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HSE Study Center “Voronovo”

Book of Abstracts

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Contents

Young Scientist Forum

Precision WZ cross sections and polarisation at 13 TeV

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Measurements of WZ production in pp collisions at a center-of-mass energy of 13 TeV are presented. The data were collected in 2015 and 2016 by the ATLAS experiment at the Large Hadron Collider, and correspond to an integrated luminosity of 36.1 f^{-1}. The WZ candidate events are reconstructed using leptonic decay modes into electrons and muons of the gauge bosons. The measured inclusive cross section in the detector fiducial region for leptonic decay modes is σfid.WZ$\rightarrow \ell' \nu \ell \ell$= 63.7± 1.0 (stat.)± 2.3 (sys.)± 0.3 (mod.)± 1.5 (lumi.) fb, in agreement with the next-to-next-to-leading-order Standard Model prediction of 61.5+1.4−1.3 fb. Cross sections for W^+Z and W^-Z production and their ratio are presented as well as differential cross sections for several kinematic observables. An analysis of angular distributions of lepton decays of W and Z bosons is performed and integrated helicity fractions in the detector fiducial region are measured for each of the W and Z bosons. The longitudinal helicity state of pair-produced vector bosons is measured in hadronic collisions.

Young Scientist Forum

Production of double charmed baryons with excited diquark at LHC

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We discuss the prospects of the observation of double heavy baryons Ξ_{cc}, Ω_{cc} with excited diquark (S and P excitations) in experiments at LHC. P-wave excitations of a diquark in double charmed baryons are supposed to be quite narrow since their decay into the ground state is highly suppressed. Relative yields of S-wave and P-wave excitations have been estimated within pQCD for the LHCb kinematics.

Young Scientist Forum

Analytic example of the Aretakis type behaviour of the metric

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Supersymmetric black holes play an important role in string theory. It is natural to ask whether they are classically stable or not, i.e. does a small initial perturbation remain small with time evolution? In supergravity from the fact that supersymmetric solution staurates BPS-bound does not imply classical stability. For example, anti-de-Sitter spacetime is a supersymmetric solution of various supergravity theories but it is classically unstable against the formation of small black holes.
In AdS classical stability was analysed under time evolution determined by the nonlinear Einstein

equation. But Aretakis showed that even linear perturbations of a supersymmetric black hole can exhibit instability. He proved that derivatives of a massless scalar field grow polinomially on the horizon of extreme Reissner-Nordstrom black hole. It's interesting to investigate stability of tensor fields.
To have an analytical solution, radial infall of non-charged massive body to a ERN black hole was considered.
Einstein equations were linearized and solved in the near-horizon limit.
As the result, it was shown that all components of metric perturbation are damped exponentially, but l=0,1 spherical harmonics of rr-component oscillate and do not decay with time.

Young Scientist Forum

Study of Bˆ0_s spectroscopy in the CMS experiment

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The recent CMS results on Bˆ0_s spectroscopy are presented. The search for exotic state X(5568) decaying into Bˆ0_s piˆ{+-} is reported together with the studies of P-wave B_s meson states Bs1(5830)0 and Bs2(5840)0, including the observation of the Bs2(5840)0 -> B0 K0s decay. The results are based on the data sample collected by the CMS experiment at the LHC in proton-proton collisions at sqrt(s)=8 TeV, corresponding to an integrated luminosity of 19.7 fbˆ-1.

Young Scientist Forum

Quantum corrections for Dirac field in external coordinate-dependent scalar field in Yukawa-like coupling

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We consider (1+1)-dimensional Yukawa theory with a massless real scalar field. We study the response of the production of fermion pairs to an external coordinate-dependent scalar field.

Poster Session - Board: 1

A study of the e+e- to KS KL pi0 process up to 2 GeV with the CMD-3 detector

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The preliminary results are obtained and presented in this poster. The current study is based on luminosity, which is 33.18 1/pb.

Poster Session - Board: 2

Cosmological analysis of possibility to constrain SIMP-like dark matter models

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In this work we investigate possibility to constrain SIMP-like dark matter (DM) model from the data on large scale structure of the Universe. Such DM candidates interact with ordinary matter until quite late stage of the Universe evolution. Because of that a scale of minimal size of the density inhomogeneity which DM particles can form, can be large. Due to the fact that these particles are coupled to relativistic plasma and therefore inhomogeneities smaller than current horizon are washed out. We are trying to put constraint on cross-section of interaction between SIMPs and ordinary matter in common case and apply it to the specific model.

