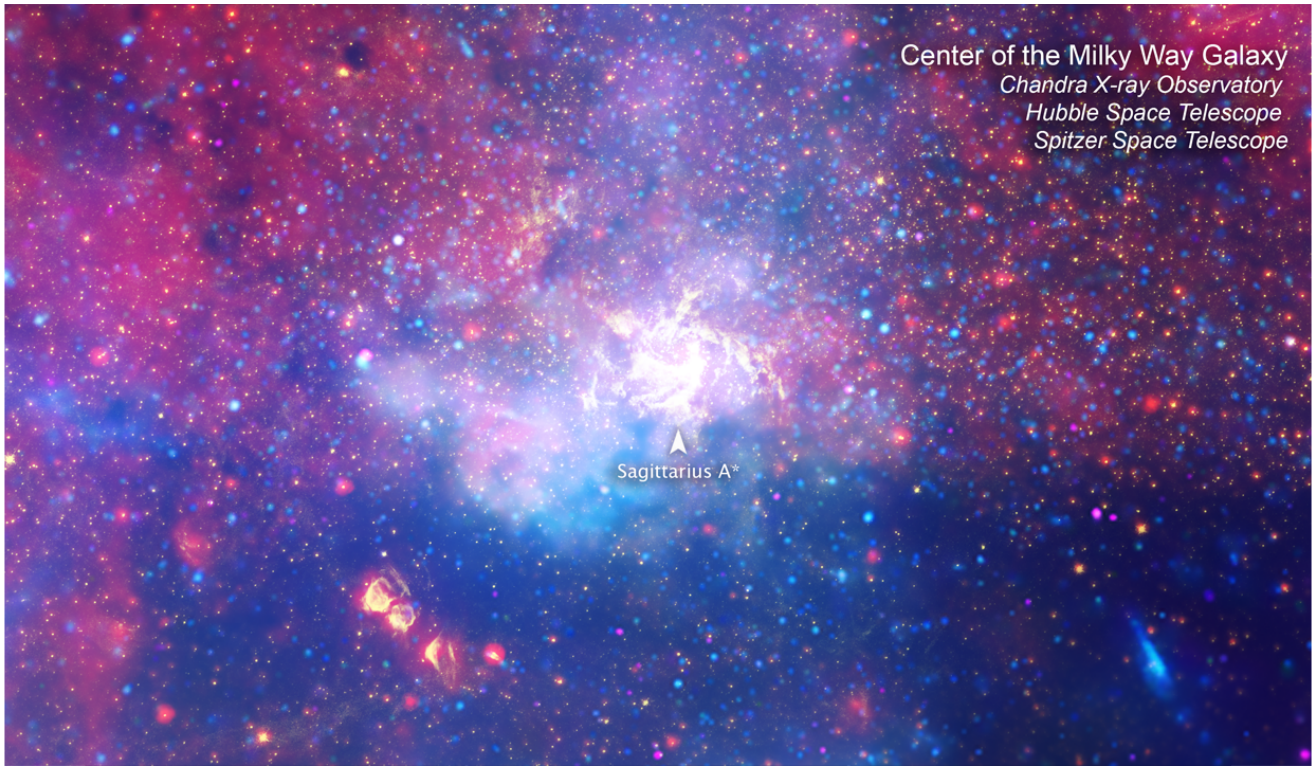
Particle Astrophysics in Poland 2022

13—16 February 2023
Auditorium Maximum UJ, Kraków



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Meeting Agenda

	MONDAY (13.02)	TUESDAY (14.02)	WEDNESDAY (15.02)	THURSDAY (16.02)
9:00	ON-SITE REGISTRATION	Session IV Gravitational Waves	Session VII Neutrino Astrophysics	Session IV cont. Gravitational Waves
9:30				
10:00				
10:30	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK	COFFEE BREAK
11:00	Session I Cosmology & Fundamental Physics	Session V Cosmic Rays	Session VI cont. Dark Matter	Session VII cont. Neutrino Astrophysics
11:30				
12:00				Session X: Contributed
12:30	LUNCH BREAK	LUNCH BREAK	LUNCH BREAK	General Discussion: Particle Astrophysics in Poland
13:00				
13:30				
14:00				
14:30	Session II Gamma-ray Astronomy	Session VI Dark Matter	Session VIII Particle Acceleration	
15:00				
15:30				
16:00	COFFEE BREAK	POSTER SESSION WITH WINE & SNACKS	COFFEE BREAK	
16:30	Session III Multiwavelength Surveys & CMB		Session IX Astrophysical Sources	
17:00				
17:30				
18:00	WELCOME RECEPTION			
18:30				
19:00			CONFERENCE DINNER	
19:30				
20:00				
20:30				
21:00				
21:30				

SOC

prof. Włodek Bednarek (University of Lodz, Łódź)
prof. Tomasz Bulik (University of Warsaw & Astrocent CAMK PAN, Warszawa)
prof. Wojciech Hellwing (CFT PAN, Warszawa)
prof. Jacek Niemiec (IFJ PAN, Kraków)
prof. Michał Ostrowski (Jagiellonian University, Kraków)
prof. Ewa Rondio (NCBJ, Warszawa)
prof. Leszek Roszkowski (Astrocent CAMK PAN & NCBJ, Warszawa)
dr hab. Łukasz Stawarz (Jagiellonian University, Kraków)
prof. Krzysztof Turzyński (University of Warsaw, Warszawa)

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mgr Goutham Krishna Anitha Kumari (Jagiellonian University, Kraków)
dr Styliani Boula (IFJ PAN, Kraków)
Jakub Dunikowski (Jagiellonia University, Kraków)
dr Elżbieta Kuligowska (Jagiellonian University, Kraków)
Patryk Liniewicz (Jagiellonian University, Kraków)
mgr Aditya Narendra (Jagiellonian University, Kraków)
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mgr Mateusz Rałowski (Jagiellonian University, Kraków)
dr hab. Łukasz Stawarz (Jagiellonian University, Kraków)
mgr Gabriel Torralba Paz (IFJ PAN, Kraków)
dr Anna Wójtowicz (Masaryk University in Brno, Czechia)

Participants

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14. dr Miljenko Cemeljic (Silesian University in Opava, Czechia & CAMK PAN, Warszawa)
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16. dr Shiuli Chatterjee (NCBJ, Warszawa)
17. mgr Małgorzata Curyło (University of Warsaw, Warszawa)
18. prof. Bożena Czerny (CFT PAN, Warszawa)
19. Milena Czubak (Jagiellonian University, Kraków)
20. Jakub Dunikowski (Jagiellonia University, Kraków)
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22. dr hab. Agnieszka Gil-Świderska (Siedlce University, Siedlce & CBK PAN, Warszawa)
23. mgr Paweł Gliwny (University of Lodz, Łódź)
24. dr hab. Dariusz Góra (IFJ PAN, Kraków)
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36. dr Katarzyna Kowalik (NCBJ, Warszawa)
37. dr Tomasz Krajewski (CAMK PAN, Warszawa)
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39. prof. Andrzej Królak (IM PAN & NCBJ, Warszawa)
40. dr Elżbieta Kuligowska (Jagiellonian University, Kraków)
41. dr hab. Marcin Kuźniak (Astrocent CAMK PAN, Warszawa)
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46. dr Volodymyr Marchenko (Jagiellonian University, Kraków)
47. Prof. Jerzy W. Mietelski (IFJ PAN, Kraków)
48. dr Marcin Misiaszek (Jagiellonian University, Kraków)
49. dr Renata Modzelewska (Siedlce University, Siedlce)
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52. dr hab. Krzysztof Nalewajko (CAMK PAN, Warszawa)
53. prof. Andrzej Niedźwiecki (University of Lodz, Łódź)
54. prof. Jacek Niemiec (IFJ PAN, Kraków)
55. dr Jacek Osiński (CAMK PAN, Warszawa)

56. prof. Michał Ostrowski (Jagiellonian University, Kraków)
57. dr hab. Jan Pękala (IFJ PAN, Kraków)
58. prof. Agnieszka Pollo (Jagiellonian University, Kraków & NCBJ, Warszawa)
59. dr Magdalena Posiadala-Zezula (University of Warsaw, Warszawa)
60. mgr Jerzy Pryga (Pedagogical University of Krakow, Kraków)
61. mgr Mateusz Rałowski (Jagiellonian University, Kraków)
62. prof. Ewa Rondio (NCBJ, Warszawa)
63. dr hab. Dorota Rosińska (University of Warsaw, Warszawa)
64. prof. Leszek Roszkowski (Astrocent CAMK PAN & NCBJ, Warszawa)
65. prof. Agata Różańska (CAMK PAN, Warszawa)
66. dr hab. Vincenzo Salzano (University of Szczecin, Szczecin)
67. dr Mahboubeh Shahrbaf (University of Wrocław, Wrocław)
68. dr Marek Siłuszyk (Siedlce University, Siedlce)
69. dr hab. Dorota Sobczyńska (University of Lodz, Łódź)
70. mgr Anna Socha (University of Warsaw, Warszawa)
71. dr hab. Jarosław Stasielak (IFJ PAN, Kraków)
72. prof. Krzysztof Stasiewicz (CBK PAN, Warszawa)
73. dr hab. Łukasz Stawarz (Jagiellonian University, Kraków)
74. prof. Christian Stegmann (Deutsches Elektronen-Synchrotron DESY, Zeuthen Germany)
75. dr Mariusz Suchenek (CAMK PAN, Warszawa)
76. dr Oleksandr Sushchov (IFJ PAN, Kraków)
77. dr Jacek Szabelski (NCBJ, Warszawa)
78. dr Krzysztof Szczepaniec (Jagiellonian University, Kraków)
79. mgr Paweł Szewczyk (University of Warsaw, Warszawa)
80. dr Bogumiła Świeżewska (University of Warsaw, Warszawa)
81. dr Andrey Timokhin (University of Zielona Gora, Zielona Góra)
82. mgr Gabriel Torralba Paz (IFJ PAN, Kraków)
83. dr Sebastian Trojanowski (Astrocent CAMK PAN & NCBJ, Warszawa)
84. prof. Krzysztof Turzyński (University of Warsaw, Warszawa)
85. dr Masayuki Wada (Astrocent CAMK PAN, Warszawa)
86. dr Marek Walczak (Astrocent CAMK PAN, Warszawa)
87. prof. Tadeusz Wibig (University of Lodz, Łódź)
88. dr hab. Alicja Wierzcholska (IFJ PAN, Kraków)
89. prof. Henryk Wilczyński (IFJ PAN, Kraków)
90. dr Anna Wójtowicz (Masaryk University in Brno, Czechia)
91. Joanna Wójtowicz (University of Lodz, Łódź)
92. prof. Andrzej Zdziarski (CAMK PAN, Warszawa)
93. prof. Staszek Zoła (Jagiellonian University, Kraków)
94. dr hab. Grzegorz Zuzel (Jagiellonian University, Kraków)
95. dr Natalia Żywucka-Hejzner (University of Lodz, Łódź)

