Program

14th APCTP-BLTP JINR Joint Workshop - Memorial Workshop in Honor of Prof. Yongseok Oh : Modern problems in nuclear and elementary particle physics

From July 9 to July 14, 2023, POSCO International Center, APCTP, Pohang, Korea

July 10, Monday		
9:00 AM	Registration	
Session 1 (Chair: Hee-Jung Lee)		
9:50 AM	Welcome Remarks	Yunkyu Bang (President of APCTP) Myung-Ki Cheoun (Soongsil Univ.)
10:00 AM	From a Dinuclear System to Close Binary Cosmic Objects	Nikolai Antonenko (JINR)
10:30 AM	Cosmological constraints of Dark Matter on the Extended Gravity	Bum-Hoon Lee (Sogang Univ.)
11:00 AM	Coffee Break	
11:15 AM	Odd even staggering and kink structure of mercury and lead isotopes	Myung-Ki Cheoun (Soongsil Univ.)
11:45 AM	Promising reactions for production of superheavy nuclei	Gurgen Adamian (JINR)
12:15 AM	Lunch	
Session 2 (Chair: Andrey Arbuzov)		
2:00 PM	Hadron Physics in Light-Front Dynamics	Chueng Ryong Ji (North Carolina State Univ.)
2:30 PM	P_{cs} pentaquarks as threshold phenomena of meson and baryon	Atsushi Hosaka (RCNP, Osaka Univ.)
3:00 PM	Excitation functions of evaporation residues in heavy ion reactions leading to compound nuclei with $Z=80-90$	Shuhrat Kalandarov (JINR)
3:30 PM	Coffee Break	
4:00 PM	DVCS and GPDs at Jefferson Lab	Hyon-Suk Jo (Kyungpook Nat. Univ.)
4:30 PM	Studies of light exotic nuclei with radioactive beams at FLNR, JINR	Evgenii Nikolskii (JINR & NRC Kurchatov Inst.)

July 11, Tuesday		
Session 3 (Chair: Nikolay Antonenko)		
10:00 AM	Physics with SPD at NICA Collider	Victor Kim (Petersburg Nuclear Physics Institute of NRC "Kurchatov Institute")
10:30 AM	FRG for dense matter, exotic nuclei and neutron stars	Youngman Kim (CENS, IBS)
11:00 AM	Coffee Break	
11:15 AM	Isoscalar giant monopole resonance in the Ca isotope chain	Nikolay Arsenyev (JINR)
11:45 AM	Carbon isotopes in NLEFT	Young-Ho Song (RISP, IBS)
12:15 AM	Lunch	
Session 4 (Chair: Alexandr Parvan)		
2:00 PM	Tensor meson photoproduction and possibility of exotic mesons	Byung-Geel Yu (Korea Aerospace Univ.)
2:30 PM	Hybrid model for the $K^- p \to K\Xi$ reactions	Sangho Kim (Soongsil Univ.)
3:00 PM	Density dependence of the heavy-light meson distribution amplitude	Parada T. P. Hutauruk (Pukyong Nat. Univ.)
3:30 PM	Coffee Break	
Memorial Session in Honor of Prof. Yongseok Oh (Chair : Byung-Yoon Park)		
4:00 PM	In memory of Prof. Yongseok Oh	Byung-Yoon Park (Chungnam Nat. Univ.)
	Prof. Yongseok Oh at Kyungpook Nat. Univ.	Hong Joo Kim (Kyungpook Nat. Univ.)
	APCTP and Prof. Yongseok Oh	Yunkyu Bang (President of APCTP)
	Prof. Oh and APCTP-BLTP JINR Workshop	Nikolai Antonenko (JINR)
	Physics and person – for the memory of Yongseok	Atsushi Hosaka (RCNP, Osaka Univ.)
	Hadronic Physics at J-PARC with the memory of Prof. Oh	Shinya Sawada (KEK)
	Hadron Physics Research Journey with Late Prof. Yongseok Oh	Chueng Ryong Ji (North Carolina State Univ.)
	Researches (MNT, KIDS and GPD) with Prof. Yongseok Oh	Myeong-Hwan Mun (Soongsil Univ.)
6:00 PM	**Memorial Dinner**	

