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Book of Abstracts

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Young Scientist Forum

Charged particles pair production in proton-proton collision via photon-photon and photon-Z fusion

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The analytical formulas describing fiducial cross section of the muon pair production in semi-inclusive proton-proton collision will be provided. The formulas describing correction to the leading photon-photon fusion process due to the photon-Z fusion will be investigated. Numerical results will be obtained. The case of heavy charged particles at higher collision energies which can be reached at future colliders will be considered.

Young Scientist Forum

Relic gravitational wave conversion into photons in the intergalactic magnetic field

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We derive a combined equation system for gravitational and electromagnetic wave propagation in an arbitrary curved space-time and in external magnetic field. After that we solve it numerically in FLRW metric for the upper limit of the intergalactic magnetic field strength, and conclude that the phenomenon of gravitational wave conversion into photons in the intergalactic magnetic field can significantly change relic gravitational wave spectrum.

Young Scientist Forum

Probing intermediate-scale Froggatt-Nielsen models at future gravitational wave observatories

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The flavor symmetry-breaking scale in the Froggatt-Nielsen (FN) mechanism is very weakly constrained by present experiments and can lie anywhere between a few TeVs and the Planck scale. We construct two minimal, non-supersymmetric, ultraviolet (UV) complete models that generate the FN mechanism, with a global $U(1)_{\rm FN}$ flavor symmetry and a single flavon field. Using the one-loop finite temperature effective potential, we explore the possibility of a strong first-order phase transition (SFOPT) induced by the flavon. We show that if the flavor symmetry-breaking occurs at intermediate scales $\sim 10^4 - 10^7$ GeV, then in certain regions of the parameter space, the associated stochastic gravitational wave (GW) background is strong enough to be detected by planned GW observatories. We identify viable parameter regions for the best detection prospects. A strong GW signal prefers $\mathcal{O}(1)$ values of the quartic coupling for Higgs-flavon mixing, λ_{HS}, and $\mathcal{O}(0.1)$ values of the flavon quartic coupling, λ_S. We show that the observed parameter space is compatible with Higgs data. While both models of flavor can produce a detectable GW background, the GW signature does not discriminate between them.

Young Scientist Forum

CP-violation measurement in D0-meson decay at CMS experiment

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The difference between the CP asymmetries in $\mathrm{D}^0 \to \mathrm{K}^0_\mathrm{S}\,\mathrm{K}^0_\mathrm{S}$ and $\mathrm{D}^0 \to \mathrm{K}^0_\mathrm{S}\pi^+\pi^-$ decays is measured to be $\Delta A_{CP} = (xx.xx \pm 3.1)\%$. The analysis is performed on the parked data of pp collisions, which were collected by the CMS experiment in 2018 at $\sqrt{s} = 13\mathrm{TeV}$ with a dedicated delayed data processing stream allowing to record more than 10^{10} events.

Young Scientist Forum

Dark photon production via proton bremsstrahlung

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We study the phenomenology of the hypothetical vector particles, dark photons. The planned experimental searches for these mediators in the fixed-target experiments, such as SHiP, DUNE and T2K, will mainly focus on the dark photon masses about O(1) GeV. The dominant production mechanism for such 0.5-1.5 GeV dark photons in the proton-proton collisions is the bremsstrahlung $pp \to pp\gamma'$. Although there already exist several approximations for proton bremsstrahlung of a massive particle, it is known that they give incompatible answers.

Thus we revisit the dark photon production via proton bremsstrahlung by explicitly considering the non-zero momentum transfer between protons. We compare the obtained bremsstrahlung cross section with the results of other authors.

The talk is based on the arXiv preprint 2306.15800.

Young Scientist Forum

Studies of Xi_b baryons spectroscopy

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Recent results of Xi_b baryons spectroscopy studies are reported, using proton-proton colliding beam data from the LHC collected by the CMS experiment at sqrt(s) = 13 TeV in 2016-2018, corresponding to an integrated luminosity of 140 fb-1.

We present the observation of new Xi_b(6100)- baryon, also the observation of new Xi_b- —> psi(2S) Xi- decay and measurement of its branching fraction with respect to the Xi_b- —> J/psi Xi- branching.

The Xi_b0 —> Xi_b- pi+ decay is also investigated, where Xi_b- baryon is reconstructed through the decays J/psi Xi-, psi(2S) Xi-, J/psi Lambda K-, and J/psi Sigmaˆ0 K-. Precise measurements of mass and natural width of Xi_b0 baryon, as well as the ratio of Xi_b*0 / Xi_b- production cross-section ratios are reported.

Young Scientist Forum

Observation of the Λ0b ⟶ J/ψΞ−K+ decay

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Using proton-proton collision data corresponding to an integrated luminosity of about $140\ \mathrm{fb}^{-1}$ collected by the CMS experiment at $\sqrt{s} = 13\ \mathrm{TeV}$ in $2016 - 2018$, the $\Lambda_\mathrm{b}^0 \to \mathrm{J}/\psi\,\Xi^-\,\mathrm{K}^+$ decay is observed for the first time with a significance exceeding 5 standard deviations. The relative branching fraction, with respect to the $\Lambda_\mathrm{b}^0 \to \psi(2\mathrm{S})\,\Lambda$ decay, is measured and also reported.