13 February — MONDAY

9:00—10:30 ON-SITE REGISTRATION

10:30—11:00 COFFEE BREAK

11:00—12:30 Session I — Cosmology & Fundamental Physics

chairman: prof. Krzysztof Turzyński (University of Warsaw, Warszawa)

dr Chunshan Lin (Jagiellonian University, Kraków)
"Review: Parametric resonance in cosmology" (30')

Parametric resonance is an exponential instability triggered by the periodical source whose frequency equals to twice of the intrinsic frequency of the system (speaking of the 1st instability band of Matheiu equation). I will review the application of this mechanism in cosmology, including its applications to reheating, the cosmic magnetic field, the primordial black hole generation, the stochastic gravitational wave background and so on.

dr hab. Vincenzo Salzano (University of Szczecin, Szczecin)
"Unifying Dark Matter and Dark Energy in DHOST gravity theory" (20')

Extended theories of gravity with additional scalar degrees of freedom have recently acquired increasing interest due to the presence of a screening mechanism that allows suppressing at small scales every modification restoring General Relativity. In this talk, we consider a second-order extended theory of gravity belonging to the family of degenerate high-order scalar-tensor theories characterized by a partial breaking of the Vainshtein screening mechanism. We study this model in two different scenarios as a description of dark energy only, and as a description of both dark matter and dark energy. Such scenarios have been tested at two different astrophysical scales. First, we have analysed a sample of high-mass galaxy clusters targeted by the cluster lensing and supernova survey with Hubble program using two complementary probes, X-ray and strong- and weak-gravitational lensing observations. Then, at galactic scales, we focus on Ultra-Diffuse galaxies, gravitational systems with quite varied properties. In fact, on one hand we have objects claimed to be highly-deficient in dark matter, at 99% purely baryonic; and on the other hand we have also observed dark matter dominated UDGs, estimated to be at 99% dark. Such variety of behaviors might be a problem for both the standard dark matter paradigm and for alternative theories of gravity. We will show all our results and how the DHOST compares with respect to GR.

dr Bogumiła Świeżewska (University of Warsaw, Warszawa)
"Gravitational waves as probes of symmetry breaking in the early Universe" (20')

I will review the issue of phase transition in the early Universe associated with electroweak symmetry breaking, focusing on the case when symmetry is broken via quantum effects (radiative symmetry breaking). A discussion of how gravitational waves are produced during a phase transition will follow, accompanied by a presentation of the results for a specific model with classical scale invariance. An interplay with dark matter relic abundance will be studied. Moreover, a summary of theoretical issues affecting the computations will be given.

dr Tomasz Krajewski (CAMK PAN, Warszawa)
"Geometrical destabilization of inflation" (20')

In multi-field inflationary models couplings between fields are not limited to a potential of the model, but can also be present in kinetic terms. In such a case they can be interpreted as a non-trivial

structure of the space of fields. Non-vanishing curvature of this space can lead, if negative, to new phenomenon called geometrical destabilization. For example, α-attractors are inflationary models in which geometrical destabilization takes place after inflation, during preheating. It causes intensive production of spacial fluctuations of fields which efficiently siphon energy from homogeneous inflaton mode leading to nearly instantaneous reheating. The geometrical destabilization not necessarily happens after inflation. It can also take place during inflationary epoch. One may suppose that it poses a threat to a successful inflation, as it may lead to its premature end. However, our studies have shown that this is not the case. The instability is shut down by the so called kinematic backreaction and the inflation proceeds further as a sidekicked inflation.

12:30—14:30 LUNCH BREAK

14:30—16:00 Session II — Gamma-ray Astronomy

chairman: dr hab. Łukasz Stawarz (Jagiellonian University, Kraków)

dr hab. Alicja Wierzcholska (IFJ PAN, Kraków)
"Recent highlights from H.E.S.S." (20')

The High Energy Stereoscopic System (H.E.S.S.) is a hybrid array of five imaging atmospheric Cherenkov telescopes located in Namibia allowing us to observe TeV gamma-ray sky for more than two decades now. During this period numerous Galactic and extragalactic sources have been discovered with H.E.S.S. in the TeV gamma-ray domain. In this talk, I will present the current status of the project and the latest H.E.S.S. results including their physical interpretation.

dr Kazuma Ishio (University of Lodz, Łódź)
"Recent highlights of the MAGIC telescopes" (20')

MAGIC is a system of two 17-m diameter imaging atmospheric Cherenkov telescopes, located at an altitude of 2200 m in the Observatorio Roque de los Muchachos on the Canary island of La Palma. MAGIC covers a broad energy coverage, detecting gamma rays from 50 GeV and up to 100 TeV. The minimum energy can be further lowered to 15 GeV when using the Sum-Trigger-II system, which was specially optimised for low energies. MAGIC collaborates with other facilities, not only by multi-wavelength campaigns, but also by reacting to alerts from other instruments. In this presentation I will report the recent highlights from MAGIC. I will cover, among others: further results of gamma-ray burst observations since the first detection of TeV emission with GRB 190114C, the evidence for proton acceleration in the nova RS Ophiuchi, the extension of the spectra of Geminga pulsar at VHE, several campaigns on active galactic nuclei and dark matter searches.

prof. Michał Ostrowski (Jagiellonian University, Kraków)
"Cherenkov Telescope Array Observatory - the project status and Polish contribution" (20')

In 2023, the Cherenkov Telescope Array, an international project of VHE gamma ray astronomy, will reach a phase of construction, after signing an international agreement for creation of an ERIC structure for the Cherenkov Telescope Array Observatory (CTAO ERIC). In the talk we will shortly describe the current status of the project and we will present in some detail numerous contributions to the project from Polish institutions.

prof. Jacek Niemiec (IFJ PAN, Kraków)
"SST-1M gamma-ray mini-array" (15')

The SST-1M (Single-Mirror Small-Sized Telescope) project operates a mini-array of two imaging air Cherenkov telescopes for astronomical observations of very high-energy gamma rays. SST-1M telescopes adopt a Davies-Cotton optics and a fully digitising silicon photomultipliers (SiPM) based camera. They have a lightweight and compact structure with 4 m-diameter mirror dish composed of 18 hexagonal glass mirrors. Their innovative cameras have a wide field-of-view of 9.1deg and employ digital electronics with fully digital trigger and readout architecture and highly performing

large-area SiPM with dedicated slow control. The SST-1M telescopes are optimized to provide gamma-ray sensitivity above 500 GeV in stereo mode. They are designed for operation in harsh environment with minimal maintenance and they allow fully robotic operation. The SST-1M mini-array is installed at the Ondřejov Observatory in the Czech Republic and undergoes commissioning and validation during which first remote observations of astronomical objects are performed. In my presentation I will report on the status of the project and discuss future prospects.

dr hab. Sabrina Casanova (IFJ PAN, Kraków)
"HAWC Recent results" (15')

I will present the most recent results of the HAWC Observatory, going from the diffuse emission from the Galactic Plane to the discovery and monitoring of transient sources

16:00—16:30 COFFEE BREAK

16:30—18:00 Session III — Multiwavelength Surveys & CMB

chairman: prof. Wojciech Hellwing (CFT PAN, Warszawa)

prof. Marek Biesiada (NCBJ, Warszawa)
"Strong lensing - new opportunities from multivawelength surveys" (25')

By now strong lensing has become a mature research field and brought many important results in extrgalactic astronomy and cosmology. However, the potential in this field is much bigger and not sufficiently explored yet. In my talk I will review some recent results on the new applications of strong lensing. First is the cosmological model independent determination of cosmic curvature possible by using strong lensing systems. Second is the possibility to constrain modified gravity theories in the parametrized post-newtonian (PPN) formalism. Third promissing application is connected with recent successful detections of gravitational waves. This opened up a new window on the Universe and in the not so far future we could expect to see some of such signals being lensed. I will also discuss the vision of what the strong lensing of gravitational waves can bring.

prof. Agnieszka Pollo (Jagiellonian University, Kraków & NCBJ, Warszawa)
"LSST and other near-future surveys - on the way to modern multimessenger time domain big data astronomy" (25')

