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Book of Abstracts

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Mesons of heavy quarks / 0

Electro-weak production of pseudovector C-even heavy quarkonia in electron-positron collisions on Belle II and BES IIIProf. ACHASOV, Nikolay¹¹ Sobolev Institute for Mathematics**Corresponding Author(s):** achasov@math.nsc.ru

It is shown that the $e^+e^- \rightarrow Z \rightarrow \chi_{c1}/\chi_{b1}$ and $e^+e^- \rightarrow \gamma^*\gamma^* \rightarrow \chi_{c1}/\chi_{b1}$ contributions do not interfere in the total cross sections. That is, the creation of longitudinally polarized electron-positron beams allows to study separately the $e^+e^- \rightarrow Z \rightarrow \chi_{c1}/\chi_{b1}$ and $e^+e^- \rightarrow \gamma^*\gamma^* \rightarrow \chi_{c1}/\chi_{b1}$.

In the discussed energy region the weak interaction grows with energy increase $\propto G_F E^2$, where $G_F = 10^{-5} m_p^{-2}$ is the Fermi constant. $G_F E^2 = 1.4 \times 10^{-4}$ for $\chi_{c1}(1P)$ and $G_F E^2 = 1.7 \times 10^{-4}$ for $\chi_{c1}(3872)$. That is, $G_F E^2 \sim \alpha^2$ in the BES III energy region. $G_F E^2 = 1.1 \times 10^{-3}$ for $\chi_{b1}(1P)$ and $G_F E^2 = 1.2 \times 10^{-3}$ for $\chi_{b1}(2P)$. That is, $G_F E^2 \gg \alpha^2$ in the Belle II energy region.

The BESS III luminosity $10^{33} cm^{-2} s^{-1}$ gives possibilities to register near hundred of events $e^+e^- \rightarrow Z \rightarrow \chi_{c1}(1P)$ per day and near thirty of them in the well-known channel $\chi_{c1}(1P) \rightarrow \gamma\psi(1S)$. If $\chi_{c1}(3872) = \chi_{c1}(2P)$, then also near hundred of events $e^+e^- \rightarrow Z \rightarrow \chi_{c1}(3872)$ per day may be registered and several of them in the channel $\chi_{c1}(3872) \rightarrow \gamma\psi(2S)$, several tens of them in the channel $\chi_{c1}(3872) \rightarrow D^0 \bar{D}^{0*} + c.c.$

The huge Belle II luminosity $8 \times 10^{35} cm^{-2} s^{-1}$ gives possibilities to register near hundred thousand of events each $e^+e^- \rightarrow Z \rightarrow \chi_{b1}(1P)$ and $e^+e^- \rightarrow Z \rightarrow \chi_{b1}(1P)$ per day and several tens of thousands of them in the well-known channels $\chi_{b1}(1P) \rightarrow \gamma\Upsilon(1S)$ and $\chi_{b1}(2P) \rightarrow \gamma\Upsilon(2S)$.

Mesons of heavy quarks / 1

Exotic molecular states in the decays of vector bottomoniaDr. NEFEDIEV, Alexey¹¹ Lebedev Physical Institute**Corresponding Author(s):** nefediev@lebedev.ru

The most recent experimental data for the decays of the vector bottomonium Upsilon(10860) proceeding through the formation of the states Zb(10610) and Zb(10650) are analysed simultaneously using solutions of the Lippmann-Schwinger equations which respect constraints from unitarity and analyticity. The interaction potential in the open-bottom channels B(*)-anti-B* contains short-range interactions as well as the one-pion exchange; both types of the interaction are taken into account fully nonperturbatively. This way, all parameters of the interaction are fixed directly from the data and the pole positions for the Zb's are determined as a prediction. In particular, both Zb states are found to be described by poles located on the unphysical Riemann sheets in the vicinity of the corresponding thresholds: the Zb(10610) is associated with a virtual state residing just below the B-anti-B* threshold while the Zb(10650) state is most likely located just above the B*-anti-B* threshold. The heavy quark spin symmetry is employed to predict, in a parameter-free way, the pole positions and the line shapes in the elastic and inelastic channels for the Zbs' spin partner states W_bJ with the quantum numbers J++ (J=0,1,2). Such spin partners can be produced in radiative decays of the Upsilon(10860) state and, if they exist, are expected to be detected in the Belle-II experiment.

Mesons of light quarks / 2

New information on the strong isospin symmetry breaking in the reactions of the a0(980) and f0(980) resonance productionDr. SHESTAKOV, Georgii¹ ; Prof. ACHASOV, Nikolay¹¹ Sobolev Institute for Mathematics

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The strong isospin symmetry breaking is discussed as a tool for studying the production mechanisms and nature of light scalar mesons. The review considers various reactions in which it can be detected and in which the mixing of $a_0(980)$ and $f_0(980)$ resonances that breaks the isotopic invariance due to the mass difference of K^+ and K^0 mesons has already been observed experimentally.

e+e- annihilation and gamma-gamma physics / 3

R measurement at KEDR

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KEDR measured the R values at twenty two center-of-mass energies between 1.84 and 3.72 GeV. This result provides the most precise information about R in this energy range. We present results mentioned above as well as prospects for R measurement with VEPP-4M collider at KEDR experiment.

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Measurements of the J/ψ and $\psi(2S)$ leptonic widths with KEDR detector

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We report latest precise results on J/ψ and $\psi(2S)$ parameters based on the data collected with the KEDR detector at the VEPP-4M e+e- collider. Leptonic width of J/ψ meson and its composition to hadronic and electronic branching fractions have been measured directly with the processes $e+e- \rightarrow \text{hadrons}$ and $e+e- \rightarrow e+e-$ at J/ψ resonance energy range. The obtained accuracy is less than 2%. The product of the electronic width of the $\psi(2S)$ meson and the branching fraction of its decay to the muon pair has been measured in the $e+e- \rightarrow \psi(2S) \rightarrow \mu+\mu-$ process with the world best accuracy about 3%. Leptonic width of $\psi(2S)$ meson was calculated, using the previous KEDR measurements with the lepton universality assumption and without it.

Mesons of light quarks / 5

Semileptonic D^0 and D^+ decays as a probe of the $a_0(980)$ nature

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The decays $D^0 \rightarrow d\bar{u}e^+\nu \rightarrow a_0^-(980)e^+\nu \rightarrow \pi^-\eta e^+\nu$ and $D^+ \rightarrow d\bar{d}e^+\nu \rightarrow a_0^0(980)e^+\nu \rightarrow \pi^0\eta e^+\nu$ (and the charge conjugated ones) are the direct probe of the constituent two-quark components in the $a_0^\pm(980)$ and $a_0^0(980)$ wave functions. Recent BESIII experiment is the first step in experimental study of these decays. We suggest adequate formulas for the data analysis and present a variant of $\eta\pi$ invariant mass distribution when $a_0(980)$ has no constituent two-quark component at all.

Status of facilities and new projects / 6**MUonE status and plans**Dr. MARCONI, Umberto¹¹ INFN**Corresponding Author(s):** umberto.marconi@bo.infn.it

The MUonE experiment aims to measure with very high-precision the hadronic contribution to the running of alpha $\Delta\alpha_{had}(t)$, for space-like transferred momenta $t = q^2 < 0$. This measurement has to be performed by means the elastic scattering of high-energetic muons (160 GeV) on electrons target at rest. The precise knowledge of $\Delta\alpha_{had}(t)$ will allow to calculate the Leading Order Hadronic contribution a_μ^{HLO} to the muon g-2, by means of the dispersive technique, with an estimated precision comparable to the time-like traditional approach. MUonE is meant therefore as a new, complementary approach to a_μ^{HLO} . To achieve the required luminosity MUonE plans to exploit the high-intensity muon beam M2 at CERN, with an expected muon rate of about 70 MHz, and low Z material targets. The envisaged detector is segmented in about 50 identical modules, each equipped with a Beryllium 1cm thick target element and 3 to 4 silicon strip tracking planes. The module length is set to 0.5m, with transverse dimensions of $10 \times 10\text{cm}^2$, in order to get the required tracking angular resolution and the geometrical acceptance. MUonE will be equipped with state of art available detector technology. The detector is being optimized to select suitable tracking elements, to define the trigger strategy and design the DAQ system. Detailed simulation studies based on GEANT4 and fast MC are ongoing to develop the analysis strategy in the LO and NLO approximations. MUonE has been proposed to CERN in the context of the Physics Beyond Collider initiative. The plan is to be ready for data taking, with a full scale prototype, already at the restart of LHC after the LS2. I will report on the MUonE project status and plans.

Baryon formfactors / 7**The proton size radius: experiment vs theory**Prof. DOROKHOV, Alexander¹¹ JINR**Corresponding Author(s):** dorokhov@theor.jinr.ru

Brief review of the proton radius problem is given. In the framework of the quasipotential method in quantum electrodynamics we calculate the contribution of light pseudoscalar (PS) and axial-vector (AV) mesons to the interaction operator of a muon and a proton in muonic hydrogen atom. The coupling of mesons with the muon is via two-photon intermediate state. The parametrization of the transition form factor of two photons into PS and AV mesons, based on the experimental data on the transition form factors and QCD asymptotics, is used. Numerical estimates of the contributions to the hyperfine structure of the spectrum of the S and P levels are presented. It is shown that such contribution to the hyperfine splitting in muonic hydrogen is rather important for a comparison with precise experimental data.

tau-lepton / 8**Recent results on tau lepton from Belle**JIN, Yifan¹¹ The university of Tokyo**Corresponding Author(s):** jin@hep.phys.s.u-tokyo.ac.jp

The world's largest statistic of tau is collected with Belle detector. Recently, we measure the branching fraction for tau- \rightarrow pi- l+ l- nu, which is predicted by the Standard Model but not yet probed due to its small branching fraction ($O(10^{-5})$). In this presentation, we show the measured result of this mode and briefly report the status of other on-going analyses at Belle, the branching fraction of tau decay into three leptons and two neutrinos, the evaluation of Michel

parameters using tau- \rightarrow l- nu nu and the branching fraction of tau decay into three hadrons and one neutrino.

g-2 / 9

Muon g-2: a new data-based analysis

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This work presents a complete re-evaluation of the hadronic vacuum polarization contributions to the anomalous magnetic moment of the muon from the combination of e+ e- \rightarrow hadrons cross section data. Focus has been placed on the development of a new data combination method, which fully incorporates all correlated statistical and systematic uncertainties in a bias free approach. All available e+ e- \rightarrow hadrons cross section data have been analyzed and included, where the new data compilation has yielded the full hadronic R-ratio and its covariance matrix in the energy range $m_\pi < \sqrt{s} < 11.2\text{GeV}$. Using these combined data and perturbative QCD above that range results in estimates of the hadronic vacuum polarization contributions to g-2 of the muon of $a_\mu^{\text{had,LOVP}} = (693.27 \pm 2.46) \times 10^{-10}$ and $a_\mu^{\text{had,NLOVP}} = (-9.82 \pm 0.04) \times 10^{-10}$. The new estimate for the Standard Model prediction is found to be $a_\mu^{\text{SM}} = (11659182.05 \pm 3.56) \times 10^{-10}$, which is 3.7σ below the current experimental measurement.

tau-lepton / 10

Semileptonic tau decays: Powerful probes of non-standard charged current weak interactions

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Traditionally, nuclear beta decays and radiative pion decays have been thought as the best processes to look for non-standard charged current weak interactions involving light quarks. We put forward recently that semileptonic tau decays are powerful probes in this respect, too. Last advances in this direction will be reviewed and compared to limits from other low-energy processes and LHC bounds.