Multibody decays of beauty hadrons present a rich laboratory to search for intermediate resonances in the decay products. In the case when decay products contain a charmonium state, such intermediate resonances could decay into a charmonium meson and a hadron, which could be a manifestation of an exotic quark content. Investigation of channels with baryons in the decay products, such as Ξ^- and Ω^-, could unveil the existence of doubly or triply strange pentaquarks. And the obtained results are important for understanding the strong interaction processes in hadronic decays of beauty baryons and the possible formation of exotic states.

Young Scientist Forum

New Physics at NICA

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We present first estimates of NICA sensitivity to Standard Model extensions with light hypothetical particles singlet under the known gauge transformations. Our analysis reveals that NICA can explore new regions in the parameter spaces of models with a hidden vector and models with an axion-like particle of masses about 30-500 MeV. Some of these regions seem unreachable by other ongoing and approved future projects. NICA has good prospects in discovery of the new physics after 1-3 months of data taking.

Young Scientist Forum

Study of the Bs --> J/Psi phi phi decay

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The report is devoted to the study of the B0s --> J/Psi Phi Phi decay using the data collected in proton-proton collisions by the CMS experiment from 2016 to 2018 at sqrt(s) = 13 TeV and corresponding to an integrated luminosity of 140 fb {-1}. Intermediate spectra of invariant masses J/Psi phi, phiphi are obtained and the relative probability of the studied decay is measured using the normalization channels: B0s --> JPsi Phi and B0s --> Psi(2S) phi.

Young Scientist Forum

Manifestation of the electric dipole moment in the decays of τ leptons produced in e+e− annihilation

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CP-odd asymmetries in the processes $e^+e^- \to \tau^+\pi^-\nu_\tau$, $e^+e^- \to \pi^+\tau^-\bar{\nu}_\tau$, $e^+e^- \to \tau^+\rho^-\nu_\tau$, $e^+e^- \to \rho^+\tau^-\bar{\nu}_\tau$, $e^+e^- \to \tau^+e^-\nu_\tau\bar{\nu}_e$, and $e^+e^- \to \tau^-e^+\nu_e\bar{\nu}_\tau$ are investigated with account for longitudinal polarization of electron (or positron) beam. These asymmetries are a manifestation of electric dipole form factor $F_3^\tau \equiv b$ in the $\gamma\tau^+\tau^-$ vertex. It is shown that to measure $\mathrm{Im}\, b$ in the specified processes, polarization is not needed, while to measure $\mathrm{Re}\, b$ it is required. The processes $e^+e^- \to \pi^+\pi^-\nu_\tau\bar{\nu}_\tau$, $e^+e^- \to e^+e^-\nu_\tau\bar{\nu}_\tau\nu_e\bar{\nu}_e$, $e^+e^- \to \mu^+\mu^-\nu_\tau\bar{\nu}_\tau\nu_\mu\bar{\nu}_\mu$, $e^+e^- \to \mu^+e^-\nu_\tau\bar{\nu}_\tau\nu_\mu\bar{\nu}_e$, and $e^+e^- \to \mu^-e^+\nu_\tau\bar{\nu}_\tau\nu_e\bar{\nu}_\mu$ are also discussed for the case of unpolarized electron and positron beams. In the latter cases it is possible to measure $\mathrm{Re}\, b$ using the differential cross section over momenta of both registered particles.

Young Scientist Forum

The branching fractions measurements of $J/\psi \to \pi^+\pi^-\eta$ and $J/\psi \to K^+K^-\eta$ at KEDR

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This work presents results of the branching fractions measurements of J/ψ decay into the final states $\pi^+\pi^-\eta$ and $K^+K^-\eta$ at KEDR.

KEDR is a universal magnetic detector located at the VEPP-4M collider in Novosibirsk. The current analysis was performed on 5.23 million of J/ψ decays.

The process into $\pi^+\pi^-\eta$ has been studied through ρ and ω resonances, taking into account their interference, the process into $K^+K^-\eta$ has been researched through ϕ resonance. In both cases, η meson decays into $\gamma\gamma$. As a result of the work, the branching fractions were obtained, the accuracy of which are comparable to the results of previous measurements.

Young Scientist Forum

Supernova neutrino oscillations and leptonic CP-violation

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We investigate effects of nonzero Dirac and Majorana CP-violating phases on neutrino-antineutrino oscillations in a magnetic field of astrophysical environments. It is shown that in the presence of strong magnetic fields and dense matter, nonzero CP phases can induce new resonances in the oscillations channels $\nu_e \leftrightarrow \bar{\nu}_e$, $\nu_e \leftrightarrow \bar{\nu}_\mu$ and $\nu_e \leftrightarrow \bar{\nu}_\tau$. The resonances can potentially lead to significant phenomena in neutrino oscillations accessible for observation in future neutrino telescopes, such as JUNO, Hyper-Kamiokande and DUNE. In particular, we show that neutrino-antineutrino oscillations combined with Majorana-type CP violation can affect the $\bar{\nu}_e/\nu_e$ ratio for neutrinos coming from the supernovae explosion.

