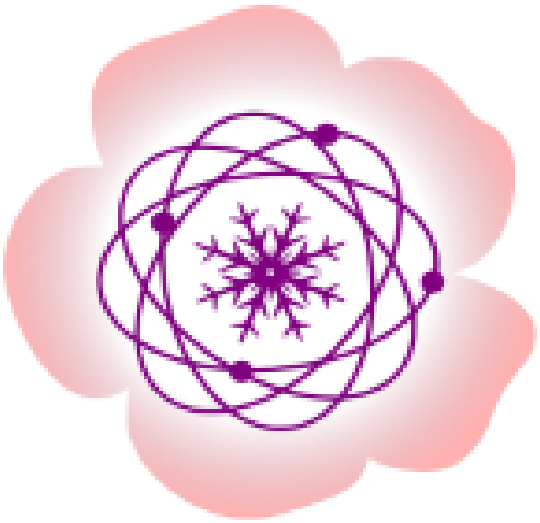
Karpacz Winter Kindergarten of Theoretical Physics



Report of Contributions

https://indico.global/e/10053

Contribution ID: **8** Type: **not specified**

Lecture L9

Second of three lectures given by Joseph Kapusta (University of Minnesota, USA).
Title: "Critical Point and Dynamics of a Phase Transition in Heavy Ion Collisions"

Session Classification: Winter School lectures

Contribution ID: **9** Type: **not specified**

Lecture L10

Third lecture by Burkhard Militzer (University of California at Berkeley, USA).
Title: "Warm Dense Plasmas from Inertial Fusion to Planetary Interiors"

Session Classification: Winter School lectures

Contribution ID: **10** Type: **not specified**

Lecture L11

Second lecture by Gerd Röpke (University of Rostock, Germany).
Title: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Session Classification: Winter School lectures

Contribution ID: **11** Type: **not specified**

Lecture L12: “Topological Phases of Matter in and out of Equilibrium”

Tuesday 21 May 2024 09:00 (1h 15m)

Second lecture by Roderich Moessner (MPI Physik Komplexer Systeme Dresden, Germany).
Title: “Topological Phases of Matter in and out of Equilibrium”

Presenter: MOESSNER, Roderich (MPI Physik Komplexer Systeme Dresden, Germany)

Session Classification: Winter School lectures

Contribution ID: **12** Type: **not specified**

Tutorials T5

Tutorials by Roderich Moessner (MPI Physik Komplexer Systeme Dresden, Germany). Title: "Topological Phases of Matter in and out of Equilibrium"

Session Classification: Winter School lectures

Contribution ID: **13** Type: **not specified**

Lecture 14 “Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems”

Tuesday 21 May 2024 12:00 (1h 15m)

Second lecture by Gerd Röpke (University of Rostock, Germany).
Title: “Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems”

Presenter: Prof. ROPKE, Gerd (University of Rostock, Germany)

Session Classification: Winter School lectures

Contribution ID: **14** Type: **not specified**

Lecture L15: “Phase Transitions in Neutron Stars”

Wednesday 22 May 2024 09:00 (1h 15m)

Second lecture by Fiorella Burgio (University of Catania, Italy).
Title: “Phase Transitions in Neutron Stars”

Presenter: Prof. BURGIO, Fiorella (University of Catania, Italy)

Session Classification: Winter School lectures

Contribution ID: **15** Type: **not specified**

Tutorials T6

Tutorials by Fiorella Burgio (University of Catania, Italy),
Title: "Phase Transitions in Neutron Stars"

Session Classification: Winter School lectures

Contribution ID: **16** Type: **not specified**

Lecture L16: "The Complexity of Neutron Star Matter: from the Liquid-Gas Phase Transition to Chiral Symmetry Breaking and Restoration"

Wednesday 22 May 2024 12:00 (1h 15m)

First lecture by Constanca Providencia (University of Coimbra, Portugal).
Title: "The Complexity of Neutron Star Matter: from the Liquid-Gas Phase Transition to Chiral Symmetry Breaking and Restoration"

Presenter: PROVIDENCIA, Constanca (University of Coimbra, Portugal)

Session Classification: Winter School lectures

Contribution ID: **17** Type: **not specified**

Lecture L17: ”Quark Deconfinement in Supernova Explosions: How to probe it?”