Poster Session - Board: 3

Evolution of quantum systems in environments: perturbation theory for Lindblad-Franke equation

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Evolution of quantum systems is described by Lindblad-Franke equation for density matrix. We seek pointers of this equation: such density matrices (i.e. quantum states) that don't change over time. Pointers are believed to be the final step in evolution of density matrices of open quantum systems and, consequently, they are expected to reveal decoherence, i.e. the process of system's loss of quantum properties and gaining classical ones.
To start with, we look at the pointers of the Liouville–von Neumann part of the equation and next we find how they change after "turning on" the Lindblad-Franke part. It is implemented by means of perturbation theory. The cases of non-degenerate and degenerate Hamiltonians are studied. We further apply our method to concrete physical setups.
This work is done in collaboration with A.A.Andrianov, M.V.Ioffe and O.O.Novikov.

Poster Session - Board: 4

Impact of detector effects on the response of highly granular ILD hadron calorimeter to single hadrons

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Highly granular calorimeters are proposed for the calorimeter systems of multi-purpose detectors at future lepton colliders. In particular, the ILD hadron calorimeter will be assembled from scintillator tiles read out directly by silicon photomultipliers. We have measured a response of the tile-SiPM system to minimum ionising particles emulated by electrons from radioactive source. The contribution of different effects, such as light collection efficiency and electronic noise, to the response width was estimated from these experimental data. The estimated contribution is implemented in the digitisation of simulated signals from single hadrons in the cells of the ILD hadron calorimeter. We show here the impact of the experimentally measured detector effects on the simulated ILD hadron calorimeter resolution for single hadrons in the energy range from 5 to 50 GeV.

Poster Session - Board: 5

Investigation of muon bundles using tracking detector based on drift chambers

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The new coordinate-tracking detector based on drift chambers to investigate muon bundles produced by ultra-high energy primary cosmic rays is being developed. The project is aimed to solve a problem of excess of muon bundles events, which increases with energies of primary particles. The reasons can be in cosmo-physical or nuclear-physical processes. Today the prototype of the detector is developed, which was called coordinate-tracking unit based on drift chambers (CTUDC). CTUDC consists of 16 multiware drift chambers with effective square 1.85 m2. The detector allows investigate muon bundles with density up to 10 particles/m2 and more at zenith angles up to 90°. The report summarizes the results of analysis of muon bundles events, registrated by CTUDC.

Poster Session - Board: 6

Investigation of the properties of the Higgs fields basis

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In this report features of some topological methods for baryogenesis and phase transition analysis, including models with an extended scalar sectors at finite temperatures are discuss. The first and second differential forms are implemented for the effective potential.Physical masses conditions is determined and the one-loop corrections to the dimensionless parameters of the effective potential are evaluated in the framework of NMSSM.

Poster Session - Board: 7

Methods for determining the response parameters of the cluster of the NEVOD-EAS air-shower array

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Extensive air showers (EAS) formed as a result of the development of the nuclear-cascade process in the atmosphere are the only source of information about the flux and interaction of cosmic rays with energies above 10ˆ15 eV. For studying of EAS in the energy range from 10ˆ15 to 10ˆ17 eV, the NEVOD-EAS air-shower array is being created at the Scientific and Educational Center NEVOD (MEPhI, Moscow). At present, the array includes 9 independent clusters of scintillation detection stations (DS) deployed over the area of about 10ˆ4 mˆ2. During the long-term experimental series, the response parameters of each array cluster are regularly monitored in order to provide correct reconstruction of registered EAS and to control the experimental data quality. The cluster response parameters include: the most probable DS response to the passage of single muons, the cross-link coefficients of the DS spectrometric channels, the relative delays of the DS response, baselines of measuring channels, cluster count rates, etc.

The main parameters of the response of the NEVOD-EAS clusters which determine the quality of the experimental data and are accounted in the reconstruction of characteristics of the registered extensive air showers, as well as the algorithms and methods for their determination are described.

Poster Session - Board: 8

Monte-Carlo study of long-range correlations of average transverse momentum and multiplicity for strange particles in pp-collisions at the LHC energies.