July 12, Wednesday		
Session 5 (Chair: Chang Ho Hyun)		
10:00 AM	Few-body dynamics and few-body correlations in the dripline nuclei	Leonid Grigorenko (JINR)
10:30 AM	S matrices of elastic α- ^{12}C scattering at low energies in cluster effective field theory	Shung-Ichi Ando (Sunmoon Univ.)
11:00 AM	Coffee Break	
11:15 AM	EM form factors of the three-nucleon systems	Serge Bondarenko (JINR)
11:45 AM	Signatures for tetraquark mixing from partial widths of the two light-meson nonets	Hungchong Kim (Korea Univ.)
12:15 AM	Lunch	
2:00 PM	**Excursion**	
6:00 PM	**Banquet**	

July 13, Thursday		
Session 6 (Chair: Homeoyng Choi)		
10:00 AM	Cosmic rays from decays of heavy dark matter particles	Elena Vladimirovna Arbuzova (Dubna State Univ.)
10:30 AM	Non-diagonal DVCS, Transitional GPDs and Hadron Structure	Kirill M. Semenov Tyan Shanskiy (Kyungpook Nat. Univ.)
11:00 AM	Coffee Break	
11:15 AM	Parton distribution functions of the nucleon in the large Nc limit	Hyeon-Dong Son (Inha Univ.)
11:45 AM	Parton density functions in QED	Andrej Borisovich Arbuzov (JINR)
12:15 AM	Lunch	
Session 7 (Chair: Leonid Grigorenko)		
2:00 PM	Gamow-Teller transitions by Charge Exchange Reactions in Raon Accelerator	Eunja Ha (Hanyang Univ.)
2:30 PM	The double gamma decay of the quadrupole state of spherical nuclei	Aleksei Severiukhin (JINR)
3:00 PM	Color transparency in proton-deuteron interactions	Alexei Larionov (JINR)
3:30 PM	Coffee Break	
4:00 PM	Hadron transverse momentum distributions in the Tsallis statistics with escort probabilities	Alexandru Parvan (JINR & DFT, IFIN-HH)
4:30 PM	Universal Relations in the Emergence of Special Points on Mass-Radius Relation of Hybrid Stars	Sen Debashree (Korea Univ.)

July 14, Friday		
Session 8 (Chair: Chang-Hwan Lee)		
10:00 AM	Heavy quarkonia in a bulk-viscous quark gluon plasma medium	Lata Thakur (APCTP)
10:30 AM	B meson decays	Aidos Issadykov (INP ME RK & JINR)
11:00 AM	Coffee Break	
11:15 AM	Constraints on cosmic-ray boosted dark matter from the XENONnT experiment	Atanu Guha (Chungnam Nat. Univ.)
11:45 AM	Probing the nuclear equation of state in core-collapse simulations of massive stars	Hajime Togashi (Daegu Univ.)
12:15 AM	Closing Remarks	
12:30 AM	Lunch	
2:30 PM	Collaboration discussions in small groups	

Abstracts

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: Modern problems in nuclear and elementary particle physics

From July 9 to July 14, 2023

POSCO International Center, APCTP, Pohang, Korea

Promising reactions for production of superheavy nuclei

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Abstract

For the hot fusion reactions 48Ca+233,235U, the excitation functions of the production of Cn isotopes in (2−5)n-evaporation channels were calculated using the dinuclear system fusion model and the predictions of nuclear properties within the microscopic/macroscopic approach. The maximum cross sections in the 3n- and 4n-evaporation channels were found to be about (0.2-0.3) pb. The maximum cross sections σ_2n,5n are smaller than those in the 3n or 4n-evaporation channels. Thus, employing the 48Ca+233U reaction in the 4n-evaporation channel, one can directly produce the 277Cn isotope, which was previously synthesized in the 1n-evaporation channel of the cold fusion reaction 70Zn+208Pb. As a result, the production cross sections of 277Cn in the cold and hot fusion reactions are comparable within the experimental and theoretical uncertainties. The fusion reactions 48Ca+233,235U can be used to fill in the gap between the isotopes of superheavy nuclei produced in cold 70Zn+208Pb and hot 48Ca+238U fusion reactions. We hope that future experiments of 48Ca+233U→277Cn+4n will explore a large difference between fusion probabilities in 208Pb-based and 48Ca-based complete fusion to maintain a strong correlation between the fusion probability and asymmetry in the entrance reaction channel.