Mesons of heavy quarks / 11

New results and perspectives in neutrino physics

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The review of the present status and futures perspectives of study neutrino oscillations in accelerator and reactor experiments will be presented. The results obtained in current long baseline accelerator experiments T2K and NOvA are discussed. An emphasis is put on a search for CP violation in neutrino oscillations. The brief overview and status of the next generation accelerator based experiments T2HK (Japan) with 260 kt Hyper-Kamiokande far neutrino detector and DUNE (USA) with 40 kt LAr TPCs will be given. The recent progress and results obtained in searches for light sterile neutrinos in accelerator and reactor experiments will be also discussed. Finally, the direct measurement of the neutrino mass and status of neutrinoless double beta decays experiments will be presented.

tau-lepton / 12**Hadronic Decays of the tau Lepton**PASSEMAR, Emilie¹¹ *Indiana University/JLab***Corresponding Author(s):** epassema@indiana.edu

Several experimental collaborations have recently invested considerable effort in precision studies of hadronic tau decays. With further improvements expected at Belle-II, it is important to discuss the theoretical implications of these experimental advances. In this talk, I will review several such implications. First, we will show that hadronic tau decays represent a clean laboratory for the precise study of Quantum Chromodynamics (QCD) in its non perturbative regime. Second, these decays can be used as a probe of the electroweak interaction. In this respect, we will discuss how tau decays and in particular $\tau \rightarrow \ell\pi\pi$ decays can be an interesting probe for lepton flavour violation allowing to unveil new phenomena.

tau-lepton / 13**Tau mass measurement at BES-III**Dr. NIKOLAEV, Ivan¹¹ *Budker Institute of Nuclear Physics***Corresponding Author(s):** i.b.nikolaev@inp.nsk.su

We had performed a tau threshold scan with $\int L \approx 130 \text{ pb}^{-1}$ for a new tau-lepton mass measurement with BES-III detector in 2018. The beam energy is determined by laser backscattering and high-purity germanium detector which is calibrated by γ -sources. We have done J/ψ and $\psi(2S)$ -meson scans to examine beam energy measurement system. In this report we present preliminary result of the tau mass measurement.

Mesons of heavy quarks / 14**XYZ states at BESIII**Dr. SUN, Zhentian¹¹ *Institute of High Energy Physics, CAS***Corresponding Author(s):** sunzt@ihep.ac.cn

BESIII has observed a lot of unclassified states which don't suit the standard quark model. These states are named as XYZ states, such as X(3872), Y(4260), $Z_c(3900)$... Some of these states are candidates of exotic tetra-quark states, molecular states, hybrid and so on. I'll report the recent experimental results from BESIII about these XYZ states.

Baryon formfactors / 15**Charmed baryons at LHCb**Dr. DZYUBA, Alexey¹¹ *B.P. Konstantinov Petersburg Nuclear Physics Institute National Research Center "Kurchatov Institute"***Corresponding Author(s):** adzyuba@cern.ch

LHCb collected a world-leading sample of charmed baryons during LHC's Run 1 (2010-2012) and Run 2 (2015-2018). With this data set, LHCb is discovering many previously unobserved charmed states and making the most precise determinations of the properties of known states. LHCb's latest results on charmed baryons are presented.

Mesons of heavy quarks / 16**Prospects of charmonium spectroscopy at PANDA/FAIR**Dr. NERLING, Frank¹¹ *GU Frankfurt, GSI Darmstadt***Corresponding Author(s):** f.nerling@gsi.de

The PANDA experiment at the new FAIR facility under construction at GSI/Darmstadt (Germany) is dedicated to a broad hadron physics programme addressing various different aspects of QCD. The multi-purpose PANDA detector will especially be best suited for charmonium spectroscopy. In combination with an intense and high-quality antiproton beam, PANDA will be able to perform precision spectroscopy via the method of resonance energy scan measurements. The uniqueness of PANDA to contribute to the field will be discussed.

Mesons of heavy quarks / 17**XYZ at LHCb**MATIUNIN, Viacheslav¹¹ *Institute for Theoretical and Experimental Physics***Corresponding Author(s):** viacheslav.matiunin@cern.ch

The LHCb experiment is designed to study properties and decays of heavy hadrons produced in proton-proton collisions at the LHC. The large statistics collected by the LHCb experiment enables precision spectroscopy studies of beauty hadrons. The recent results on spectroscopy of conventional and exotic hadrons based on the data collected in Run-1 and Run-2 of LHC will be presented.

Dark sector, violations / 18**Search for the dark gauge vector and scalar bosons, the axion-like pseudo-scalar, and the dark matter at lepton colliders**Mr. JAEGLE, Igal¹¹ *University of Florida***Corresponding Author(s):** ignatov@inp.nsk.su

Since 1933, cosmological anomalies are reported at different scales and ages of the Universe. These anomalies could be due to a non-luminous mass ("dark matter"), change of the laws of gravity, or a combination of both. Lepton colliders can investigate the non-luminous mass scenario by searching for different dark matter candidates (millicharged dark matter, axion-like, or very stable multi-quark states) and new force carriers (dark vector, dark scalar, or axion-like). We will review the new results of BABAR and Belle, and the expected Belle II sensitivities to these searches.

Mesons of heavy quarks / 19**Charmonium studies at Belle**CHILIKIN, Kirill¹¹ *LPI RAS***Corresponding Author(s):** chilikin@lebedev.ru

We present an overview of conventional charmonium studies at Belle. It includes the observation of the $\chi_{c0}(3860)$, the measurement of the absolute branching fractions of $B^+ \rightarrow X_{c\bar{c}}K^+$, the observation of $e^+e^- \rightarrow \chi_{c1}\gamma$, and other new results.

Mesons of heavy quarks / 20**Review of bottomonium studies at Belle**Dr. MIZUK, Roman¹¹ *Lebedev Physical Institute***Corresponding Author(s):** roman.miziuk@gmail.com

We review recent Belle results on bottomonium. They include $Y(2S) \rightarrow \gamma \eta_b(1S)$ with measurement of the $\eta_b(1S)$ mass; $Y(4S) \rightarrow \eta' Y(1S)$; energy scan of $e+e- \rightarrow \omega \chi_{bJ}(1P)$; and updated result on energy scan of $e+e- \rightarrow \pi+\pi- Y(1,2,3S)$ (new for this conference).

Baryon formfactors / 21**Overview of a baryon-antibaryon pair production from electron-positron annihilation**Prof. KUPSC, Andrzej¹¹ *Uppsala University***Corresponding Author(s):** ignatov@inp.nsk.su

The well-defined and simple, initial state makes a baryon-antibaryon pair production at an electron-positron collider a perfect system to test discrete symmetries in the baryon sector and to study baryon properties. In particular the production yields are much enhanced at the vector resonances such as J/ψ and ψ' . The spin orientations of the baryon and antibaryon are correlated and, for spin one-half baryons, the pair is produced either with parallel or antiparallel helicities. The transitions to the respective helicity states can acquire a relative phase, due to the strong interaction in the final state, leading to a time-reversal-odd observable: a transverse spin polarization of the baryons. The polarization could be determined for hyperons using their weak decays. This effect was recently observed at BESIII in the $J/\psi \rightarrow \Lambda_{\bar{b}} \Lambda$ process. The polarization in baryon-antibaryon exclusive processes allows novel type of experiments such as simultaneous determination of the Λ and $\Lambda_{\bar{b}}$ decay asymmetries. In the talk the method will be described and the prospects for the studies of weak decays of hyperons and for CP tests in baryon sector will be discussed.

Mesons of light quarks / 22**Meson production in e+e- annihilation and tau-lepton decays within extended NJL model****Author(s):** Prof. ARBUZOV, Andrej¹**Co-author(s):** Prof. VOLKOV, Mikhail ² ; Dr. PIVOVAROV, Alexei ² ; Mr. NURLAN, Kanat ²¹ *Joint Institute for Nuclear Research*² *JINR, Dubna***Corresponding Author(s):** arbuzov@theor.jinr.ru

The extended Nambu–Jona-Lasinio model is briefly described and various ways of its application are demonstrated. Theoretical treatment of low-energy meson production processes in colliding e+e- beams and tau lepton decays is reviewed. The processes considered occur via intermediate scalar, vector, and axial-vector mesons in the ground state and in the first radial excited one. The model employed uses the concept of spontaneous chiral symmetry breaking to describe such states. Experimental and theoretical comparisons with other phenomenological strong interaction models are presented. The talk is based on the review [M.K. Volkov, A.B. Arbuzov, Phys. Usp. 60 (2017) 643] and a few later articles.

Mesons of light quarks / 23

The decay $J/\psi \rightarrow \gamma X(J[U+1D3E]) \rightarrow \gamma[U+03D5][U+03D5]$: Dynamical analysis of $X(J[U+1D3E]) \rightarrow [U+03D5][U+03D5]$ resonance contributions.