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This study is motivated by the phenomenon of the enhanced production of multi-strange hadrons observed for the first time by the ALICE Collaboration in high-multiplicity pp-collisions at $\sqrt{s} = 7$ TeV at the LHC. We investigate this effect of strangeness enhancement in pp-collisions in the framework of the MC event generator PYTHIA 8 where the collectivity processes are taken into account by the formation of a so-called ``flavour rope''. The latter is hadronized with a larger effective string tension providing the increase of strangeness yield. This concept of the ``flavour rope'', as a source of multi-strange hadrons, extended in rapidity, is being tested by the study of so called long-range correlations (LRC) between the average transverse momentum $\langle p_T \rangle$ and multiplicity n for particles containing strange quarks produced in high energy pp-collisions.
The dependencies of correlation coefficients b_{n-n}, b_{p_T-n})and $b_{p_T-p_T}$ on the gap between forward and backward pseudorapidity windows, and on the width of the forward pseudorapidity windows, are studied.
The behaviour of correlation coefficients for strange particles is compared with the behavior of correlation coefficients for charged particles. It is demonstrated that the positive n-n, p_T-n and p_T-p_T correlations are observed for all studied types of particles. The correlation coefficients of strange particles in each of the considered cases are noticeably less than for charged particles. The difference in the behavior of the correlation coefficients of charged particles and strange particles is discussed.

Poster Session - Board: 9

New 3D fine-grained scintillator detector for a T2K ND280 neutrino active target

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An upgrade of the long baseline neutrino experiment T2K near detector ND280 is currently being developed with the goal to reduce systematic uncertainties in the prediction of number of events at the far detector Super-Kamiokande. The upgrade program includes the design and construction of a new highly granular fully active scintillator detector with 3D WLS fiber readout as a neutrino target. The detector of about 200×180×60 cm3 in size and a mass of ~2.2˜tons will be assembled from about 2×106 plastic scintillator cubes of 1×1×1 cm3. Each cube is read out by three orthogonal Kuraray Y11 Wave Length Shifting (WLS) fibers threaded through the detector. Currently beam tests of two prototype of new detector were done. And the tests of individual elements of the detector are continuing.

Poster Session - Board: 10

Non-commutativity for Closed String on non-geometric background

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Discussion of non-commutativity for Closed String on non-geometric background.

Poster Session - Board: 11

Rate of cluster decomposition via Fermat point

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In quantum field theory with a mass gap correlation function between two spatially separated operators decays exponentially with the distance. This fundamental result immediately implies an exponential suppression of all higher point correlation functions, but the predicted exponent is not optimal. We argue that in a general quantum field theory the optimal suppression of a three-point function is determined by total distance from the operator locations to the Fermat point. Similarly, for the higher point functions we conjecture the optimal exponent is determined by the solution of the Euclidean Steiner tree problem. We discuss how our results constrain operator spreading in relativistic theories.

Poster Session - Board: 12

Reconstruction of extensive air showers registered by the NEVOD-EAS cluster type array

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To study muon bundles in a wide range of zenith angles and multiplicities using the NEVOD and DECOR detectors at the Scientific and Educational Center NEVOD (MEPhI, Moscow), the method of local muon density spectra (LMDS) is used. This method for estimation of the primary particle energy has rather low accuracy ($\sigma(\lg E_0) \tilde{} 0.4$) due to the contribution of extensive air showers (EAS) with different energies detected at different distances from their axes to the events with fixed local muon density. A new NEVOD-EAS array which is being created in MEPhI will allow to increase the accuracy of the LMDS technique by supplementing the information on muon component with data on the EAS axis position and to calibrate this method by comparing the energy spectra of cosmic rays obtained by simultaneous registration of the same events by muon bundles and EAS electron-photon component. The array consists of clusters of scintillation counters deployed around the NEVOD-DECOR complex. The cluster of the array is an independent EAS detector that is capable to determine the number of particles registered by its counters and the air-shower arrival direction. The methods for the EAS reconstruction according to the data of the NEVOD-EAS cluster type array are described and the obtained results are presented.

Poster Session - Board: 13

Restrictions on the parameters of the Supersymmetric Standard Model with CP violation.

