University of Hradec Králové
Faculty of Science

PROCEEDINGS OF
2^{nd} INTERNATIONAL PHYSICS DAYS
of HRADEC KRÁLOVÉ 2023

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2nd Hradec Králové International PHYSICS DAYS
University of Hradec Králové
12 – 13 October 2023
Conference Sections:
Theoretical and Mathematical Physics
Experimental and Applied Physics
INFORMATION
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Hradec Králové International Physics Days 2023 Programme

Time zone Prague time	12 October 2023 Thursday	
ONLINE-LIVE	Chairman: Bekir Can LUTFUOGLU	
08:00-08.15	Jan **KRIZ**	OPENNING TALK
08.20-08.45	Gurkan **CELEBI**	PHYSICS EDUCATION AND RESEARCH IN I.U.
08.50-09.15	Mustafa **MOUMN**I	EUP EFFECTS ON 3D DKP OSCILLATOR
09.20-09.45	Latevi **LAWSON**	STATISTICAL DESCRIPTIONS OF IDEAL GAS FROM POSITION DEFORMED NONCOMMUTATIVITY
ONLINE-LIVE	Chairman: Bekir Can LUTFUOGLU	
10.15-10.30	Karsten **GLOWKA**	MICROSTRUCTURE CHARACTERISTIC OF $(TiTaNbZr)_{100-x}Cu_x$ HIGH ENTROPY ALLOYS FOR POTENTIAL ANTIBACTERIAL PROPERTIES
10.35-10.50	Deniz **KAYA**	CALCULATION OF PAIR CORRELATION FUNCTION IN GAS AND CRYSTAL PHASES OF TEMPERATURE SENSITIVE COLLOIDAL SYSTEM
10.55-11.10	Ulas **SAKA**	HOW TO CALCULATE BLACK HOLE SHADOW
11.15-11.30	Soroush **ZARE**	BUMBLEBEE BLACK HOLES SURROUNDED BY DARK MATTER SPIKE
11.35-11.50	Mahsaalsadet **HOSSEINI**	THE WEYL EQUATION IN THE SOM-RAYCHAUDHURI SPACE-TIME IN THE PRESENCE OF AN EXTERNAL ELECTROMAGNETIC FIELD
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13.30-13.55	Andrii **KHRABUSTOVSKYI**	NEUMANN SIEVE PROBLEM REVISITED
14.00-14.25	Miloslav **ZNOJIL**	QUANTUM GRAVITY VIA TWO WHEELER-DEWITT EQUATIONS
14.30-14.45	Jan **LOSKOT**	MICROANALYSES OF 3D-PRINTED PRODUCTS MADE OF THERMOPLASTICS BY THE HOT-MELT EXTRUSION METHOD
14.50-15.05	Marzieh **BARADARAN**	MAGNETIC QUANTUM GRAPHS WITH TIME-REVERSAL NON-INVARIANT VERTEX COUPLING
ONLINE-LIVE	Chairman: Ulas SAKA	
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16:20-16.35	Bakhta **CHERIFI**	THE FACT OF MOTION IN DIPOLAR BEC
16.40-16.55	Fariba **KAFIKANG**	RADIUS OF THE WHITE DWARF ACCORDING TO FERMI ENERGY IN A κ-DEFORMED FRAMEWORK
17.00-17.15	Hadjar **REZKI**	NON-COMMUTATIVE KLEIN-GORDON EQUATION AND MECHANISM OF SCALAR PARTICLES PAIR PRODUCTION
17:20-17.35	Moussa **ABBAD**	A STUDY OF THE MOTION OF BOSON PARTICLES WITH INTERACTION IN THE COSMIC STRING SPACE TIME
17.40-17.55	Mouna **BOUHELAL**	SHELL-MODEL STUDY OF THE SPECTROSCOPIC PROPERTIES OF THE ^{26}Mg AND ^{26}Si MIRRORS
18.00-18.15	Fatima **KOUDJIL**	TRIPLE BOSE MIXTURES ON A SINGLE SPECIES
18:20-18.35	Abir **SELIM**	SHELL MODEL DESCRIPTION OF THE ^{24}Al-^{24}Na MIRRORS STRUCTURE

Hradec Králové International Physics Days 2023 Programme

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08.15-08.30	Atika **MEHEDI**	CORRELATIONS IN 1D HOMOGENEOUS BOSE MIXTURES
08.30-08.45	Zohra **MEHRI**	EXPANSION A 3D DIPOLAR BEC IN RANDOM POTENTIALS
08.45-09.00	Amenallah **ANDOLSI**	THE PLANNER VECTOR DKP OSCILLATOR WITH MINIMAL LENGTH
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09.30-09.45	Zeyneb **TAIBI**	SOLITON SOLUTION OF GROSS-PITAEVSKII EQUATION
09.45--10.00	Karima **ABBAS**	QUANTUM LIQUID DROPLETS IN BOSE MIXTURES WITH WEAK DISORDER
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The scientific board would like to thank Ulaş Saka for technical support.

SHELL MODEL DESCRIPTION OF THE ^{24}Al-^{24}Na MIRRORS STRUCTURE

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Abstract

In recent years, there has been much experimental and theoretical work on the structure of nuclei close to the valley of stability, such as the sd shell nuclei region. Among the sd shell nuclei, the properties of the protonrich nuclei constitute a major challenge in nuclear astrophysical processes. In rp-process nucleosynthesis, the proton-rich ^{24}Al is reached through the $^{23}Mg(p,\gamma)^{24}Al$ reaction as well as the $^{22}Mg(p,\gamma)^{23}Al(p,\gamma)^{24}Si(\beta)^{24}Al$ reaction chain [1].

The updated experimental spectrum of ^{24}Al has been reported recently in Ref. [2]. All states above the proton threshold, 1.86 MeV, have either uncertain or unknown J^{π} assignments. In order to confirm the proposed spin/parity assignments and to determine the unknown ones, a comparison with shell-model calculation and with the mirror nucleus ^{24}Na is crucial. We performed a shell-model calculation using the $(0+1)\ \hbar\omega\ PSDPF$ interaction [3] and Nathan code [4] to calculate the excitation energy spectrum of ^{24}Al up to 5 MeV, which includes the range above the proton threshold that is important for the astrophysical applications [5]. The comparison of our results, energy spectrum, and electromagnetic transitions, with their experiment and with their counterparts in ^{24}Na will be presented in this contribution.

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SCATTERING AND BOUND STATES FOR THE COULOMB POTENTIAL WITH DUNKL OPERATOR IN 3 - DIMENSIONS

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Abstract

In this paper, our aim is to explore the phase shift resulting from Coulomb scattering within the framework of the Dunkl operator applied to a non-relativistic system. To accomplish this, we will solve the Schrödinger equation in three dimensions, taking into account both the Dunkl operator and the Coulomb potential. Our solutions will be expressed in the form of Hypergeometric functions. Subsequently, we will assess the behavior of these solutions as the system approaches its limiting state, allowing us to compute the phase shift caused by scattering. Furthermore, we will investigate the influence of the μ-deform parameter on the phase shift and, consequently, on the wave function

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THE PLANNER VECTOR DKP OSCILLATOR WITH MINIMAL LENGTH

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Abstract

We explore the two-dimensional vector Duffin-Kemmer-Petiau (DKP) oscillator within the minimal length assumption. Using the momentum representation underlying the generalized uncertainty principle, we worked out exactly the corrected energy eigenvalues of the oscillator then we visualize some numerical solutions in the presence of the deformed algebra. In addition, the associated wave functions were expressed in terms of Jacobi polynomials. Moreover, we discussed the spin-1 boson dynamics in the presence of an external transverse homogeneous magnetic field.