Based on:
[1] A.Popov, A.Studenikin, Manifestations of nonzero Majorana CP-violating phases in oscillations of supernova neutrinos, Phys.Rev.D 103 (2021) 11, 115027
[2] A.Popov, A.Studenikin, Neutrino eigenstates and flavour, spin and spin-flavour oscillations in a constant magnetic field, Eur.Phys.J.C 79 (2019) 2, 144
[3] A.Popov, A.Studenikin, Effects of nonzero Majorana CP phases on oscillations of supernova neutrinos, J.Phys.Conf.Ser. 2156 (2021) 012226

Young Scientist Forum

Cosmological Constant Suppression in Non-Stationary Scalar Covariant State

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We study spatial-temporal structure of quantum fluctuations in stress-energy tensor of zero-point modes of scalar field in order to formulate relativistically covariant model. The model describes a vacuum contribution to cosmological constant in non-stationary state of finite volume. Bare and effective mean values of vacuum energy are compared.

Young Scientist Forum

Search for the light invicible axion-like particle in $K^+ \to \pi^+\pi^0 a$ decay

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A high statistics of charged kaon decays is obtained by the OKA collaboration. A missing mass analysis is performed in order to search for a signal from light invisible pseudoscalar axion-like particle (ALP) a in the decay $K^+ \to \pi^+\pi^0 a$. No signal is observed, based on $3.7 \cdot 10^9$ K^+ decays, the 90% CL limit on the branching fraction of the decay varies from $2.5 \cdot 10^{-6}$ to $2 \cdot 10^{-7}$ for the ALP mass from 0 to 200 MeV/c^2, except for the region of π^0 mass, where the upper limit is $4.4 \cdot 10^{-6}$. The corresponding lower limit for the $|F^A_{sd}|$ constant, describing the axion coupling to sd-axial vector current is $6.4 \cdot 10^7$ GeV, which is the best limit among HEP experiments.

Young Scientist Forum

The scaling limit of the XXZ spin chain and integrable structures in CFT

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The goal of the work is to describe a spin chain such that, when passing to the scaling limit, it gives an integrable CFT with Zr symmetry. Then it will be possible to apply to it the methods of both the BLZ approach and the approach of A. Litvinov and I. Vilkovisky. To do this, you first need to be able to describe relatively simple models of spin chains with sl(n) symmetry, that is, such that each lattice node with a period r is assigned its own weight. In this research project for r = 1, 2, 3 the ground and low-energy excited states are described, as well as the spectrum of the Hamiltonian model is constructed and the eigenvalues of the reflection operator are found. For numerical diagonalization

of the Hamiltonian we will use the explicit construction of a matrix on a lattice, as well as reducing it to canonical form in terms of σ matrices. To determine the states of the model using the BLZ method, it is necessary to find the roots of the Bethe ansatz

Young Scientist Forum

Early universe phase transition within holographic composite Higgs model

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Baryon asymmetry problem is one of the most discussed question of the cosmology. Composite Higgs model suggests one of the possible the approaches to the problem within electroweak phase transition. However, the required first order phase is hardly described within perturbative methods. AdS/CFT provides non-perturbative approach to this problem. We estimated the parameters of the first order phase transition in the bottom-up holographic composite Higgs model and the gravitational wave spectrum produced during the bubble nucleation. We consider string top-down models to generalize our approach to the problem.

Poster Session - Board: 2

Dependence of coherent elastic neutrino neutrino-nucleus scattering count rate in the RED-100 experiment at Kalinin nuclear power plant on the models of reactor antineutrino energy spectra

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In this poster,is shown how the current models of reactor antineutrino energy spectra impact the estimates of the count rate for coherent elastic neutrino-nucleus scattering ($CE\nu NS$) in the RED-100 experiment. We have analyzed the spectra-averaged differential cross-section $\frac{d\sigma}{dT}$, where T represents the energy of a xenon nuclear recoil, for each model and compared the resulting RED-100 count rates at a distance of 19 meters from the Kalinin nuclear power plant (KNPP) reactor core.

Poster Session - Board: 3

Spatial detector based on strong scattering scintillator medium

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The opaque scintillator detector is a novel concept for a new generation of position-sensitive detectors. The main idea is to localize the light near the point of its scintillation via the scattering medium. The first and only published results were presented by the LiquidO collaboration, so further investigation is required.