Multimessenger time domain big data science - this phrase is probably the closest description of what astronomy is going to become in a large part during the nearest decade. In my talk, I will present the current status of one of the largest planned sky surveys of the near future -- The Large Synoptic Survey Telescope (LSST) conducted at the Vera Rubin Observatory, and plans for the participation of Polish groups in this project. While present-day astronomical catalogues already contain billions of sources, LSST and other coming surveys will raise these numbers by orders of magnitude. The increase is not only in numbers: newly observed objects will be fainter, more distant, or otherwise different from the ones which are already well studied. At the same time, the amount of information available for each source from one catalog only will be usually very limited. This means that exploiting the synergy between different datasets gathered by different instruments in different domains will become a necessity. This new situation results in many challenges, both on the side of data analysis and scientific interpretation. In my talk, I plan to review some scientific results from my group based on presently available data, as an illustration of future problems... and ways to solve them.

prof. Agata Różańska (CAMK PAN, Warszawa)
"New-ATHENA - the impact of X-ray surveys on cosmology" (20')

I will overview the current status of Athena X-ray future mission. In the next step, I will discuss in general what X-ray surveys can do for our knowledge of cosmology from the point of view of AGN feedback and clusters. As a summary, I'm going to report the status of currently taking observations and very near future missions.

dr hab. Paweł Bielewicz (NCBJ, Warszawa)
"Cross-correlation between the Planck CMB lensing potential and galaxy catalogues from the Herschel Extragalactic Legacy Project" (20')

The effect of gravitational lensing of the cosmic microwave background (CMB), caused by the gravitational interaction of the CMB photons with matter inhomogeneities encountered on their way from the last scattering surface to an observer, provides a unique opportunity to obtain a picture of the gravitational potential of the large-scale structure of the Universe at very high redshifts. Cross-correlation of the gravitational potential with other tracers of the large-scale structure at known redshifts allows tracing the evolution of the structure and testing cosmological models. We present the measurement of the cross-correlation between galaxy catalogues from the Herschel Extragalactic Legacy Project and the state-of-the-art map of the CMB lensing potential derived from the Planck mission data. We discuss the constraints obtained on the galaxy bias and the amplitude of the cross-correlation, and present several tests of different systematic errors that may affect the cross-correlation measurement.

18:00—21:00 WELCOME RECEPTION

14 February — TUESDAY

9:00—10:30 Session IV — Gravitational Waves

chairman: prof. Tomasz Bulik (University of Warsaw & Astrocent CAMK PAN, Warszawa)

prof. Andrzej Królak (IM PAN & NCBJ, Warszawa)
"Contribution of Polgraw group to LIGO and Virgo projects" (20')

Polgraw is a group of scientists and engineers from Polish institutions that is a member of gravitational wave detector project - Virgo. I shall present activities of the Polgraw group within Virgo project in the recent years. Our activities consist of contrbutions to the construction of the Advanced Virgo detector including measurements of various types of noises in the detector, analysis of LIGO and Virgo detector data, astrophysical interpretion of the gravitational wave observations, governance of the Virgo project and outreach.

dr hab. Dorota Rosińska (University of Warsaw, Warszawa)
"Einstein Telescope, a future underground gravitational waves observatory" (20')

mgr Małgorzata Curyło (University of Warsaw, Warszawa)
"Pulsar Timing Arrays: highlights from nHz gravitational wave astronomy" (15')

With almost two decades of dedicated pulsar timing we are now reaching the levels of sensitivity that can probe theoretically predicted low-frequency gravitational waves. The main sources of such signals, inspiraling supermassive black holes, have not yet been observed by any means, but are believed to be the one of the key elements of cosmological evolution of galaxies. In the talk, I will present the latest status of Pulsar Timing Array experiments and discuss the astrophysical implications of current upper limits and the prospective detection.

prof. Tomasz Bulik (University of Warsaw & Astrocent CAMK PAN, Warszawa)
"LISA: science and Polish participation" (10')

LISA is the future satellite gravitational wave observatory working in the milihertz band. I will describe the LISA science and the current efforts for participation of Poland in construction and science for LISA.

prof. Christian Stegmann (Deutsches Elektronen-Synchrotron DESY, Zeuthen Germany)
SPECIAL TALK: *"Deutsches Zentrum fur Astrophysik" (25')*

10:30—11:00 COFFEE BREAK

11:00—12:30 Session V — Cosmic Rays

chairman: prof. Jacek Niemiec (IFJ PAN, Kraków)

dr hab. Dariusz Góra (IFJ PAN, Kraków)
"The Pierre Auger Observatory: a review of recent results and prospects" (25')

The Pierre Auger Observatory is the world's largest detector of ultra-high energy cosmic rays (UHECR). It uses an array of fluorescence telescopes and particle detectors on the ground to record the so-called extensive air showers, induced by cosmic ray particles in the atmosphere. Observations of extensive air showers (above the energy of 10^17 eV) by the Pierre Auger Observatory, with with an unprecedented accuracy, can be used not only to study hadronic interactions at high energy, in a kinematic and energy region not accessible by man-made accelerators, but also to search for the origin of UHCERs and their sources.In this talk, recent results from the Pierre Auger Observatory will be discussed, including detailed measurements of cosmic ray spectral features, studies of the anisotropy of cosmic ray arrival directions at both large and medium angular scales, mass composition, and searches for multimessenger particles. In addition, the main goals and potential capabilities of the ongoing upgrade of the Pierre Auger Observatory, called AugerPrime, will be shown.

dr Kevin Almeida-Cheminant (IFJ PAN, Kraków)
"Investigating the muon excess in Extensive Air Showers with Top-Down simulations" (15')

The muon content in extensive air showers observed by UHECR-dedicated experiments such as the Pierre Auger Observatory exceeds the number predicted by simulations performed with high-energy hadronic interaction models tuned to LHC data. More than 20 years after the first report of this discrepancy, a meta-analysis performed by the WHISP group has established this effect at an 8 sigma level, starting above a few tens of PeV. The reasons behind this disagreement could have remarkable consequences for hadronic interactions at the highest energies and for experiments relying on the detection of air showers to study the nature of UHECR. In this contribution, we describe a new method based on so-called /top-down/ reconstructions of hybrid shower events - events for which both the longitudinal profile and the particle distribution at the ground have been observed - to quantify the muon excess around 10 EeV and to infer on quantities that govern hadronic interactions.

dr hab. Piotr Homola (IFJ PAN, Kraków)
"The Cosmic Ray Extremely Distributed Observatory: Science Highlights 2023" (15')

The Cosmic Ray Extremely Distributed Observatory (CREDO) pursues a global, multi-primary approach to observing and studying cosmic rays (CR) and cosmic-ray ensembles (CRE): groups of at least two CR with a common primary interaction vertex or the same parent particle. The CREDO program embraces testing known CR and CRE scenarios, as well as getting prepared for observing unexpected physics which would manifest itself by statistically significant signal variations; it is also suitable for multi-messenger and multi-mission applications, e.g. for studying the recently observed cosmo-seismic correlations. Perfectly matched to CREDO capabilities, CRE could be formed both within classical models (e.g., as products of photon–photon interactions), and exotic scenarios (e.g., as results of decay of Super-Heavy Dark Matter particles). Their fronts might be significantly extended in space and time, and they might include cosmic rays of energies spanning the whole cosmic-ray energy spectrum, with a footprint composed of at least two extensive air showers with correlated arrival directions and arrival times, thus requiring observation strategies based on engaging a possibly wide variety of radiation detectors spread globally. In this talk I will highlight the most promising research directions that are currently being implemented within the CREDO

Collaboration: the effort to understand the physics processes behind the cosmo-seismic correlations and the continuation of indirect searches for Super-Heavy Dark Matter through CRE resulting from the interactions of ultra-high energy photons with magnetic fields. Kind of surprisingly, the research shows that these two seemingly independent directions might be tightly coupled.

dr Jacek Szabelski (NCBJ, Warszawa)
“JEM-EUSO Collaboration experiments - towards Ultra High Energy Cosmic Ray Measurements from Space” (15’)

Experiments: EUSO-Balloon, EUSO-TA (on the ground), EUSO_SPB (balloon), Mini-EUSO (ISS), EUSO-TA2 (on the ground), EUSO-SPB2 (balloon to be launched in April 2023). The JEM-EUSO mission is to measure Extensive Air Showers (EAS) generated in the atmosphere by Cosmic Rays (CR) with energies well above 10^19 eV by observation of very large area of the Earth’s atmosphere from space. Scientific targets are related to CR origin (source direction, acceleration mechanism, CR energy spectrum etc.). The idea of Ultra High Energy Cosmic Ray (UHECR) measurements from space will be presented together with equipment developed and used in EUSO experiments. Polish contribution will be highlighted. Selected results obtained so far will be shown to illustrate current status and research progress.

dr Renata Modzelewska (Siedlce University, Siedlce)
“Heliospheric modulation of cosmic rays” (20’)

We discuss our recent results concerning the modulation of cosmic rays in the heliosphere in the solar cycle 24. Analysis are based on neutron monitor (NM) measurements at Earth and space probes (e.g. ACE, SOHO, STEREO, PAMELA, ARINA, AMS). We analyze the relationship of GCR variations with heliospheric parameters: solar wind velocity, heliospheric magnetic field, tilt angle and sunspot number.

