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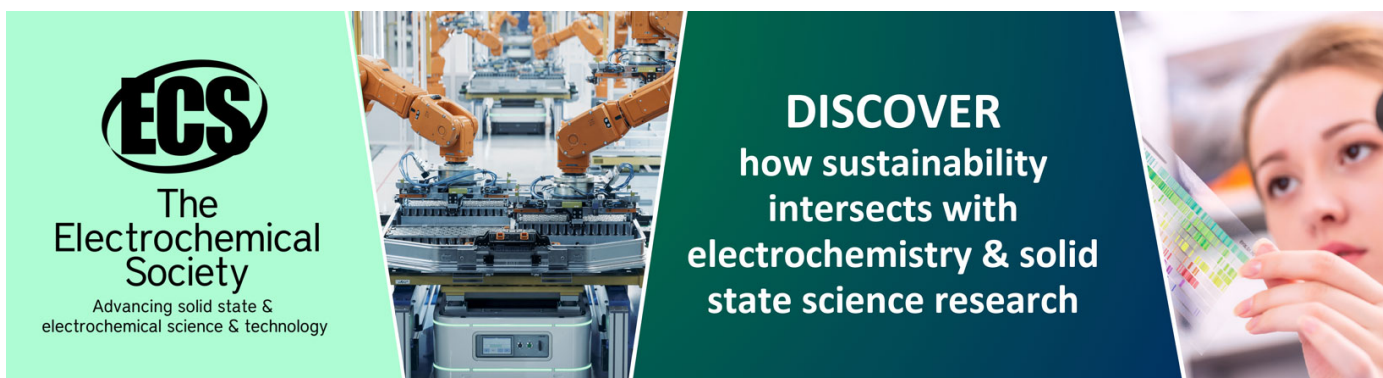
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ABSTRACTS LIST

2.1.2 Search for $K^+ \rightarrow \pi^+ \nu \nu$ at NA62

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The decay $K^+ \rightarrow \pi^+ \nu \nu$, with a very precisely predicted branching ratio of less than 10^{-10} , is one of the best candidates to reveal indirect effects of new physics at the highest mass scales. The NA62 experiment at CERN SPS is designed to measure the branching ratio with a decay-in-flight technique, novel for this channel. NA62 took data in 2016, 2017 and another year run is scheduled in 2018. Statistics collected in 2016 allows NA62 to reach the Standard Model sensitivity, entering the domain of 10^{-10} single event sensitivity and showing the proof of principle of the experiment. The analysis is reviewed and the preliminary result from the 2016 data set presented.

2.1.3 NNLO QCD corrections for $K^+ \rightarrow \pi^+ \nu \bar{\nu}$

Maria Cerdà-Sevilla

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Motivated by the future prospects of the NA62 experiment, which aims to measure the rare kaon decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$, we discuss here the present uncertainties of the Standard Model theory prediction. We will also examine which calculations could further improve the theoretical accuracy of the charged and neutral decay modes (and provide a short discussion of the generic sensitivity to new physics).

2.2.1 A three-site gauge model for flavour hierarchies and flavour anomalies

Javier Fuentes-Martin et al.

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Recent data in B physics show intriguing hints of Lepton Flavour Universality violations, both in neutral- and in charged-current interactions. We present an ultraviolet complete model, based on gauged lepto-quark interactions, able to explain both these anomalies, and linking the observed pattern of deviations to the origin of the Standard Model Yukawa couplings. The model is consistent with low- and high-energy bounds, and predict an interesting series of new phenomena in B and in tau physics that could be observed in the near future.

2.2.2 Multibody charmless b-hadron decays at LHCb

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The contributions of tree-level and penguin topologies have similar magnitudes in the decays of b-hadrons to charmless final states, making these decays an excellent laboratory to search for new particles not present in the Standard Model. However the interpretation of the CP asymmetries of these decays in terms of CKM quantities is not trivial, due to the additional hadronic parameters in the amplitudes due to the penguin contributions. The measurements of CP violation quantities across the phase space of multi-body decays allow to disentangle these various contributions, allowing for a full exploitation of their discovery potential. We present the most recent analyses of multi-body charmless decays of b mesons and b baryon at LHCb. Particular emphasis will be put on amplitude analysis of the Dalitz plane of b-meson decays.