Thursday 23 May 2024 09:00 (1h 15m)

First lecture by Takami Kuroda (Albert-Einstein Institute Potsdam, Germany).
Title: “Quark Deconfinement in Supernova Explosions: How to probe it?”

Presenter: Dr KURODA, Takami (Albert-Einstein Institute Potsdam, Germany)

Session Classification: Winter School lectures

Contribution ID: **18** Type: **not specified**

Tutorials T7

Tutorials by Takami Kuroda (Albert-Einstein Institute Potsdam, Germany).
Title: "Quark Deconfinement in Supernova Explosions: How to probe it?"

Session Classification: Winter School lectures

Contribution ID: **19** Type: **not specified**

Lecture L18: "The Complexity of Neutron Star Matter: from the Liquid-Gas Phase Transition to Chiral Symmetry Breaking and Restoration"

Thursday 23 May 2024 12:00 (1h 15m)

Second lecture by Constanca Providencia (University of Coimbra, Portugal).
Title: "The Complexity of Neutron Star Matter: from the Liquid-Gas Phase Transition to Chiral Symmetry Breaking and Restoration"

Presenter: Prof. PROVIDENCIA, Constanca (University of Coimbra, Portugal)

Session Classification: Winter School lectures

Contribution ID: **20** Type: **not specified**

Lecture L19: “Quark Deconfinement in Supernova Explosions: How to probe it?”

Second lecture by Takami Kuroda (Albert-Einstein Institute Potsdam, Germany).
Title: “Quark Deconfinement in Supernova Explosions: How to probe it?”

Presenter: Dr KURODA, Takami (Albert-Einstein Institute Potsdam, Germany)

Session Classification: Winter School lectures

Contribution ID: **21** Type: **not specified**

Lecture L20: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Friday 24 May 2024 09:00 (1h 15m)

Third lecture by Gerd Röpke (University of Rostock, Germany).
Title: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Presenter: Prof. RÖPKE, Gerd (University of Rostock, Germany)

Session Classification: Winter School lectures

Contribution ID: **22** Type: **not specified**

Tutorials T9

Second tutorials by Gerd Röpke (University of Rostock, Germany).
Title: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Session Classification: Winter School lectures

Contribution ID: **23** Type: **not specified**

Presentation ”Introductions to generalised symmetries”

Wednesday 22 May 2024 14:30 (30 minutes)

Abstract: “Throughout history of physics, symmetry was arguably the most important idea in the description of nature. Especially fruitful was 20th century, when by combining it with Quantum Field Theory physicists managed to create the most accurate scientific theory in history, the Standard Model of particle physics. Beyond that, symmetry has been used as a guide to create better phenomenological description of studied systems in condensed matter physics and high energy physcis. However, in recent years, a new understanding of symmetries emerged, which leads to reinterpretation of some of the previously known theory as well as creation of new tools in theoretical physics. These generalized symmetries find themselves at the forefront of contemporary research in Quantum Field Theory that incorporates ideas from mathematics, high energy physics as well as condensed matter. This talk will provide merely an introduction to the topic of generalized symmetries and hopefully spark an interest in this exciting area of research.”