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Higgs boson with the mass equal to 126 GeV was discovered in 2012 at the LHC. Now the main objective of the LHC is the investigation of Higgs boson's properties. This state is compatible with the Standart Model of particle physics (SM) and with the predictions of the Minimal Supersymmetric Standard Model with CP violation (MSSM). The MSSM contains the large number of free parameters. In this report we were looking for the regions of parameter space where the mass of one of the MSSM Higgs bosons is interpreted as the discovered Higgs boson. Using the experimental value of the mass of the Higgs boson, the MSSM parameters' limitations were obtained, phenomenological scenarios were determined, and an analysis of possible regions of the MSSM parameter space was carried out.

Poster Session - Board: 14

Search and study of extensive air shower events in the TUS detector data

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The main aim of the TUS experiment is to study the Ultra High Energy Cosmic Rays (UHECR) at E ˜100 EeV from the space orbit by measuring the fluorescence and Cherenkov radiation of the Extensive Air Showers (EAS). The ``Lomonosov'' satellite, with the TUS detector on board, was launched on solar-synchronized orbit with altitude of about 500 km on April 28, 2016. It is the first orbital telescope aimed for such measurements. The TUS apparatus structure, methods of UHECR on-line selection and off-line data analysis are briefly presented. The preliminary results of the TUS data analysis are presented.

Poster Session - Board: 15

Simulation study for the test of lepton universality in B-decays at Belle.

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Recently Belle, BaBar, and LHCb reported on a large deviation of $R(D^{(*)})$ from the Standard Model (SM) prediction. In many theoretical attempts to explain this disagreement the new interactions, that can be of different Lorentz structure from $V-A$, are implemented. If the amplitude of the new interaction is proportional to the lepton mass, we can expect that e-μ lepton nonuniversality will be also revealed in semileptonic B-decays. In particular, one can expect the difference of D^{*+} polarizations in $\bar{B} \to D^{*+} l^- \bar{\nu}_l$ (l denotes e or μ) due to small non $V-A$ correction to the semimuonic decay. We choose the D^{*+} polarization as a probe for new contribution because the systematic effects of

different μ and e reconstruction and identification efficiencies are cancelled out in each bin of the lepton momentum.

We perform the Monte Carlo study to verify the method of $\bar{B} \rightarrow D^{*+} l^- \bar{\nu}_l$ reconstruction and optimization of the selection criteria for the highest statistical and systematic accuracy. We studied all possible backgrounds and divided them into three categories: those, obtained from the data, universal backgrounds, i.e. real leptons which contribute equally to both electron and muon samples, and flavor dependent, which can contribute differently. The latter causes the most systematic errors to the proposed measurement. Using the Belle sample of generic Monte Carlo for both charged and neutral B-meson production, we studied how to decrease and then estimate the systematic uncertainty of the measurement.

Poster Session - Board: 16

Study of the process e+e− ⟶ π+π−γ with the CMD - 3

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Physics program of the experiments with the CMD-3 includes precise measurement of the cross-sections of the e+e− ⟶ hadrons processes. Such measurements are necessary for the calculation of the hadronic contribution to the anomalous magnetic moment of the muon (α=(g−2)/2). Value of α is one of the great instrument for the Standard Model test. Among hadronic channels the process e+e− ⟶ π+π− is very important because it gives the main contribution to the value of hadronic part of α (˜72%) in the low energy region (S < 2 GeV2).
Radiative corrections to the e+e− ⟶ π+π− cross-section are calculated under the hypothesis of point-like pions. In this work we study of the e+e− ⟶ π+π−γ process with photon radiation from the final state and test of the hypothesis about point-like pions used in the MCGPJ generator. In order to increase a part of events with FSR we study this process in the energy region left from the ρ-meson peak. The analysis of the process e+e− ⟶ π+π−γ was carried out in the energy region 660÷785 MeV and based on the integrated luminosity about 8.4 pb-1. The comparison of the experimental data for photon energy spectrum with the simulation results are in agreement with the hypothesis of point-like pions.

