bridge between the normal star-forming galaxies and the Ultra-Luminous Infrared Galaxies. We report the physical properties of 11 LIRGs.We utilized multi-wavelength photometric archival data and applied Code Investigating GALaxy Emission (CIGALE) to extract the physical parameters of each system.Our results are following:1) from the CIGALE modeling, the median values of AGN fraction, SFR, dust luminosity, stellar mass and the infrared to radio luminosity (at 1.4 GHz) ratio are, 5%, 1.3 Msun/yr, 11.05 Lsun, 10.47 Msun, and 2.5, respectively, compared to those reported in the literature,2)majority of our galaxies show up to few percent thermal fraction,3) the mean synchrotron spectral index from the CIGALE modeling turns out to be -0.9 which is steeper than the canonical value of -0.7.

14:00 – 14:30 — Quantum Key Distribution

Mateusz Stępniak, KMPS UJ, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University in Kraków, Poland

Quantum key distribution (QKD) is a secure communication method which implements a cryptographic protocol involving components of quantum mechanics. It enables two parties to produce a shared random secret key known only to them, which can then be used to encrypt and decrypt messages. I will present most popular methods and protocols used in QKD that are consider to be used in real quantum networks.

15:20 – 15:35 — Predicting the redshift of gamma ray loud AGNs using machine learning

Aditya Narendra, Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian /university in Kraków

Active Galactic Nucleis (AGN) are one of the most luminous and powerful objects in the universe. In this work we use the AGNs observed by the Fermi space satellite to train a supervised machine learning model such that it predicts the redshift of these AGNs without requiring extensive spectroscopic measurements.

15:45 – 15:55 — Crisis in cosmology and how to solve it

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

How much are we biased in cosmological observations? Why do different measurements not agree with each other? What are we doing wrong? How can we extend our measurements? Are Gamma-Ray Burst and Quasars a hope for the solution to those mysteries? The newest procedures aiming to remove the selection bias and "redshift

evolution" from the data might be a key to the puzzle, but how much work do we still have to do in order to make any progress?

16:05 – 16:20 — How to predict particles masses? – the χQSM model

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

Hadrons are particles in which quarks and gluons are bound by strong interactions. Quantum Chromodynamics describing strong interactions is almost not applicable in the low level limit. Therefore, to calculate masses of baryons we need to employ a model which describes effectively strong interactions. An example of such a model is a model called chiral quark solliton model (χQSM). The solution of the Dirac equation with mean chiral field, called chiral soliton, has SU(2)×SU(3) global symmetry. Parameters of this hamiltonian (such as moments of inertia) can be calculated from the Dirac equation. I have treated those parameters as free parameters to be fit to the experimental data. This presentation will be started by bringing out the theoretical background and physical intuition about χQSM. I will explain how the eigenvalues of dirac equation are derived and how we can obtain the predictions for heavy pentaquarks masses, and what to do next to prove experimentally that they are correct.

16:55 – 17:10 — Positronium annihilation - how can it be used in different studies?

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

In positronium annihilation there are created photons. The number which can be created in this event is determined by spin of positronium, at least we think it is Depending on spin value we call

it para- or ortho-positronium. In my presentation I will say how positronium annihilation can be used in different studies such as quantum entanglement phenomenon or breaking CPT symmetry.

17:20 – 17:35 — Kibble–Zurek Mechanism – Defect formation in condensed matter

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

This talk will lay a foundation for understanding Kibble—Zurek Mechanism (KZM), a theory that describes the defects formation during the second—order phase transition with finite transition rate. This mechanism biggest advantage is its universality, as knowing only basic parameters of a system we can estimate properities of a system after transition to ordered phase.

The talk will consist of two parts. First one will be gentle introduction into quantitive description of KZM, second one will consist of intuitive look at this mechanism and some real life and computational examples.

17:55 – 18:10 — LOFAR

Weronika Puchalska, KNSA; SPIE NCU Student Chapter; WFAiIS, Nicolaus Copernicus University in Toruń

When thinking of radio telescope, most people picture of a large parabolic antenna, such as RT4 in Piwnice or Effelsberg in Germany.

However, interferometers (radio telescope networks) are being used to obtain high-resolution images. An example of this is LOFAR (Low Frequency Array), which unlike classical radio telescopes, consists of many individual dipole antennas.

It is also characterized by the fact that it has no moving parts, so it is much cheaper to maintain and rarely breaks down.

During my internship at the LOFAR station in Bałdy near Olsztyn, I had opportunity to see this simple but brilliant construction.

18:20 – 18:35 — Your inner amoeba

Piotr Balwierz, KMPS UJ, Institute of Clinical Sciences, Imperial College London, London, United Kingdom

Regulation of gene expression in eukaryotes is a sophisticated multi-level process. At the core of the process is the initiation of transcription of messenger RNA from DNA. In bacteria and unicellular eukaryotes, gene expression program is largely encoded in the DNA sequence directly upstream of gene start, called proximal gene promoter.

All multicellular organisms are known to use additionally long-range DNA looping.This looping mechanism provides additional DNA sequence space and complexity necessary for encoding developmental gene expression programs.

We investigated a rare and very special kind of cell in zebrafish body (a model organism in developmental biology), a primordial germ cell (PGC). Several genome-wide assays showed that PGCs have gene expression regulation very much like single cell organisms. There are little regulatory elements compared to cells that form the rest of the body. Moreover, these elements are located nearby to gene promoters and are enriched in structural DNA motifs instead of gene-regulatory motifs, suggesting that, unlike all other cells, DNA looping is not necessary for gene expression regulation in PGCs.

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