Presenter: KALINOWSKI, Stanisław (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **24** Type: **not specified**

Presentation ”Haldane phase in fermionic systems”

Wednesday 22 May 2024 15:00 (30 minutes)

Presenter: JAŻDŻEWSKA, Agnieszka (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **25** Type: **not specified**

Presentation ”Spontaneous symmetry breaking and Goldstone Theorem”

Wednesday 22 May 2024 15:30 (30 minutes)

Abstract: “We discuss the concept of spontaneous symmetry breaking and illustrate it with a general example. We consider Wigner-Weyl and Nambu-Goldstone realisations of symmetry in the quantum theory. Next, we state Goldstone’s theorem and sketch its proof. We discuss why quantum chromodynamics is not realised in the Wigner-Weyl mode. We also consider different order parameters of spontaneous chiral symmetry breaking.”

Presenter: SZYMAŃSKA, Emilia (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **26** Type: **not specified**

Presentation ”Spontaneous symmetry breaking of global symmetries”

Wednesday 22 May 2024 16:00 (30 minutes)

Abstract: “Exploration of global symmetry breaking process and its effects on the system. Attempting to understand the general meaning of symmetry in physical system and following specific example of symmetry breaking by exploring chiral effective models of QCD.”

Presenter: SMOLENCHENKO, Dariia (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **27** Type: **not specified**

Presentation ”Non-Hermitian control of Hermitian waveguide arrays”

Wednesday 22 May 2024 16:30 (30 minutes)

Abstract: “In the present paper we consider an optical waveguide array with embedded active nonlinear elements. We derive the theoretical background that describes wave propagation in the individual elements of the examined array, by combining nonlinearity with coupled mode equations, leading, under suitable assumptions, to the discrete non-linear Schrödinger equation, (DNLS). Adjusting DNLS to the individual elements of the array, we examine their propagation dynamics and we verify our findings through numerical simulation. Lastly we execute the numerical simulation on the examined array, searching for properties with the potential of utilization in technological applications.”

Presenter: RIZOS, Spyros (National Technical University of Athens)

Session Classification: Kindergarten

Contribution ID: **28** Type: **not specified**

Presentation ”Closing the gap in XXZ chain via magnon interactions”

Wednesday 22 May 2024 17:00 (30 minutes)

Abstract: “The XXZ model, being a generalisation of the Heisenberg model, is one of the most basic descriptions of magnetism. The description of its low lying excitations in 1D is especially difficult because the conventional approximation of linear spin waves breaks down. Despite that, a magnon description can still provide a meaningful insight into the excitation spectrum. I will show the influence of magnon-magnon interactions on the correlation function and effects it has on the energy gap of the spectrum.”

Presenter: WALICKI, Mikołaj (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **29** Type: **not specified**

Presentation ”Unveiling the mysteries of diamagnetism: from theory to fabrication”

Wednesday 22 May 2024 17:30 (30 minutes)

Abstract: “In this presentation, we delve into the intriguing world of diamagnetism, exploring its theoretical foundations and practical implementations in materials science and physics. Commencing with an elucidation of the fundamental principles governing diamagnetic phenomena, we unravel the intricacies of its response to external magnetic fields and its unique properties. Transitioning from theory to application, we explore various techniques utilized in the fabrication of diamagnetic materials, encompassing synthesis methodologies, characterization approaches, and potential real-world applications across a spectrum of disciplines. By shedding light on the mysteries of diamagnetism from both theoretical and practical standpoints, this presentation endeavors to provide a comprehensive understanding of this phenomenon and its significance in contemporary scientific research and technological innovations.”

Presenter: BLAUT, Marcel (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **30** Type: **not specified**

Presentation ”Bounce of spinning sports balls”

Tuesday 21 May 2024 16:00 (30 minutes)

Abstract: “Standard university or high-school physics teaching materials usually do not focus on bounce incydent. Description of arbitrarily spinning bouncing balls, however, is an important element of sports ball motion. We can describe the bounce using a set of equations that comes from the linear and angular impulse-momentum theorems. Finally, the numerical simulation results of different balls and surfaces will be compared with experimental data, giving agreement to within centimeters.”