12:30—14:30 LUNCH BREAK

14:30—16:00 Session VI — Dark Matter

chairman: prof. Leszek Roszkowski (Astrocent CAMK PAN & NCBJ, Warszawa)

dr Marek Walczak (Astrocent CAMK PAN, Warszawa)
"*Searching for dark matter with liquid-argon detectors” (30’)*

Status and plans for dark matter searches with detectors based on liquid argon will be presented: the currently operating DEAP-3600 experiment (at SNOLAB) and DarkSide-20k (at Gran Sasso), which is under construction, with the AstroCeNT group involved in the veto detector development and construction.

dr Masayuki Wada (Astrocent CAMK PAN, Warszawa)
“Liquid Argon Technology for Dark Matter Search and Medical Application” (30’)

Within the dark matter community, there is increasing interest in developing novel detector technologies with sensitivity to a wide range of dark matter (DM) candidates, complementing the many planned large-exposure searches for weakly interacting massive particles (WIMPs). The results from the DarkSide-50 detector, a dual-phase liquid argon time projection chamber (LAr TPC) located at the Laboratori Nazionali del Gran Sasso (LNGS), Italy, demonstrated the ability to extend the reach of a LAr TPC to WIMPs with masses below 10 GeV/c2 that scatter on nuclei (low-mass WIMPs), and to DM particles that scatter on electrons with masses down to 20 MeV/c2 (electron-scattering DM). I will present new results from DarkSide-50 for low-mass DM and current ongoing effort for a tonne-scale LAr TPC, DarkSide-LowMass experiment, as well as low energy nuclear recoil calibration experiment. I will also present our effort to apply the LAr technology to a medical scanner with Positron Emission Tomography (PET).

dr Sebastian Trojanowski (Astrocent CAMK PAN & NCBJ, Warszawa)
“Light thermal dark matter: current status and future searches” (30’)

The well-known “WIMP miracle” and the thermal dark matter (DM) production mechanism has laid the foundation for DM searches over the last several decades. It can also be extended to a wider class of new physics models and particular emphasis in recent years has been put on scenarios predicting the existence of light DM species with the mass in between the electron and proton. In this talk, we will briefly review the current status of these discussions and future prospects for such searches.

16:00—18:00 POSTER SESSION WITH WINE & SNACKS

15 February — WEDNESDAY

9:00—10:30 Session VII — Neutrino Astrophysics

chairman: prof. Ewa Rondio (NCBJ, Warszawa)

dr Marcin Misiaszek (Jagiellonian University, Kraków)
"*Solar neutrinos and the latest Borexino results” (25’)*

Borexino recently reported the first experimental evidence for a CNO neutrino. Since this process accounts for only about 1% of the Sun’s total energy production, the associated neutrino flux is remarkably low compared to that of the pp chain, the dominant hydrogen-burning process. This experimental evidence for the existence of CNO neutrinos was obtained using a highly radio-pure Borexino liquid scintillator. Improvements in the thermal stabilization of the detector over the last five years have allowed us to exploit a method of constraining the rate of 210-Bi background. Since the CNO cycle is dominant in massive stars, this result is the first experimental evidence of a major stellar hydrogen-to-helium conversion mechanism in the Universe.

dr Magdalena Posiadala-Zezula (University of Warsaw, Warszawa)
“Studies of the atmospheric neutrinos at the Super-Kamiokande detector” (25’)

Super-Kamiokande (SK) is the world's largest underground water Cherenkov detector which has been studying the atmospheric neutrino oscillations since 1996. Atmospheric neutrinos are famous for covering a wide energy range, have both neutrinos and antineutrinos, with electron and muon flavours, which oscillate to tau neutrinos and are sensitive for matter effects in the earth. In this talk we would like to present new results on atmospheric neutrino oscillations using five SK periods (data collected from SK-I to SK-V, years 1996-2020). The data analysis has beed improved by expanding the fiducial volume (FV) of the SK, by adding neutrino interactions taking place 1m from the detector walls. This allowed us to increase the data statistics up to 20 %, and thanks to improvement to the reconstruction algorithms we were able to keep systematics uncertainties still satisfactory.

dr hab. Jan Pękala (IFJ PAN, Kraków)
“Search for ultra-high energy neutrinos in the Pierre Auger Observatory” (20’)

The Pierre Auger Observatory, constructed for the detection of ultra-high energy cosmic rays, has also the capability to detect neutrinos with energies above 100 PeV. The identification, through the special characteristics of highly inclined showers, is efficiently performed for neutrinos of all flavours. This presentation reviews the status of the neutrino search at the Observatory. Upper bounds on the neutrino flux from diffuse and point-like sources were established, placing constraints on models of neutrino production at EeV energies and on the properties of the sources

of ultra-high-energy cosmic rays. High sensitivity in searches for transient sources has also been achieved.

prof. Jan Kisiel (University of Silesia in Katowice, Katowice)
"Towards underground laboratory in Poland" (20')

Activities aimed at establishing an underground laboratory in Poland will be presented, including the considered locations and a presentation of the topics of research possible to be conducted there.

10:30—11:00 COFFEE BREAK

11:00—12:30 Session VI (cont.) — Dark Matter

chairman: prof. Leszek Roszkowski (Astrocent CAMK PAN & NCBJ, Warszawa)

dr Andrzej Hryczuk (NCBJ, Warszawa)
"Elastic self-scatterings in the calculation of dark matter relic abundance" (30')

Elastic self-scatterings do not change the number of dark matter particles and as such have been neglected in the calculation of its relic abundance. In this talk I will highlight scenarios where involvement of self-scatterings has a significant impact through the modification of dark matter momentum distribution influencing the effectiveness of annihilation processes. I will discuss example freeze-out scenarios involving resonant and sub-threshold annihilations, as well as models with additional source of dark matter particles from decays of a heavier mediator state. Interestingly, when calculation is performed at the level of dark matter momentum distribution function, one finds that injecting additional energetic dark matter particles onto the thermal population can lead to a decrease, rather than increase, of its final relic abundance.

dr Jacek Osiński (CAMK PAN, Warszawa)
"Dark Matter Production in Nonstandard Cosmologies: from WIMPs to Axions" (25')

The Universe is typically assumed to be radiation dominated in the period preceding big bang nucleosynthesis, however we do not currently have any observational probes to confirm this. Nonstandard cosmological histories, where some other form of energy density dominates for a time, commonly arise in theories of the early Universe. These histories have important consequences for processes such as dark matter production occurring in that time. In this talk I will briefly review nonstandard cosmological histories and their effects on dark matter production before presenting a recent example of axion production via misalignment in a history with a period of increasing temperature.

mgr Anna Socha (University of Warsaw, Warszawa)
"Truly dark Dark Matter" (20')

The existence of dark matter (DM) has been well established by overwhelming indirect evidence indicating the presence of a dark Universe. However, very little is known about its origin and nature. Despite our general lack of knowledge, it is indisputable that dark matter interacts gravitationally with visible matter. Although in a plethora of DM models, it is commonly assumed that DM couples to the Standard Model particle content through some additional force, in fact, this premise might be naive wishful thinking. Thus, it is natural to raise a question: what if DM has only gravitational interactions with the visible sector? In this talk, I will explore a very minimal DM scenario by assuming that the dark sector comprises massive particles with no direct or indirect interactions other than gravity. In particular, I will focus on the description of DM production mechanisms in the primordial Universe, considering the scenario of a non-standard and non-instantaneous reheating phase. It will be demonstrated that accounting for the dynamics of the early Universe is crucial for determining the evolution of purely gravitational dark matter.

dr Biswajit Karmakar (University of Silesia in Katowice, Katowice)
“Origin of Dark Matter, Neutrino Masses and Mixing with Flavor Symmetric Scoto-Seesaw Model” (15’)

We analyze a hybrid scoto-seesaw model based on the A_4 discrete symmetry to understand neutrino masses and mixing. The minimal type-I seesaw generates tribimaximal neutrino mixing at the leading order. The scotogenic contribution deviates from this first-order approximation of the lepton mixing matrix to yield the observed non-zero θ_{13} and to accommodate a potential dark matter candidate.

12:30—14:30 LUNCH BREAK

14:30—16:00 Session VIII — Particle Acceleration

chairman: prof. Michał Ostrowski (Jagiellonian University, Kraków)

dr hab. Krzysztof Nalewajko (CAMK PAN, Warszawa)
“Particle acceleration during relativistic magnetic reconnection” (25’)

Extreme astrophysical environments typically associated with sources of energetic gamma rays (e.g., relativistic jets of active galaxies, pulsars) are thought to be characterized by relativistic magnetizations, which means that magnetic energy density dominates even the rest mass density of matter, and very low densities with negligible particle collisions. In such environments, the primary mechanism of energy dissipation is relativistic magnetic reconnection. Relativistic reconnection in collisionless plasma has been demonstrated by kinetic numerical simulations to be an efficient mechanism of non-thermal particle acceleration. This presentation shall attempt to demonstrate, based on the latest results, that the overall picture of particle acceleration during relativistic reconnection appears robust, while the details are quite complex.

dr Oleh Kobzar (Cracow University of Technology, Kraków)
“Particle acceleration at the large scale merger shocks in galaxy clusters” (25’)

Shock waves in cosmic plasmas are usually considered as places of the electromagnetic turbulence generation and acceleration of particles. They can be found in different astrophysical objects at widely varying scales, from Earth's bow shock and solar flares, through Supernova Remnant (SNR) shocks, to large scale shocks in the clusters of galaxies. In the latter case, the galaxy merger shocks are found to generate X-ray and radio emission, that indicate the efficient electron acceleration at these objects. They are also considered as possible sources of Ultra High Energy Cosmic Rays (UHECR). Typically, merger shocks propagate in relatively hot plasma with plasma beta $\beta >> 1$ at low Mach numbers, $M << 10$. The detailed mechanisms of the particle acceleration at such conditions are not fully understood yet. Recent studies indicate that Shock Drift Acceleration (SDA) accompanied by the particle-wave interaction can be responsible for the initial electron energization here. Our last investigations with use of the large-scale 2D Particle-In-Cell (PIC) simulations demonstrate the important role of the multi-scale wave structures, especially the ion-scale shock rippling modes, in the electron acceleration at low-Mach-number hi-beta shocks. We showed that the main mechanism of the electron acceleration at such conditions is stochastic SDA (or SSDA), when the electrons gain energy from the motional electric field, being confined in the shock transition region by pitch-angle scattering. Although we do not observe direct transition to the Diffusive Shock Acceleration (DSA), which could produce particles with highest observed energies, the SSDA nevertheless looks as a plausible mechanism for the electron injection to DSA.