S matrices of elastic $\alpha-{}^{12}\mathrm{C}$ scattering at low energies in cluster effective field theory

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Abstract

The elastic $\alpha-{}^{12}\mathrm{C}$ scattering at low energies for $l=0,1,2,3,4,5,6$ is studied in effective field theory. We discuss the construction of the S matrices of elastic $\alpha-{}^{12}\mathrm{C}$ scattering in terms of the amplitudes of sub-threshold bound and resonant states of ${}^{16}\mathrm{O}$, which are calculated from the effective Lagrangian. The parameters appearing in the S matrices are fitted to the phase shift data below the $p-{}^{15}\mathrm{N}$ breakup threshold energy, and we find that the phase shifts are well described within the theory.

From a Dinuclear System to Close Binary Cosmic Objects

Nikolai Antonenko
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Abstract

Applying the ideas from microscopic objects to macroscopic stellar and galactic systems, the evolution of compact di-stars and di-galaxies is studied in the mass asymmetry coordinate. The formation of stable binary systems is analyzed. The role of symmetrization of an initially asymmetric binary system is revealed in the transformation of gravitational energy into internal energy of stars or galaxies accompanied by the release of a huge amount of energy. For the contact binary stars, the change of the orbital period is explained by evolution to symmetry in mass asymmetry coordinates.

Parton density functions in QED

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Abstract

Evolution equations for parton density functions of electron are discussed. Iterative solutions are found with the next-to-leading logarithmic approximation. Analytic results are presented up to the $O(\alpha^3 L^2)$ order. Both space-like and time-like cases are evaluated. The results are relevant for future high-precision experiments in particle physics. Applications to processes of electron-positron annihilation and muon decays are described.

Cosmic rays from decays of heavy dark matter particles

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Abstract

We consider multidimensional modification of gravity that predicts an existence of superheavy dark matter particles. These particles could decay according to the Zeldovich mechanism through virtual black hole formation. The decay products could make noticeable contribution into the spectrum of cosmic rays of ultra high energies.

Isoscalar giant monopole resonance in the Ca isotope chain

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Abstract

The properties of the isoscalar giant monopole resonance (ISGMR) in the Ca isotope chain are analyzed in the framework of a microscopic model based on a Skyrme interaction. The effects of the coupling between one-, two- and three-phonon terms in the wave functions of 0^+ states have been studied. Using the same set of parameters, we describe available experimental data. The effects of the phonon-phonon coupling leads to a redistribution of the main monopole strength to lower energy states and also to higher energy tail. It is shown that the gross structure of the ISGMR in the calcium isotopes 40,42,44,46,48Ca is caused by the complex configurations.

EM form factors of the three-nucleon systems

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Abstract

We use the relativistic separable kernel of quark-quark interactions for the Bethe-Salpeter equation to calculate the pion vertex function. Using obtained functions we consider the one- and two-particles electromagnetic current to calculate pion form factor. We assume also non-zero anomalous magnetic moment of the quarks.

Odd even staggering and kink structure of mercury and lead isotopes

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Abstract

We examine the odd-even staggering (OES) of charge radii of Hg isotopes, which has been first measured 1977 and recently has been confirmed by advanced laser techniques. To understand the nuclear structure underlying this phenomenon, we utilize the deformed relativistic Hartree-Bogoliubov theory in continuum (DRHBc) model. Our analysis reveals that the OES observed in 180−186Hg isotopes can be attributed to the coexistence of different nuclear shapes in the Hg isotopes. Specifically, we find that prolate shapes of 181,183,185Hg result in an increase in the charge radii compared to the oblate even-even 180,182,184,186Hg isotopes, whose deformations are determined by considering shape coexistence. We explain the OES due to the change of the deformation by calculating the evolution of the neutron single-particle-states of the Hg isotopes in detail. We also investigate the kink structure of the charge radii of the Hg isotopes in the vicinity of the $N=126$ shell.