Dr. KOZHEVNIKOV, Arkadii¹

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The dynamics of the $J^{PC} = 0^{-+}, 0^{++}$, and 2^{++} resonance contributions to the decay $J/\psi \rightarrow \gamma X(J^{PC}) \rightarrow \gamma\phi\phi$ is analysed using the data obtained by BESIII collaboration. The effective coupling constants parameterising invariant amplitudes of the transitions $J/\psi \rightarrow \gamma X(J^{PC})$ and $X(J^{PC}) \rightarrow \phi\phi$ and masses of $X(J^{PC})$ resonances are found from the fits. They are used for evaluation of the branching fractions $B_{X(J^{PC}) \rightarrow \phi\phi}$, relative branching fractions $B_{J/\psi \rightarrow \gamma X(J^{PC}) \rightarrow \gamma\phi\phi}$, and for obtaining the photon angular distributions.

Mesons of light quarks / 24

Measurement of the $e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$ cross section below $\sqrt{s}=2\text{GeV}$

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The process $e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$ is studied at the center-of-mass energy below 2 GeV with the SND detector at the VEPP-2000 e^+e^- collider. The four intermediate states contribute to this process: $\omega\eta$, $\phi\eta$, $a_0(980)\rho$, and a structureless $\pi^+\pi^-\pi^0\eta$ state. We measure the total $e^+e^- \rightarrow \pi^+\pi^-\pi^0\eta$ cross section and the cross sections for its components: $\omega\eta$, $\phi\eta$, and a sum of $a_0(980)\rho$ and the structureless state. Our results are in agreement with previous measurements and have comparable or better accuracies.

tau-lepton / 25

Tau physics at Belle II

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The Belle II experiment is a detector coupled to the SuperKEKB electron-positron accelerator, located in Tsukuba, Japan. From April to July of 2018, Belle II completed the Phase II of commissioning in which ~ 500 pb⁻¹ of data was recorded. Phase III will start in 2019 and, by 2025, a dataset of 50 ab⁻¹ is expected. This large dataset will provide a unique opportunity to study tau lepton physics with high precision. In this talk, the tau lepton rediscovery and mass measurement using the Phase II data will be presented, followed by a review of the tau physics program for Phase III.

Baryon formfactors / 26

Baryon form factors at BESIII

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In this talk, I shall present some recent progresses at BESIII for the studies of baryon form factors, including the measurement of Lambda electromagnetic form factors, the proton electromagnetic

form factor in $e+e-\rightarrow p\bar{p}$ in energy region 2.0 - 3.08 GeV. These results will be followed by a short discussion about how does that improve our knowledge of the baryon form factors and the prospects of the BESIII program in this area.

Mesons of light quarks / 27

Light mesons from decays

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The τ is the only lepton massive enough to decay into hadrons. Its semileptonic decays provide a privileged scenario to study low-energy effects of the strong interactions under rather clean conditions. Such advantageous framework is used to improve our understanding of the hadronization of QCD currents, to study meson form factors and to extract the physical parameters of the intermediate resonances produced in the decay. In this talk, we will review the status of the hadronic decay modes with particular attention to its decays into two hadrons. By exploiting the synergy between dispersion relations and Chiral Perturbation Theory we describe the meson form factors that come up into play. We will also briefly review higher-multiplicity decay modes. These involve a richer dynamical structure but accounting for the strong rescattering effects is not an easy task when three or more hadrons are present. The fantastic possibilities offered by the Belle-II experiment to study physics and low multiplicity final states with high precision make these studies of timely interest.

Mesons of heavy quarks / 28

Charm Physics

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Understanding charm hadrons structures and dynamics motivates many studies within QCD. In particular Lattice QCD can provide us with precise calculation of the hadronic inputs required in the extraction of the CKM matrix elements as well as leads to understanding of the exotic QCD structure as tetraquarks.

In the electroweak sector B meson anomalies and muon anomalous magnetic moments initiated many studies of physics beyond the Standard Model. The question is whether charm sector can be affected by the same New Physics.

Intensive studies of Dark Matter stimulated a number of studies aimed to constrain or observe its presence in charm meson decays with the invisible particles in the final state.

Mesons of light quarks / 29

An amplitude analysis of the $e+e-\rightarrow 4\pi$ reaction

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My talk is about an analysis of the process $e^+e^- \rightarrow 4\pi$ with the CMD-3 detector at the VEPP-2000 Collider in the energy range 0.9–2.007 GeV. In my contribution I will focus on the study of the intermediate dynamics of the reaction, i.e. I will talk about the results in the distinguishing of different intermediate mechanisms. The dominance of the $(\omega\pi^0)$ and $(a_1\pi)$ amplitudes will be proved, as well as the contribution of the $\rho^+\rho^-$, ρ^0 , $\rho^0\sigma$ and etc. states will be discussed. Also, I will demonstrate the test of the isospin relation between the processes $e+e-\rightarrow \pi^+\pi^-\pi^0$

Mesons of heavy quarks / 30**XYZ at Belle**Dr. LANGE, Jens Soeren¹¹ *University Giessen***Corresponding Author(s):** ignatov@inp.nsk.su

New results and present status of exotic, narrow states with heavy quarks, often referred to as “XYZ states”, at the Belle experiment will be presented. Not only observations, but also results of negative searches will be reviewed. Interpretation in view of the landscape of so far observed conventional and exotic states will be attempted, with comparison to theory expectations.

Dark sector, violations / 31**Search for highly ionizing particles with the Belle II pixel detector**Ms. DORT, Katharina¹¹ *Justus Liebig University Giessen***Corresponding Author(s):** katharina.dort@physik.uni-giessen.de

The Belle II experiment, located at the SuperKEKB collider at the high-energy research facility KEK in Tsukuba, Japan, started operation in 2018. Compared to the predecessor experiment Belle, Belle II plans to increase the peak luminosity by a factor of <40, by employing nano-beam technology in the interaction region.

In particular the new, innermost sub-detector of Belle II - the Pixel Vertex Detector (PXD) - is in close proximity to the interaction point. This allows for the detection of particles, which do not leave a signal in the outer sub-detectors. Among these, Highly Ionizing Particles (HIPs) encounter a characteristically high energy loss, limiting their penetration depth into the detector. Anti-deuterons, magnetic monopoles and stable tetraquarks as possible HIPs are considered. Without a signal in the outer sub-detectors, no track trigger is issued, resulting in possible non-observation. Therefore, in this talk, the possibility of identifying HIPs solely with information provided by the PXD is presented, by using neural network algorithms operating in a multidimensional parameter space of e.g. PXD cluster data. Most notably, the application of unsupervised learning in the form of Self-Organizing Maps (SOM) is presented.

32**STUDY OF PRODUCTION OF FOUR CHARGED PIONS WITH CMD-3 DETECTOR AT VEPP-2000 COLLIDER****Author(s):** Mr. KOROBV, Alexandr¹**Co-author(s):** Dr. EIDELMAN, Simon ¹¹ *Budker Institute of Nuclear Physics***Corresponding Author(s):** korobovfech@gmail.com

The cross section of the process $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ has been measured using an integrated luminosity of 17 pb^{-1} collected with the CMD-3 detector in the center-of-mass energy range 650-1000 MeV. High-precision measurements of various hadronic cross sections are of great interest in relation with the problem of the muon anomalous magnetic moment $g-2$. This measurement can be also used to test the relation between the cross-section of $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ and the spectral function for the $\tau^- \rightarrow \pi^-\pi^0\pi^0\pi^0$ decay predicted by the conservation of vector current(CVC).

Dark sector, violations / 33**COMET status and plans**

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Lepton Flavour Violation in the charged lepton sector (CLFV) is forbidden in the Standard Model. Therefore, the observation of CLFV process would be clear evidence of physics beyond the Standard Model. The COMET (COherent Muon to Electron Transitions) experiment will measure one of these processes: $\mu N \rightarrow eN$ at the Japan Proton Accelerator Research Complex (J-PARC) in Tokai, Japan. The COMET experiment will be conducted in two phases. Phase-I of the experiment is aiming at a signal sensitivity of 3.1×10^{-15} . Phase-II will use much more intense beam and a more complex detection system to achieve a single-event sensitivity of $\sim 3 \times 10^{-17}$. This report gives an overview of construction and status of the COMET experiment.

Mesons of light quarks / 34

The Neutral Pion Radiative Width: The Final Result from PrimEx (Jefferson Lab)

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The $\pi^0 \rightarrow \gamma\gamma$ decay amplitude is determined by the chiral anomaly. Recent theoretical calculations have been made within Chiral Perturbation Theory and predict decay width at a percent precision level. Precise measurement of $\pi^0 \rightarrow \gamma\gamma$ decay width gives a possibility to check these predictions. The PrimEx experiment unutilized Primakoff effect to measure π^0 radiative decay width. Primakoff effect is a powerful tool for measuring radiative width of particles. In this talk, the final result of the PrimEx experiment performed in Hall-B at Jefferson Lab will be presented. The PrimEx-I experiment performed in 2004 achieved precision of 2.8%. PrimEx-II has been conducted in 2010 with a collection of five times more statistics and achieved 1.6% precision. $\eta \rightarrow \gamma\gamma$ decay width measurement experiment planned at Jefferson Lab will also be discussed. The project was supported in part by NSF MRI PHY 0079840 and RFBR 18-02-00938.

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Measurement of the $e^+e^- \rightarrow n\bar{n}$ cross section with the SND detector at the VEPP-2000 collider

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New data on $e^+e^- \rightarrow n\bar{n}$ cross section from the 2017 run with the SND detector at the VEPP-2000 collider are presented. The integrated luminosity above nucleon-antinucleon threshold is 17 inverse picobarn. The new measured cross section is compared with previous data.