Presenter: JANKOWSKI, Stanisław (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **31** Type: **not specified**

Presentation ”Public opinion dynamics in the active voter model”

Tuesday 21 May 2024 16:30 (30 minutes)

Abstract: “The aim of the research was to propose a model of social interactions that could explain the characteristic dynamics of election polling. In democratic societies, strong polarization of public opinion is often observed along with tight outcomes of elections. The presented model is based on the classical Ising model, where evolving in time, asymmetric weights of interactions in the social network were introduced. The dynamics of these weights are coupled to the results of polling. In the following research, the dependence of the system’s parameters on its dynamics was presented. In contrast to the ferromagnetic phase typical in the Ising model, the analysis identifies a clustering phase marked by a phase transition associated with a discontinuity in the system’s energy. Within the clustering phase, the system splits into two regions with distinct states. The system’s dynamics can be partially described by analyzing instabilities along the interface of phases using mean-field analysis. The research aims to establish a connection between the clustering phase and the polarization of public opinion in democratic societies. The discussion of the results includes their applications in the field of social physics and their correspondence with real-life polling data.”

Presenter: RAKOWSKI, Stanisław (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **32** Type: **not specified**

Presentation ”Energy levels in a 2D spin-dependant optical lattice”

Tuesday 21 May 2024 17:00 (30 minutes)

Abstract: “In this study the energy levels of a 87Rb atom in a 2D spin dependent optical lattice are examined. Four counter-propagating laser beams produce a periodic scalar potential. As shown by Le Kien et al. [1], polarizing the beams by 45° results in an additional, spin dependent vector potential, that can be expressed through a fictitious magnetic field B_fic. The spectrum of energy levels is analyzed as a function of the external magnetic field B_ext, in lattice cells of various n x m sizes, with either Dirichlet (DBC) or periodic (PBC) boundary conditions. It is found that avoided crossing between multiplets of eigenstates occurs only for cells larger than 1 by 1 with DBC. Szulim et al. [2] also observed level crossing in a 1 by 1 DBC cell of a honeycomb lattice and suggested hexagonal symmetry as the cause. Rectangular cells are studied by varying the angle between the laser beams and it is shown that even with the loss of rotational symmetry, avoided crossing does not occur with PBC or in a 1 by 1 cell with DBC. Furthermore, eigenstates are discovered in DBC cells, with energies lying outside the bands computed for a PBC cell. Analysis of the probability density of their wave functions reveals that they are hinge states. It is further demonstrated how the states localized near the Dirichlet walls tend to have higher energies than corresponding states localized in the center of the cell. [1] F. Le Kien et al., European Physical Journal D 67 92 (2013) [2] P. Szulim et al., New Journal of Physics 24, 033041 (2022)”

Presenter: DUTKIEWICZ, Kamil (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **33** Type: **not specified**

Presentation ”Theory of stellar nucleosynthesis at low-energy scales”

Tuesday 21 May 2024 17:30 (30 minutes)

Abstract: “The evolution of the main-sequence stars is governed by the reaction rates of the nuclear processes that occur in their interiors. The talk will cover the topic of a low-energy stellar nucleosynthesis reactions in the systems composed of the non-degenetate matter, in which the Maxwell-Boltzman distribution is valid. The reaction rates of the resonant and non-resonant reaction tuons will be discussed, as well as the key koncepts behind the so-called R and S processes, responsible for the origin of heavy elements, which are created during the collapse of the stars.”

Presenter: SOKOŁOWSKI, Marcin (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **34** Type: **not specified**

Presentation ”The mystery of classical cepheids in globular clusters”

Friday 24 May 2024 15:30 (30 minutes)