Universal Relations in the Emergence of Special Points on Mass-Radius Relation of Hybrid Stars

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Abstract

Neutron stars (NSs) are one of the most exotic and interesting celestial objects that present matter at its densest form. Terrestrial experiments performed till date to understand the physics of dense matter, are confined at densities much lower than the density domain (ρ) of the NSs. One thus relies on theoretical modelling of NS matter. On the other hand, the QCD phase diagram suggests that at extreme conditions of high temperature or density the matter is prone to undergo phase transition from hadronic to quark matter. In the present work we invoke first order hadron-quark phase transition in NS cores with the help of Maxwell construction. For this purpose, we consider six different and well-known relativistic mean field hadronic models for the pure hadronic phase. The quark phase is described with the MIT Bag model in which the density dependence of the bag pressure $B(\rho)$ is invoked in a Gaussian form. As the density increases, a deconfinement transition from hadron to quarks is expected which implies the vanishing of the difference between the perturbative and the non-perturbative (true) vacuum and hence the bag pressure should also vanish. This justifies strongly in favour of bag pressure being a density dependent quantity, rather than being a constant. The dependence is considered for different asymptotic values (B_{as}) which indicates the value of $B(\rho)$ where the quarks acquire asymptotic freedom. With such hadronic and quark models we study the hadron-quark phase transition and the properties of hybrid stars (HSs). The HS configurations exhibit twin star characteristics and distinct special points (SPs) on the mass-radius diagram, irrespective of the transition densities and the value of B_{as}. For any particular value of B_{as}, the mass corresponding to SP (M_{SP}) and the maximum mass ($M_{\max}$) of the HSs, obtained with different hadronic models, follow a nearly linear (fitted) relationship where the slope is independent of the value of B_{as}. The $M_{SP}-M_{\max}$ dependence of the HSs is found to be consistent with any hadronic equation of state chosen to obtain the hybrid

EoS. Thus such relations can be considered as universal relations in the context of formation of SPs. A change in the value of B_{as} shifts the position of the fitted line in the $M_{SP}-M_{\max}$ plane, with the linearity, however, retained.

Few-body dynamics and few-body correlations in the dripline nuclei

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Abstract

Studies of nuclear systems close to and beyond the driplines is an important field of the modern radioactive ion beam studies. Because of paring and clusterization effects the lowest threshold in the dripline systems are often few-body thresholds ($2p, 2n, 4p, 4n$, etc.). This lead to emergence near such thresholds of states having expressed few-cluster structure or/and corresponding few-body cluster decay channels. Such states may demonstrate complicated forms of few-body dynamics. These forms of nuclear dynamics are often poorly understood and their studies could be challenge for theory. I review several examples of theoretical studies focusing on various qualitative few-body phenomena near the driplines: (1) Two-proton radioactivity and "true" three-body decay. (2) "Transitional dynamics" in the three-body decays. (3) Soft dipole (E1) excitations in three-body systems. (4) Experimental studies of $2n$, $3n$, and $4n$ decays.

Constraints on cosmic-ray boosted dark matter from the XENONnT experiment

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Abstract

Sub-MeV cold dark matter (DM) particles are unable to produce electronic recoil in the XENONnT experiment above the detector threshold. The mechanism of boosted dark matter (BDM) scenario comes into picture to constrain the parameter space of such low mass dark matter from direct detection experiments. We consider the effect of the leading components of cosmic rays to boost the cold DM. To present a concrete example, we choose to work on a model consisting of a Dirac fermion χ with a new $U(1)'$ gauge symmetry while the new gauge boson A' being kinetically mixed with the standard model $U(1)_Y$ gauge boson. We found that the energy dependence of the cross section plays a crucial role in improving the constraints. We also considered the earth shielding effect on BDM in losing energy while travelling to the underground detector through the earth. We present an approximate analytical estimate for this purpose.