Our approach suggests the usage of granular organic scintillator as a medium for the detector and an array of WLS fibers with SiPMs as a light collector. The report describes the process of calibration,

the procedure of track reconstruction and the estimation of the medium's parameters. Precise measurements of spatial accuracy will be presented. Also, the Monte-Carlo simulations were processed in order to evaluate the immeasurable parameters of the setup and to study the possibilities of further improvements.

Poster Session - Board: 4

Estimation of the sensitivity of the NuGeN experiment to antineutrino magnetic moment.

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The NuGeN experiment is aimed to investigate antineutrino properties at the Kalinin Nuclear Power Plant using a P-type point contact high purity germanium detector. The experimental setup deployed at about 11 meters from the reactor core benefits from the combination of active and passive shielding. This talk presents the sensitivity of the experiment to antineutrino magnetic moment derived from the 38.7 day reactor off dataset.

Poster Session - Board: 5

Commissioning of the 3D segmented neutrino detector SuperFGD

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The SuperFGD detector, a 3D segmented neutrino detector for accelerator neutrinos, is a significant part of the T2K (Japan) long-base experiment. The design size is 192 × 56 × 184 cm3 along the axes x-y-z respectively. The main components are 56000 channels and 2 million scintillation cubes. The scintillator composition is polystyrene doped with 1.5% of paraterphenyl (PTP) and 0.01% of POPOP. The size of each cube is 1 × 1 × 1 cm3 light collected and read in three orthogonal directions using spectroscopic fibers WLS Kuraray Co Y-11. The SuperFGD detector will be the central element of the near neutrino detector in the T2K and Hyper-Kamiokande experiments.

The primary focus of the work is the development of an algorithm to calibrate 60,000 channels for detecting scintillation signals. These signals are based on spectrum-substituting fibers and avalanche micropixel photodiodes (MPPC). The algorithm also determines the baseline position for each channel and the optimal threshold value for each Application-Specific Integrated Circuit (ASIC), which is dependent on the photoelectronic peaks for each ASIC.

Poster Session - Board: 6

Multifunctional Detector of Muons for Investigations of the Vertical Muon Flux of Extensive Air Showers at High Energies

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Keywords: Muon Flux, Local Muon Density Spectrum, High Energies, Extensive Air Showers, Multi-Wire Drift Chambers.

In this talk the concept of the Multifunctional Detector of Muons (MDM) which is currently developed in the National Research Nuclear University MEPhI is described. MDM represents an array of multi-wire drift chambers shielded by absorber layers, designed to investigate single and multi-particle events within the zenith angle range of 0° to 60°.

The synergy of MDM with the large-scale TREK detector, constructed with similar drift chambers, opens up the possibility for a unified methodology and detection technique for studying muon flux in Extensive Air Showers (EAS) across the full zenith angle range.

In the first configurations, the MDM will consist of two pairs of coordinate planes, each pair consisting of 14 drift chambers, and every chamber covers an area of 1.85 m². Future extension plans involve doubling the number of coordinate planes.

The detector design, deployment of the drift chambers, the position and dimensions of the absorber and in particular the detector parameters obtained as a result of the modeling in the Geant4 software package are considered. Possible contributions of the installation for scientific research and its further development when increasing the number of layers of drift chambers and the absorber are discussed.

Poster Session - Board: 7

Search for heavy neutrinos with the T2K near detector ND280

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The goal of the current work is an upgrade of the heavy neutrinos search with T2K near detector ND280. The poster represents current status of the aforementioned upgrade and main results of the previous analysis.

First reason for the upgrade is availability of the new statistics since year 2018. Secondly, in previous analysis charged pions decays to heavy neutrinos were not taken into account. Including charged pions decays alongside with charged kaons decays will allow to increase statistics in low HNL mass range. Thirdly, published in year 2018 T2K's upper limits on mixing elements are still competitive. Moreover, the contribution of both negative and positive charged mesons decays will be considered for each (neutrino/antineutrino) magnets operation mode in order to increase statistics.

Poster Session - Board: 8

Study of B_c to ψ(2S) π and J/ψ π decays

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The report includes the results of $B_c^+ \to \psi(2S)\ \pi^+$ and $B_c^+ \to J/\psi\ \pi^+$ decays study. The analysis is performed using RunII pp collision data collected by CMS in 2016−2018 at center-of-mass energy $\sqrt{s} = 13\ TeV$. The data corresponds to an integrated luminosity of 140 fb^{-1}.

Poster Session - Board: 9

Search for photon-induced air showers at the Carpet-3 experiment

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We report our results on the new technique for searching for photon-induced EAS events at the Carpet-3 experiment. To search for photon-like events, we employ a neural network, trained on Monte-Carlo simulations of the experiment. Both reconstructed EAS parameters and raw detector signal data are being used. On Monte-Carlo simulations our method achieves considerably higher background rejection efficiency than traditional methods, particularly for EAS events with high muon content.