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Recent BaBar results in light hadron spectroscopy

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A program of measuring the light hadrons production in exclusive $e^+e^- \rightarrow \text{hadrons}$ processes is in place at BABAR, with the aim to improve the calculation of the hadronic contribution to

the muon $g-2$. We present the most recent results obtained by using the full data set of about 470 fb^{-1} collected by the BABAR experiment at the PEP-II e+e- collider at a center-of-mass energy of about 10.6 GeV. In particular, we report the results on the channels $e+e- \rightarrow \pi+\pi-\pi^0\pi^0$, $\pi+\pi-\pi^0\pi^0(\eta)$, $e+e- \rightarrow \pi+\pi-\eta$. Additionally, we present the study of the two-photon process $e+e- \rightarrow e+e-\eta'$ in the double-tag mode. The results for the form factor are compared with the predictions based on pQCD and VMD.

tau-lepton / 37

Measurement of Michel parameters in tau decays at high luminosity e+ e- factories

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Michel parameters (MP) define the Lorentz structure of the Charged Weak Interaction mediated by W boson in the Standard Model (SM). They are in the list of the basic properties of tau lepton. The difference of the measured MP from their SM expectation will exhibit clear signature of the New Physics. We discuss the key points of the analysis of the huge data sample of taus collected at Belle to measure MP in leptonic tau decays. Essential point of the analysis is to consider the spin-spin correlation of taus, which allows us to extract MP related to tau polarization. At the e+ e- factories with unpolarized beams one have to analyze decay products of both taus to be sensitive to the spin-spin correlation. Nonzero average polarization of single tau at the Super Charm-Tau factory with polarized e- beam provides unique possibility to measure all Michel parameters without tagging the opposite tau.

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Two-photon physics at Belle

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The Belle experiment has measured various two-photon physics processes, mostly using a no-tag method, and for a few of them also a single-tag technique. This way to analyze physics processes is useful to investigate transition form factors, as well as search for XYZ exotic states and baryons. A review of the main achievements at Belle will be given, and recent results will be shown.

Mesons of light quarks / 39

Light mesons from JPAC analyses

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Identifying properties of excited hadronic states in the light meson sector remains an ongoing challenge, due to large widths, significant overlaps, and multiple decay channels of the resonances. A systematic approach using the unitarity-based coupled channel frameworks is required; for the reaction-independent determination of the resonance parameters, the pole positions of the resonances need to be extracted. As will be shown in the talk, several works in this direction have been performed by the Joint Physics Analysis Center (JPAC) in the past year in the tensor ($J^{PC} = 2^{++}$) and exotic ($J^{PC} = 1^{-+}$) waves of $\eta(\prime)\pi$ system measured by the COMPASS experiment (PLB 779 (2018) and PLB 779 (2018)). The spin-exotic sector $J^{PC} = 1^{-+}$ is also accessible from the partial wave analysis of the three pions system measured in diffractive reaction $\pi p \rightarrow 3\pi p$, however, the studies are hampered by the presence of a large, coherent, non-resonant

background, known as the Deck process. I will highlight ongoing work on a comparison of the various models for this non-resonant production and show its influence found in the data. As the first steps in the route of understanding interaction in the $J^{PC} = 1^{++}$ sector and the Deck process, we have built a model based on the approximate three-body unitary, fixed the free parameters by fitting it to the clean ALEPH data on $\tau \rightarrow 3\pi \nu_\tau$ decay. The pole position of the $a_1(1260)$ has been extracted for the first time using the unitary model (PLB 779 (2018)).

Baryon formfactors / 40

The neutron EDM and bounds on rare decays of eta and eta-prime mesons

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Here will be present an improved estimate of the CPV coupling constants of the η and η' mesons to two pions using upper limits from data on the neutron electric dipole moment (nEDM). Using a phenomenological Lagrangian approach based on nonderivative couplings of the pseudoscalar mesons with nucleons, we include the full momentum dependence of the eta-pi-pi or eta-prime-pi-pi couplings in a two-loop approach to the nEDM calculation. Furthermore, this approach enables the inclusion of charged pion loops, therefore allowing for the leading electric photon minimal couplings. The upper limits for the rates of the CPV decays eta(eta-prime) into pair of pions that we derive are by orders of magnitude more stringent than those from the existing experiments so far.

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Meson Decay Studies from MAMI A2

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Decays of the light mesons π^0, η, ω , and η' provide a unique laboratory to test fundamental aspects of hadron physics. Precision studies of such diverse topics as the light quark mass ratio, $\pi - \pi$ scattering lengths, and searches for physics beyond the Standard Model are possible. Additionally, their Dalitz decays provide a way of measuring the electromagnetic meson Transition Form Factors (TFFs) in the time-like region. Precise knowledge of pseudoscalar TFFs is vital for the precision frontier of the Standard Model as they are needed as experimental input in calculations of the hadronic Light-by-Light contribution to the anomalous magnetic moment of the muon.

The A2 tagged photon facility at the Mainz Microtron (MAMI) provides a high yield of light mesons produced by photo-induced reactions on protons. It makes the experiment ideal for high precision measurements of meson decays. The experimental setup utilises the Bremsstrahlung distribution of the A2 photon beam, produced from the MAMI electron beam, along with a system of detectors that nearly covers the full solid angle.

This talk will highlight the recent contributions as well as ongoing studies by the A2 collaboration in the field of light meson interactions.

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Precision Hadron Physics at the future MESA accelerator

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Based on the expertise in high-intensity electron accelerator technology at the Mainz Microtron MAMI, a new accelerator MESA (Mainz Energy-Recovering Superconducting Accelerator) is currently under construction at the Institute for Nuclear Physics at Johannes Gutenberg University Mainz. MESA will be operated at low beam energies below 155 MeV, but at high intensities of at least 1 mA of beam current. The high intensity will provide the basis for a series of precision experiments in the fields of hadron and low-energy particle physics. In this talk, highlights of the research programme at MESA will be discussed including a new measurement of the electroweak mixing angle at low momentum transfer (P2 experiment), measurements of the electromagnetic form factors of the nucleons (MAGIX experiment) as well as searches for dark sector particles (the MAGIX and the beam dump experiment BDX). These experiments will be operated either in the extracted beam mode of MESA (P2 and BDX) or in the energy-recovering mode (MAGIX) of the accelerator, in which for the first time a high-intensity energy-recovering beam will be operated in conjunction with a gas internal target.

Status of facilities and new projects / 43

MEG2 and Mu3E status and plans

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The status of the MEG II experiment, the upgrade of MEG, whose goal is to search for the forbidden decay $\mu \rightarrow e \gamma$ with increased precision, is presented. After a brief review of the motivations behind such a search and the current limit due to MEG, we present the design of the detector in detail. The motivations of the upgrade of each subdetector is presented with the resolution improvements expected and measured. Novel subdetectors and calibration hardware are introduced. Results from beam tests on the subdetectors are presented. The schedule of the forthcoming years is presented. We conclude with the expected sensitivity of the MEGII experiment.

tau-lepton / 44

Leptonic decays of the tau lepton

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I will review of theoretical aspects of the tau leptonic decays, including the radiative ($\tau \rightarrow l \gamma \nu \bar{\nu}$) and the five-body ($\tau \rightarrow ll \nu \bar{\nu}$) decay modes, which are among the most powerful tools to study precisely the structure of the weak interaction and to constrain possible contributions beyond the V-A coupling of the Standard Model.

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Strange Light Resonances

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I will review recent work on the determination of strange resonance parameters from meson-meson scattering data, using dispersion relations and other techniques based on analytic properties of amplitudes. Although I will discuss resonances below 1.7 GeV, I will pay particular attention to the lightest strange resonance $K^*(800)$ or kappa meson and the dispersive determination of its existence and its pole parameters as well as its possible non-ordinary nature.

Flavour / 46**Open Charm Physics at BESIII**Dr. WEIDENKAFF, Peter¹¹ *Institut fuer Kernphysik, Mainz***Corresponding Author(s):** ignatov@inp.nsk.su

The BESIII experiment at the BEPCII collider analyses e^+e^- collisions in the charmonium region. The accessible energy range covers several charm related thresholds, such as $D\bar{D}$, $D_s D_s^*$. BESIII has recorded large samples at those energies and the special topology of quantum-correlated pairs of D decays serves as ideal laboratory for the study of charm decays.

In this talk we present recent results from the analysis of D^0 , D^+ and D_s decays. In particular, the measurement of form-factors and decay constants using leptonic and semi-leptonic final states and results from partial-wave analyses and branching fraction measurements of hadronic final states.

e+e- annihilation and gamma-gamma physics / 47**Recent results from SND detector at VEPP-2000 collider.**Prof. ACHASOV, Mikhail¹¹ *BINP***Corresponding Author(s):** m.n.achasov@inp.nsk.su

Recent results on e+e- annihilation to hadrons from SND experiment at VEPP-2000 collider are presented. Corresponding data set is about 80 pb-1 of integrated luminosity collected at sqrt{s} below 2 GeV.

e+e- annihilation and gamma-gamma physics / 48**Recent results on hadronic Physics at KLOE-2**Dr. CURCIARELLO, Francesca¹¹ *INFN-Laboratori Nazionali di Frascati***Corresponding Author(s):** francesca.curciarello@lnf.infn.it

The KLOE-2 experiment at the Frascati ϕ -factory ended last year collecting more than 5 fb^{-1} at the ϕ peak. The new data sample together with the KLOE one corresponds to 2.4×10^{10} and 3.1×10^8 η meson events. It represents the largest sample ever collected at the ϕ peak in e^+e^- colliders allowing to study light mesons with unprecedented statistics.

Recent results obtained with KLOE data on hadron physics e.g. rare η meson decays, combination of hadron cross section measurements and determination of $a_\mu^{\pi\pi}$, measurement of the running of the fine structure constant below 1 GeV and progress in $\gamma\gamma$ studies will be reviewed.

Status of facilities and new projects / 49**BINP electron-positron facilities****Author(s):** SHWARTZ, Dmitry¹**Co-author(s):** Dr. SHATUNOV, Petr²¹ *BINP*² *Budker Institute of Nuclear Physics***Corresponding Author(s):** dshwartz@inp.nsk.su

The overview of two running BINP electron-positron colliders VEPP-4M (1-5 GeV/beam) and VEPP-2000 (0.15-1 GeV/beam) is presented. Since 2016 both colliders are joint to the single

accelerator complex via common injector of high quality intensive beams. In 2017 VEPP-2000 resumed data taking after 3 years of upgrade. The luminosity was increased in a factor of 3-5 in a whole energy range.