Gamow-Teller transitions by Charge Exchange Reactions in Raon Accelerator

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Abstract

Charge exchange(CE) reaction is very useful to study the spin-isospin excitations of nuclei. In particular, Gamow-Teller(GT) transition is the simplest spin-isospin excitation of a nucleus and is a main transition in neutrino-nucleus reaction in nucleosynthesis. The GT strength, B(GT), is related to the half-life of an allowed beta-decay. We investigated the effect of deformation and tensor force on GT transitions in nuclei. However, we do not have enough data for GT transition to confirm the theoretical estimation, like pairing interactions as well as tensor force, and deformation effect inside nuclei. We expect roles of RAON accelerator.

P_{cs} pentaquarks as threshold phenomena of meson and baryon

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Abstract

We study strange pentaquark P_{cs} in terms of a hybrid model of $\Lambda_c, \overline{D_s^*}, \Xi_c^{\prime *}, \overline{D^*}$ molecules coupled to compact five-quark states. The resulting P_{cs}'s appear as molecules near thresholds formed by the suitable cooperation of heavy quark and chiral symmetries. We reproduce the experimental masses and quantum numbers J^P of P_{cs} as LHCb has announced. We predict other P_{cs}'s as molecular states near threshold regions that can be studied by LHCb.

Density dependence of the heavy-light meson distribution amplitude

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Abstract

Understanding the dynamics of heavy quarks inside heavy-light mesons is very challenging and still needs more studies. In this talk, I will present the distribution amplitude of the heavy-light meson in a nuclear medium to understand the heavy-light meson structure. To confirm the reliability of our model approach, we first compare our result with the recent lattice data. It is found that the heavy-light meson distribution amplitude in free space has good agreement with the lattice results. Implications of the distribution amplitudes of the heavy-light meson in the nuclear medium will be presented and discussed.

B meson decays

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Abstract

We study the rare decays corresponding to $b\to d$ transition in the framework of the covariant confined quark model. The transition form factors for the channels $B^+(0)\to(\pi^+(0),\rho^+(0),\omega)$ and $B^0 s\to K_0^*$ are computed in the entire dynamical range of momentum transfer squared. Using the form factors, we compute the branching fractions of the rare decays and our results are found to be matching well with the experimental data. We also compute the ratios of the branching fractions of the $b\to s$ to $b\to d$ rare decays using the inputs from previous papers on $b\to s l^+ l^-$ using this model. Further, using the form factors, model dependent and independent parameters, we also compute different other physical observables such as forward backward asymmetry, longitudinal polarization and angular observables in the entire q^2 range as well as in q^2 bins [0.1 -- 0.98] GeV^2 and [1.1 -- 6] GeV^2. We also compare our findings with different theoretical predictions.

Hadron Physics in Light-Front Dynamics

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Abstract

I will present the recent development of hadron physics in the light-front dynamics. In particular, I'll discuss the uniqueness of pseudoscalar and vector meson decay constants using all available components including the minus component of the current in the light-front quark model (LFQM) consistent with the Bakamjian-Thomas construction. Regardless of the current components, the polarization vectors, and the reference frames, the meson decay constants are uniquely determined in the non-interacting constituent quark and antiquark basis while the interactions of the constituents are

added to the meson mass operator in the LFQM.

DVCS and GPDs at Jefferson Lab

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Abstract

There are still many unsolved questions about how the partons, i.e. quarks and gluons, are distributed in space, momentum and spin inside the nucleon. Generalized parton distributions (GPDs) describe the complex internal structure of the nucleon in terms of those partons. Among other aspects, GPDs reveal the correlation between the longitudinal momentum fraction and the transverse position of partons inside the nucleon, allowing us to perform nucleon tomography. GPDs can be accessed through the measurements of exclusive reactions such as deeply virtual Compton scattering (DVCS). An overview of DVCS measurements at Jefferson Lab will be presented.