Poster Session - Board: 10

Study of semileptonic decays of B_s mesons

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This analysis provides research of semileptonic decays of B_s mesons on Belle experiment. The analysis makes use of hadronic tagging and is performed on 121.4 fb^{-1} of data collected at $\Upsilon(5S)$ resonance state at the KEKB asymmetric energy e^+e^- collider located at the High Energy Accelerator Research Organisation, Japan. The goal is to optimize the recovery of the lost neutrino's kinematics, taking into account possible pair production processes $B_s^*\bar{B}_s^*$, $B_s^*\bar{B}_s$ and $B_s\bar{B}_s$. The study includes modeling of signal and background, estimation of backgrounds, optimization of selection.

Poster Session - Board: 11

Study of the accuracy of reactor antineutrino spectrum reconstruction

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To date, many experiments in the field of reactor antineutrinos show a discrepancy between the predicted antineutrino spectrum and the measured one. Therefore, the problem of reconstruction of the antineutrino spectrum seems so actual. It is possible to compare the measured and predicted spectra of positrons and not solve the inverse problem which requires a complicated unfolding procedure. However, this makes it difficult to compare positron spectra between different experiments, simply because each experiment has its own unique detector. By solving the inverse problem, we remove the contribution from detector response and obtain a pure antineutrino spectrum.

DANSS is a one cubic meter highly segmented solid scintillator detector. It consists of 2500 scintillation strips covered with gadolinium loaded reflective coating and read out with SiPMs and PMTs via wavelength shifting fibers. The antineutrinos are produced by a 3.1 GW industrial reactor at the Kalinin NPP (Russia). The process of inverse beta decay (IBD) is used to detect antineutrinos. DANSS detects about 5000 IBD events per day (in the position closest to the reactor core), with a few percent of the background induced by cosmic muons and fast neutrons.

The positron energy spectra are unfolded to obtain the antineutrino energy spectra with the SVD and Bayesian unfolding techniques. To check the correctness of the methods used, it is proposed to first unfold artificially generated positron spectra. The Huber-Muller model is used to generate antineutrino spectra. The positron spectra are obtained using a Monte-Carlo simulation of the passage of an antineutrino through the detector. Moreover, the systematic uncertainties in the unfolding process are carefully studied and quantified. As a result, the estimated accuracy of antineutrino energy spectrum reconstruction will be presented.

Poster Session - Board: 12

Novel method to extract the femtometer structure of strange baryons using the vacuum polarization effect

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One of the fundamental goals of particle physics is to gain microscopic understanding of the strong interaction. Electromagnetic form factors quantify the structure of hadrons in terms of charge and magnetization distributions. While the nucleon structure has been investigated extensively, data on hyperons is still scarce. It has recently been demonstrated that electron-positron annihilations into

hyperon-antihyperon pairs provide a powerful tools to investigate their inner structure. We present a novel method useful for hyperon-antihyperon pairs of different types which exploits the cross section enhancement due to the vacuum polarization effect at the J/ψ resonance. Using the 10 billion J/ψ events collected with the BESIII detector, this allows a thorough determination of the hyperon structure. The result is essentially a precise snapshot of a Λ¯Σˆ0 (ΛΣ¯ˆ0) pair in the making, encoded in the form factor ratio and the phase. Their values are measured to be R=0.860±0.029(stat.)±0.010(syst.), ΔΦ_1=(1.011±0.094(stat.)±0.010(syst.)) rad for Λ¯Σˆ0 and ΔΦ_2=(2.128±0.094(stat.)±0.010(syst.)) rad for ΛΣ¯ˆ0, respectively. Furthermore, charge-parity (CP) breaking is investigated for the first time in this reaction and found to be consistent with CP symmetry.

Poster Session - Board: 13

Anomalous cosmic-ray correlations revisited with a complete full-sky sample of BL Lac type objects

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Cosmic rays with energies above 10^{19}eV, observed in 1999 - 2004 by the High Resolution Fly's Eye (HiRes) experiment in the stereoscopic mode, were found to correlate with directions to distant BL Lac type objects (BL Lacs), suggesting non-standard neutral particles travelling for cosmological distances without attenuation. This effect could not be tested by newer experiments because of their inferior angular resolution. The distribution in the sky of BL Lacs associated with cosmic rays was found to deviate from isotropy, which might give a clue to the interpretation of the observed anomaly. However, previous studies made use of a sample of BL Lacs which was anisotropic by itself, thus complicating these interpretations. In this work we use a recently compiled isotropic complete sample of BL Lacs and the same HiRes data to confirm the presence of correlations and to strengthen the case for the local large-scale structure pattern in the distribution of the correlated events in the sky (see the picture, where red boxes - sample used in [1], θ = 0.8°, blue stars - isotropic sample, θ = 1.3°, shading represents the weighted density of galaxies [2]).