Poster Session - Board: 17

STUDYING THE TIME CHARACTERISTICS OF THE COORDINATE-TRACKING DETECTOR ON DRIFT CHAMBERS

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In the scientific-educational center NEVOD the new coordinate-tracking unit on drift chambers (CTUDC) has been created [1]. Its inclusion in the unique experimental complex allowed to significantly expand the existing possibilities for studying high-density muon bundles (up to 10 particles per square meter). During the development and operation of the first installation in the world of this type, it was possible to resolve a number of issues related to the modes of joint operation of large-area multi-wire drift chambers and their recording electronics with other installations of the complex, methods for reconstructing of multiparticle events and organizing the necessary technological systems. The accumulated experience will be used in the development of the largest coordinate-track detector for the registration of cosmic rays TREK [2] with an area of over 250 square meters.
The report describes the registration system of the installation [3], the results of the study of its time characteristics. The prospects for creating a similar system for a new detector, approaches to the

development of new time-to-digital converters are discussed. The work was performed at the Scientific and Educational Center NEVOD MEPhI with the financial support of the Russian Foundation for Basic Research in the framework of the research project No. 18-32-00687.

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Poster Session - Board: 18

The amplitude spectrum of the responses of the Cherenkov water detector at registration of events in conjunction with the facility PRISMA-32

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The work is devoted to reconstruction of the energy of the cores of extensive air showers, registered by the Cherenkov Water Calorimeter NEVOD [1] and the cluster of detectors of electromagnetic and neutron components of secondary cosmic rays PRISMA-32 [2].
Cherenkov Water Calorimeter (CWC) is a pool with a volume of 2000 m3 filled with distilled water. In the pool there are 91 quasi-spherical detection module with 6 photomultipliers PMT-200 in each. CWC NEVOD allows to measure the energy release of the cores of EAS.
PRISMA-32 is a cluster of 32 en-detectors based on ZnS(Ag)+LiF scintillator with an area of 0.36 m2, allowing to simultaneously register the electron-photon component and thermal neutrons component of the EAS.
Description of the method of searching for joint events in CWC NEVOD and PRISMA-32 facilities is given. Data on the response of CWC and PRISMA-32 to the passage of the EAS in joint events are presented.
The work was supported by the Russian Foundation for Basic Research (grant 18-32-00214 mol_a).

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Young Scientist Forum

Statistical data analysis in the DANSS experiment

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DANSS is a one cubic meter highly segmented solid scintillator detector. It consists of 2500 scintillator strips, covered with gadolinium loaded reflective coating and read out with SiPMs via wavelength shifting fibers. DANSS is placed under a 3 GW industrial reactor at the Kalinin NPP (Russia) on a movable platform. The distance from the reactor core center is varied from 10.7 m to 12.7 m on-line. The inverse beta decay (IBD) process is used to detect antineutrinos. DANSS detects about 5000 IBD events per day with the background from cosmic muons at the level of few percent.
Sterile neutrinos are searched for assuming a 4 neutrino model (3 active and 1 sterile neutrino). The exclusion area in the $\sin^2 2\theta$, Δm^2 plane is obtained using a ratio of positron energy spectra collected at different distances. Therefore results do not depend on the shape and normalization of the reactor $\tilde{\nu_e}$ spectrum, as well as on the detector efficiency. The talk will cover the statistical methods used to obtain exclusion areas and the description of CL_s method which is more conservative then Raster Scan method. Comparison with the Raster Scan method will be presented as well as estimated detector sensitivity. CL_s method includes a point from sterile neutrino parameter plane into exclusion area only if the experiment sensitivity to such point is good. The systematic uncertainties and their influence on obtained results will be discussed. The excluded area covers a wide range of the sterile neutrino parameters up to $\sin^2 2\theta < 0.01$ in the most sensitive region. The Reactor Antineutrino Anomaly optimum point is excluded with a confidence level higher than 5σ.

Young Scientist Forum

Secularly growing loop corrections in the Yukawa model

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We consider 1+1 Yukawa model in the strong background field (namely, linearly growing scalar field). We derive exact harmonics, calculate the fermionic current and find that it grows logarithmically. We reproduce this result by integrating out the fermion degrees of freedom in the effective action. Finally, we calculate loop corrections to the scalar and fermion propagators and observe that they receive growing with time infrared contributions. This indicates the breakdown of the perturbation theory.

Young Scientist Forum

Phase diagram and dualities of dense baryonic matter with chiral imbalance

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In this talk the phase structure of the dense baryonic/quark matter has been investigated in the presence of baryon, isospin, chiral and chiral isospin chemical potentials in the framework of Nambu--Jona-Lasinio model. It has been shown that in the large-Nc limit there exist several dualities of the phase portrait. One of the key conclusions of our studies is the fact that chiral imbalance generates charged pion condensation in dense baryonic/quark matter even in the case of charge neutral matter, which is interesting in the context of the astrophysics of neutron stars. It was also shown that our results in particular cases are consistent with the simulation of lattice QCD. Our studies show that different types of chiral imbalances can occur in the cores of neutron stars or in heavy ion collision

experiments where large baryon densities can be reached, due to the so-called chiral separation and chiral vortical effects.