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NEUMANN SIEVE PROBLEM REVISITED

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Abstract

Let $\Omega \subset \mathbb{R}^n$ be a domain, which is intersected by a hyperplane Γ. We make a lot of small holes $D_{k,\varepsilon}$, $k = 1, 2, 3\ldots$ in $\Gamma \cap \Omega$, where $\varepsilon > 0$ is a small parameter; when $\varepsilon \to 0$, the number of holes tends to infinity, while their diameters tends to zero. Let $\mathcal{A}_\varepsilon$ be the Neumann Laplacian in the perforated domain $\Omega_\varepsilon = \Omega \setminus \Gamma_\varepsilon$, where $\Gamma_\varepsilon = \Gamma \setminus (\cup_k D_{k,\varepsilon})$ ("sieve"). It is well-known that under some critical scaling of the holes radii, the operator $\mathcal{A}_\varepsilon$ converges in the strong resolvent sense to the Laplacian on $\Omega \setminus \Gamma$ subject to the so-called δ'-conditions on $\Gamma \cap \Omega$. In this talk we discuss some resent improvements of this result obtained in [A.K., Ann. Mat. Pura Appl. (2023), 202:1955–1990], where under rather general assumptions on the shapes and locations of the holes we derived estimates on the rate of convergence in terms of $L^2 \to L^2$ and $L^2 \to H^1$ operator norms.

THE KLEIN–GORDON OSCILLATOR IN THE PRESENCE OF A MINIMAL LENGTH

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Abstract

In this talk, We present an exact solution of the Klein–Gordon oscillator in the momentum space in the presence of minimal length uncertainty, The obtained results, namely the energy eigenvalues and eigenfunctions, present interesting characteristic behavior.

CORRELATIONS IN 1D HOMOGENEOUS BOSE MIXTURES

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Abstract

Based on a semi classical approach, we have analyzed the equilibrium properties of binary mixture. By using a Gaussian density operator we derive the TDHFB equations from the Balian-Veneroni variational principle. The TDHFB equations are applied to a system of self-interacting trapped bosons to derive a coupled dynamics of the condensate, the non condensate and the anomalous densities. We determine variationally analytic expressions for both the anomalous and the non condensate densities for one, two and three dimensional systems. The anomalous averages and the non condensate densities for a 1D homogeneous bose mixture at zero temperature are computed numerically.

Keywords: Mean field Method, Semi-classical approach, Binary BEC, One-body correlations.

THE FACT OF MOTION IN DIPOLAR BEC

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Abstract

We study the properties of a moving single dipolar BEC using the full Hartree-Fock-Bogoliubov theory. The analytical and numerical calculations emphasize that the interspecies dipole-dipole interactions may affect the behavior of the condensed depletion, The behavior of the LHY corrected-energy It is found that in the lower branch of the single, these quantities are unimportant and present an unconventional behavior.

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AN ANALYSIS ON THE THERMAL QUANTITIES OF QUANTUM-CORRECTED SCHWARZSCHILD ADS BLACK HOLE SURROUNDED BY QUINTESSENCE MATTER

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Abstract

In this study, we explored the shadows and thermal quantities of a quantum-corrected Schwarzschild AdS black hole surrounded by quintessence matter. For this purpose, we attached the quintessence matter field terms to the lapse function of the quantum-corrected Schwarzschild AdS black hole. At first, we obtained the mass function, and we discussed the effects of the quintessence matter field in the presence and absence of quantum corrections. We observed that quantum corrections are effective only in relatively small event horizon radii. We found that the quintessence field effects are more effective on relatively greater event horizon radii. We also found that for a particular value of the quintessence state parameter, the black hole cannot exist for all event horizon values. Then, we derived the Hawking temperature. Our detailed analysis revealed similar effects of quantum corrections and quintessence matter fields. Then, we studied the entropy function. We showed that its functional form does not change. After that, we derived the Gibbs free energy and specific heat functions to discuss the stability of the black hole. We found that the black hole could be stable or unstable, depending on the event horizon value. Next, we found the geometric equation of state and investigated the isotherms graphically.

CALCULATION OF PAIR CORRELATION FUNCTION IN GAS AND CRYSTAL PHASES OF TEMPERATURE SENSITIVE COLLOIDAL SYSTEM

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Abstract

Colloids are extensively used in technology and industry, while also playing a pivotal role in scientific endeavors. One notable example is their utilization in conjunction with light microscopes, which enables the association of micrometer-sized spherical colloid particles with atomic systems, constituting the fundamental building blocks of matter. This association serves as a valuable model system for investigating fundamental aspects of statistical mechanics, such as the mechanisms underlying phase transitions. The initial results of usage and calculation of pair interaction function in dilute and dense colloidal systems are shown in this study. We have used temperature sensitive microgel colloid particles to create a 2-dimensional (2d) gaseous phase (dilute) and 3-dimensional (3d) crystal (dense) phases. Images were taken under the light microscope and the positions of the particles were measured via image analysis techniques. From these data, pair correlation function were calculated for both systems which yielded the interaction potential between colloidal particles and various structural properties of the colloidal crystal were calculated.

1 Introduction

The structural characteristics of colloidal systems closely resemble those of atomic structures, and the precise measurement of colloid particle positions can be achieved with remarkable accuracy, thanks to the capabilities of light microscopy. Consequently, this enables the simultaneous execution of both local and dynamic measurements which cannot be achieved in atomic systems using existing technology. Such measurements involving colloid particles and light microscopy can yield novel insights into colloidal systems and shed light on previously unanswered questions within the realm of atomic systems. There are many studies who demonstrated this fact and readers can refer to the citations of an seminal paper by Crocker and Grier [1] for such applications. Through precise control of both the sensitivity and size of the synthesized colloid particles in response to temperature variations, we have been able to simultaneously observe the interactions among these particles within confined geometries and under varying temperature conditions. This allowed us to measure their respective physical properties. In our study, we acquired the data through video microscope with the assistance of an image processing program. Subsequently, we directly computed the pair interaction potential energy of the colloid particles based on the particle positions of each particle in dilute and concentrated colloidal systems.

Our work is organized as follows: In the Materials and Methods section, we describe calculation of the pair correlation function in subsection 2.1 and the experimental details regarding synthesis of colloidal particles, preparing dilute (2d systems) and crystal (3d systems) in subsections of 2.2, 2.3, 2.4, respectively. Then the results of pair correlation function in dilute and crystal regimes are discussed in Results and Discussion section 3. Through our initial results in the study, the conclusions and the possible future studies and experiments are suggested in the section 4 .