prof. Krzysztof Stasiewicz (CBK PAN, Warszawa)
"Ion and electron heating mechanisms at the bow shock - revisited with Magnetospheric Multiscale measurements" (25')

New four-point measurements obtained from NASA Magnetospheric Multiscale (MMS) mission have led to re-definition of the mechanisms responsible for heating and acceleration of ions and electrons at shocks. It is shown that streaming solar wind ions are first thermalised by a Ballistic Stochastic Thermalisation (BST) mechanism on magnetic field gradients in the shock ramp during time shorter than 1/10 of the gyroperiod. The BST process is followed by stochastic heating related to cross-field current-driven instabilities that drive strong turbulence in the frequency range from the proton cyclotron to electron cyclotron frequency. Large gradients of the electric field render ion motion stochastic, which makes it possible to effectively heat ions and to accelerate some particles to large velocities. The stochastic ExB wave energisation mechanism can explain acceleration of ions to 10 keV in quasi-perpendicular shocks and to 200 keV in quasi-parallel shocks. Satellite measurements show that electrons are heated quasi-adiabatically, T_e ~ B^{1+α} where α describes departure from adiabaticity. The observed values of α in the range -2/3 to 0.5 are explained theoretically. The role of three types of electric fields observed at shocks: 1) convection, 2) cross-shock, and 3) electrostatic waves is also elucidated.

dr hab. Łukasz Stawarz (Jagiellonian University, Kraków)
"Electron Acceleration at Relativistic Shocks" (15')

In this talk I will discuss acceleration of electrons and positrons at the fronts of astrophysical shocks. I will focus on recent observational findings constraining the two main aspects of the problem, namely the injection mechanism at parallel and quasi-parallel shocks, and the acceleration efficiency in the regime of relativistic bulk velocity of the plasma.

16:00—16:30 COFFEE BREAK

16:30—18:00 Session IX — Astrophysical Sources

chairman: prof. Włodek Bednarek (University of Lodz, Łódź)

dr Andrey Timokhin (University of Zielona Gora, Zielona Góra)
"Physics of Radio Pulsars" (25')

Radio pulsars, discovered more than half a century ago, remain one of the profound mysteries of modern astrophysics. There are still no reliable quantitative models for pulsar emission mechanisms. However, with the advent of powerful computers, significant progress has been achieved in numerical techniques for modeling relativistic plasma which lead to the creation of reliable numerical models of the pulsar magnetosphere. It gives us hope to solve the problem of pulsar emission mechanism(s) in the foreseeable future. In this talk, I will briefly review our current understanding of the physics of pulsar magnetospheres and describe a few ways to the solution of the pulsar emission mechanism problem.

prof. Bożena Czerny (CFT PAN, Warszawa)
"New developments in Active Galactic Nuclei" (25')

Over the years, active galactic nuclei (AGN) started to be relatively well understood, and the unification schemes were proposed where all AGN are basically the same but there are three parameters which govern their structure and the way how we see them: viewing angle, dimensionless accretion rate, and black hole spin. However, with the recent development of observational studies of the transient sources, puzzling new phenomena appeared now. They are generally known under the name of Changing Look AGN, and in addition a new class of sources appeared known as Quasi-Periodic Eruptions. They may be (or may not be) related to accretion disk atypical instabilities or Tidal Disruption Events observed before in non-active galaxies. I will review those developments.

prof. Andrzej Zdziarski (CAMK PAN, Warszawa)
"Jet-disc connection and magnetic fields in black-hole binaries" (25')

I will discuss physical properties of jets in these systems, their connection to accretion discs, the presence of magnetically-arrested accretion, and their broad-band emission from radio to high-energy gamma-rays. I will also address the issue of the electron-positron pair content of jets and the physical processes in which pairs can be produced.

prof. Włodek Bednarek (University of Lodz, Łódź)
"Gamma-ray emission from Novae" (15')

Novae have been recently established as a new type of gamma-ray sources in the GeV, sub-TeV energies. We confront results of these observations with the theoretical models which argue for different sites and mechanisms for the high energy emission.

19:00—22:00 CONFERENCE DINNER

16 February — THURSDAY

9:00—10:30 Session IV (cont.) — Gravitational Waves

chairman: prof. Tomasz Bulik (University of Warsaw & Astrocent CAMK PAN, Warszawa)

dr Mariusz Suchenek (CAMK PAN, Warszawa)
"Seismic and infrasound monitoring in gravitational waves observatories" (15')

Seismic and infrasound noise in gravitational wave detectors limits the low-frequency sensitivity. Analyzing these noises by distributed seismic and infrasound sensors may provide a design of a noise-cancellation system and regain sensitivity in the low-frequency regions of gravitational wave detectors. Therefore, monitoring seismic and infrasound noise becomes an important issue.

dr Volodymyr Marchenko (Jagiellonian University, Kraków)
TBA (15')

dr hab. Michał Bejger (CAMK PAN, Warszawa)
"Applications of Machine Learning in Gravitational-Wave Astrophysics" (15')

Gravitational-wave detections by means of state-of-the-art interferometers - LIGO, Virgo and now also KAGRA - create a new way of studying the Cosmos. However, the astrophysical signals are weak and buried in the detectors' noise: the sensitivity is generally limited by the presence of transient, non-Gaussian noise artifacts as well as stationary disturbances. I this talk I will describe the problems that have to be faced while facilitating routine detections and parameter estimation of interesting signal types, as well as opportunities, as most of these tasks may be alleviated with various machine learning techniques.

prof. Marek Biesiada (NCBJ, Warszawa)
"Quantum gravity, gravitational waves and multimessenger astronomy" (15')

Quantum gravity is still a Holy Grail of modern physics and none of proposed approaches can be regarded as close to the final solution. Hence we are forced to be happy with any phenomenological effects, which are testable on existing or the near future data. Such effects comprise e.g. the modified dispersion relation (so called Lorentz Invariance Violation) or massive graviton. I will review recent results on constraining such effects - in particular LIV - with modern

high energy astrophysics. In this context, prospects for gravitational wave astronomy will be also discussed.

mgr Paweł Szewczyk (University of Warsaw, Warszawa)
"Core-collapse supernova models and their GW searches" (15')

Core-collapse supernovae are one of the important gravitational wave (GW) sources in the bandwidth range of ground-based GW detectors. Numerical simulations predict a wide range of emission models, varying in emitted energy by several orders of magnitude. The complicated nature of the collapse makes detecting CCSN a challenging task. So far the search for a supernova signal has not resulted in confident detection, but a potential galactic supernova falls into the range of detection for planned observing runs of LIGO Virgo and KAGRA. I will present an overview of various models predicting GW emission from core-collapse and prospects of detecting such events in the future. I will also summarize the current status of the targeted searches in data from previous runs, highlighting crucial problems in the search.

dr Marek Lewicki (University of Warsaw, Warszawa)
"Search for new physics through primordial gravitational wave signals" (15')

We are currently witnessing the dawn of a new era in astrophysics and cosmology, started by the LIGO/Virgo observations of Gravitational Waves (GW). Thanks to the fact that these signals propagate freely from the moment of their production they also open a new window into processes taking place in the first moments of our Universe. I will discuss prospects for detection of a GW signal from the early Universe with the next generation of experiments. My focus will be sources associated cosmological phase transitions. I will discuss recent updates in the modelling of these events and their impact on the resulting GW spectra.

10:30—11:00 COFFEE BREAK

11:00—12:30 Session VII (cont.) — Neutrino Astrophysics

chairman: prof. Ewa Rondio (NCBJ, Warszawa)

dr Katarzyna Kowalik (NCBJ, Warszawa)
"Astrophysics with Neutrinos at Hyper-Kamiokande" (20')

Observation of solar and supernova neutrinos provides a unique probe of stellar objects. This talk will briefly discuss the measurements in the Super-Kamiokande water Cherenkov detector and prospects for its successor, the Hyper-Kamiokande detector, which should start taking data in the next few years.

dr hab. Paweł Malecki (IFJ PAN, Kraków)
"Activities in Baikal-GVD and P-ONE Collaborations" (20')

The talk will describe the experimental setups of the existing Baikal-GVD telescope as well as that of the Pacific Ocean Neutrino Experiment (P-ONE) under construction in the Pacific waters next to Vancouver. It will also outline the activities that were carried out in Kraków for the Baikal-GVD project and their continuation in P-ONE collaboration.

dr hab. Grzegorz Zuzel (Jagiellonian University, Kraków)
"Searches for neutrino-less double beta decay, status of the Legend project" (20')

The Large Enriched Germanium Experiment for Neutrinoless Double Beta (0vbb) Decay (LEGEND) is designed to answer one of the highest priority questions in fundamental physics: is the neutrino Majorana or Dirac particle, is the lepton number conserved, and what is the neutrino mass ? In the presentation the present status of LEGEND-200 will be discussed, as well as the perspectives for construction of the full-scale detector based on 1000 kg of Ge-76. LEGEND-1000 is designed to

probe Neutrinoless Double Beta Decay with a discovery sensitivity in the Ge-76 half-life of about 10^(28) years, corresponding to an effective Majorana mass upper limit in the range of 9-21 meV to cover the inverted-ordering neutrino mass scale with 10 years of live time.