Young Scientist Forum

On Machine Learning application in B physics spectroscopy

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The talk will showcase some of the Machine Learning (ML) methods being applied in B physics spectroscopy. Using the data collected with the CMS experiment and the Bs⟶psi(2S) phi decay as a playground several most commonly used algorithms will be examined and compared while searching for a well-known intermediate psi(2S) resonance. The main emphasis will be given to a proper understanding of the given 'signal vs. background' classification problem with a thorough discussion on possible pitfalls which could arise from both physics and ML sides. The motivation behind the talk is not just to present how ML can be applied in B physics and how it could significantly improve the analysis performance. It is of more importance to emphasize the bridge one could build between physics and ML to complement each other. Namely, to show how one could deploy physics knowledge to a given ML model to modify it to one's needs and thus obtaining more physically motivated results and vice versa - how a properly trained model is in fact highly interpretable in a physics sense, which allows one to gain better insights into the problem.

Young Scientist Forum

Event reconstruction in large liquid scintillator detectors with machine learning techniques

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Detection of rare neutrino interactions requires a large target mass. One of commonly used solutions is a detector composed of liquid scintillator surrounded by an array of photo-multiplier tubes. Its large dimensions and a variety of optical effects lead to non-uniformity of light collection, which significantly complicates deriving the neutrino energy from the raw photo-multiplier signals. Machine learning techniques may be a good alternative to the traditional methods usually used for this task. This talk discusses advantages and drawbacks of machine learning techniques for the energy and vertex reconstruction for two cases of near future detectors: a small scale detector prototype at Baksan Neutrino Observatory and a large 20-kiloton detector of the JUNO experiment.

Young Scientist Forum

Search for new physics in the $B \to K\ell\bar{\ell}$ processes at Belle II

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The analysis of flavor changing neutral currents (FCNC) is one of the best tools to look for new physics in High Energy Experiments, since these are highly suppressed in the Standard Model (SM), which makes both contributions from NP and from the SM to affect the decays at the same level.
Moreover, the $B \to K\ell\overline{\ell}$ decay (governed by the transition $b \to s\ell\overline{\ell}$) provides multiple measurements for probing into the effects of NP scenarios: a differential branching fraction both in the dilepton mass and in the lepton charge asymmetry angle ($d\Gamma/dq^2 d\cos\theta$), the forward-backward lepton asymmetry A_{FB}, the direct CP asymmetry, the CP-averaged Isospin asymmetry and the ratio of the branching fraction for the two possible lepton flavors (e and μ).
B factories are the only experiments where all of this measurements can be performed. BaBar and Belle have reported multiple studies in both of the lepton channels, while the LHCb collaboration has done the same with the muon channel.
As the newest member of the B factories group, the Belle II experiment is the best place to revisit this decay due to its increased luminosity and the improvement made to the sub-detectors in comparison with its predecessor.
We present here the current status of the study on $B \to K\ell\overline{\ell}$ aimed to be performed with the data from Phase III (March-August of 2019).

Young Scientist Forum

Particle identification methods for the CALICE highly granular SiPM-on tile calorimeter.

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The Analog Hadronic Calorimeter AHCAL is a highly granular sampling calorimeter developed by the CALICE collaboration for the future International Linear Collider (ILC). It is designed in accordance with the requirements of particle flow algorithms to achieve a good jet energy resolution. The AHCAL technological prototype consists of ~ 22000 channels equipped with $3 \times 3\ cm^2$ scintillator tiles with individual readout by silicon photomultipliers. The prototype was tested with muon, electron and pion beams at the CERN SPS facilities. To classify events according to the initial particle type, we apply cut-based and multivariable analysis methods using topological parameters of events. Monte-Carlo simulations are used for tuning and testing the classification methods. In this contribution we will demonstrate the performance of AHCAL technological prototype for particle identification using different methods.