2 Materials and Methods

2.1 Calculation of pair correlation function

The pair correlation function, denoted as $g(r)$, measures the distance between one particle and the central position of another particle, providing insight into the likelihood of finding particles at specific distances. In situations involving short distances, it characterizes the way particles arrange themselves, resembling the arrangement of closely packed hard spheres stacked atop each other. In such cases, the minimum possible separation between two particle centers corresponds to the diameter of the particles which is named as hard sphere system [2], [3]. Additionally, g(r) is normalized with respect to density, and for larger values, it converges towards a value of 1. For N(t) particles in the field of view at time t, distribution of particles can be expressed as

$$\rho(\mathbf{r},t) = \sum_{j=1}^{N(t)} \delta(\mathbf{r} - \mathbf{r}_j(t)) \tag{1}$$

as j index scans through all individual particles as $\mathbf{r}$ is the location of the particles [2]. For a system characterized by radially symmetric pairwise additive interactions, information can be extracted from two-body correlation function $g(r)$.Applying liquid structure theory, effective pair potential $u(r)$ can be extracted from $g(r)$ [4], [5], [6], [7]. From density pair distribution function $g(\mathbf{r}_1, \mathbf{r}_2)$ for a homogeneous system can be written as follows:

$$g(\mathbf{r}_1, \mathbf{r}_2) = \left\langle \sum_{\alpha \neq \alpha'} \delta(\mathbf{r} - \mathbf{r}_\alpha(t))\delta(\mathbf{r} - \mathbf{r}_{\alpha'}(t)) \right\rangle \tag{2}$$

By substituting Eq.1 into Eq.2, the pair correlation function can be expressed as

$$g(\mathbf{r}_1, \mathbf{r}_2) = \frac{1}{n^2} \left[\langle \rho(\mathbf{r}_1)\rho(\mathbf{r}_2) \rangle - \langle \rho(\mathbf{r}_1) \rangle \, \delta(\mathbf{r}_1 - \mathbf{r}_2) \right] \tag{3}$$

where $n = \langle \rho = N/A \rangle$ is the areal number density of particles. Given a particle at some location r_1, $g(r_1, r_2)$ is the probability of finding a second particle at location r_2. For transitionally invariant system, the pair distribution function is pair correlation function which can be interpreted as

$$g(\mathbf{r}) = \frac{1}{n} \left\langle \sum_{\alpha \neq 0} \rho(\mathbf{r} - \mathbf{r}_\alpha + \mathbf{r}_0) \right\rangle . \tag{4}$$

In this final form, the brackets represents averaging over time, angle and field of view. If the system isotropic then radius can be expressed in terms of magnitude and hence $g(r)$ becomes radial distribution function. Strong correlation in a radial distribution function is expressed as the values higher than 1, in liquids the correlation increases with particle diameter and decreases adjacent to this region, at longer distances, correlation is 1. Radial distribution function is measured by counting pairs separated by r to $r + dr$ and then normalized by $2\pi rndr$.

The pair correlation function is related to potential of mean force, $w(r)$ through Boltzman distribution;

$$w(r) \equiv -kTln[g(r)] \tag{5}$$

where $w(r)$ reduces to $u(r)$ at very low density limit. Since measurements are made in finite concentrations, many-body interactions may introduce additional structure into the pair correlation function. The resulting minima of $w(r)$ is not the evidence of attraction, but describes many-body structural correlations. One should correct for the finite density by using approximation methods. Ornstein-Zernicke equation describes the evolution of many body interactions from a hierarchy of pairwise interactions [3]. Truncating the hierarchy results in approximations that may be inverted to obtain expressions for $u(r)$. Hypernetted Chain Approximation (HNC) is found to be accurate for soft potentials while Percus-Yevick (PY) is more accurate for short ranged interactions. The pair potential is evaluated with these formulas [8], [9], [10]: via Hypernetted chain approximation

$$u(r) = w(r) + kTnI(r) \tag{6}$$

and via Percus-Yevick approximation

$$u(r) = w(r) + kTln[1 + nI(r)]. \tag{7}$$

The term $I(r)$ represents the iterative integration part, which is an convolution integral expressed as

$$I(r) = \int_A [g(r') - 1 - nI(r)][g(|r' - r|) - 1]d^2r'. \tag{8}$$

These equations can be solved iteratively to get the final interaction potential energy term expressed as $u(r)$ [11].

2.2 Synthesis of colloidal particles

The synthesis of N-isopropylacrylamide (NIPAAm) microgels were performed by surfactant free emulsion polimerization method. In a 100 mL reaction flask, a mixture containing 0.5 g of N-isopropylacrylamide (NIPAAm), 0.016 g of acrylamide (AAm) monomers, 0.08 g of cross-linker methylenebisacrylamide (MBA), and 0.08 g of initiator (2,2-azobis (2-methylpropionamidine) hydrochloride (AMPDH)) dissolved in 50 mL of ultra-clean water was prepared. This solution was then placed in a water bath heated to 70 degrees Celsius, and polymerization was conducted under a nitrogen environment with continuous stirring at 70 degrees Celsius for a duration of 2 hours. Following the 2-hour polymerization period, the reaction flask was removed from the hot water bath and allowed to cool down to room temperature. After reaching room temperature, the resulting PNIPAAm particles were subjected to purification through centrifugation and subsequent washing with water on two occasions. The PNIPAAm colloidal particles were approximately 1 micron in size when measured by Mastersizer 2000 device.

2.3 Preperation of dilute systems

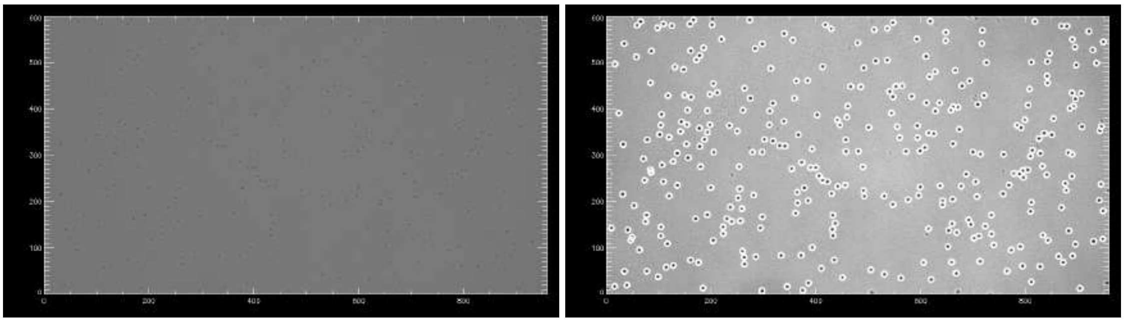
The 2d system was prepared by diluting the batch of synthesized PNIPAM colloidal particles by deionized water. The sample holder was two pieces of coverslips. The diluted solution was pipetted onto one of the cover slips so that the liquid formed a thin layer. Then the other coverslip was gently placed over this and the edges were sealed with epoxy for eliminating the evaporation. The sample thickness was less than two particle diameter thick so that particles could not diffuse in z direction. The temperature was set to room temperature ($T = 23^oC$) by Warner Instrument stage and objective heater, where roughly 50000 images were taken.

2.4 Preparation of crystal systems

We used the same particles to create colloidal crystals with a similar experimental setup but in this case, the sample holder were the coverslips which separated by roughly 100 μm thick of parafilm strips. The concentration of colloidal suspension was much more concentrated so that an amorphous or crystal phase could be achieved. The dense sample was pipetted into the channels of the sample holder. After closing the gaps with epoxy, the sample was placed onto the light microscope. The initial phase of the system was amorphous and the temperature was raised to melt the sample. The melt was cooled down gradually to grow crystals, heating-cooling annealing steps were repeated until a crystal grain was grown. For the crystal grain, we acquired 10000 images at five different temperatures. For all images, the image analysis routines were performed to get subpixel resolution [1].