Abstract: “In the paper ”Additional Galactic Cepheids from the OGLE Survey”from 2020 the authors showed four classical cepheids OGLE-BLG-CEP-034, OGLEBLG-CEP-068, OGLE-BLG-CEP-098 and OGLE-GD-CEP-1244 in the regions outlined by the tidal radii of globular clusters NGC 6355, Pal 6, NGC 6569 and GLIMPSE01. The research aims to check if those cepheids are located inside those globular clusters and whether they may have originated inside them. The age of both cepheids and clusters has been computed to check this. The cepheids were probably not formed during the formation of these clusters, as their ages are significantly different. Afterwards, the distances were determined by two methods, from the parallax and by analysing the magnitudes. From the first method obtained results d_034 = 6.74 ± 2.97 kpc, d_068 = 5.20 ± 8.02 kpc, d_098 = 17.67 ± 20.69 kpc, d_1244 = 6.51 ± 3.87 kpc. The distances in the second method will be calculated including two different interstellar extinction sources and then averaging the results obtained for the different light filters. Based on the literature review, distances to globular clusters were checked. Unfortunately, there are large differences between them depending on the source, which makes them not very reliable. Finally, brightness period relationships were examined for all the stars to ensure that the stars were correctly classified as classical cepheids. If the study confirms that these cepheids are not located within the clusters this will be consistent with current models of star formation. If it is shown that one of them is inside the cluster, it will be the first observation of the classical cepheid in the global cluster.”

Presenter: RYDUCHOWSKA, Zuzanna (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **35** Type: **not specified**

Poster session

During this session participants will display their posters presenting the topic of their choice and answer questions during the poster-session discussion.

Session Classification: Kindergarten

Contribution ID: **36** Type: **not specified**

Presentation "Green's Function method for Tetraquarks"

Friday 24 May 2024 16:00 (30 minutes)

Abstract: "The topic of exotic hadrons and their possible structures has been discussed deeply since the discovery of $\chi_{c_1}(3872)$. We will present possible structures for tetraquarks, and discuss how to use Green's functions to depict them. We will put a particular focus on the quark exchange diagrams in context of all-charm tetraquarks and explaining their properties."

Presenter: KUCHTA, Morgan (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **37** Type: **not specified**

Presentation ”Simulating cosmic ray air shower radio emission for the Askaryan Radio Array”

Friday 24 May 2024 16:30 (30 minutes)

Abstract: “The flux of cosmic neutrinos drops rapidly towards the highest energies. Therefore, huge volumes of dense, signal transparent, material have to be probed to allow for their detection. The Askaryan Radio Array collaboration aims to probe this flux through the radio signal from the in-ice particle cascade induced upon the interaction of a cosmic neutrino. Recently, it was shown cosmic rays can induce a signal with very similar properties to a neutrino-induced cascade. Therefore, this signal not only poses a background to the neutrino search, but if understood properly allows for the in-situ calibration of the detector.”

Presenter: MOLLER, Nicolas (Université Libre de Bruxelles (ULB))

Session Classification: Kindergarten

Contribution ID: **38** Type: **not specified**

Presentation ”Cosmological horizons and conserved quantities”

Friday 24 May 2024 17:00 (30 minutes)

Abstract: “FLRW metric give three cosmological horizons. They tell about relations between possibility of communication and change of Universe size. It may be also shown that the Hubble horizon give a part of Universe where talking about energy conservation has a sense.”

Presenter: MATYSIAK, Robert (Wrocław University of Technology)

Session Classification: Kindergarten

Contribution ID: **39** Type: **not specified**

Presentation ”The footprint of nuclear saturation properties on the neutron star f mode oscillation frequencies: a machine learning approach”

Friday 24 May 2024 17:30 (30 minutes)