Young Scientist Forum

On inhomogeneous states in CP(N-1) and O(N) sigma models

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Resently new inhomogeneous field configurations similar to kinks in the Gross-Neveu model were found in the CP(N-1) model in the large N limit. We will discuss properties of the solutions. In particular, energy of the inhomogeneous states is lower then energy of the homogeneous one. Thus the question about the true ground state of the model arises. In context of this question we discuss periodic elliptic solutions. The talk is mainly based on the preprint (arXiv:1811.05449).

Young Scientist Forum

Ionization and light yield measurements using two-phase argon detector

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Two-phase argon detector is being developed in the Laboratory of Cosmology and Particle physics of the Novosibirsk State University jointly with the Budker Institute of Nuclear Physics. One of the main purpose of this detector is to measure the ionization yield and scintillation efficiency of nuclear recoils, which is of paramount importance for the energy calibration in rare-event experiments such as those of direct dark matter search and coherent neutrino-nucleus scattering. Another purpose is to study the methods of increasing the light yield to decrease the energy threshold of nuclear recoils detection what is the critical task for dark matter search. In this work we demonstrate our the latest achievements in ionization yield measurements and light yield increasing.

Young Scientist Forum

Veto signal consideration for the muon induced single neutron background in the DANSS experiment

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The DANSS experiment aims to search for sterile neutrinos. It is a compact neutrino spectrometer located at the Kalinin NPP close to the core of an industrial power reactor. Detection of the reactor antineutrino is based on the Inverse Beta-Decay (IBD) reaction. The detector records about 5000 events per day after subtracting the background. The significant contribution to background events is made by neutrons from the interaction of cosmic muons formed in the materials surrounding the detector volume.
In this study the distribution of single secondary neutrons from muons in passive shielding was simulated considering the veto background suppression.

Young Scientist Forum

Application of an automated observable selection algorithm for associated Zgamma production components separation at hadron colliders.

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Measurement of electroweak (EWK) component of associated $Z\gamma$ production is a precise test of the electroweak theory and a probe of BSM theories that predict anomalous vector boson self-couplings. However, recognition of it in the presence of QCD $Z\gamma$ production component on hadron collider experiment is a very challenging task due to identical final states and higher cross section of the background process. The main difference is the origin of two leading jets in these two processes. Machine learning (ML) algorithms allow one to use jet kinematic variables and kinematic balances of

the whole system more effectively increasing the significance of the measurement. A new algorithm for the construction and selection of the input kinematic observables for the ML classifier was used with the ultimate goal of better separation EWK and QCD $Z\gamma$ production components. The expected significance of distinguished EWK production measurement for LHC experiments conditions at the second datataking period (Run2) with 140 fb^{-1} amount of data was estimated.

Young Scientist Forum

Parameters of log-normal spectrum of PBH

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It is suggested that Primordial Black Holes (PBHs) could be one of the plausible constituents of Massive Compact Halo Objects (MACHOs). It is likely that such PBHs were produced after the completion of inflation (or more specifically, during the epoch of reheating). We follow a particular scenario of PBH formation which is based on the Affleck-Dine mechanism of baryogenesis. It was predicted that if there was a coupling between inflation and baryon complex scalar field, bubbles of baryonic matter could be created, which at a later stage form PBHs. It was shown that such PBHs have the log-normal mass function. In this work, we put constraints on the parameters of this log-normal distribution from observational data. For this distribution, we have calculated the fraction of the energy density of Dark Matter (DM) that is contributed by MACHO and the calculated value is much smaller than the result observed in different microlensing experiments. This inconsistency between calculated and observed data may indicate that PBHs have formed clusters and their distribution at present time may be direction-dependent.

Young Scientist Forum

Rotation-Invariant Observables as Density Matrix Invariants

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The Drell-Yan process in which a lepton pair is produced in hadron-hadron collisions is one of the most extensively studied reactions. The precision measurements of dilepton angular coefficients at various energies were presented over the past years. However, the values of angular coefficients strongly depend on the choice of a reference frame. That is why an adequate comparison between observables measured in different coordinate systems and between theory and experiment requires the development of a frame invariant formalism. Therefore, an interesting research avenue is a search for frame-independent combinations of angular coefficients. Such parameters would provide a powerful tool for the data analysis, can reveal systematic biases that were not taken into account and overall are expected to be better observables.