Excitation functions of evaporation residues in heavy ion reactions leading to compound nuclei with $Z = 80 - 90$

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Abstract

The excitation functions of ER's in xn, pxn and alpha xn channels for the reactions leading to CN with $Z = 80 - 90$ are investigated in the framework of the dinuclear system (DNS) model. The stationary solution of master equation is applied to calculate the formation-decay probabilities of DNS states. The results show that the maxima of excitation functions in xn, pxn and alpha xn channels are comparable for the reactions leading to compound nuclei from Hg to Th. This means that p and alpha particles emission along with neutron emission influence the survival probability of CN in these reactions. Neutron deficiency of CN leads to favor both

charged particle emission and fission.

FRG for dense matter, exotic nuclei and neutron stars

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Abstract

As a method to go beyond the mean field approximation, we use functional renormalization group (FRG). In this presentation, I will present the current status of FRG applied to nuclear matter, finite nuclei and neutron stars.

Signatures for tetraquark mixing from partial widths of the two light-meson nonets

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Abstract

The tetraquark mixing model has been proposed as a possible structure for the two nonets in the $J^P = 0^+$ channel, the light nonet composed of $a_0(980)$, $K_0^*(700)$, $f_0(500)$, $f_0(980)$, and the heavy nonet of $a_0(1450)$, $K_0^*(1430)$, $f_0(1370)$, $f_0(1500)$. The wave functions of the two nonets are constructed by the mixtures of two tetraquark types that diagonalize the color-spin interaction. Among various signatures, we report in this talk that the experimental partial decay widths collected from Particle Data Group (PDG) support this mixing model. Specifically, we demonstrate that the coupling strengths of the light nonet to two pseudoscalar mesons estimated from the experimental partial widths are consistently larger than those of the heavy nonet. This feature agrees qualitatively well with the predictions from the tetraquark mixing model and, therefore, provides supporting evidence for the tetraquark mixing.

Physics with SPD at NICA Collider

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Abstract

Physics with Spin Physics Detector at the NICA collider facility at JINR, Dubna is briefly reviewed.

Hybrid model for the $K^- p \to K \Xi$ reactions

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Abstract

We investigate the $K^- p \to K^+ \Xi^-$ and $K^- p \to K^0 \Xi^0$ reactions in a hybrid Regge-plus-resonance approach involving rescattering diagrams. We take into account Λ, Σ, and $\Sigma(1385)$ Regge trajectories in the u channel. Additionally, we consider various Λ and Σ resonances in the s channel to explain the bump structures at $1.9 < W < 2.4$ GeV. The rescattering diagrams are derived from the 3-dimensional reduction of the Bethe-Salpeter equation.

Color transparency in proton-deuteron interactions

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Abstract

Color transparency (CT) is a reduced interaction of the color-singlet quark configurations - formed in exclusive processes with high momentum transfer - with surrounding nuclear medium. Studies of electron-induced reactions on nuclei at JLab confirmed CT in exclusive pion and rho-meson production channels. AGS@BNL experiments addressed CT effects in $A(p,pp)$ process on heavy nuclear targets. Theoretical interpretations of the observed non-monotonic dependence of nuclear transparency on the proton beam momentum involve the interference of the quark configurations of large- and small size. More clean CT signal is expected with deuteron that has a relatively simple and well-defined internal wave function. In this talk, the $d(p,pp)n$ channel will be discussed at p_{lab} =6-75 GeV/c. Both produced protons are fast in the deuteron rest frame while the neutron is slow [1]. Appreciable CT effects are expected on the nuclear transparency and tensor analyzing power. It is suggested to explore this channel in NICA SPD experiment.

[1] A.B. Larionov, Color coherence effects in the reaction $^2\mathrm{H}(p,2p)n$, Phys. Rev. C 107, 014605 (2023).