Abstract: “We investigate the intricate relationships between the non-radial f mode oscillation frequencies of neutron stars (NS)s and the corresponding nuclear matter equation of state (EOS) using a machine learning (ML) approach within the ambit of the relativistic mean field (RMF) framework for nuclear matter. With two distinct parameterizations of the Walecka model, namely, (1) with non-linear self interactions of the scalar field (NL) and, (2) a density dependent Bayesian model (DDB), we perform a thorough examination of the f mode frequency in relation to various nuclear saturation properties. The correlations between the f mode frequencies and nuclear saturation properties reveal, through various analytical and ML methods, the complex nature of NSs and their potential as the cosmic laboratory for studying extreme states of matter. A principal component analysis (PCA) has been performed using mixed datasets from DDB and NL models to discriminate the relative importance of the different components of the EOS on the f mode frequencies. Additionally, a Random forest feature importance analysis also elucidates the distinct roles of these properties in determining the f mode frequency across a spectrum of NS masses. Our findings are further supported by symbolic regression searches, yielding high-accuracy relations with strong Pearson coefficients and minimal errors. These relations suggest new methodologies for probing NS core characteristics, such as energy density, pressure, and speed of sound from observations of non-radial f mode oscillations of NSs.”

Presenter: KUMAR, Deepak (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **42** Type: **not specified**

Lecture ”Looking at the Universe: Neutron Stars as laboratories for nuclear and particle physics ”

Thursday 23 May 2024 16:30 (1h 30m)

Presenter: Prof. PROVIDENCIA, Constanca

Session Classification: Kindergarten

Contribution ID: **43** Type: **not specified**

Lecture ”A Journey through the Mysteries of Neutron Stars”

Friday 24 May 2024 14:30 (1 hour)

Presenter: Dr BURGIO, Fiorella (University of Catania, Italy)

Session Classification: Kindergarten

Contribution ID: **44** Type: **not specified**

Lecture ”Accelerator Disaster Scenarios, the Unabomber and Scientific Risk”

Tuesday 21 May 2024 14:30 (1h 30m)

Presenter: Prof. KAPUSTA, Joseph (University of Minnesota, USA)

Session Classification: Kindergarten

Contribution ID: **45** Type: **not specified**

Poster "Uncertainty relations in Defermed Special Relativity"

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: "In the twentieth century, two theories were intensively developed: the theory of relativity and quantum mechanics. They effectively model phenomena on their respective scales, but it is known that they are not compatible with each other. In the search for a single coherent theory, it is often postulated to introduce new elements into known models and to test hypotheses created in this way. In the case of Deformed Special Relativity, a second scale independent of the observer is introduced into the special theory of relativity, after the speed of light. This leads to modifications of the Poincaré algebra and consequently to a non-commutative phase space. My poster will present the reasoning leading to uncertainty relations in the discussed model as well as their experimental aspect."

Author: DZIEWISZ, Grzegorz (University of Wrocław)

Presenter: DZIEWISZ, Grzegorz (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **46** Type: **not specified**

Poster ”Simulating and explaining the mechanism behind magnetic gears”

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: “The coupling of mechanical gears is usually done through their teeth, but a similar mechanism can be made using sets of magnets, so that the gears do not touch each other. I have investigated the phenomenon, visualized the magnetic field through simulation and brought to light the working principle of the mechanism.”

Author: MAZUR, Tomasz (University of Warsaw)

Presenter: MAZUR, Tomasz (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **47** Type: **not specified**

Poster ”Spontaneous Symmetry Breaking and Goldstone Theorem”

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: “We discuss the concept of spontaneous symmetry breaking and illustrate it with a general example. We consider Wigner-Weyl and Nambu-Goldstone realisations of symmetry in the quantum theory. Next, we state Goldstone’s theorem and sketch its proof. We discuss why quantum chromodynamics is not realised in the Wigner-Weyl mode. We also consider different order parameters of spontaneous chiral symmetry breaking.”