3 Results and Discussion

Following the procedure described in the previous sections, first we identified the particle via image analysis techniques. In figure 3 the raw image is shown, the particles are identified in figure 3. Following the steps of calculation in section 2.1, $g(r)$ and $u(r)$ was calculated.



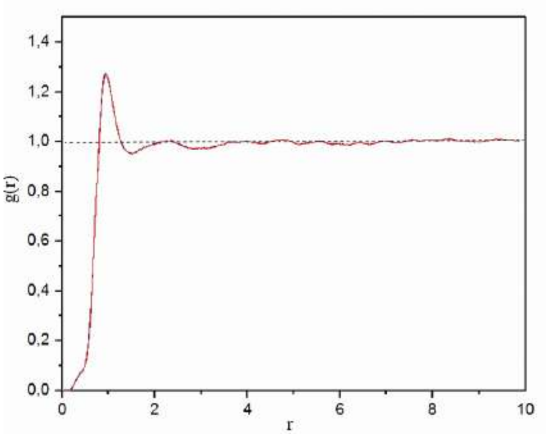
(a)Contrast enhanced image of a colloidal particles in 2d system

(b) Particle locations laid over the image

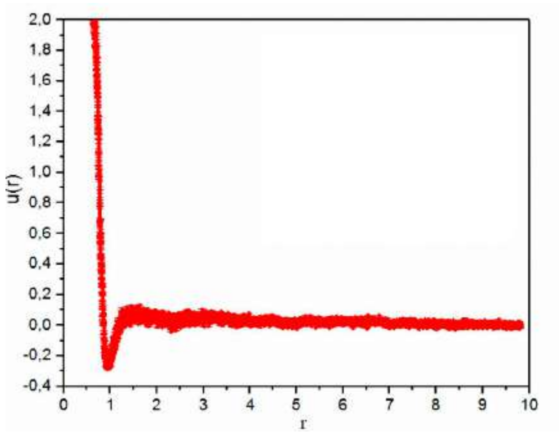
Figure 1: Steps of image analysis

For the 2d dilute system, a peak has been observed at $r = 0.94mm$ for in both Fig. 3 and Fig.3. For $g(r)$, this means the correlation value is the highest at that distance, hence the highest probability of finding a particle shown in Fig. 3. The interaction potential $u(r)$ reveals the min value around that location which can be interpreted as attraction force shown in Fig.3. Since the magnitude of the negative potential was about -0.3k_BT, the particles do not got stuck to each other at room temperature. Other result from the interaction potential is the repulsion part as in hard sphere model of interaction potential which was an expected property of colloidal systems.

The crossectional view of 3d crystal grain is shown in Fig. 3 where the boundaries are emphasized with red lines. The crystal grain was around 90x60 μm in size and the layer of crystal studied in this work was located roughly 30μm above the bottom coverslip. After finding the particle locations with subpixel resolution, pair correlation function (radial distribution function) was calculated for each temperature. These $g(r)$ functions were rescaled on their maximum value, which corresponds to their first peak as shown in Fig.3. In concentrated colloidal crystals, the crossectional layers were [111] plane of FCC (Face centered cubic) crystal. The peaks of $g(r)$ correspond to the correlation of finding the neighbors of the central particle, starting from the nearest one which is the first and the highest peak. With increasing temperature, the particles were fluctuating more which yielded wider distributions in



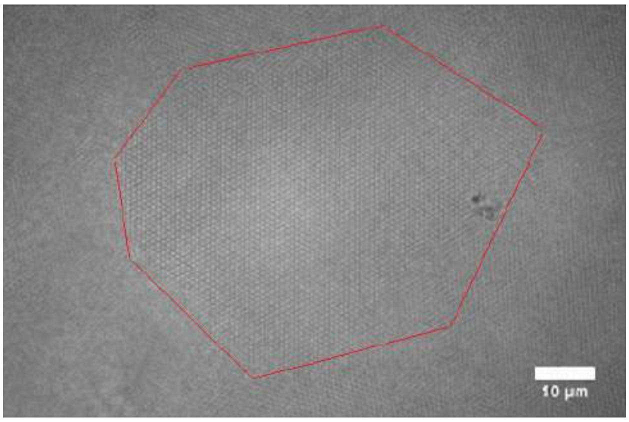
(a)Pair correlation function



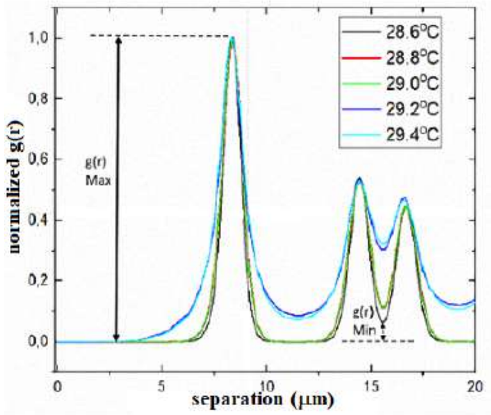
(b) Interaction potential energy vs distance

Figure 2: Results of 2d dilute system

$g(r)$ distributions. Since the graph in Fig. 3 is normalized according to the first peak, the change in the distributions of the second and third peaks can be studied in detail.



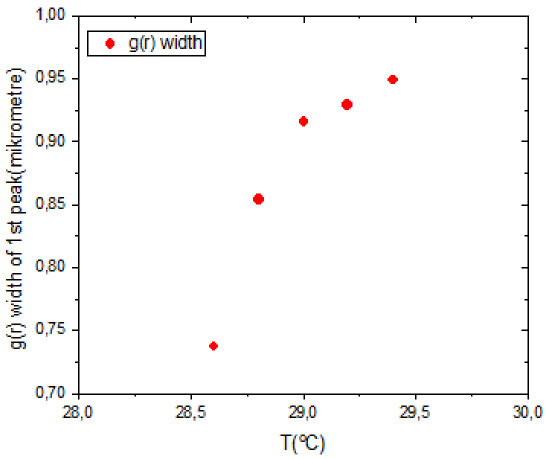
(a) Cross-sectional view of the crystalline grain



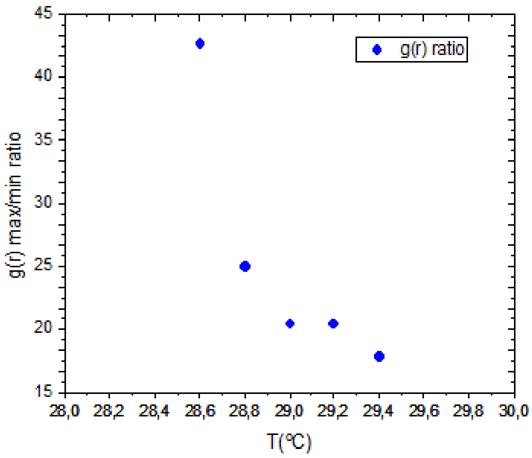
(b) Pair correlation function of crystal normalized to the maximum peak

Figure 3: Crystalline grain and the corresponding pair correlation function at various temperatures

The detailed analysis of $g(r)$ in the crystal data were shown in Fig.4. The first peak was fitted to a Gaussian function and the width was calculated. The width is increasing with the temperature as shown in Fig.3. Also, the ratio of the maximum value (which is normalized to value of 1 for all peaks) and the minimum value of $g(r)$ was shown in Fig3. This ratio is decreasing as the temperatures increases. These results show the phase of the crystal as it is been heated towards melting. Both graphs show two different regions as the rate of change in $g(r)$ have changed around 28.8 ^{o}C. We should emphasize the fact that, at the highest temperature, the crystal did not melt. Further analysis such as dynamics of individual particles, and location of each particle with respect to the grain boundary can be done to understand this behavior better [12]. Since the melting had not happened at the temperatures studied in the system, analysis of $g(r)$ function reveals two region within the melt phase.