Special Session X — Contributed Talks

dr Mariana Jaber (CFT PAN, Warszawa)
"Probing a single equation of state to model Dark Energy and Modified Gravity with observations" (10')

Perhaps the most explored hypothesis for the accelerated cosmic expansion rate arises in the context of extra fields or modifications to General Relativity. A prevalent approach is to parameterize the expansion history through the equation of state, w(z). We present a parametric form for w(z) that can reproduce the generic behaviour of the most widely used physical models for accelerated expansion with infrared corrections. The present proposal has at most 3 free parameters which can be mapped back to specific archetypal models for dark energy. We analyze in detail how different combinations of data can constrain the specific cases embedded in our form for w(z). We implement our parametric equation for w(z) to observations from CMB, the luminous distance of SNela, cosmic chronometers, and baryon acoustic oscillations identified in galaxies as well as in the Lymann-a forest. We find that the parameters can be well constrained by using different observational data sets. Our findings point to an oscillatory behaviour consistent with an f(R)-like model or an unknown combination of scalar fields. When we let the three parameters vary freely, we find an EoS which oscillates around the phantom-dividing line, and, with over 99% of confidence, the cosmological constant solution is disfavored.

dr Miljenko Cemeljic (Silesian University in Opava, Czechia & CAMK PAN, Warszawa)
"Role of reconnection in the ejection of flux ropes and making of the flares nearby the supermassive black holes" (10')

In Athena++ full 3D general relativistic ideal MHD simulations, we trace the formation of the flux ropes at the surface of the accretion flow and their subsequent ejection in the coronal region. We find reconnection layers below the flux ropes emerging with the same periodicity from the disk as the ejections of the material. We find that the period and velocity of ejections match the values observed in Sag A*, M87 and similar objects.

prof. Tadeusz Wibig (University of Lodz, Łódź)
"CREDO-Maze Project; Extensive system of local EAS mini-arrays" (10')

The CREDO-Maze project was developed at the University of Łódź to extend the CREDO Program with a system of local, school-based mini-arrays for small EAS registration. We designed minimal detector systems for monitoring cosmic ray showers, with minimization focused on construction costs. The idea is that such ready-made detector stations are to be lent to the schools concerned, which will commit to keeping them in good shape and regularly uploading data to the CREDO-Maze Project's central server, eventually to the CREDO database. Several of them are currently in operation at high schools in Lodz.

12:30—14:00 General Discussion: Particle Astrophysics in Poland

chairman: prof. Leszek Roszkowski (Astrocent CAMK PAN & NCBJ, Warszawa)

presentation by **dr Anna Wieczorek**, coordinator for Physical Sciences and Engineering at the National Science Centre

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THE END

POSTERS

mgr Jyotismita Adhikary (NCBJ, Warsaw)
"Neutrino spin-flavour precession in magnetized white dwarf"

The observation of phenomena of neutrino spin flavour precession (SFP) will require very high magnetic field as the neutrino magnetic moment is predicted to be extremely small. This makes only a handful of systems suitable to study this phenomenon. In this work, we point out the potential of white dwarf (WD) in studying the spin-flavour oscillation of neutrinos. From recent analysis, it has been inferred that young isolated WDs may harbor very strong internal magnetic field, even without exhibiting any magnetic field at the surface. The presence of magnetic field enhances the cooling process and along with that, renders the spin-flavour oscillation of neutrinos emitted in the neutrino cooling process. Employing the standard WD specifications, we analyse whether a magnetized WD is a suitable environment to distinguish between the Dirac and Majorana nature of neutrino. Higher value of spin flavour transition probability implies reduced active neutrino flux which is possible to be estimated in terrestrial neutrino detectors. We find that the spin flavour transition probability of Dirac neutrinos is much higher in comparison to the Majorana neutrino, which converts the active neutrino flavours to sterile in a significant amount. We also examine the sensitivity of the spin flavour transition probability to the neutrino magnetic moment.

dr Sk. Shariful Alam (CAMK PAN, Warszawa)
"Characterization of the Seismic Field in Virgo Buildings"

The general theory of relativity predicts that all moving objects with asymmetric mass distributions generate gravitational waves (GWs). LIGO, Virgo, and KAGRA are the interferometric detectors searching for GWs and by investigating GWs the astrophysical sources can be identified. Fluctuations of the Newtonian noise (NN) resulting from environmental seismic and anthropogenic disturbances set a limit to the sensitivity of ground-based GW detectors at the low-frequencies ranging from 1 Hz to 10 Hz. Seismic disturbances are predicted to be the strongest contribution to NN. It is significant to characterize the seismic environment near the gravitational wave detector and comprehend how the neighboring environments play a vital role in the performance of the interferometric GW detectors. Several simplified designs of seismic arrays for active NN cancellation are suggested in such a way that monitors the earth's gravity gradients near all the test masses, measures the noise produced by those gravity gradients, and subtract those gravity gradient noises from the GW signal. We would like to introduce the impact of seismic gravity perturbations that put a limit to the detection of low-frequency GW signals in future underground GW detectors. The mitigation of NN depends strongly on the number of seismometers, the sensitivity of the seismometers, and the position of these seismometers around the test masses. All these parameters can be controlled with proper modeling of the seismic field. There are number of seismic sensors present near the GW detectors and the sensor array has been analysed in terms of wave-vector space ($\vec{k}$ = (k_x,k_y)) at different frequencies to identify the presence of potential local seismic sources. We find the spatial spectrum from the cross-spectral densities originated from each pair of sensors. It is noticed two similar wave-fields are present continuously in the spatial spectrum while the mode of propagation (i.e., velocity) of the wave-fields are different. For proper characterization of the seismic field, we find the amplitude, velocity, and direction (angle) of the seismic wave field for the frequency range 5Hz ~ 20Hz. Therefore, we wish to build a model based on optimized sensor arrays that will be able to characterize the seismic field in the underground, and cancellation of the NN can be achieved.

dr David Alvarez Castillo (IFJ PAN, Kraków)
"Exotic QCD states as candidates for the solution of the muon puzzle"

Exotic QCD states, like the sexaquark particle or the QCD axion could solve the so called muon puzzle, i.e. the deficit of high energy cosmic rays produced muons as predicted by state-of-the-art simulations with respect with detections. Both particles are candidates for dark matter. In one

hand the sexaquark allows for the solution of the hyperon puzzle in compact star matter whereas the QCD axion may solve the strong CP problem. In this contribution we present the expected properties of these particles, the current search methodologies for their discovery as well as the role that they could play in potentially solving the muon puzzle.

dr hab. Gopal Bhatta (IFJ PAN, Kraków)
"Production of optical flares in blazars"

Flaring episodes in blazars represent one of the most violent processes observed in extra-galactic objects. Studies of such events shed light on the energetics of the physical processes occurring in the innermost regions of blazars, which cannot otherwise be resolved by any current instruments. In this work, we present some of the largest and most rapid flares captured in the optical band in the blazars 3C 279, OJ 49, S4 0954+658, TXS 1156+295, and PG 1553+113. The source flux was observed to increase by nearly ten times within a timescale of a few weeks. These violent events might originate from magnetohydrodynamical instabilities near the base of the jets, triggered by processes modulated by the magnetic field of the accretion disc. Here we explain the production of the flares owing to the particle injection at the shock wave front of the relativistic jets. Alternatively, the flares may have arisen due to geometrical effects at the jets. We discuss both source-intrinsic and source-extrinsic scenarios as the possible explanation for the observed large amplitude flux changes.

dr Stella Boula (IFJ PAN, Kraków)
"Hybrid-kinetic simulations of quasi-perpendicular shocks in high beta cosmic plasmas"

We study particle acceleration at radio relics in galaxy clusters, which emit synchrotron radiation produced by non-thermal populations of electrons accelerated at so-called merger shocks. Low sonic Mach numbers and high plasma beta characterize these shock conditions. Here, we present an investigation of electron acceleration at merger shocks that develop multi-scale turbulence through plasma instabilities, including large-scale shock corrugations. We utilize a hybrid-kinetic numerical approach with a recently developed energetic particle-magnetohydrodynamic (EP-MHD) code. We discuss the shock structure in a range of high plasma beta and the shock Mach numbers, including subcritical and supercritical conditions.

mgr Juan Esau Cervantes Hernandez (NCBJ, Warszawa)
"Higgs Portals dark matter from non-supersymmetric strings"

Large classes of non-supersymmetric string models equipped with standard model features have been constructed, but very little of their phenomenology is known. Interestingly, their spectra exhibit scalar fields whose only couplings to observed particles is through a multi-Higgs sector. At the same time, bottom-up models with Higgs portals are one of the simplest realizations to construct portals between the dark and visible sectors. In this poster we discuss the realizations of two promising heterotic orbifold models without supersymmetry with Higgs portals interactions. We find that a sample model includes Higgs vacua that are stable at one-loop, in which the Higgs sector is compatible with particle-physics observations and a scalar can account for the measured dark matter abundance. In such vacua interesting constraints on the masses of the dark matter candidate and the heavy Higgs sector are uncovered.

dr Shiuli Chatterjee (NCBJ, Warszawa)
"Faint light of old neutron stars from dark matter capture and detectability at the James Webb Space Telescope"

Neutron stars (NS) of age >10^9 yrs exhaust thermal and rotational energies and cool down to temperatures below O(100) K. Accretion of particle dark matter (DM) by such NS can heat them up through kinetic and annihilation processes. This increases the NS surface temperature to a maximum of ~2600 in the best case scenario. The maximum accretion rate depends on the DM ambient density and velocity dispersion, and on the NS equation of state and their velocity distributions. Upon scanning over these variables, we find that the effective surface temperature varies at most by ~40%. Black body spectrum of such warm NS peak at near infrared wavelengths with magnitudes in the range potentially detectable by the James Webb Space Telescope (JWST).

Using the JWST exposure time calculator, we demonstrate that NS with surface temperatures ≳2400 K, located at a distance of 10 pc can be detected through the F150W2 (F322W2) filters of the NIRCAM instrument at SNR ≳10 (5) within 24 hours of exposure time.