2.2.3 Λ_c decays at BESIII

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The BESIII Experiment at the Beijing Electron Positron Collider (BEPCII) has accumulated the world's largest samples of e^+e^- collisions in the tau-charm region. Based on the samples taken at $\psi(3770)$ peak, around the $\psi(4040)$ nominal mass, and at the $\Lambda_c^+\Lambda_c^-$ mass threshold 4.6 GeV, we can study the charmed hadron decays under a uniquely clean background. In this talk, we will review the recent results on the D , D_s and Λ_c decays, such as the analyses of the purely leptonic and semi-leptonic decays of D meson, the measurements on strong phase and $D^0 - \bar{D}^0$ mixing parameters using quantum coherence at threshold, D Dalitz analyses, determination on the absolute branching fraction of Λ_c hadronic decays and first model-independent study on the semi-leptonic Λ_c decay rate $B(\Lambda_c^+ \rightarrow \Lambda e^+ \nu)$.

2.2.4 Spectroscopy of Heavy Hadrons

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The spectroscopy of excited hadronic states in the beauty sector, double heavy hadrons and quarkonia provides a rich proofing ground for effective theories of the strong interaction. The decays of these states also provide a source of exotic hadrons, especially in the charmonium mass region. The unique data samples collected during Run I and II of the LHC open new possibilities for precision studies of these states. Recent results from LHCb on heavy hadron spectroscopy, including exotic mesons and baryons will be presented.

2.3.1 Masses, decay constants and HQE matrix elements of pseudoscalar and vector heavy-light mesons in Lattice QCD

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We present a precise lattice computation of masses and decay constants of pseudoscalar and vector heavy-light mesons with $m_{ell} = m_{u/d}$, m_s and m_h in the range $(m_c - 4m_c)$. To this end, we employ the ETMC gauge configurations with both $N_f = 2$ and $N_f = 2 + 1 + 1$ dynamical quarks that highlight an unusual quenching effect of the strange quark in the vector decay constants. Specific masses combinations are then

analyzed in terms of the Heavy Quark Expansion (HQE) to extract matrix elements up to dimension-6, including $\bar{\Lambda}$, μ_π^2 and μ_G^2 with a good precision. These parameters play a crucial role in the inclusive determination of the V_{ub} and V_{cb} matrix elements.

2.3.2 Measurements of the CKM angle γ at LHCb

Jonas Rademacker

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The CKM angle gamma remains the least precisely measured angle of the unitarity triangle, and is the only easily accessible with purely tree level decays, making it a benchmark for Standard Model flavour processes. We present the Run-II update of the measurement of gamma using the GGSZ method with the golden mode $B^+ \rightarrow DK^+$, $D \rightarrow K_s hh$. The results of the latest LHCb gamma combination are also shown, giving the most precise determination of gamma from a single experiment.

2.3.3 Polarized Drell-Yan measurements at COMPASS

Maxim Alexeev

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The COMPASS experiment at CERN is one of the leading experiments studying the nucleon structure. Transverse Momentum Dependent Parton Distribution Functions (TMD PDFs) are extensively studied at COMPASS using both Semi-Inclusive Deep Inelastic Scattering measurements and the complementary Drell-Yan reactions. In 2015 COMPASS has carried out the first ever polarized Drell-Yan measurement using a negative pion beam on a transversely polarized ammonia target; this measurement will be continued during the 2018 running. Since in COMPASS the Drell-Yan and SIDIS data lay in a comparable kinematic range, we have the unique opportunity to test for the predicted sign change of the Sivers TMD, without relying on the TMD evolution knowledge. In this talk the COMPASS results on transversely polarized Drell-Yan will be presented. Relevant SIDIS results and theoretical predictions will be also discussed.

2.3.4 Soft QCD and Central Exclusive Production at LHCb

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The forward acceptance of LHCb, $2.0 < y < 5.0$, provides complementary reach to the general purpose detectors at the LHC for the study of Soft QCD processes. In addition, the installation of a series of scintillating pad detectors (Herschel), bracketing the LHCb detector along the beamline, for Run 2 of the LHC, with dedicated triggers, has significantly enhanced LHCb's sensitivity to central exclusive production (CEP). Recent LHCb measurements of the pp inelastic cross-section, minimum bias properties, and particle production in CEP will be presented.

2.3.5 Dilepton exclusive production with proton tagging

Michele Gallinaro

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The CMS-TOTEM Precision Proton Spectrometer (CT-PPS) is a detector system to add tracking and timing information at approximately ± 210 m from the interaction point around the CMS detector, and it was designed to operate at high luminosity with up to 50 interactions per 25 ns bunch crossing to perform measurements of e.g. the quartic gauge couplings and search for rare exclusive processes. During 2016 and 2017, CT-PPS took data in normal high-luminosity proton-proton LHC collisions. Exclusive dilepton production with proton tagging in the CT-PPS, the status of the ongoing program, and the planned upgrade projects for the tracking and timing detectors are discussed.