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Low-energy electron-positron collider to search and study ($\mu^+ \mu^-$) bound state

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From six leptonic atoms ($e^+ e^-$), ($\mu^+ e^-$), ($\mu^+ \mu^-$), ($e^+ e^-$), ($e^+ \mu^-$), ($e^+ e^-$) only positronium ($e^+ e^-$) and muonium ($\mu^+ e^-$) were observed. Observation and study of dimuonium ($\mu^+ \mu^-$) will test QED and quantum mechanics computations in the new regime. Dimuonium radius is 200 times smaller than positronium; therefore, it has a higher new-physics reach potential in comparison with other exotic atoms. We propose a low energy $e^+ e^-$ collider for production of the not yet observed ($\mu^+ \mu^-$) bound system. Low beam energy $E_{\text{beam}} \approx 400$ MeV and small circumference ≈ 30 m of the machine make it inexpensive to manufacture and operate. Large angle ($[U+3016] 75 [U+3017] \hat{\circ}$) crossing of $e^+ e^-$ beams produces dimuonium with non-zero momentum shifting decay point from beams collision area and providing effective suppression of the main source of background $[U+F02D]$ elastic $e^+ e^-$ scattering. The peak luminosity at $\mu^+ \mu^-$ production threshold is $8 \times [U+3016] 10 [U+3017] \hat{3} 1 \text{ cm}^2 \text{ s}^{-1}$. Reversing one of the beams direction allows to study π^\pm and η $[U+F02D]$ mesons with high luminosity.

g-2 / 51

Axial-vector meson LbL contribution to g-2 of muon in non-local quark model

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The light-by-light contribution to muon anomalous magnetic moment from axial-vector meson exchanges is estimated in the framework of nonlocal quark model. The full kinematic dependence of the transition form-factor is taken into account. The comparison with existed parametrizations based on the experimental data on the transition form factor is performed. The corresponding contribution to the hyperfine splitting in muonic hydrogen is discussed.

Status of facilities and new projects / 52

LHCb status and plans

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This talk will present a status overview of ongoing LHCb upgrade. The new detector is designed to operate at the instantaneous luminosity of $2 \cdot 10^{33} \text{ cm}^{-2}\text{s}^{-1}$, more than five times higher than in Run 2. A crucial part of the upgrade is the software-only trigger, which should be able to select the desired events at 30MHz input rate with up to six visible interactions per bunch crossing. Current upgrade status and highlight performance results will be shown. In addition, the LHCb physics program and preparation for future challenges will be presented.

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FARICH system: prototyping and simulation progress report

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The excellent PID system is needed for successful execution of the broad experimental program at future Super C- Factory in Novosibirsk. The main requirements for PID system are following: good π/K -separation in whole operational momentum range and good μ/π -separation in momentum range from 0.4 up to 1.2 GeV/c. The RICH detector based on focusing aerogel (FARICH) suits for all these requirements. The method FARICH is described and beam test results are presented. The scheme of the FARICH system for the universal detector of Super C- Factory project is given.

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Simulation of physics background in Super c-tau factory detector

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Simulation of background particle fluxes generated by colliding beams is performed with FLUKA package for the Super C-Tau factory Detector (SCTD). Two processes are considered as main sources of luminosity generated background: two-photon production of electron-positron pairs and Bha-Bha scattering with bremsstrahlung photon emission (radiative Bha-Bha). The SCTD geometry is described corresponding to the last version of the Conceptual Design Report. The magnetic field based on the calculation in ANSYS is introduced in the model. Main results of the simulation for beam energy of 3.5 GeV, luminosity of $10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and 1.5 T magnetic field are the following: charged particle fluence in the region of the Inner Tracker (radius 5 cm – 20 cm, Z between -30 cm and 30 cm) is between 10^5 particles/cm²s and $\sim 10^3$ particles/cm²s; 1-MeV neutron equivalent fluence for Si in the regions corresponding to electronics of the Inner Tracker and the Drift Chamber is below $10^{11} \text{ n/cm}^2\text{y}$ and absorbed dose is below 100 Gy/y in the hottest regions of the detector.

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Proposal of the muon system for the Super Tau-Charm factory

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The talk is devoted to the results of the Super Charm-Tau factory muon system simulation. The first estimation of the main characteristics such as space resolution and muon identification efficiency are presented. A design of the muon system for the Super Charm-Tau factory based on the organic scintillator + WLS fiber + SiPM is proposed.

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Development of the CsI(Tl) based muon beam profile monitor for the muon $g-2$ /EDM experiment at J-PARC

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The muon $g - 2$ /EDM experiment at J-PARC is preparing to investigate the discrepancy of $\sim 3.5\sigma$ between measured muon $g - 2$ and Standard Model prediction. The experiment uses the surface muon beam stopped and cooled in an aerogel target, then re-accelerated up to 300 MeV/c and injected to the storage magnetic field where the Si strip tracker is placed. The sophisticated accelerator apparatus has to be developed and operated. What should be accompanied by proper beam diagnostic systems. In such a way the task of continuously monitoring transfer profile of the upcoming to the aerogel target surface muon beam is arise. One of solutions is to use a thin $5\mu\text{m}$ CsI(Tl) foil with optical read out.

During the beam test three different CsI(Tl) foils were used, we had performed linearity study, and tried different BPM configuration: with a mirror and without it. In the last case three different angles respect to the beam axis were used. Also the effect of a mylar foil on light collection efficiency was studied, and signal dependence on muon momentum was observed. The proposal of a thin CsI(Tl) foil based BPM for the muon $g - 2$ /EDM experiment at J-PARC is presented.

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Off-shell fermion polarization and t-quark production

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Standard calculation of polarization of final electron for pure initial state may be reformulated as a problem of looking for the complete polarization axis of produced state. In this problem the scattering amplitude is used (instead of its square in standard approach) and it gives method for calculation of polarization applicable for both final and intermediate state fermions. For this purpose it is convenient to use fermion propagator (bare or dressed) in form of spectral representation, which is based on eigenvalue problem and gives the system of orthogonal off-shell energy projectors.

These two points together: (i) problem of looking for the complete polarization axis and (ii) spectral representation of fermion propagator allow to give a correct definition for polarization of intermediate fermion.

Most interesting is the case of fermion resonance (i.e. dressed propagator) in theory with P-parity violation. Corresponding the energy projection operators differ from the standard off-shell projectors and also contain γ^5 . Moreover, in such theory the standard spin projectors do not commute with propagator and also should be modified.

The obtained projectors are used to give the most accurate parametrization of t-quark resonance curve and simultaneously for its off-shell polarization.

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Isoscalar and isovector kaon form factors from e+e- and data

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The recent precise measurements of the $e^+e^- \rightarrow K_S K_L$ and $e^+e^- \rightarrow K^+ K^-$ cross sections and the hadronic spectral function of the $\tau^- \rightarrow K^- K_S \nu_\tau$ decay are used to extract the isoscalar and isovector electromagnetic form factors and their relative phase in a model independent way. The experimental results are compared with a fit based on the vector-meson-dominance model.

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Simulation of different options of the Inner Tracker for Novosibirsk Super Charm-Tau Factory Detector

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Inner Tracker of Novosibirsk Super Charm-Tau Factory Detector (SCTD) has to measure momenta of soft hadrons, which do not reach the drift chamber; complement the drift chamber in measuring the momenta; detect secondary vertices of short-lived particles. Thus, proper choice of the option for the Inner Tracker is of significant interest. The simulation of charged pions propagation in the perpendicular direction to the beam axis was carried out with DD4HEP program based on GEANT4. Three options were considered: 4-layer cylindrical silicon strip detector, 4-layer cylindrical Gas Electron Multiplier (GEM) detector and Time Projection Chamber (TPC). The Detector in the simulation was located in 1.5 T magnetic field directed along beam axis. The simulation shows that pions with initial momenta less than 50 MeV/c do not pass through the beampipe and cannot be registered. Pions with momenta above 65 MeV/c leave energy depositions in all 4 layers of the Inner Tracker based on silicon strips, and their trajectories can be reconstructed. Cylindrical GEM detector provides reconstruction possibility (hits in 4 layers) for pions with momenta more than 60 MeV/c. TPC with thin inner wall provides reconstruction of pions with momenta higher than 55 MeV/c. However, in this case the reconstruction procedure will be much more complicated due to large number of background particle tracks in the sensitive volume.

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PID system for STC factory project based on threshold aerogel Cherenkov detectors

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The particle identification (PID) system based on the threshold aerogel Cherenkov detectors has been suggested for Super Charm Tau factory project. The main aim of the system is to separate pions and muons in the momentum range from 450 to 900 MeV/c. For this purpose counters with two different refractive indices (1.015 and 1.030) are arranged in 3 layers. The system employs the ASHIPH method of Cherenkov light collection. To increase the number of detected photons the SiPM photodetectors are used. This helps to extend the working momentum region of PID system. The main characteristics of system design are presented.

61

Identification of the $e^+e^- \rightarrow n \bar{n}$ anti-n events in CMD-3 detector

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Identification technique of the $e^+e^- \rightarrow n\bar{n}$ events is described.

Neutron passing through the detector systems does not interact with the calorimeter and can not be registered. Antineutron annihilates in the calorimeter and as a result of the interaction a number of new particles are born, which can be registered. Near the production threshold antineutrons have a relatively low velocities and correspondingly a long time of flight through the detector. The average times of annihilation in the calorimeters have a typical delay time about 4–11 ns with respect to the beam collision, which can be used for the identification of the $e^+e^- \rightarrow n\bar{n}$ events.

The main background events in this case are cosmic events which comes at random times, and its number is 10^4 times more than $n\bar{n}$ events. The described technique of identification $n\bar{n}$ events is using main detector systems and neural network to reduce the background of cosmic events.

Dark sector, violations / 62

New Physics Beyond the SM at BESIII

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Numerous astrophysical observations strongly suggest the existence of Dark Matter, which provides a hint of dark sector physics. There could exist many dark candidates predicted by theories BSM, such as dark photons and invisible things, that communicate with the Standard Model sector. The masses and decay modes of these particles are expected to be accessible at the BESIII experiment which is the only currently running tau-charm factory with the largest threshold charm samples and some other unique datasets. We have recently performed searches of dark photons and invisible things in several decay modes. Besides, light Higgs, FCNC processes, BNV/LNV processes are also investigated. This talk will summarize the recent results at BESIII on these searches for new physics BSM.