Presenter: SZYMAŃSKA, Emilia (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **48** Type: **not specified**

Poster ”The mystery of classical cepheids in globular clusters”

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: “In the paper ”Additional Galactic Cepheids from the OGLE Survey”from 2020 the authors showed four classical cepheids OGLE-BLG-CEP-034, OGLEBLG-CEP-068, OGLE-BLG-CEP-098 and OGLE-GD-CEP-1244 in the regions outlined by the tidal radii of globular clusters NGC 6355, Pal 6, NGC 6569 and GLIMPSE01. The research aims to check if those cepheids are located inside those globular clusters and whether they may have originated inside them. The age of both cepheids and clusters has been computed to check this. The cepheids were probably not formed during the formation of these clusters, as their ages are significantly different. Afterwards, the distances were determined by two methods, from the parallax and by analysing the magnitudes. From the first method obtained results d_034 = 6.74 ± 2.97 kpc, d_068 = 5.20 ± 8.02 kpc, d_098 = 17.67 ± 20.69 kpc, d_1244 = 6.51 ± 3.87 kpc. The distances in the second method will be calculated including two different interstellar extinction sources and then averaging the results obtained for the different light filters. Based on the literature review, distances to globular clusters were checked. Unfortunately, there are large differences between them depending on the source, which makes them not very reliable. Finally, brightness period relationships were examined for all the stars to ensure that the stars were correctly classified as classical cepheids. If the study confirms that these cepheids are not located within the clusters this will be consistent with current models of star formation. If it is shown that one of them is inside the cluster, it will be the first observation of the classical cepheid in the global cluster.”

Presenter: RYDUCHOWSKA, Zuzanna (University of Warsaw)

Session Classification: Kindergarten

Contribution ID: **49** Type: **not specified**

Poster ”The Mass And Possible Quantum Numbers of X(6900)”

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: “The poster will discuss various properties of X(6900) and demonstrate and explanation of its unusual properties obtained by reducing one four-body problems into three two-body problems. Th solutions were obtained with Mathematica 12, first for charmonium spectrum, then for all-charm tetraquark spectrum which is understood as a pair of two-particle states, mesons or diquark- antidiquark states.”

Presenter: KUCHTA, Morgan (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **50** Type: **not specified**

Poster ”Gravitational waves”

Thursday 23 May 2024 10:30 (1h 15m)

Abstract: “As we know today, massive astrophysical bodies act as sources of gravitational waves, traveling deformations of the gravitational field. Although Albert Einstein predicted their existence in 1916, a better theoretical understanding of gravitational waves didn’t emerge until 50 years later, spurred by Trautman’s analysis of the radiation energy. Direct observation of these waves has been achieved only a century later through the international collaboration LIGO, using precise interferometric devices. In this presentation, we provide an overview of theoretical treatments of gravitational radiation, including the problems of recoil and self-force of radiating point bodies, and showcase various approaches to calculating radiated energy.”

Presenter: MILAS, Maja (University of Zagreb)

Session Classification: Kindergarten

Contribution ID: **51** Type: **not specified**

Lecture L19: ”Quark Deconfinement in Supernova Explosions: How to probe it?’

Thursday 23 May 2024 15:00 (1h 15m)

Presenter: Dr KURODA, Takami

Session Classification: Winter School lectures

Contribution ID: **52** Type: **not specified**

Lecture L21: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Friday 24 May 2024 12:00 (1h 15m)

Third lecture by Prof. Gerd Röpke (University of Rostock, Germany)
Title: "Correlations, Cluster Formation and Phase Transitions in Dense Fermion Systems"

Presenter: RÖPKE, Gerd (University of Rostock, Germany)

Session Classification: Winter School lectures

Contribution ID: **53** Type: **not specified**

Poster ”Quantum Kinetic Equation for Pair Production in a Laser Field: Is There a Berry Phase?”

Thursday 23 May 2024 14:00 (1 hour)

Abstract: “The phenomenon of pair production in a laser field holds significant implications for understanding fundamental aspects of quantum mechanics in intense electromagnetic environments. In this study, we delve into the dynamics of pair production within the framework of quantum kinetic equations, focusing particularly on the interplay between quantum coherence effects and the presence of a Berry phase. Our investigation aims to elucidate whether the Berry phase, a geometric phase arising from the adiabatic evolution of a quantum system, manifests itself in the context of pair production. Through rigorous theoretical analysis and numerical simulations, we explore the conditions under which the Berry phase may influence the dynamics of pair creation processes in laser fields. Our findings not only deepen our understanding of quantum phenomena in extreme conditions but also offer potential insights into harnessing quantum coherence for advanced technological applications.”