(a)The width of the first peak vs temperature



(b) Max/Min ratio vs temperature

Figure 4: Analysis of the $g(r)$ function at various temperatures

4 Conclusion

We have shown the steps of calculation pair correlation function for colloidal systems of two different phases. In the dilute phase, the resultant interaction potential energy showed a -0.3 k_BT value which might be a indication of attraction between the particles at room temperature. In order to make a conclusion of such, we need to take care of imaging artifact due to closely located particles. Also in order to understand how interaction potential changes with temperature, data should be taken at different temperatures which we plan to do in near future. For the 3d system of colloidal crystal, analysis of $g(r)$ pair correlation function yielded an evolution at different temperatures. The distribution and height of each peak reveals the changes between the particle distances as the system was heated towards melting temperature. Since the sample studied was not a bulk crystal but a crystal grain, the boundary effects played a crucial role in the results. Similar analysis must be repeated to understand the effect of the size for much bigger crystals to identify the dynamics of melting in our temperature sensitive colloidal crystal system.

Acknowledgements

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RADIUS OF THE WHITE DWARF ACCORDING TO FERMI ENERGY IN A κ-DEFORMED FRAMEWORK

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Abstract

In this article, the κ-deformation formalism, which is in the form of $e_k(x) = (\sqrt{1+\kappa^2x^2}+\kappa x)^{(\frac{1}{\kappa})}$, is investigated. Using the κ-deformation, the Fermi energy, for box problem with the Schrödinger equation, has been investigated and calculated. In addition, we calculated the internal energy and pressure, and also calculated the radius of the white dwarf with the pressure due to degeneracy and gravity.

BOSE GAS OF A QUASI TWO-DIMENSIONAL HARMONICALLY TRAPPED IN THE DUNKL ALGEBRA

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Abstract

In the context of Dunkl-Boson theory, our work focuses on exploring the Bose-Einstein condensation of Dunkl-Bosons. This system is characterized by a finite number of particles and is trapped in a two dimensional harmonic potential trap. We employ a modified density of states method to analyze this phenomenon, we obtain the expressions of the effective Dunkl-critical temperature T_c^D, the ground state population N/N_0^D, the Dunkl-internal energy U^D and the Dunkl-specific heat function C^D. The numerical calculations show that the Dunkl-Bose-Einstein condensation in this system exhibits particular and intriguing characteristics distinct from those observed in a conventional trapped boson system. We think that this work has the potential to offer significant insights into the Dunkl-deformed boson theory and could be valuable for future exploration of Bose-Einstein condensation involving trapped Dunkl-Bosons

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TRIPLE BOSE MIXTURES ON A SINGLE SPECIES

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Abstract

In this work, we will study the trimer correlations of triplets states in a single-species Bose gas system, This is performed by a consistent variational approach, free of perturbative hypothesis by examining whether these results accurately describe the physics by calculating certain physical parameters.

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PHYSICS EDUCATION and RESEARCH IN I. U.

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Abstract

It seems we have a problem and I don't exactly know how to address it. Current state of physics and education here in I.U. is in trouble. Over more than 30 years, I have been observing the decay in our education system in our department. Even the most fundamental concepts of physics is foreign to our graduates not to mention the scientific process that they should have been equipped for during their education. Yet, the number of publications that coming out of our department per year has been increasing at an accelerated rate in parallel to the number of faculty member that we are accumulating by promoting from our current researchers and teaching assistants. I would like to talk about these seemingly contradictive trends and discuss the possible reasons why this is becoming our current state of education and research.

NON-COMMUTATIVE KLEIN-GORDON EQUATION AND MECHANISM OF SCALAR PARTICLES PAIR PRODUCTION

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Abstract

The phenomena of scalar particles being created in a non-commutative space-time setting in the presence of an electric field is investigated here. Our goal is to investigate the role that the electric field plays in the emergence of particles from the vacuum of space. We have determined the number density of spin-0 produced particles in a non-commutative space-time by using the Bogoliubov transformation approach. We explored the process of particle creation from solutions that are expressed in terms of special functions. Our research was conducted in accordance with the formalism of the Klein-Gordon equation in non-commutative space-time. The findings have been analyzed and evaluated. The results obtained from this study provide confirmation of the phenomenon of particle production as a characteristic of curved space-time. Moving forward, our objective is to investigate the process of Dirac particle generation inside non-commutative spaces.

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MICROANALYSES OF 3D-PRINTED PRODUCTS MADE OF THERMOPLASTICS BY THE HOT-MELT EXTRUSION METHOD

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Abstract

This contribution provides a general overview of extrusion-based 3D printing from thermoplastic materials, its applications, and methods of analysis of the printed products on a microscopic scale. We focused on assessing the influence of print speed on the characteristics of products made from glycol-modified polyethylene terephthalate (PETG) by fused filament fabrication (FFF) technology. The study involves a comprehensive analysis of the microstructure and morphology of the printed PETG products using scanning electron microscopy (SEM), surface roughness testing, and X-ray microtomography (microCT) imaging. Notably, higher print speeds were found to result in the formation of structural anomalies and voids, affecting both the surface and internal features of the printed items. Additionally, a non-linear relationship between print speed and the orientation of polymer chains in the printed material was found by means of polarized Raman spectroscopy. This alignment of PETG chains is unlikely to be the primary cause of the surface voids, but there are some potential correlations of the chain alignment degree with some micromechanical properties (Vickers microhardness, Young's modulus, indentation work) of the printed material. The research concludes that print speeds up to 60 mm s^{-1} are suitable for printing PETG with our printer configuration. Overall, this contribution offers comprehensive insights into analyzing products made by hot melt extrusion of polymeric materials, thus showing ways to improve the output quality control of the products.

QUANTUM LIQUID DROPLETS IN BOSE MIXTURES WITH WEAK DISORDER

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Abstract

We study the properties of self-bound liquid droplets of three-dimensional Bose mixtures in a weak random potential with Gaussian correlation function at both zero and finite temperatures. Using the Bogoliubov theory, we derive useful formulas for the ground-state energy, the equilibrium density, the depletion, and the anomalous density of the droplet. The quantum fluctuation induced by the disorder known as the glassy fraction is also systematically computed. At finite temperatures, we calculate the free energy, the thermal equilibrium density, and the critical temperature in terms of the disorder parameters. We show that when the strength and the correlation length of the disorder potential exceed a certain critical value, the droplet evaporates and is eventually entirely destroyed. We calculate the density profiles of this exotic state by means of numerical simulations of the corresponding generalized disorder Gross-Pitaevskii equation. Our predictions reveal that as the strength of the disorder gets larger, the atomic density varies rapidly in the plateau region. We point out in addition that the peculiar interplay of the disorder and the repulsive Lee-Huang-Yang corrections play a pivotal role in the collective modes of the self-bound droplet.