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[2] - Troitsky, S. Eur. Phys. J. C 81, 264 (2021)

Poster Session - Board: 15

Using effective parameters for model-independent constraints on the Z'-boson parameters at next-generation e^+e^- accelerators

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Currently the Standard Model (SM) is considered as a low-energy approximation of the future fundamental theory describing all interactions. The SM is agreement with almost all experimental data, but also has obvious disadvantages, which are the reason for further, deeper verification of the SM and search for new physics. The deviation from the SM predictions can be interpreted by the emergence of the massive gauge boson – Z'. In this case the experimental information can be presented in the form of constraints on the Z' parameters, which can be used to verify the Z' models (SSM, LRM, ALRM, E_6-models and other).

The improved model-independent constraints on new, effective parameters for the process $e^+e^- \to f\bar{f}(f = \tau, b)$ at the ILC and CLIC are obtained as a result of the research. The technique of further improvement of constraints is presented.

Poster Session - Board: 16

Quantum effects and the effective action analysis in the massive two-dimensional CP(N-1) sigma model in the large N limit.

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The two-dimensional CP(N-1) sigma model we consider is an effective theory on the world-sheet of a non-Abelian string with a special mass deformation parameter. As the model is a non-supersymmetric, it may contain, the study of which is one of the purposes of this work.

CP(N-1) model is asymptotically free [1], dynamic scale in this Λ arises from the dimensional transmutation, similar to QCD. Furthermore, as a result of the renormalization procedure, a new parameter with the dimension of mass arises, Λ_σ. In the limit of vanishing mass deformation parameter, m≪Λ,Λ_σ, the model is at a strong coupling. For the m=0 it was solved by Witten [2] in the large-N limit: photon interacts with N “quarks” --- scalar fields with charges ~1/√N which appear in the spectrum only in pairs nˆ*n, since between them there is a confining potential that grows linearly with distance. We call this phase Coulomb/confining since a photon field is massless in it. In this massless limit Z_N symmetry remains unbroken. When m≫Λ, the theory is at weak coupling, Z_N symmetry is spontaneously broken, because scalar fields n develop non-zero vacuum expectation value. That is why we call this regime the Higgs phase.

In this work we generalize the result, obtained by Witten in [2] to the case with m≠0, we also work in the large-N limit. The first step is to calculate an effective potential, from which we derive vacuum equations and solve them in two different phases. Then we find a phase transition point and explore a vacuum energy behavior near it, which allows us to determine its type. In the last step we study the dynamics of fields and make some conclusions about applicability of using large-N method.

One of the important results of this work is the need to modify the original gauge-invariant formulation of the model --- as will be shown, there is a need to introduce an additional term into the original Lagrangian to carry out a self-consistent renormalization procedure, as a result of which another mass dimension parameter appears in the theory, in addition to Λ, that is, Λ_σ. There is a paper on this topic [3], in which the absence of an additional term in the original Lagrangian leads to the fact that the minimum of the potential becomes a maximum at sufficiently small masses, that is, the theory becomes unstable.

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[2] E. Witten. Instantons, The Quark Model, And The 1/N Expansion, Nucl. Phys. B 149, 285 (1979).
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Poster Session - Board: 17

$W_{1+\infty}$ and $\widetilde{W}$ algebras, and Ward identities

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It was demonstrated recently that the $W_{1+\infty}$ algebra contains commutative subalgebras associated with all integer slope rays (including the vertical one). In our work, we realize that every element of

such a ray is associated with a $\widetilde{W}$ algebra. In particular, the simplest commutative subalgebra associated with the rational Calogero Hamiltonians is associated with the $\widetilde{W}$ algebras studied earlier. We suggest a definition of the $\widetilde{W}$ algebra based on the matrix realization of the $W_{1+\infty}$ algebra, and also suggest an unambiguous recursive definition, which, however, involves more elements of the $W_{1+\infty}$ algebra than is contained in its commutative subalgebras. The positive integer rays are associated with $\widetilde{W}$ algebras that form sets of Ward identities for the WLZZ matrix models, while the vertical ray associated with the trigonometric Calogero model describes the hypergeometric τ-functions corresponding to the completed cycles.

Poster Session - Board: 18

Ising field theory in a magnetic field: analytic properties of the free energy

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This work is devoted to the study of the scaling function $\Phi(\eta)$, associated with the free energy of the Ising model in the region $T \to T_c$, $H \to 0$, using numerical data obtained by the truncated free fermion space approach method (TFFSA method). Using this method, an estimate of some parameters of this function is provided, including the position of the Yang-Lee singularity and the leading amplitudes of the associated singular expansion. The analyticity of the scaling function and the proof of the "extended analyticity" hypothesis were tested.

The numerical TFFSA method is implemented using the Python programming language. This is the technical part of this research work. Also, the work provides a full justification for why the proof of this analyticity is an important issue. A brief rationale is presented below.

As is known, in the classical theory of phase transitions, which does not take into account fluctuation effects, the Langer feature of low-temperature free energy at $H = 0$ is absent. Instead, the analytic continuation of the classical free energy at low T shows a singularity with a branching at some finite negative value of H, $H = -H_{SP}$, known as the ``spinodal point''. This feature arises because at sufficiently large H ($|H| > H_{SP}$) the metastable state becomes unstable with respect to classical decay. When fluctuations are taken into account, the free energy becomes singular (even weakly singular) at $H = 0$, since the metastable phase is always prone to decay through nucleation. But what happens to the spinodal feature? This is a question that still remains open, and the authors of this research work, upon completion, hope to answer it.