Milena Czubak (Jagiellonia University, Kraków)
“Low-background studies for the DarkSide-20k experiment"

The DarkSide-20k experiment has been designed to search for direct interactions of cold dark matter particles with argon nuclei. It is based on a two phase time projection chamber and located in the underground laboratory in Italy (laboratory Nazionali del Gran Sasso). One of the key parameters of the dark matter detectors is background, which has to be suppressed practically to zero in order to maximize the detector’s sensitivities. One of the most important background sources in DarkSide are neutrons, especially those produced in the alpha-n reactions. Suppression of content of alpha emitting isotopes in the DarkSide detector construction materials is therefore crucial for the experiment. A measurement program devoted to searches for materials with low Po-210 content (the main alpha emitter) will be presented. It is based on application of a unique, large surface and low background alpha spectrometer and supported by dedicated Monte Carlo simulations. Details of the measurements, results for selected samples and implications for the DarkSide experiment will be discussed.

dr Josiah Ensing (Astrocent CAMK, Warszawa)
"*Noise analysis at Sos Enattos: Potential site for Einstein Telescope”*

Infrasound and seismic waves are expected to be the main contributors to the gravity-gradient noise (Newtonian noise) of the third-generation subterranean gravitational wave detectors. This noise will limit the sensitivity of the instrument at frequencies below 20 Hz. Analysis of various noise sources in the infrasound and seismic wavefields are a crucial part of site selection. Here we present analysis of several environmental noise sources.

dr hab. Agnieszka Gil-Świderska (Siedlce University, Siedlce & CBK PAN, Warszawa)
“Geoeffective space weather events sings in cosmic rays behaviour during the first half of SC 24”

Events having their origin at the Sun are persistently manifested in galactic cosmic ray (GCR) flux observed at the ground level by neutron monitors. We analyse time intervals of sporadic Forbush decreases (Fd) observed by neutron monitors (NM) during the first half of solar cycle 24. We consider NMs data, as well as, solar, heliospheric and geomagnetic activity parameters, around those periods, using different mathematical tools. Subsequently, an impact of space weather phenomena on energy infrastructure is well known, in the further step we consider logs from one of the Polish transmission lines operators during the time intervals of Fds. Based on the data from the Institute of Meteorology and Water Management-Polish National Research Institute we exclude from the analysis the weather-related failures. We found the growth in the superposed averaged number of failures occurs around Forbush decreases.

mgr Paweł Gliwny (University of Lodz, Łódź)
“Study of faint Flat Spectrum Radio Quasars with the MAGIC telescopes”

Flat Spectrum Radio Quasars (FSRQs) are a class of active galaxies with strong emission lines in their optical spectra and whose jets are pointing towards the observer. The MAGIC telescopes are a stereoscopic system composed by two 17 m diameter Imaging Atmospheric Cherenkov Telescopes located at Observatorio del Roque de los Muchachos (La Palma). MAGIC is leading an observational program on FSRQ, motivated by the low energy threshold and good performance of MAGIC in the low energies, which makes the instrument ideal for studying these sources up to high redshifts. A long-standing question is the location of the γ-ray emission region of FSRQs. Fast variability observed from those sources suggest that the emission is produced in a compact region in the inner part of the jet. At such distances, VHE (E > 100GeV) photons are however expected to be absorbed strongly in the broad-line region (BLR) radiation field. In this contribution, we report on the observations of FSRQs performed with the MAGIC telescopes between 2008 and 2020. Contemporaneous multi-wavelength data (covering the GeV, X-ray, UV and optical bands) for the

study sources are also presented. We also present the broadband emission modeling of these sources.

mgr Michał Karbowiak (University of Lodz, Łódź)
"Small shower array for education purposes 'Cosmos seen from Lodz'"

The idea of building a cosmic ray detection station as part of the 'Cosmos Seen from Lodz' grant awarded by the Ministry of Education and Science as part of the 'Social Responsibility of Science' programme is to draw the attention of secondary school students to practical classes in modern high-energy physics, astrophysics or particle physics. The small-scale extensive experiments with air showers are intended to further satisfy young people's scientific curiosity and increase their interest in science and physics in particular. As part of the CREDO-Maze project, we plan to equip local secondary schools with sets of four small detectors, with a simple system for triggering, recording and online communication with the world. Networked experiments from several schools add significant new educational value to the process of developing good behaviour appropriate to scientific communities. Cooperation and competition at the stage of one's own research and information sharing are important new values in the education of the young generation. Small local 'CREDO-Maze' boards connected to the global CREDO network will provide additional data and opportunities for important cosmic ray research, which is an additional benefit of the CREDO Maze project. The poster shows the characteristics of our detectors and the results of the prototype array.

mgr Fatemeh Kayanikhoo (CAMK PAN, Warszawa)
"Magnetic reconnection in astrophysical systems: performing Orszag-Tang test problem"

The magnetic energy dissipation in astrophysical systems was poorly understood until R. Giovanelli (1946) and F. Hoyle (1949) proposed that magnetic X-type nulls can cause heating and accelerating plasma during solar flares. Currently, magnetic reconnection is accepted as the most effective mechanism in astrophysical plasma for heating and accelerating plasmoids and particles in a variety of systems, such as solar flares, accretion discs, and jets of compact objects, and magnetic substorms in the Earth's atmosphere. We use the Orszag-Tang vortex, a simple, well-known test problem in magnetohydrodynamic (MHD) codes to study the magnetic energy dissipation and estimate the reconnection rate in a weakly magnetized plasma. We quantitatively compare the results obtained between the relativistic and non-relativistic, resistive and non-resistive, as well as 2D and 3D setups with two state-of-the-art codes, PLUTO and KORAL. We show that in the resistive setup, the reconnection rate is proportional to the square root of the resistivity (Sweet-Parker model). Also, we study the effect of resolution on the reconnection rate and estimate a reasonable resolution in each setup. We find that the reconnection rate in the turbulent system (which is more realistic in astrophysical systems) is one order of magnitude higher than in the isolated reconnection layer.

mgr Dominika Król (Jagiellonia University, Kraków)
"Possible Gravitational Microlensing Events in the Optical Lightcurve of Active Galaxy S50716+714"

Here, we present a possible microlensing event found in the Transiting Exoplanet Survey Satellite observations of the blazar S5 0716+714. During the data inspection we have found several conspicuous events with `volcano-like' symmetric shape, lasting all for several hours, which closely resemble the achromatic events detected with the previous Whole Earth Blazar Telescope campaigns targeting the source. We propose that those peculiar features could be due to the gravitational micro-lensing of the innermost segments of the precessing jet in the system, by a binary lens. Studing the magnification pattern of the lens with the inverse-ray shooting method, and the source trajectory parameters with the Python package MuLensModel, we were able to fit all the selected events with a single lens, adjusting slightly only the source trajectory parameters for each lensing event. Based on the fit results, we postulate the presence of a massive binary lens, containing an intermediate-mass black hole, possibly even a super-massive one, and a much less massive companion (by a factor of $\lesssim 0.01$), located within the host galaxy of the blazar, most likely the central kiloparsec region.

Prof. Jerzy W. Mietelski (IFJ PAN, Kraków)
"Are there traces of interactions of baryonic dark matter possible to find on Earth?"

The existence of baryonic dark matter in form of ultra-dense quark "nuggets" was predicted by E. Witten in 1984 [1]. This hypothesis is not a favorable or mainstream forms of possible dark matter, however some authors noticed that such object can hit Earth causing earthquakes [2] and in particular that kimberlite pipes formation [3,4] (at least 6000 of such geological forms difficult to explain on basis of present knowledge were found already on Earth [5]) and many of yet not explained features of rare events like Tunguska meteorite impact [4,6,7] could be simply explain in frames of Witten's hypothesis . Moreover, the lacking source of heat generation inside the globe could be explained this way on a statistical basis of about single event per century. A more direct confirmation of Witten's hypothesis could be given by finding some isotopic traces which might be a result of nuclear reactions during such impact. Namely, a search for rare nuclides like Pu-244, U-236, Sm-146 etc. in kimberlite pipe rock samples is proposed.

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mgr Tomasz Mróz (Jagiellonia University, Kraków)
"Development of radiochemical techniques for estimation of the α,n background in searches for direct dark matter interactions in the DarkSide experiment"

Searches for rare nuclear processes like neutrino-less double beta decay or direct interactions of dark matter particles require today ton-scale detectors with zero background. In order to eliminate background events every material and component planned to be use in the detector has to be carefully screened in order to be sure that it fulfils the specification with respect to the radio-activities. Various radio-isotopes can contribute to background by emitted radiation, or indirectly e.g. by production of neutrons in the α-n reactions. The latter is of special interest for the dark matter experiments as the interactions of neutrons with the target material are indistinguishable from the interactions of dark matter particles. Activities of long-lived radionuclides from upper and middle part of radioactive chain like 238-U or 232-Th can be measured precisely by means of gamma-ray or mass spectrometry. However, due to highly possible disequilibrium, activities in lower part of chain have also be measured directly. Radiochemical methods to measure 210-Po and Pb-210 in various materials and electronic components will be presented. Radiochemical separation followed by low-background alpha spectrometry allow to achieve detection limits at level of mBq per kilogram of a sample. Several procedures and results developed and obtained within this study will be discussed. They are crucial for proper material selection, and provide very important data for both, detector background and sensitivity simulations.

mgr Aditya Narendra (Jagiellonia University, Kraków)
"Predicting the redshift of gamma-ray loud AGNs using supervised machine learning"

Active galactic nuclei (AGNs) are very powerful galaxies characterized by extremely bright emissions coming from their central massive black holes. Knowing the redshifts of AGNs provides us with an opportunity to determine their distance to investigate important astrophysical problems, such as the evolution of the early stars and their formation, along with the structure of early galaxies. However, redshift determination is challenging because it requires detailed follow-up of multiwavelength observations, often involving various astronomical facilities. In this presentation I will discuss about the methodology developed by our team, where we apply a powerful machine learning technique called SuperLearner to estimate the redshift of gamma-ray loud AGNs from the