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MICROSTRUCTURE CHARACTERISTIC OF $(TiTaNbZr)_{100-x}Cu_x$ HIGH ENTROPY ALLOYS FOR POTENTIAL ANTIBACTERIAL PROPERTIES

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Abstract

Multi-principal elements alloys (MPEAs) have drawn large attention of the scientific community around the globe. The novel and innovative group of MPEAs includes high entropy alloys (HEAs). The first published independent studies about HEAs were literature-reported in 2004 [1,2] . In this year, two definitions of high entropy materials based on the chemical composition and mixing entropy (ΔS_{mix}) have been proposed [3] . HEAs are being more widely used in various applications due to their promising properties for example in biomedicine. Materials for biomedical applications belong to a particular group of engineering materials. The chemical composition must include mostly biocompatible elements [4] . The literature data revealed that biomedical high entropy alloys (bio-HEAs) exhibit high biocompatibility, improved mechanical properties, and higher corrosion resistance in comparison to conventional alloys [5–7] . It was also presented that the antibacterial properties of bio-HEAs could be denoted as new future trends in biomedical high entropy materials [8] . Literature data showed that copper (Cu) could be classified as an antibacterial element. It was reported that Cu-ions favour the inactivation process of bacteria [8] . Moreover, antibacterial alloys could be very beneficial in the current medical applications. In the presented studies the influence of Cu-addition on the structure and properties of $(TiTaNbZr)_{100-x}Cu_x$ (where: x = 0, 5, 7, 10, 15, 20 at. entropy alloys was investigated. Samples were obtained from elemental powders followed by blending in a high-energy ball mill to improve homogeneity. As-blended powders were pressed and further melted using the vacuum arc-melting technique. Obtained buttons were heat-treated and followed by a rapid quench in ice water. In the presented work results of the X-ray diffraction

(XRD) phase analysis, transmission electron microscopy (TEM) microstructure analysis, scanning electron microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and mechanical properties analysis will be discussed.

Keywords: high entropy alloys, microstructure, antibacterial properties

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LOW-COST COPPER THIOCYANATE AS AN ALTERNATE HOLE-TRANSPORT MATERIAL FOR PEROVSKITE SOLAR CELLS

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Abstract

For photo-generated charge transport, choice of interfacial layers are important are important for improving the performance of perovskite solar cells (PSCs). In n-i-p architecture of PSCs, spiro-OMeTAD has been widely used as hole transport material (HTM). However, the same is costly and processing of its thin film is complex. Moreover, due to its low mechanical toughness cracks are induced in the film which results in penetration of moisture and oxygen in the perovskite layer. Copper thiocyanate (CuSCN) has been a good alternative to spiro-OMeTAD and has resulted in comparable power conversion efficiency (PCE). It possesses high hole mobility, wide bandgap, chemical and thermal stability and solution processability that makes it a good choice for HTM of perovskite solar cells. In this work, the role of CuSCN as HTM in triple cation perovskite solar cells in the stability studies is discussed. Triple cation perovskite cells with CuSCN HTM are tested for indoor and outdoor photostability studies under one Sun condition and the average T 80 of the devices exceeded when compared to perovskite cells with Spiro as HTL.

DUFFIN KEMMER PETIAU OSCILLATOR IN A UNIFORM MAGNETIC FIELD IN ANTI de SITTER SPACE

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Abstract

The study of the two dimensional bosonic oscillator equation within a uniform magnetic field was investigated analytically. We consider the presence of a minimal uncertainty in momentum caused by anti de Sitter space. Hence, the energy eigenvalues and the wave functions are obtained using Nikiforov Uvarov method and we deduced that the study leads to the same system of Klein Gordon (spin0). For spin 1 dkp case, we deduce the behaviour of the DKP equation and write the non relativistic energies and we show that the space deformation adds a new spin orbit term.

Keywords: DKP equation, Anti deSitter space, scalar and vector cases.

STATISTICAL DESCRIPTIONS OF IDEA GAS FROM POSITION DEFORMED NONCOMMUTATIVITY

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Abstract

A set of position-dependent noncommutative algebra in two dimension (2D) that describes the space near the Planck scale had been introduced [1]. This algebra predicted the existence of minimal and maximal length uncertainties from position-dependent noncommutativity and a minimal momentum arising from generalized versions of Heisenberg's uncertainty relations. It is well known from Kempf *et al* formalism [2] that, the presence of minimal uncertainties raise the question of singularity of the space i.e the space is inevitably bounded by minimal quantities beyond which any further localization of particle is not possible. In the present paper, to avoid the difficulties in dealing with the minimal uncertainties which restrict the dimension of the wave function representations, we reduce this algebra through first order approximations of deformed parameters τ, θ. These approximations lead to a new position-dependent noncommutativity. In this new noncommutative space, we analyticaly solve the Schrödinger-like equation which describes a free particle system in a null quantum well potential. The spectrum of this system is asymetrically deformed and exhibits different behaviours from the one obtained in ordinary quantum mechanics. Thus, we observe that by increasing the reduced deformed parameter τ_r, the energy decreases and this decrease is more pronounced as the quantum number increases. Finally, we evaluate the thermodynamic quantities within the canonical ensemble and we show that these results are consistent with the ones recently obtained by Bensalem and Bouaziz [3].

Keywords: Noncommutative quantum mechanics; Position-dependent mass systems, Partition function of ideal gas.

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THE WEYL EQUATION IN THE SOM-RAYCHAUDHURI SPACE-TIME IN THE PRESENCE OF AN EXTERNAL ELECTROMAGNETIC FIELD

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Abstract

In this presentation, we consider a massless spinor Dirac particle in the background gravitational field of the Som-Raychaudhuri space-time in order to study the influence of topology on this system. It is shown that the presence of the topological defect breaks the degeneracy of energy levels depending on the angular deficit which does not occur in usual space-time. We describe the Som-Raychaudhuri space-time by considering an external electromagnetic field. We obtain solutions of the Weyl equation by the Quasi-exact solvability (QES) method. We also obtain the eigenfunctions and the energy levels of the relativistic field.

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MAGNETIC QUANTUM GRAPHS WITH TIME-REVERSAL NON-INVARIANT VERTEX COUPLING

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Abstract

Motivated by the application of quantum graphs to model the anomalous Hall effect, we discuss spectral properties of periodic quantum graphs assuming that the vertex coupling is non-invariant with respect to the time reversal. Special attention is paid to the asymptotic behavior of the spectral bands in the high-energy regime; we see that the Band-Berkolaiko universality holds as long as the graph edge lengths are incommensurate. Moreover, we see that the transport properties of the graphs depend on the network topology, in particular, on the parity of the vertices involved.

This is a joint work with Pavel Exner and Jiří Lipovský based on Refs. [1] and [2].

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APPROXIMATE SOLUTIONS OF THE ROSEN-MORSE POTENTIAL BY MEANS OF THE NIKIFOROV-UVAROV METHOD

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Abstract

The use of approximated methods to solve the Schrödinger equation plays a vital role in exploring various aspects of diatomic molecules (DMs) such as their spectroscopic properties, electronic structure, and energetic characteristics. In this study, we employed the Nikivarov-Uvarov method to solve the Inverse Rosen-Morse potential. By applying this method we were able to obtain approximate solutions for the bound state energy eigenvalues and their corresponding eigenfunctions. Additionally, we graphically represented the effective potentials for several well-known DMs. We also provided numerical tables for the bound state energy levels. Notably, the results obtained in this study demonstrate excellent agreement with existing findings in the literature.

Keywords: Rosen-Morse potential, Nikiforov-Uvarov method, Diatomic molecules, Schrödinger equation, Approximate solution.