Poster Session - Board: 19

Nonequillibrium Schwinger-Keldysh correlators and its analytic properties

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We develop Schwinger-Keldysh in-in formalism for generic nonequilibrium dynamical systems with mixed initial states. We construct the generating functional of in-in Green's functions and expectation values for a generic density matrix of the Gaussian type and show that the requirement of particle interpretation selects a distinguished set of positive/negative frequency basis functions of the wave operator of the theory, which is determined by the density matrix parameters. Then we consider a special case of the density matrix determined by the Euclidean path integral of the theory, which in the cosmological context can be considered as a generalization of the no-boundary pure state to the

case of the microcanonical ensemble, and show that in view of a special reflection symmetry its Wightman Green's functions satisfy Kubo-Martin-Schwinger periodicity conditions which hold despite the nonequilibrium nature of the physical setup.

Young Scientist Forum

Monte-Carlo simulation of processes with heavy neutrino exchange on lepton colliders

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We study discovery potential for the heavy right-handed neutrino exchange contribution in the process $l^+l^- \to W^+W^- \to 4j$ $(l = e, \mu)$ at future high-energy lepton colliders. Using the Whizard generator and DELPHES detector simulation framework it is shown that after applying cuts the only non-negligible background process from Standard model is $l^+l^- \to W^+W^-$. Generator uses seesaw type-I model to simulate signal. We use angular distributions to distinguish the signal from background due to heavy neutrinos right polarisation. Using a likelihood analysis we obtain upper limits for the mixing parameter as a function of the heavy neutrino mass for future lepton colliders at $\sqrt{s} = 1, 3, 10$ TeV.

Young Scientist Forum

And Then Everything Exploded: Exploring the H0 Tension

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The current consensus cosmological model, LCDM, is for the most part in good agreement with observations. However, not all is well: as our measurements of both early and modern Universe are becoming more and more precise, a gap opens between different indirect measurements of the Hubble constant, i.e. the rate at which the Universe is expanding today. Many attempts to cross this gap have been made, but none have resoundingly solved the H0 problem. The talk outlines the current state of the problem and showcases the difficulties in solving it with an extended theoretical cosmological model (the phantom-crossing dark energy) and the necessity of carefully choosing how to combine ovservational datasets when comparing between models, as the most significant case of the H0 tension arises from a discordance in type Ia supernova magnitude calibrations using a local and an inverse distance ladder. The talk is based on the work of D. Gorbunov, A. Chudaykin and N. Nedelko in the paper ``Exploring ΛCDM extensions with SPT-3G and Planck data: 4σ evidence for neutrino masses and implications of extended dark energy models for cosmological tensions'' (2203.03666, in preparation for publication)

Young Scientist Forum

Development of the NTSim Software Package for Designing Neutrino Telescopes and Evaluating Detection of Neutrino-Induced Events in the Baikal-GVD Experiment

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The experimental foundation of modern neutrino astronomy is designing and scaling of neutrino telescopes which are typically arrays of optical detectors placed in a natural transparent medium (water, ice). The prominent representatives of neutrino telescopes are the IceCube at the South Pole, KM3NeT in the Mediterranean Sea and Baikal-GVD in Lake Baikal. For successful analyses of experimental data and verification of theoretical models, as well as for evaluating detection of neutrino-induced events, it is necessary to use precise simulation of physical processes that occur in the detector.

The NTSim software package (Neutrino Telescope Simulation) for designing neutrino telescopes serves this purpose. Among other similar toolkits, NTSim stands out due to the following underlying principles. First, NTSim is written using the Python programming language, including the central core of the simulation – a pythonized shell for the Geant4 package, a toolkit for the simulation of the passage of particles through matter. Second, the modular principle allows the user to design neutrino telescopes and calculate responses resulting from generation of neutrino-induced events. Third, a balance is achieved between the rate of modelling and the accuracy of reproducing physical processes, for instance, such as generation and propagation of hadron and electromagnetic cascades. All this allows NTSim to be a convenient and efficient toolkit for developing existing and designing future neutrino telescopes, as well as for reconstructing neutrino-induced events.