Cosmological constraints of Dark Matter on the Extended Gravity

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Abstract

Recent precise astrophysical measurements are challenging the standard cosmology of the so-called Lambda CDM model. Various extended gravity models may shed some light on lessening the conflict. One simple direction is to add the Gauss-Bonnet term which is a simple higher curvature term. We will investigate the constraint on such a model using dark matter phenomenology. The deviations from the standard scenario are well allowed in higher temperatures or in the early universe, as long as they satisfy the boundary condition that the universe's evolution almost gets back to the standard scenario near the Big Bang Nucleosynthesis.

Studies of light exotic nuclei with radioactive beams at FLNR, JINR

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Abstract

The progress in exploration of light exotic nuclei at the border of nucleon stability has been mainly possible due to the development of Radioactive Ion Beams (RIBs) at accelerator facilities. At FLNR, JINR the research program for studying light nuclei far from proton/neutron driplines was started in 1996 at the ACCULINNA in-flight separator at the U400M cyclotron. In 2017, the FLNR experimental complex was extended by commissioning of a new generation of facility – the ACCULINNA-2 fragment separator. It has opened a wide range of new experimental possibilities for studies of exotic nuclear systems using RIBs at the energy range of 5-50 MeV/nucleon. An overview of the results obtained at these facilities related to study of light exotic nuclei lying far from stability line will be made. The experimental program that could be realized at the ACCULINNA-2 separator at near future will be also discussed.

Hadron transverse momentum distributions in the Tsallis statistics with escort probabilities

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Abstract

The exact transverse momentum distributions of the Tsallis statistics with escort probabilities (the Tsallis-3 statistics) for the Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics of particles have been derived. The transverse momentum distribution in the zeroth term approximation has also been calculated. We have revealed that the Maxwell-Boltzmann transverse momentum distribution of the Tsallis-3 statistics in the zeroth term approximation exactly coincides with the phenomenological Tsallis distribution. The exact Maxwell-Boltzmann transverse momentum distribution of the Tsallis-3 statistics and the phenomenological Tsallis distribution have been compared and applied to describe the experimental spectra of the charged pions produced in the proton-proton collisions at high energies. We have revealed that the numerical results for the parameters of the phenomenological Tsallis distribution deviate essentially from the results of the Tsallis-3 statistics for all values of collision energy. Thus the phenomenological Tsallis distribution fails to approximate the exact transverse momentum distribution of the Tsallis-3 statistics. Moreover, in the zeroth term approximation the entropy of the system is equal to zero for all values of the variables of state. Therefore, the phenomenological Tsallis distribution in the framework of the Tsallis-3 statistics corresponds to the unphysical condition of zero entropy of the system.

Hadronic Physics at J-PARC and beyond

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Abstract

Prof. Oh has been a center of collaboration between Asian countries and the US in the field of hadronic physics. His activities extend far beyond just theoretical fields. His deep insight has greatly influenced the plans of future accelerator facilities such as J-PARC and EIC. I will briefly introduce hadronic physics at J-PARC and relation to Prof. Oh's achievements.

Non-diagonal DVCS, Transitional GPDs and Hadron Structure

Kirill M. Semenov Tyan Shanskiy
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Abstract

We consider a generalization of Deeply Virtual Compton Scattering and Hard Exclusive Meson Electroproduction to the processes with production of Δ and πN in the final state. We discuss a description of these reactions within the collinear factorization framework and review the properties of the relevant Generalized Parton Distributions. We present an overview of possible applications of these reactions to understand the processes involved in resonance formation and to investigate the properties of baryons.

The double gamma decay of the quadrupole state of spherical nuclei

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Abstract

This paper reports on the situation, in which the double gamma-decay of the low-energy quadrupole state of the even-even nucleus occurs in a nuclear transition which could proceed by a single gamma-decay in competition. The phonon-phonon coupling is taken into account within the microscopic model based on the Skyrme energy density functional. It is shown that the double gamma-decay width is sensitive to the interaction between one- and two-phonon configurations of the giant dipole resonance. We conclude that the two-state scenario may provide a globally applicable analysis of the double gamma-decay width of the lowest quadrupole excitation. A further systematic study of the impact of the phonon-phonon coupling on the double gamma-decay width is clearly necessary and is in progress.