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

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The preliminary cross-section of this process are obtained. The collected luminosity is 33 reverse pb.

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The Super C- τ Factory PID system options.

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The Super C- τ Factory at Novosibirsk is a project of electron-positron collider with luminosity $10^{35} \text{cm}^{-2}\text{s}^{-1}$ for experiments at energy range of τ -lepton and charmonium states production. To investigate rare decays of D-mesons or τ -leptons and for search of “new Physics” the excellent particle identification system is needed. The main requirements for PID system are following: good π/K -separation in whole operational momentum range and good μ/π -separation up to 1.2 GeV/c. Few options are under consideration today: FARICH (Focusing Aerogel RICH) based on 4-layer aerogel tiles and more than 1 million channels photon detection pixels, threshold ASHIPH (Aerogel SHifter PHotomultiplier) counters with 6000 liters of aerogel of two refractive indexes and TOF approach with time resolution better than 30 ps. All options are described. Results of simulation and some results of prototypes tests are presented.

tau-lepton / 66

Physics with tau leptons at CMS

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Tau lepton is an important tool for new physics searches at the LHC. This talk focuses on the measurement of the reconstruction and identification performance of the hadronic tau decays by the CMS detector. The measurements include the performance of the identification, trigger, energy calibration and decay mode classification algorithms for reconstructed tau candidates. Applications of the developed tau reconstruction algorithms to physics measurements with tau leptons at CMS detector are also presented.

Flavour / 67

Recent results on Kaon Physics at KLOE-2

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KLOE-2 extends the physics program of the forerunner KLOE experiment, especially in the field of discrete symmetries tests with neutral kaons. KLOE and KLOE-2 have collected together the largest sample of electron-positron collisions at an energy equal to the ϕ -meson mass, corresponding to about 2.4×10^{10} produced mesons.

In this talk I will review the latest results on neutral kaon physics at KLOE together with the status and prospects of the analyses of KLOE-2 data. I will report about a new measurement of the charge asymmetry in K_S semileptonic decays with 1.7fb^{-1} of KLOE data, which improves the sensitivity of previous measurements of about a factor two. Furthermore, I will discuss the status of the analysis devoted to directly test T and CPT symmetries in neutral kaons transitions, as well as the search of the pure CP-violating $K_S \rightarrow 3\pi^0$ decay using part of the recently acquired KLOE-2 dataset.

Status of facilities and new projects / 68**Super Charm-Tau project at Novosibirsk**LOGASHENKO, Ivan¹¹ BINP**Corresponding Author(s):** i.b.logashenko@inp.nsk.su

The Super Charm-Tau factory at the Budker Institute of Nuclear Physics (Novosibirsk, Russia) is an electron-positron collider that will operate in the center-of-mass energy range from 2 to 5-6 GeV with the peak luminosity of about $10^{35} \text{ cm}^{-2}\text{s}^{-1}$. The main goal of experiments is to study processes with c quark or leptons in the final state. The experiments at Super Charm-tau factory are complementary to experiments at LHCb and Belle-II.

We'll discuss the physics case for the Super Charm-Tau factory, the conceptual design of the collider and the detector and the status of the project.

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Study of the process $e^+e^- \rightarrow K^+K^-\pi^0$ with the CMD-3 detectorMr. EROFEEV, Andrei¹¹ Budker Institute of Nuclear Physics, Novosibirsk State University**Corresponding Author(s):** andrikola@yandex.ru

The process $e^+e^- \rightarrow K^+K^-\pi^0$ has been studied at a center-of-mass energy up to 2 GeV using a 80.6 pb^{-1} data sample collected with the CMD-3 detector at the electron-positron collider VEPP-2000. The preliminary results of the cross-section measurement are presented.

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Muon-electron scattering at NLODr. CARLONI CALAME, Carlo M.¹ ; Prof. MONTAGNA, Guido² ; Dr. PICCININI, Fulvio¹ ; Dr. NICROSINI, Oreste¹ ; Dr. CHIESA, Mauro³¹ INFN, Sezione di Pavia - Pavia, Italy² Dipartimento di Fisica, Universita' di Pavia - Pavia, Italy³ Wurzburg Universitat**Corresponding Author(s):** carlo.carloni.calame@pv.infn.it

In this talk, based on arXiv:1811.06743, I will review the NLO electro-weak radiative corrections to the $\mu^\pm e^- \rightarrow \mu^\pm e^-$ process and discuss their relevance for the MUonE experiment, proposed at CERN.

The aim of MUonE is the high precision measurement of the QED running coupling constant in the space-like region, from which the full hadronic contribution can be extracted and used to provide a new and independent determination of the leading-order hadronic correction to the muon $g - 2$.

In this context, the required accuracy demands that radiative corrections are accounted for at the highest level of precision and implemented into a Monte Carlo event generator for data analysis. The first step towards the final goal of theoretical precision, which will require the full set of NNLO corrections and resummation of higher orders, is the inclusion of NLO electro-weak corrections.

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Baryon Studies at Belle

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Although 10 years have passed since the last beam time of Belle, baryon spectroscopy analysis using 980 fb⁻¹ data sample collected by the KEKB e⁺e⁻ collider near Υ resonances is still active. Over the last few years, we have discovered new excited Ω and Ξ baryons. In the charmed baryon region, we observed a doubly Cabibbo-suppressed decay of Λ_c^+ and measured masses and widths of excited Ξ_c baryons precisely. In this presentation, there will be a review of the baryon studies in Belle in recent years. The baryon studies expected from Belle II will also be briefly explained.

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Open charm studies at Belle

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Until recently, parameters of vector charmonia lying above the open-charm threshold were determined from the inclusive cross section of the electron-positron annihilation to hadronic final states. However, the parameters of the resonances obtained this way are model-dependent and they suffer from large uncertainties. On the other hand, measurements of exclusive cross sections of the e⁺e⁻ annihilation to charm hadrons should provide important missing information about strong interaction in this region so that the results of such measurements are of large interest both for developments of experimental methods, and theory. In particular, the aforementioned measurements should shed light on the nature of the charminium states with quantum numbers 1⁻-, which are not fully understood yet. Determination of the masses and widths of these resonances in a model-independent way and extraction of their coupling constant to elastic open-charm channels will allow to obtain information on the wave functions of the vector charmonia and to verify the phenomenological models for heavy hadrons. New results are obtained for the exclusive cross sections of the e⁺e⁻ annihilation into charmed hadron pairs with initial state radiation. The analysis is based on the data sample collected with the Belle detector with the integrated luminosity of 951 fb⁻¹. The accuracy of the cross section measurement is increased by a factor of 2 compared with the previous Belle study and, for the first time, the e⁺e⁻ → D^{*}D^{*} cross section is decomposed into three components corresponding to different helicities of the D^{*}'s in the final state.

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Charmonium studies at LHCb

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A large set of data collected by the LHCb experiment in proton-proton collisions at $\sqrt{s}=7,8$ and 13TeV allows many precise measurements for charmonia production and properties, in particular, the precise determination of the masses and the natural widths of several charmonium states.

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Theoretical Aspects of XYZ states

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Selected theoretical aspects of the XYZ states, including different structure models and effects from kinematical singularities, will be discussed.

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Charmonium at BESIII

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BESIII is an ideal laboratory to study charmonium decays, due to its largest sample on J/psi, psi(2S) etc. Its achieved luminosity has reached the design luminosity. Recently, a lot of interesting studies are performed by BESIII, such as study of psi(2S) -> e+ e- chi_cJ, chi_cJ -> e+ e- J/psi, J/psi -> Lambda_c+ e- + c.c. etc. This talk will introduce a few of them briefly.

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COMPASS++/AMBER and the Proton Radius Puzzle

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CERN provides the large variety of high-energy beams for nuclear and particle physics research. One is the beam line M2 which is optimized to deliver an intense muon beam, but also hadron beams of both polarities. They are brought to an overground hall, which is used since many years almost exclusively by the COMPASS collaboration, with a broad experimental physics program on Quantum Chromodynamics (QCD). The most relevant results and activities of the collaboration, in terms of pion-photon reactions for determination of the chiral anomaly and the related radiative width of the rho meson, will be discussed.

Since many questions around QCD remain still open, the follow-up facility COMPASS++/AMBER is envisaged, aiming at up-to-date detector architecture and a large variety of measurements. They range from lowest-Q² physics as the determination of the proton radius from elastic muon-proton scattering, to average-Q² reactions for hadron spectroscopy and high-Q² hadron structure investigations via the Drell-Yan process and deeply-virtual Compton scattering.

The recently submitted Letter of Intent for COMPASS++/AMBER will be discussed. Focus will be given to the elastic muon-proton scattering measurement, that may contribute significantly to solve the proton radius puzzle due to the usage of a high-energy muon beam.

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Methods of parameterization of amplitudes and extraction of resonances, D-decay amplitudes

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Various necessary conditions which two-body amplitudes (e.g. FSI) must meet will be presented and discussed. Methods of extraction of resonances from these amplitudes will be studied and examples of different results will be presented. The advantages and disadvantages of these methods will be analyzed and the methods that meet the necessary mathematical conditions and are convenient to describe the data will be shown. Example of Dalitz plot analysis for three body D decay with unitary two body amplitudes will be presented.

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The MUonE project: theory progressProf. PASSERA, Massimo¹¹ *INFN Padova***Corresponding Author(s):** ignatov@inp.nsk.suQED radiative corrections to $\mu e \rightarrow \mu e$: NNLO calculation; Theory status and progress.