Young Scientist Forum

Polyvector deformations of IIB supergravity solutions

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The investigation of theories with a deep connection to experimental physics, such as supersymmetric gauge theories (SUSY QFT) or theories of strongly correlated systems, is of great interest to modern science. One of the most promising and fundamental tools for studying these theories in modern theoretical physics is string theory, thanks to a large number of discoveries made in it. One notable example is the AdS/CFT correspondence, which has provided the opportunity to creation of various methods for studying gauge field theories. Among them, solution-generating methods are particularly useful, allowing the exploration of the properties of gauge field theory families, the generation of new gauge field theories, and obtaining information about non-Lagrangian operators by utilizing the geometric properties of supergravity solutions, which is the low-energy limit of string theory. One such method is the Yang-Baxter deformation technique. Its essence lies in mapping of a special nonlinear transformation, given by a family of solutions of the supergravity equations, onto the space of gauge field theories by using of the AdS/CFT correspondence. By doing so, a family of field theories with properties determined by the specified nonlinear transformation is obtained. This transformation is referred to as the Yang-Baxter deformation of supergravity solutions and arises from the hidden symmetries of the supergravity equations. It is parameterized by a known (seed) solution of the supergravity equations and a polyvector constructed from the Killing vectors of the seed solution. Previously, this formalism could only be constructed for solutions with Abelian isometries, significantly limiting the application of holographic mapping and leading to the discovery of only supersymmetric manifolds of conformal theories. However, an extension of this method has been developed for the case of seed solutions with non-Abelian isometries. Thanks to this extension, utilizing the AdS/CFT correspondence, it has been possible to demonstrate the existence of a new non-supersymmetric conformal manifold and its position in the space of gauge field theories.

Young Scientist Forum

Search for the new decay of Lambda_b with X3872 in the final state

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In modern particle physics it is becoming increasingly popular study the b baryons with charmonium-like final states in attempt to find a new tetraquark candidates. Searching such candidates may shed a new light into unclear nature of such states.

Using a data sample collected by the CMS experiment in 2016-2018 and 2022 years, $\Lambda_b^0 \to \psi(2S)\Lambda$ decay was reconstructed, and searching for the new $\Lambda_b^0 \to X(3872)\Lambda$ decay was performed.

Young Scientist Forum

Effective lifetime measurement of Bs0 meson using Bs0->JPsiKs0 channel

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The study of B decays has led to a much better understanding in the flavor sector of the SM. In the CP-violation study, the measurement of sin(2β) has an important role. The "golden channel" B0 ⟶ J/ψK0S plays an outstanding role for a clean measurement of sin(2β), where β is one of the angles of the CKM unitarity triangle. The channel B0s ⟶ J/ψK0S is related to B0 ⟶ J/ψK0S through interchanging all d quarks with s quarks and allows to get a handle on the penguin effects. The determination of the effective lifetime in the B0s ⟶J/ψK0S will be an essential step towards the time-dependent CP violation study. As a first step, we are measuring the effective lifetime of the decay B0s ⟶ J/ψK0S with the full RunII data collected by CMS detector.

Young Scientist Forum

Non-thermal WIMPy Baryogenesis with Primordial Black Hole

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We consider the possibility that the weakly interacting massive particles produced from the evaporation of primordial black hole can explain both the relic density of dark matter and the baryon asymmetry of the Universe, through their annihilation which violate B and CP-symmetry. We find that the primordial black hole with mass less than 10^7g is a good candidate as an source of TeV dark matter with the total annihilation cross section $\langle\sigma_a v\rangle \leq 10^{-7}\ \mathrm{GeV}^{-2}$ and the B-violating scattering cross section $\langle\sigma_B v\rangle \leq 2\times 10^{-9}\ \mathrm{GeV}^{-2}$. This large annihilation cross section of dark matter in this model would make it available to search them in the indirect search for dark matter such as gamma-ray or neutrino observations.

Young Scientist Forum

The eigenvalue spectrum of a large real antisymmetric random matrix with non-zero mean

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In our work, we consider the problem of finding the spectrum of eigenvalues of a random real antisymmetric matrix J with large size $N \gg 1$. We study the case of non-zero mean value using the replica method.

This problem is motivated by a SYK_2 model with connections from a Gaussian distribution with non-zero mean.

Young Scientist Forum

Evolution of the background with time in the νGeN experiment

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The νGeN experiment continues exposition at the Kalinin Nuclear Power Plant aiming for the best reactor-based constraints on the antineutrino magnetic moment and an observation of coherent elastic scattering of antineutrino on germanium nuclei. The background count rate of the HPGe spectrometer in a wide energy range varies with time. This talk presents efforts in understanding and quantification of these variations.

Young Scientist Forum

Spin-parity measurement of J/psi J/psi structures

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The CMS, LHCb, and ATLAS experiments have observed up to three resonances in the X $\longrightarrow$ J/ψ J/ψ $\longrightarrow$ 4μ decay channel in the invariant mass spectrum between 6 and 8 GeV. These resonances are candidates for ccc$^-$ c$^-$ tetra-quark states. In order to study this hypothesis, and to understand the nature of these resonances, we perform a spin-parity study using kinematic distributions of the four muons. A matrix-element approach is employed to create optimal discriminants to distinguish pairs of hypotheses from the list of J P = 0+, 0−, 1+, 1−, 2+, 2−, where both gluon fusion and quark-antiquark production mechanisms are considered. The results of this study are presented using the full Run-2 dataset from the CMS experiment.