Parton distribution functions of the nucleon in the large N_c limit

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Abstract

We talk about the properties of the parton distribution functions of the nucleon in the large N_c limit. Firstly, we describe the chiral quark-soliton model, which provides reasonable predictions for various nucleon properties. Next, we review the pioneering works by Diakonov et al. [1] for the twist-2 quark distributions of the nucleon. Finally, we discuss the recent developments on the quark quasi-distribution functions and provide the future perspectives.

[1] D. Diakonov et al, Nucl.Phys.B 480 (1996) 341-380, Phys. Rev. D 56 (1997) 4069-4083

Carbon isotopes in NLEFT

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Abstract

A recently developed novel Wave Function Matching method for quantum many-body problem is applied for the Carbon isotopes up to drip line in a Nuclear Lattice Effective Field Theory approach. The binding energy calculation shows very good agreement with the experimental data providing the validity of the WFM Hamiltonian for neutron rich nuclei. We discuss the implication of the dynamics of nucleons in the neutron rich nuclei.

Heavy quarkonia in a bulk-viscous quark gluon plasma medium

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Abstract

In recent years, the bulk viscosity of a quark gluon plasma is gaining increasing attention concerning the beam energy scan program, since the bulk viscous effect is expected to be enhanced near a critical point. Here we address the question of whether heavy quarkonia, which are produced at the early stage of the heavy ion collisions, are sensitive to the bulk viscous nature of the quark gluon plasma. If this is the case, we might be able to use heavy quarkonia as a probe of the non-equilibrium properties of the plasma. We incorporate the bulk-viscous nature of the medium by deforming the distribution functions of thermal quarks and gluons, with which the dielectric permittivity is computed within the hard thermal loop approximation. The modified dielectric permittivity is used to calculate the in-medium heavy quark complex potential, which includes both perturbative Coulombic as well as non-perturbative string-like terms. Based on the modified heavy quark complex potential, we compute the quarkonium spectral function, with which the physical properties such as binding energies and decay widths are computed. We estimate experimental observables such as the ψ' to J/ψ ratio and the nuclear modification factor

R_{AA} and discuss the implication of bulk viscous effect on them.

Probing the nuclear equation of state in core-collapse simulations of massive stars

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Abstract

The equation of state (EOS) of dense matter is one of the crucial ingredients in numerical simulations for astrophysical phenomena, such as core-collapse supernovae, cooling of nascent proto-neutron stars, black hole formations, and binary neutron star mergers. While considerable efforts have been devoted to understanding the dense-matter EOS from terrestrial experiments, astrophysical observations, and theoretical calculations, the relation between the nuclear EOS, which is governed by the nuclear repulsive force, and the mechanism of astrophysical compact phenomena is still unclear. Under this situation, we have recently constructed a new nuclear EOS based on the variational many-body theory with realistic nuclear forces (AV18 + UIX), and the resultant EOS table is available on the Web for the use in various astrophysical simulations. In this talk, I will present the properties of our nuclear EOS and its application to core-collapse simulations of massive stars. I will show the numerical simulations with several progenitor models to discuss the EOS effects on the mechanism of successful core-collapse supernovae and black hole formations due to failed supernova explosions. Furthermore, I will report on the current status of some extensions of the present EOS, such as hyperon mixing in high-density nuclear matter, spin susceptibility of supernova matter to calculate the neutrino-nucleon scattering, and so on.

Tensor meson photoproduction and possibility of exotic mesons

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Abstract

Photoproductions of tenson meson $f_2(1270)$ and $a_2(1320)$ of spin-2 are investigated within the Reggeized model for the vector meson exchanges in the t-channel. In particular, the new data recently measured in the CLAS Collaboration in the JLab need a production mechanism other than the vector meson exchange in the conventional approach. In this talk, we show that the hybrid meson of spin-2 is possible to account for the discrepancy between data and the t-channel vector meson exchange. This shows the plausibility of searching for exotics through the multipion photoproduction and a few comments on such an aspect are added to axial vector meson photoproduction.