The search of rotational invariants was an actively discussed topic for the past ten years. Several special invariants for $SO(2)$ rotations around fixed coordinate axes were proposed [1-4]. In addition, significant progress was achieved in [5], where the number of $SO(3)$ rotational invariants for the most general form of the dilepton angular distribution were counted and a recipe for their derivation was developed.

Our present work is focused on the dilepton angular distributions in vector decays. We suggest a method which is a generalization of the procedure first proposed in [6]. The key idea of the approach

is to express the hadronic tensor (initial state density matrix) corresponding to the process in terms of the coefficients of the final state angular distribution and then explore the invariants of the obtained matrix. This formalism allowed us to derive five independent $SO(3)$ rotational invariants and constrain their values using the positivity of the hadronic tensor. Moreover, the set of invariants that we propose seem to be more convenient for use since the expressions we obtained are more compact compared to the results from [5]. In addition, in our analysis we reduced the maximum power of the angular coefficients entering the invarinats by one (from the fifth power to the forth).

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Young Scientist Forum

Study of neutrons from antineutrino interactions in ND280 of T2K

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An initial study of neutron detection in the near detector ND280 of T2K was done. Monte Carlo data simulated for muon antineutrino interactions on a CH active target with energies about 0.6 GeV was analysed. Kinematics of quasi-elastic scattering was reconstructed using time-of-flight technique. Efficiency of neutron detection, kinematics of secondary particles were measured and energy distribution of neutrino events were reconstructed. Parameters obtained in this analysis will be applied for analysis of experimental data.

Young Scientist Forum

Z(nunu)gamma measurement and neutral aTGC limits at 13 TeV

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The production of Z bosons in association with a high energy photon (Zγ production) is studied in the neutrino decay channel of the Z boson using pp collisions at √s=13 TeV. The analysis uses a data sample with an integrated luminosity of 36.1 fb−1 collected by the ATLAS detector in 2015 and 2016. Zγ events with invisible decays of the Z boson are selected by requiring significant missing transverse energy (EmissT) in conjunction with a single isolated photon with large transverse energy (ET). The rate of Zγ production is measured as a function of photon ET, EmissT and jet multiplicity. Evidence for anomalous triple gauge coupling is sought in Zγ production with photon ET greater than 600 GeV. No excess is observed relative to the Standard Model expectation, and upper limits are set on the strength of ZZγ and Zγγ couplings.

Young Scientist Forum

Investigation of possibility to suppress FSR in specific dark matter models explaining cosmic positron data

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There is a problem of overproduction of gammas in decay or annihilation of dark matter (DM) while trying to explain cosmic positron data. We consider the specific models where DM particle decays to e+ e- and e+ e+. These modes can have different physical reasons of final state radiation (FSR) suppression, which is the subject of our investigation.

Young Scientist Forum

Inflationary limits on the size of compact extra space

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We study restrictions imposed on the parameters of the Kaluza-Klein extra space supplied by the standard inflationary models. It is shown that the size of the extra space cannot be larger than $\sim 10^{-27}$cm and the D-dimensional Planck mass should be larger than $\sim 10^{13}$GeV. The validity of these estimates is discussed.
We also study creation of stable excitations of scalar field as the result of the extra metric evolution. It is shown that the possibility of their overproduction at the inflationary stage gives strong restrictions on the ratio of inflationary and compactification scales.

Young Scientist Forum

The master equation for the reinforcement learning

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We look the reinforcement learning dynamics. As the dynamics is a stochastic process, the adequate mathematical tool is the master equation. We introduce the probability distributions for the actions and value functions, then get a master equation, describing the reinforcement learning process. We derived a Hamilton-Jacobi equation for the latter equation. We verify a unique feature of the model (compared to the Master equation of the chemical reaction with few molecules or evolution models with finite population): the variance of distribution disappeared at the steady state, which gives a good credit for the application of the moment closing approximation. Our method (recursive equations) gives accurate expressions both for the mean and variance of variables, while HJE provides only correct results for the mean values. Looking the recursive equations, we express the value function distribution via the solution of a system of ordinary differential equations.

Young Scientist Forum

Imaginary parts of Gaussian effective actions in various patches of de Sitter space

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We consider Feynman propagators between two different $\alpha-$states in global de Sitter space and in Poincare patch. Then we separately consider $\alpha - \alpha$, in-in and in-out Feynman propagators. They are used to find the imaginary contribution to the effective actions.