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Light exotic mesons at COMPASSProf. KETZER, Bernhard¹¹ *University of Bonn***Corresponding Author(s):** bernhard.ketzer@uni-bonn.de

In recent years, the spectroscopy of hadrons containing heavy quarks has brought forward a plethora of new and unexpected resonance-like signals. Many of these so-called X, Y, Z states are candidates for states beyond the quark-antiquark configurations of mesons, which have been sought after since the introduction of the quark model. Similar studies in the light-quark sector are more challenging due to the wide and overlapping nature of known resonances. Recent high-quality data samples, collected by the COMPASS experiment at CERN, open the possibility to search for exotics also at masses below 2.5 GeV. In particular, access to hadrons with explicit gluonic degrees of freedom is expected to be easier in this mass region. Recently, lattice QCD started to make predictions on the multiplet structure of exotic hadrons, which may be used as a guideline in the experimental searches.

The COMPASS experiment at CERN uses a high-energy pion beam scattered off protons and heavier nuclei to produce mesonic excitations, which are observed in multi-particle final states subjected to partial-wave analyses. In addition to studying the properties of established mesons with unprecedented accuracy, the large existing data samples allow us to detect possibly exotic states. These either do not fit current theoretical expectations, like the recently observed $a_1(1420)$, or carry spin-exotic quantum numbers, like the $\pi_1(1600)$. The talk will give an update on ongoing studies of these states involving novel analysis techniques and discuss possible interpretations. Future plans concerning hadron spectroscopy in the strange and charm quark sector, envisaged at AMBER/COMPASS++, a new fixed-target QCD facility at CERN, will be presented.

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Measurement of the Time-like Pion Transition Form Factor at BESIII**Author(s):** Mr. LENZ, Thomas¹**Co-author(s):** Mr. ACHIM, Denig²; Dr. REDMER, Christoph Florian³¹ *Institut für Kernphysik, JGU Mainz*² *JGU Mainz*³ *Institute for Nuclear Physics, Johannes Gutenberg-University Mainz***Corresponding Author(s):** lenz@uni-mainz.de

Transition form factors of light pseudoscalar mesons play an important role in the calculations of hadronic contributions to the anomalous magnetic moment of the muon. The BESIII experiment at the e^+e^- collider BEPCII in Beijing has collected 9.0 fb^{-1} of data at energies above 3.773 GeV. Based on these data the process $e^+e^- \rightarrow \pi^0\gamma$ is studied. The analysis aims at the determination of the transition form factor of the π^0 in a region of momentum transfer above 14 GeV^2 which will also shed light on the discrepancy between BABAR and BELLE. We will give an overview of the current status of the analysis.

Status of facilities and new projects / 83**New Muonium Hyperfine Structure Measurement at J-PARC KEK IMSS**Prof. SHIMOMURA, Koichiro¹¹ *KEK IMSS***Corresponding Author(s):** koichiro.shimomura@kek.jp

High precision measurements of the ground state hyperfine structure (HFS) of muonium, a leptonic system made of a bound state of a positive muon with an electron, is a stringent tool for testing bound-state quantum electrodynamics (QED) theory, determining fundamental constants of the muon magnetic moment and mass, and searches for new physics. Muonium is the most suitable system to test QED because both theoretical and experimental values can be precisely determined.

At the J-PARC Muon Science Facility (MUSE), the MuSEUM collaboration is planning complementary measurements of muonium HFS both at zero field and at high magnetic field. The new high-intensity muon beam that will soon be available at MUSE H-Line will provide an opportunity to improve the precision of these measurements by one order of magnitude. The previous measurements at zero field [1] and high field [2] were performed decades ago at LAMPF with experimental uncertainties mostly dominated by statistical errors. An overview of the different aspects of these new muonium HFS measurements, the current status of the preparation for high-field measurements, and the latest measurements at zero field will be presented.

[1] D. E. Casperson et al., *Physics Letters* 59B (1975) 397.[2] W. Liu et al., *Physical Review Letters* 82 (1999) 711.**Baryon formfactors / 84****The NNbar and multihadron production at the threshold at VEPP2000**Prof. SOLODOV, Evgeny¹¹ *BINP***Corresponding Author(s):** ignatov@inp.nsk.su

A study of hadron production at the nucleon-antinucleon threshold has been performed with the CMD-3 detector at the VEPP-2000 e^+e^- collider. A very fast rise with about 1 MeV width has been observed in the $e^+e^- \rightarrow p\bar{p}$ cross section. A sharp drop in the $e^+e^- \rightarrow 3(\pi^+\pi^-)$ cross section has been confirmed and found to have a less than 2 MeV width, in agreement with the observed fast rise of the $e^+e^- \rightarrow p\bar{p}$ cross section. For the first time a similar sharp drop is demonstrated in the $e^+e^- \rightarrow K^+K^-\pi^+\pi^-$ cross section. The behavior of the $e^+e^- \rightarrow 3(\pi^+\pi^-)$, $K^+K^-\pi^+\pi^-$ cross sections cannot be explained by an interference of any resonance amplitude with continuum, therefore this phenomenon cannot be due to a narrow near-threshold resonance. No such structure has been observed in the $e^+e^- \rightarrow 2(\pi^+\pi^-)$ cross section.

Dark sector, violations / 85**Searching for dark sector with missing mass technique in fixed target experiments**KOZHUKHAROV, Venelin¹¹ *LNF-INFN & University of Sofia***Corresponding Author(s):** venelin@phys.uni-sofia.bg

Currently, the existence of a dark sector almost completely decoupled from the Standard Model is a viable solution for numerous long-standing problems in physics, including the nature of dark matter and the muon anomalous magnetic moment. A new gauge mediator, the dark photon,

could be the portal to this hidden sector. The most general probe to its existence is the missing mass technique which requires a precise knowledge of the initial state of the process but does not put constraints on the dark photon final states. The experimental approaches to the search for dark photons in positron-on-target annihilation and in mesons decay in flight will be presented and the physics reach will be discussed.

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A review of present experimental status of the $K \rightarrow \pi \nu \bar{\nu}$ decays at the NA62

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A review of present experimental status of the $K \rightarrow \pi \nu \bar{\nu}$ decays is given in the talk. The NA62 experiment at CERN SPS is designed to measure the branching ratio of the $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ decay using a novel kaon decay-in-flight technique, while the KOTO experiment at JPARC aims to study the $K_L \rightarrow \pi^0 \nu \bar{\nu}$ decay. Both experiments produced new results in 2018. The NA62 experiment observed one candidate event, compatible with the Standard Model prediction. The KOTO experiment improved the existing upper limits on the branching ratio of the neutral kaon decay by an order of magnitude.

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The KLOE-2 experiment at DAPHNE

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The KLOE-2 experiment at the INFN Laboratori Nazionali di Frascati has finished its data-taking campaign at the DAΦNE [U+03D5]-factory with the collection of 5.5 fb^{-1} of integrated luminosity. A peak luminosity of $2.4 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$ and a maximum daily integrated of 14 pb^{-1} were achieved with the crab waist scheme of beam collisions. KLOE-2 represents the continuation of the KLOE experiment with a improved physics program mainly focused on the study of K_S , η rare decays as well as on kaon interferometry, test of discrete symmetries, and search for physics beyond the Standard Model. The collected data sample will allow to perform CPT symmetry and quantum coherence tests using entangled neutral kaons, studies of pseudoscalar mesons produced in $\gamma\gamma$ -physics collisions, and the search for signals of a hidden dark-matter sector, among the fields to be addressed. The general purpose KLOE detector, composed by one of the biggest Drift Chamber ever built surrounded by a lead-scintillating fiber Electromagnetic Calorimeter among the best ones for energy and timing performance at low energies, undergone several upgrades including an Inner Tracker made of cylindrical GEMs, to improve vertex reconstruction capabilities near the interaction region, a tagging system for scattered electrons in $\gamma\gamma$ processes, and small angle calorimeters to improve the acceptance for particles coming from the Interaction Point. An overview of the KLOE-2 experiment will be given including present status and achievements together with physics plans.

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Meson spectroscopy at VES and COMPASS

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Diffractive production of $\pi^+\pi^-\pi^-$ and $\pi^-\pi^0\pi^0$ final states are subjects of comprehensive studies performed recently by VES and COMPASS experiments. The 3π states are produced at VES by 29 GeV/c π^- beam on Be target (87×10^6 $\pi^+\pi^-\pi^-$ events and 32×10^6 $\pi^-\pi^0\pi^0$ events analyzed at $0 < t' < 1$ GeV/c²). At COMPASS 3π states are produced by 160 GeV/c π^- beam impinging on liquid hydrogen target (50×10^6 $\pi^+\pi^-\pi^-$ events and 3.5×10^6 $\pi^-\pi^0\pi^0$ events analyzed at $0.1 < t' < 1$ GeV/c²).

The COMPASS collaboration pioneered the application of novel methods of partial-wave analysis: mass-independent PWA in multiple (m,t')-cells, mass-dependent analysis performed at-once for density matrices measured in all t' regions, the analysis with free shapes of $\pi^+\pi^-$ isobars. The COMPASS observed new narrow state: $a_1(1420)$. The VES has leading world statistics of $\pi^+\pi^-\pi^-$ and $\pi^-\pi^0\pi^0$ events, compatible in two final states. This makes perspective the comparison of isospin relations between two states, using both: PWA with established shapes of isobars and PWA with freed $\pi\pi$ isobars.

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Dispersive approach to the hadronic light-by-light contribution to the muon g-2

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I will summarize the status of the dispersive approach to the hadronic light-by-light contribution to the muon $g - 2$, and in particular report on recent progress, in particular concerning the role of short-distance constraints.

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Dispersive analysis of the two-pion contribution to the hadronic vacuum polarization to the $(g-2)_\mu$

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I will present the results of a dispersive analysis of the pion vector form factor, which determines the two-pion contribution to the $(g - 2)_\mu$ below 1 GeV. As a by-product, both the P -wave $\pi\pi$ phase shift as well as the pion charge radius have been determined with higher precision than before.

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Recent results of the NA64 experiment at the CERN SPS

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We report the recent results of the NA64 experiment at CERN on the search for a hypothetical X-boson which could explain the 8Be^* anomaly. The results of the search for the dark photon A' which could mediate a new interaction between the visible and dark sectors and future NA64 research program will be also discussed.

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The updated status of the pseudoscalar glueball studies

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The present theoretical and experimental status of the pseudoscalar glueball studies will be reviewed. We'd show that a converged picture from both theoretical and experimental evidences does not support the eta(1405) to be the so-far broadly quoted pseudoscalar glueball candidate.