Presenter: ASTARYAN, Levon (International Scientific-Educational Center Institution ”Pan-Armenian Center for Excellence”)

Session Classification: Kindergarten

Contribution ID: **54** Type: **not specified**

Poster ”The effect of late-time heating in hybrid millisecond pulsars”

Thursday 23 May 2024 14:00 (1 hour)

Abstract: “We study the thermal evolution of compact stars within the realistic hybrid equation of state that incorporates hadronic matter and quark-gluon plasma in the core of the star. By performing 1D numerical simulations of the thermal evolution of compact stars, it is shown that for rapidly rotating millisecond pulsars matter can deviate from the chemical equilibrium causing an appearance of a new heating source, dubbed the rotochemical heating. Moreover, these simulations accounted for a different atmosphere composition, as well as pairing between nucleons and quarks. The obtained results reveal a notable effect of the rotochemical heating in quark matter on the cooling of old millisecond pulsars that could be used to probe the existence of deconfined quarks.”

Presenter: PANASIUK, Pavlo

Session Classification: Kindergarten

Contribution ID: **55** Type: **not specified**

Poster ”Black hole shadows”

Thursday 23 May 2024 14:00 (1 hour)

Abstract: “Black holes cannot be observed directly, in the sense that they represent a causally separated region of spacetime. However, there are many different sources of electromagnetic radiation in its surroundings and visual background, whose photons allow us to trace the black hole’s effects on spacetime. Null geodesics are strongly curved in the presence of a black hole’s (or other ultra compact objects) gravitational field, and thus outline a specific visual profile known as the shadow. We will give an overview of the theoretical models and methods used to study the shadows of black holes, as well as some open questions, including the use of these models to discriminate between candidate theories based on observational data.”

Presenter: BUSAK, Laura (University of Zagreb)

Session Classification: Kindergarten

Contribution ID: **56** Type: **not specified**

Poster ”QED synchrotron radiation extension for PIConGPU simulation”

Thursday 23 May 2024 14:00 (1 hour)

Presenter: OPTOŁOWICZ, Filip (University of Wrocław)

Session Classification: Kindergarten

Contribution ID: **57** Type: **not specified**

Poster ”Energy levels in a 2D spin dependent optical lattice”

Thursday 23 May 2024 14:00 (1 hour)

Abstract: “In this study the energy levels of a 87Rb atom in a 2D spin dependent optical lattice are examined. Four counter-propagating laser beams produce a periodic scalar potential. As shown by Le Kien et al. [1], polarizing the beams by 45° results in an additional, spin dependent vector potential, that can be expressed through a fictitious magnetic field B_fic. The spectrum of energy levels is analyzed as a function of the external magnetic field B_ext, in lattice cells of various n x m sizes, with either Dirichlet (DBC) or periodic (PBC) boundary conditions. It is found that avoided crossing between multiplets of eigenstates occurs only for cells larger than 1 by 1 with DBC. Szulim et al. [2] also observed level crossing in a 1 by 1 DBC cell of a honeycomb lattice and suggested hexagonal symmetry as the cause. Rectangular cells are studied by varying the angle between the laser beams and it is shown that even with the loss of rotational symmetry, avoided crossing does not occur with PBC or in a 1 by 1 cell with DBC. Furthermore, eigenstates are discovered in DBC cells, with energies lying outside the bands computed for a PBC cell. Analysis of the probability density of their wave functions reveals that they are hinge states. It is further demonstrated how the states localized near the Dirichlet walls tend to have higher energies than corresponding states localized in the center of the cell. [1] F. Le Kien et al., European Physical Journal D 67 92 (2013) [2] P. Szulim et al., New Journal of Physics 24, 033041 (2022)”

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