SOLUTION OF THE DUFFIN-KEMMER-PETIAU EQUATION IN SNYDER-DE SITTER SPACE

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Abstract

In this work, we present the solution of the Duffin–Kemmer–Petiau (DKP) equation in the Snyder-de Sitter (SdS) space, this equation describes the particles that have the spin is integer (s=0 and s=1). The analytical solution of the DKP equation in (SdS) space leads us to calculate the energy spectrum E_n of the particles and the corresponding wave functions $\phi_n(x)$, where the wave functions $\phi_n(x)$ are given as a function of the Romanovski polynomial. Finally, the limit cases of the energy spectrum E_n are deduced.

Keywords: Duffin–Kemmer–Petiau Equation, Snyder-de Sitter, Energy Spectrum.

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QUANTUM GRAVITY VIA TWO WHEELER-DEWITT EQUATIONS

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Abstract

A methodical analysis will be presented, devoted to certain aspects of some of the not yet resolved theoretical problems concerning a consistent quantization of gravity. Our considerations will be based on a simplified, extremely schematic cosmological model of paper [1] mimicking the unitary-evolution birth of the Universe from an initial quantum Big Bang singularity at its "proper time" $t = 0$.

We will argue (cf. also the more recent amendment of the model in paper [2]) that a specific realization of the Big-Bang phase transition could be rendered possible via the degeneracy of eigenvalues of a time-dependent operator $R(t)$ representing the (in our non-covariant model, observable) space-time. This means that our "operator of geometry" $R(t)$ (representing, in our schematic and most elementary scenario, a growing radius of the Universe) must admit a specific exceptional-point (EP) degeneracy at the EP time $t = t^{(EP)} = 0$.

The latter operator must have a real spectrum at $t > 0$. In the language of mathematics (cf. also paper [3]) this means that $R(t)$ must be not only non-Hermitian (in any sufficiently user-friendly Hilbert space $\mathcal{H}_{(unphysical)}$) but also, at the same time, self-adjoint (in a non-equivalent, properly amended Hilbert space $\mathcal{H}_{(physical)}$). Thus, given $R(t)$, one must reconstruct a highly nontrivial physical inner-product metric $\Theta(t)$ (cf. also a few related technical comments in paper [4]).

In the talk we will show that under these assumptions it is still possible to keep the evolution of the Universe unitary in $\mathcal{H}_{(physical)}$ (cf. also a few illustrative, phenomenologically motivated examples in paper [5]). One must only guarantee that its theoretical description is performed using the so called non-Hermitian interaction-picture (NIP), i.a., an innovative quasi-Hermitian reformulation of the conventional quantum theory in its non-stationary version – see also all of the references [6]- [11] for various specific technical details.

In such an overall mathematical setting the construction of a non-covariant but otherwise formally internally consistent picture of physics requires that for any observ-

able $\Lambda(t)$ of interest (i.e., e.g.,, for the instantaneous energy $\Lambda_0(t) = H(t)$ of the whole Universe) we must be able to write down and solve the corresponding Heisenberg-like operator-evolution equation using a suitable Heisenberg's generator $\Sigma(t)$ tractable, phenomenologically, as a sort of quantum Coriolis force (the most detailed account of the structure and properties of this force may be found in paper [6]).

From a purely pragmatic perspective the applicability of the theory is strongly dependent on the feasibility of the solution of the latter Heisenberg equation. In some models a perceivable simplification of this task has been achieved via certain *ad hoc* factorizations of the physical inner-product metric $\Theta(t)$ (cf., in particular, the first proposal of such a trick in [7]).

As a consequence, even the abstract NIP approach itself acquires a richer, "hybrid theory" structure of the form outlined in papers [8] - [10]. From a more abstract conceptual perspective the existence of the latter amendment of the NIP quantum theory implies that a key advantage of its application to the non-stationary gravity is that one can simplify or even entirely circumvent the complicated explicit construction of the correct and time-dependent physical inner-product-metric operator $\Theta(t)$.

In the talk we will show how such a goal can be achieved by working just with the states of the Universe in a dyadic representation. This means that it is sufficient to control the kinematics by solving the mere doublet of the Schrödiner-Wheeler-DeWitt equations. In some sense the latter statement is the key message to be delivered during the talk. We may summarize that the NIP approach using two Schrödiner-Wheeler-DeWitt equations renders the conventional recommendations of the use of the time-dependent inner-product-metric operator $\Theta(t)$ redundant.

Serendipitously one reveals that the two Schrödiner-Wheeler-DeWitt generators of the evolution of the "kinematical" state of the Universe, i.e., in our notation, the operator $G(t)$ and its conjugate partner $G^\dagger(t)$ *do not* have real spectra. In contrast to the rather widespread beliefs, these spectra are also practically never composed of the complex conjugate pairs. The spectrum of the above-mentioned Heisenberg's-evolution generator $\Sigma(t)$ is also, in parallel, practically never real.

Still, one can require that the evolution of the Universe is unitary, i.e., characterized by the reality of the whole instantaneous spectrum of its observable energy. In this case an explicit information about the unitarity of the dynamics is shown to be carried by the hidden self-adjointness (i.e., by the reality of the spectrum) of the observable Hamiltonian defined by an amazingly elementary formula $H(t) = G(t) + \Sigma(t)$.

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POSITRON ANNIHILATION LIFETIME SPECTROSCOPY MEASUREMENTS USING Na-22 POSITRON RADIO-ISOTOPE

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Abstract

In this presented work, we dive into the concepts and steps of Positron annihilation Lifetime spectroscopy (PALS) experimental procedures, a technique used to study materials for defects' inspection and positron lifetime in metals. The study focuses on measuring and analyzing the behavior of positrons emitted from a 22NaCl salt source incident upon a Kapton foil in a sandwich configuration with different materials (Si, Al, Cu, Ni, and Kapton NH500) resulting in a structure called "sandwich source" (Specimen-Kapton-22NaCl-Kapton-Specimen) selected to have bulk lifetimes sufficiently distinct from the lifetime of the positron source. This selection allowed us to investigate the unique contribution of each material to the annihilation process. The lifetimes and relative intensities of annihilating positrons are measured and compared, revealing the dependence of source contribution on the atomic number (Z) and density of the traversed material. The work presents the main steps of this procedure at room temperature, the two-state Conventional Model (CM) as the best and efficient fitting approach for results used by LT (Lifetime Toolkit) ver 9.2 including 22Na contributions and different elements in the sample, to be identified and quantified. Understanding PALS measurement system and the role of the electronic equipment and it beneficial for the analysis of PALS results and how it effects the source count rate is presented.

Keywords: Positron annihilation spectroscopy; positron source; positron lifetime; Na-22 source contribution; Source Correction.

SHELL-MODEL STUDY OF THE SPECTROSCOPIC PROPERTIES OF THE ^{26}Mg AND ^{26}Si MIRRORS

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Abstract

The sd shell nuclei exhibit very different structural properties ranging from nuclei near the stability-line to those deficient or rich of neutrons. Additionally, the neutron-deficient side is of great relevance in astrophysics, especially the rapid proton capture rp-process [1]. Advances in spectroscopic studies of these nuclei have aroused renewed interest. One of the most important rp-process is the ^{25}Al(pγ)^{26}Si reaction. The determination of the correct levels of ^{26}Si, based on their analogues in the mirror nucleus ^{26}Mg , is crucial to calculate the reaction rate. The spectroscopic properties, energy spectrum up to about 10 MeV and electromagnetic transition properties of ^{26}Mg are comprehensively studied in a shell model context. These properties are quantitatively reproduced using the effective (0+1)$\hbar\omega$ PSDPF interaction [2]. The comparison of the obtained results with available experimental data [3] led to the confirmation of the ambiguous states and to the prediction of the spin/parity assignments of the unknown states. Detailed discussion of this study will be presented in our contribution.