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R value measurement at BESIII

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Using data samples collected with BESIII detector operating at BEPCII storage ring, the R value is measured at 14 energy points from the center-of-mass energies 2.2324 to 3.671 GeV. This talk gives the descriptions and information for the data analysis, the calculations of the initial state radiations and generators simulations. (The average uncertainty of 14 R values is about 3%, which is dominated by the systematic uncertainty.)

Dark sector, violations / 94

Search for dark forces at KLOE-2

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During the last years several Dark Sector Models have been proposed in order to address striking and puzzling astrophysical observations which fail standard interpretations. In the minimal case a new vector particle, the so called dark photon or U-boson, is introduced, with small coupling with Standard Model particles. Also, the existence of a dark Higgs boson h' is postulated, in analogy with the Standard Model, to give mass to the U-boson through the Spontaneous Symmetry Breaking mechanism. The discovery of such a Dark Force Mediator would belong to a new field of Physics Beyond the Standard Model. The KLOE experiment, working on the DAΦNE e+e- collider in Frascati, searched for the existence of the U-boson in a quite complete way, investigating several different processes and final states. Tight limits on the model parameters have been set at 90%CL. Further improvements are expected in terms of sensitivity and discovery potential with the new KLOE-2 detector working on the improved DAFNE e+e- collider, which has collected more than 5 fb⁻¹.

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The Muon g-2 experiment at Fermilab

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The study of the anomalous magnetic moment of the muon, Muon g-2, stands as an enduring and stringent test of the Standard Model (SM), where the current 3.5 standard deviations (or higher) discrepancy between the theoretical prediction and the experimental measurement could be an indication of new physics beyond the SM. The E989 Muon g² experiment at Fermilab aims to measure the muon anomaly to an unprecedented precision of 140 parts-per-billion, with an aim

to either resolve or confirm this discrepancy. In this talk, I will discuss the current status of the analysis of Run-1 data taken during the spring of 2018 and give an update on overall progress as we enter a new data-taking period.

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BEPCh and BESIII Status and Plans

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The BESIII detector and BEPCh accelerator represent major upgrades over the previous version of BES and BEPC; the facility is used for studies of hadron spectroscopy and χ -charm physics. The design luminosity was reached in 2016, setting a new world record for the accelerator in this energy regime. After operating for more than ten years, BESIII has achieved great success. In my this report, I review current status of BEPCh and BESIII, and also will show the future plan for the upgrade.

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J-PARC muon $g-2$ /EDM experiment

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The J-PARC muon $g-2$ /EDM experiment (E34 experiment) aims to measure the muon anomalous magnetic moment with a precision of 0.5 ppm and search for muon electric dipole moment with a sensitivity of 10^{-21} e-cm. The method of this experiment is independent of Fermilab's experiment, and a low-emittance muon beam and a factor of 20 smaller muon storage magnet are utilized. A new muon beam line (H-line) at J-PARC and dedicated muon LINAC to reaccelerate ultra-slow muons are under construction to supply a low-emittance muon beam. The latest update and current status of this experiment will be reported.

tau-lepton / 98

Status of tau lepton measurements

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We report the recent progress on the tau lepton measurements and on the HFLAV and PDG tau branching fractions global fits. We present the up-to-date lepton universality tests and V_{us} determinations based on tau measurements.

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Progress of Super Tau-Charm Facility (STCF [U+FF09] in China

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The super tau-charm facility is of rich in the physics program, is an unique platform for the physics with charmed quark and tau lepton, and provide a great opportunity for study of QCD, exotic hadrons as well as search for new physics. BEPCII/BESIII, which is the only one machine running at the tau-charm region at present, is producing fruitful physics results, but will end its mission in 5-8 years. A STCF in China is a nature extension of BEPCII/BESIII, and the R&D process is ongoing in China. In this talk, we will introduce you the progress of STCF in China.

Mesons of light quarks / 100

Light Hadron Spectroscopy at BESIII

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Light Hadron Spectroscopy at BESIII

Dark sector, violations / 101

QCD effects in searches for GeV-scale new physics.

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The Standard Model of particle physics fails to explain several important phenomena like neutrino oscillations, matter-antimatter asymmetry of the Universe, cosmological dark matter. While we definitely need some new physics capable of explaining the phenomena above, the absence of any new particles at colliders implies that they are either very heavy or feebly interacting with the known particles. In the latter case they can be at GeV mass range, produced by and/or decaying to hadrons. We discuss the associated with QCD difficulties in obtaining the accurate predictions for the new particle production and decay rates, concentrating on the singlet scalar, fermion and vector messengers to the hidden sector.

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Search for the process $e^+e^- \rightarrow D^{*0}(2007)$ with the CMD-3 detector

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A search for the process $e^+e^- \rightarrow D^{*0}(2007)$ has been performed with the CMD-3 detector at the VEPP-2000 e^+e^- -collider. Two main decay modes $D^0\pi^0$ and $D^0\gamma$ with $D^0 \rightarrow K^+\pi^-\pi^+\pi^-$ are used in this analysis. Using an integrated luminosity of 3.7 pb^{-1} collected at the center-of-mass energy $E_{c.m.}=2006.62 \text{ MeV}$ we preliminary get an upper limit for $B_{D^{*0} \rightarrow e^+e^-} < 1.7 \cdot 10^{-6}$ at 90% C.L.

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Study of the $e^+e^- \rightarrow \pi^+\pi^-\gamma$ process at 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 $e^+e^- \rightarrow$ hadrons processes. Such measurements are necessary for the calculation of the hadronic contribution ($\alpha\mu_{\text{had}}$) to the anomalous magnetic moment of the muon ($\alpha\mu=(g-2)/2$). Value of $\alpha\mu$ is one of the great instrument for the Standard Model test. Among hadronic channels the process $e^+e^- \rightarrow \pi^+\pi^-$ is very important because it gives the main contribution to the value $\alpha\mu_{\text{had}}$ (~72%) in the low energy region ($S < 2 \text{ GeV}^2$). Radiative corrections to the $e^+e^- \rightarrow \pi^+\pi^-$ process are calculated under the assumption of point-like pions. In this work we study of the $e^+e^- \rightarrow \pi^+\pi^-\gamma$ 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 $e^+e^- \rightarrow \pi^+\pi^-\gamma$ was carried out in the energy region 660÷785 MeV and based on the integrated luminosity about 8.4 pb⁻¹. The comparison of experimental data for photon energy spectrum with the simulation results are in agreement. with the assumption of point-like pions.

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The XYZ mesons: what aren't they?

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The list of XYZ mesons, which was initiated 16 years ago, continues to expand. Although these states have a number of common properties, including: large branching fractions to hidden-quarkonium states (in spite of kinematically accessible open-flavor, fall-apart decay channels); relatively narrow widths; and preferences for $J^{P(C)} = 1^{+(+)}$ quantum numbers, no single theoretical model can provide a comprehensive description for them. Since the models that have been proposed: molecules, tetraquarks, QCD-hybrids, hadro-quarkonium, etc., can, at best, provide adequate descriptions for only a small subset of the observations, a concise exposition of what are they? is a Sisyphean task that I have given up on. Instead, I restrict myself to the easier question: what aren't they?

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Hadronic and Transition Form Factor Measurements at BE-SIII

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Motivated by the need of experimental input to improve the Standard Model prediction of the anomalous magnetic moment of the muon a_μ , the BESIII collaboration started a dedicated program to measure hadronic cross sections as well as transition form factors (TFF) with high accuracy. In this presentation we will focus on the two-photon physics program, which is dedicated to the measurement of TFFs. The data acquired at BESIII allow to study the momentum dependence of the TFFs of light pseudoscalar mesons dominating the hadronic Light-by-Light contribution to a_μ in the relevant kinematic region. The current status and ongoing investigations of will be discussed.

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Study of the process $e^+e^- \rightarrow K^+K^-\eta$ with the CMD-3 detector at VEPP-2000 collider

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The process $e^+e^- \rightarrow K^+K^-\eta$ has been studied in the center-of-mass energy range from 1.59 to 2.007 GeV using the data sample of 59.5 pb^{-1} , collected with the CMD-3 detector at the VEPP-2000 e^+e^- collider in 2011-2012 and 2017 years. In the production of $K^+K^-\eta$ final state we observe the contribution of $\phi(1020)\eta$ intermediate state only. The cross section of $e^+e^- \rightarrow \phi(1020)\eta$ process has been measured on the base of about 3473 ± 78 selected signal events with the systematic uncertainty of 6%. From the cross section approximation the $\phi(1680)$ meson parameters have been determined.

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Recent results from CMD-3

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XYZ search at Belle II

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The Belle II experiment has successfully concluded Phase-2 of data taking in July 2018, and soon will start Phase-III, with the complete detector setup, planned in April 2019. Great perspectives and unique physics cases are enhanced in the Belle II physics program. In the sector of charmonium and spectroscopy, Belle II will investigate several physics processes: ISR physics for the vector states and bottomonium search are some examples where the contribution of the this experiment will help in better understanding QCD, for which several open questions still remain. First simulations and data analyses will be shown, with the first available dataset (2018), and the plan for spectroscopy search at Belle II will be discussed.

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Super KEKB and Belle2 status and plans

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Study of the fast calorimeter prototype for modern e^+e^- factories

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Modern e^+e^- factories with high luminosity require fast response time of the detector subsystems to suppress severe beam background. The prototype of the electromagnetic calorimeter based on the counter with pure CsI crystal, novel wavelength shifter with nanostructured organosilicon luminophores and avalanche photodiodes Hamamatsu S8664-55 is discussed. The results of measurements of the basic characteristics of such counters will be reported.

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Luminosity measurement with the CMD-3 detector

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The CMD-3 detector has taken data at the electron-positron collider VEPP-2000 since december 2010. The collected data sample corresponds to an integrated luminosity of 180 pb^{-1} in the c.m. energy range from 0.32 up to 2 GeV. The integrated luminosity was measured by counting $e^+e^- \rightarrow e^+e^-$ and $e^+e^- \rightarrow \gamma\gamma$ events, allowing additional photons in the final state. Preliminary results of the luminosity measurement are presented for various energy ranges and its accuracy is estimated to be 1%.