Fermi 4th LAT catalog (4LAC). Using the 4LAC's observed properties we train the machine learning model on 1112 AGNs, obtaining a correlation of 75% between the predicted and observed redshift. We also explore the application of an imputation method called Multivariate Imputation by Chained Equations (MICE), using which we impute missing data for 24% of the catalog and proceed to investigate its effects on the redshift estimation. Further, we also explore the application of bias corrections and feature engineering for improving our results. Finally, we provide predicted redshift for 300 BL Lacertae Quasars of the 4LAC using our methodology.

mgr Mateusz Rałowski (Jagiellonia University, Kraków)
"Covering factor in AGNs: evolution or selection"

Recent studies have reported on a possible evolution of the covering factor (CF) with redshift. The goal of the presentation is to answer the question if this evolution is real or whether selection effects play an important role. The presented analysis was based on cross-matched multiwavelength photometrical data from the five major surveys (SDSS, GALEX, UKIDSS, WISE, Spitzer). A sample of over 17,000 quasars was derived, and separated into two redshift bins – low-z and high-z. The data were further divided into smaller subsets based on the data quality. CF estimation used in our work was calculated from the ratio between dusty torus infrared luminosity (L[ir]) and the accretion disk optical luminosity (L[agn]), as it was postulated in the literature. We found that the accuracy of the WISE W4 filter is problematic and, whenever possible, Spitzer MIPS 24 μm should be used instead. This allowed us to reduce bias especially in the more distance sources. Luminosity evolution with redshift for both L[ir] and L[agn] was confirmed with the Efron&Petrosian test. The low-z and high-z samples follow, however, a similar correlation between L[agn] and L[ir]. No evolution of the CF is detected based on the subsample within the high SMBH mass bin, or with high luminosities: the low-z and high-z values of our CF estimator are found to have the same distribution. The relation between L[ir] and L[agn] is slightly different than the 1:1 scaling, hinting for a more complex relationship between CF and L[agn], affected by possible contaminations.

dr Mahboubeh Shahrbaf (University of Wrocław, Wrocław)
"Constraining free parameters of a color superconducting non local NJL model using Bayesian analysis of neutron star mass and radius measurements"

We provide a systematic study of hybrid neutron star equations of state (EoS) consisting of a relativistic density functional for the hadronic phase and a covariant nonlocal Nambu–Jona-Lasinio (nlNJL) model to describe the color superconducting quark matter phase. The favorable parameters are obtained from a systematic Bayesian analysis for which the multi-messenger constraint on the neutron star radius at 1.4 solar mass and the combined mass-radius constraint for PSR J0740+6620 from NICER experiment are used as the constraints. Three new observations interesting for neutron star phenomenology are reported: 1) We show that the constant sound speed (CSS) EoS provides an excellent fit to that of the nlNJL model which implies the squared speed of sound at high densities to be about 0.5 for the optimized parameters; 2) we give a simple functional form for the mapping between the parameter spaces of these two models valid for the whole range of relevant chemical potentials and 3) we observe that the special point property of hybrid EoS based on CSS quark matter generalizes to a set of lines consisting of special points when two EoS parameters are varied instead of one. A lower limit for the maximum mass of hybrid stars as a function of the vector coupling strength is obtained.

dr Marek Siłuszyk (Siedlce University, Siedlce)
"Experimental study of the delay time problem of galactic cosmic rays in solar cycles"

We analyze long-term changes in the intensity of galactic cosmic rays (GCRs) in different epochs of the solar magnetic cycles (SMC).We prove the existence of varying Delay Time (DT) between the changes of GCR intensity and the parameters characterizing solar activity (SA). Our investigation of DT study focuses on various parameters characterizing the conditions in the heliosphere in comparison to changes in GCR intensity. We obtained different DTs in epochs with different global solar magnetic field polarities. SA governs the dominant long-term variations of cosmic parameters, but these may DT the original changes due to another astrophysical phenomena. Here, we analyzed the pairwise DT between global solar and heliospheric indices: sunspot numbers (SSN), representing the solar surface magnetic activity and the GCR intensity near Earth, using the

Pearson's correlation. We postulate that the observed DT is an important proxy for the characterization of GCR modulation in the heliosphere.

dr hab. Jarosław Stasielak (IFJ PAN, Kraków)
"Radio detection of cosmic rays in the Pierre Auger Observatory"

Ultra-high-energy cosmic rays (UHECRs) are studied with giant ground-based detector systems - such as the Pierre Auger Observatory - recording extensive air showers, induced by cosmic ray particles in the atmosphere. Extensive air showers consist of charged particles that undergo acceleration in the atmosphere and thus they are a source of radio emission, which can be detected by radio antennas. In the last decade, a huge progress has been made in measuring the characteristics of air showers based on their radio signal and the technique of their radio detection has reached maturity. As part of the ongoing AugerPrime upgrade of the Pierre Auger Observatory, water-Cherenkov detectors will be equipped not only with scintillators, but also with radio antennas, creating the world's largest radio detector, covering an area of 3000 km2. The new radio detector will operate together with the upgraded surface detector (water-Cherenkov and scintillator detectors), providing a unique setup to measure the properties of extensive air showers. In this contribution, we will outline the basics of air showers radio detection, the concept and design of the AugerPrime radio detector under construction, as well as inform on its current status and plans for deployment.

dr Oleksandr Sushchov (IFJ PAN, Kraków)
"Simulations of cosmic-ray ensembles initiated by synchrotron radiation"

Cosmic-ray ensembles (CRE) are cascades of product particles, expected to form as a primary cosmic ray propagates in space and interacts with radiation and matter. The potential observation of such phenomena can make an important contribution to cosmic ray astrophysics. We present simulations of CRE formation and propagation as the key objective of the scientific program initiated by the Cosmic Ray Extremely Distributed Observatory (CREDO) collaboration. Preliminary results, obtained for synchrotron radiation as the conventional energy loss process, are discussed.

dr Krzysztof Szczepaniec (Jagiellonia University, Kraków)
"Development of pulse shape discrimination method for identification and rejection of alpha events in HPGe detectors"

HPGe detectors made of material enriched in Ge-76 were and are used by many experiments (GERDA, MAJORANA, LEGEND). Their main advantage is high detection efficiency (detector = source), high intrinsic radiopurity and excellent energy resolution. In order to achieve high discovery potential of the 0vbb decay, the above listed features must be supported by ultra-low background of an experiment. One of the most problematic background sources come from alpha decays taking place on the p+ contact of the HPGe detector. They may be caused by decay of Po-210 or Pb-210 and may pose practically a constant background source over the entire lifetime of the experiment. Alpha particles passing the dead layer will lose part of their energies and may contribute to the counts in the region of interest. In order to be able to efficiently reject events induced by alpha decays a dedicated pulse shape discrimination method has been developed.

mgr Gabriel Torralba Paz (IFJ PAN, Kraków)
"Machine Learning Methods for Analysis of Accelerated Particles in PIC Simulations"

Particle-in-cell (PIC) simulations can be used to study acceleration processes in astrophysical plasmas that produce cosmic radiation observed on Earth. Particle tracing has been implemented in many PIC codes to trace particles and unveil the inner mechanisms that can accelerate 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 for which we have traced momenta in all three directions as time series of 1200 time steps long. These particles are taken from our recent PIC simulations of non-relativistic shocks in which the Buneman instability is observed to pre-accelerate a portion of particles to high energies. We perform regression and anomaly detection 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.

dr Anna Wójtowicz (Masaryk University in Brno, Czechia)
"*Multiavelength survey of nearby early-type galaxies*"

We present the analysis of the radio, infrared, optical, and X-ray data for nearby elliptical galaxies (distances $\lesssim 153$ Mpc) with directly measured masses of central supermassive black holes. We focus in particular on the the radio data, collected with ~arcmin resolution, correspond to low and very low monochromatic luminosities $L_{\rm r} \sim 10^{35} - 10^{41}$ erg s^{-1}. Objects included in the sample are associated with various systems ranging from centers of the rich clusters to poor groups of galaxies, and are unbiased with respect to the type or the level of the central activity. In our sample of 62 sources we found statistically significant evidence for a bimodal distribution of the 1.4 GHz integrated radio luminosity expressed in Eddington units. We investigate the origin of this observed bimodality, speculating in this context either on a bimodal distribution of the accretion episodes, or a bimodal distribution of black hole spins in early-type galaxies.

Joanna Wójtowicz (University of Lodz, Łódź)
“Model for the gamma-ray emission from ultra-soft X-ray sources”

The ultrasoft X-ray source is the advanced phase of the Nova explosion when the radiation from a hot surface (a few 10^5 K) of the white dwarf is able to escape through its dense wind. We assume that during such a phase the wind can still drive the magnetic field of the white dwarf into reconnection which is able to accelerate leptons to ~TeV energies. These leptons comptonize thermal radiation to the gamma-ray energies. A part of these gamma-rays are again absorbed in this same radiation field. We calculate the gamma-ray spectra expected in such a model from the late stage of the Nova explosion.

dr Natalia Żywucka-Hejzner (University of Lodz, Łódź)
“A new correction method applied to MC simulated LST images affected by cloud”

We present the results of a preliminary study of a correction method applied to the Imaging Air Cherenkov Telescope images affected by clouds. The studied data are the Monte Carlo simulations made with CORSIKA and sim_telarray, imitating the very high energy events registered by a set of four Large-Sized Telescopes (LST) composing the Cherenkov Telescope Array. We implement the cloud correction method in the ctapipe/lstchain analysis framework. The correction is based on a simple geometrical model of the emission. We show the effect of the correction method on the image parameters and the stereo reconstructed shower parameters.