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A STUDY OF THE MOTION OF BOSON PARTICLES WITH INTERACTION IN THE COSMIC STRING SPACE TIME

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Abstract

In this work, we study scalar bosons with vector potentials in a cosmic string spacetime background. We choose DKP equation spin 0 with a position-dependent mass via transformation $m \rightarrow (m + S(r))$ for three different types of potential, such as linear type and Coulomb type and we obtain a second-order differential equation known as the hypergeometric and the corresponding confluent Heun function. Finally, we solve the wave equation by the Frobenius method as a power series expansion around the origin and obtain the energy levels and the wave function.

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EUP EFFECTS ON 3D DKP OSCILLATOR

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Abstract

We present the exact solutions for the three-dimensional Duffin-Kemmer-Petiau equation for both spin 0 and spin 1 particles in the field of a harmonic oscillator potential, while considering the presence of minimal uncertainty in momentum within the anti-de Sitter model. We use the representation of vector spherical harmonics for the wave-functions and the Nikiforov-Uvarov method to precisely determine analytical expressions of the energy eigen-values and the wave eigen-functions for both scalar and vector cases. Our analysis of the energy spectrum leads to a new interpretation of the correspondence principal between classical and quantum systems and a new formulation of natural and unnatural vector states.

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CALCULATION OF SELF INDUCTANCE OF A FINITE COIL

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Abstract

This study focuses on the calculation of self-inductance of a coil. The magnetic field generated by a current passing through a single turn is first expressed as a Taylor series expansion in terms of powers of the distance from the center of the turn. Subsequently, the magnetic field at the points off axis, is computed as a linear serial combination of Legendre polynomials. By integrating the component of this magnetic field parallel to the axis, the magnetic flux produced by one turn in another turn is determined. This result is then utilized to obtain the total magnetic flux passing through all turns. The total magnetic flux is equated to L I, where L represents the self-inductance of the coil, and I is the current passing through it. This equation allows for the direct calculation of the self-inductance.

EXPLORING THE EFFECT OF GUP ON SCATTERING OF SCHWARZCHILD BLACK HOLE

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Abstract

This work examines the quantum correction of the Schwarzschild black hole metric using the generalized uncertainty principle (GUP). We consider a massless scalar field, explore the associated effective potential and calculate the GUP-corrected reflection and transmission coefficients of the scattered radial wave function using the Pösch-Teller method. Our findings provide insights into the behavior of these coefficients under GUP corrections, which can deepen our understanding of black hole physics.

NANOCRYSTALLINE NiTi ALLOYS PRODUCED BY COLD ROLLING IN THE MARTENSITIC STATE

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Abstract

Near equiatomic NiTi alloys exhibit unique properties of shape memory (SME) and superelasticity (SE) caused by reversible thermoelastic martensitic transformation. Additionally, due to the high content of Ti, which leads to the formation of a passive layer on the material surface of this alloy, these alloys exhibit high corrosion resistance and biocompatibility [1]. Because of these unusual properties, NiTi alloys are widely used in medicine as implants in orthopaedic surgery. In recent years, severe plastic deformation (SPD) has drawn more attention due to the possibility of forming nanostructures in bulk metals and alloys [2]. This process relies on material amorphisation caused by large plastic deformation and further annealing in order to cause recrystallisation and grain growth of the deformed structure. It was shown that nanostructured materials own increased yield strength and ductility. Moreover, nanostructured Ti shows better corrosion resistance and cytocompatibility, which are important features in medicine and implantology [3]. In present studies, the Ni-49.3 % at.Ti alloy in the form of 3.5 mm wire, characterised by temperatures Mf -11.5 °C and Af 52.1 °C, was subjected to

SPD by cryo-rolling in the martensitic state. To maintain the material at a reduced temperature, it was cooled in a liquid nitrogen batch after each pass. After deformation, the obtained materials were annealed at 350, 400 and 450 °C for 15, 60 and 240 minutes without a protective atmosphere and quenched in ice-cold water. Transmission electron microscopy (TEM) observation was carried out to investigate structure changes. The received material exhibited an unusual course of martensitic transformation, which was examined by in situ heating X-ray diffraction (XRD) method and differential scanning calorimetry (DSC), which the non-homogenous structure of cold-rolled alloy might cause. Additionally, recrystallisation and grain growth kinetics were investigated.

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BUMBLEBEE BLACK HOLES SURROUNDED BY DARK MATTER SPIKE

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Abstract

We explore the impact of dark matter spike in the vicinity of the supermassive black hole at the center of the M87 galaxy within the context of Bumblebee Gravity, a framework for gravitational physics. Our primary goal is to assess how the background characterized by spontaneous Lorentz symmetry breaking affects the characteristics of the horizon, ergoregion, and shadow of the Kerr Bumblebee black hole in the spike region. To achieve this, we initially introduce the distribution of dark matter into a Lorentz-violating spherically symmetric space-time, treating it as part of the energy-momentum tensors within Einstein's field equations. This process yields a space-time metric describing a Schwarzschild Bumblebee black hole with dark matter distribution in the spike region and beyond. Subsequently, we extend this solution to encompass a Kerr Bumblebee black hole, employing the Newman-Janis-Azreg-Ainou algorithm. We then consider observational data concerning the density and radius of the dark matter spike, as well as the Schwarzschild radius of the supermassive black hole in the M87 galaxy. Using this information, we analyze the shapes of shadows and illustrate how the spin parameter, the Lorentz-violating parameter, and the corresponding parameters of the dark matter halo influence the deformation and size of the shadow.

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HOW TO CALCULATE BLACK HOLE SHADOW

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Abstract

In this talk, we present an analytical calculation scheme of black hole shadows in various cases. First, we give the definition of the shadow of a black hole then we present its relation with the critical parameters. We explain how to derive the angular size of the shadow for an observer at any distance from the black hole and we calculate the shadow of Kerr black hole for an observer at large distance. Finally, we discuss the deformation of the shadow of the Kerr black hole when it is surrounded by matter in different profiles.

SOLITON SOLUTION OF GROSS-PITAEVSKII EQUATION

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Abstract

The Gross-Pitaevskii equation describes Bose-Einstein condensates in the low-temperature regime. We drive analytical solutions of nonlinear equations by applying the Lax pair and Darboux transformation to find the solution as form soliton and its subsequent in optical fiber, quantum gases, hydrodynamics, and plasma, etc.

Keywords: Darboux transformation, Lax Pair, Soliton and Gross- Pitaevskii equation.

EXPANSION A 3D DIPOLAR BEC IN RANDOM POTENTIALS

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Abstract

We study the effects of dipole-dipole interaction on the diffusion of an expanding atomic Bose-Einstein condensate with tunable s-wave interactions in a three-dimensional disorder potential. First-order correction due to local and nonlocal nonlinearities to the average atomic density is analytically calculated in the long expanding time limit using a perturbative theory. It is found that the diffusion coefficient exhibits a stronger anisotropy-dependence due to the dipolar interactions. We show that the intriguing interplay of dipolar and nondipolar interactions and disorder potential may affect the diffusive expansion.

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