2.4.1 Two Photon Physics at BESIII

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The anomalous magnetic momentum of the muon, a_μ , has been measured in experiment and calculated in theory with a precision up to 0.5 ppm. But there is a long standing 3 to 4 standard deviations between these two accurate values. The dominant contribution to the uncertainty in the theoretical calculation comes from the hadronic contribution, including contributions from the hadronic vacuum polarization and the hadronic light-by-light. The meson transition form factors measured in two photon process at BESIII can be used as input or constrain for the calculation of the hadronic light-by-light contribution to a_μ . Recent experimental activities, including the measurements of the space like transition form factor of π^0 , η , and η' and the cross section of $\gamma\gamma^* \rightarrow \pi\pi$ will be presented.

2.4.2 Recent QCD results from NA48/2 - Precision measurement of the form factors of semileptonic charged kaon decays

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We present a measurement of the charged kaon semileptonic form factors based on 4.3 million $K^\pm \rightarrow \pi^0 e^\pm \nu_e$ and 2.1 million $K^\pm \rightarrow \pi^0 \mu^\pm \nu_\mu$ decays collected by the NA48/2 experiment. The single results for the semi-electronic and semi-muonic channel have better and similar precision, respectively, than previous measurements. The combination of both channels yields the most precise measurement of the form factors of semileptonic kaon decays.

2.4.3 Baryon form factors with BESIII

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Λ , Σ and Ξ hyperons are members of the same SU(3) baryon octet as the nucleon. Hyperons are difficult to study in the space-like region since they are unstable - hyperon targets are unfeasible and the quality of hyperon beams is in general not sufficient. Time-like form factors, therefore offers the best opportunity to study hyperon structure.

An interesting difference between space-like and time-like form factors is that whereas space-like form factors are real numbers, the time-like can be complex with a relative phase. This phase is a non-perturbative phenomenon and reflects that in the time-like region, intermediate hadron-antihadron states are possible. This phenomenon has polarization effects on the final state, even if the initial state is unpolarized. The polarization, and thus the phase, is experimentally accessible for hyperons thanks to their self-analyzing decay, e.g., $\Lambda \rightarrow p\pi^-$. I would like to talk about the latest results of hyperon time-like form factors measurements by BESIII. In the case of $e^+e^- \rightarrow \Lambda\bar{\Lambda}$, the joint angular distribution of the Λ , $\bar{\Lambda}$ and their decay products, enabled the first extraction of the ratio between the electric and the magnetic form factor G_e/G_m and the relative phase between G_e and G_m . Thus, the time-like electromagnetic form factors of the Λ can be completely determined, including their relative phase, for the first time for any baryon.

2.4.4 Hyperons Production Systematics, Form Factors, and Diquark Correlations

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The first measurements of the production of Λ , Σ , Ξ , and Ω hyperons at large timelike momentum transfers of 13.6, 14.2, and 17.4 GeV² have been made using e^+e^- annihilation data taken at the CESR electron-positron collider at Cornell using the CLEOc detector. The measurements reveal interesting features of hyperon production systematics and timelike form factors, and provide evidence for diquark correlations in hyperon structure.

3.1.1 Highlights from the LHC Higgs and top-quark results

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The LHC represents the current energy frontier in collider experiments. Its most notable result so far was the experimental discovery of the Higgs boson, by the ATLAS and CMS collaborations. It is also very well suited to explore the physics of the top quark, the heaviest known elementary particle, with a Yukawa coupling of order 1. The data collected by these experiments during the LHC Run II allowed several recent top and Higgs experimental results, provide very stringent tests of the Standard Model expectations near the electroweak scale, and therefore likely windows into new physics. This presentation will show a few of the most recent experimental highlights in this area.

3.1.2 Rare H,Z decays to quarkonia

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The search of rare decays modes of Higgs and Z bosons involving the production of quarkonium states offers a very clean experimental signature. The processes involving the production of charmonium states such as Higgs and Z decaying to ψ and a photon and the rare decay mode of Z to a lepton pair and a vector meson using data collected by the CMS experiment will be presented. The observation of the Z boson rare decay to ψ meson and two oppositely charged same-flavour leptons is the first experimental result of the Z boson decay channel. The measurement of this particular branching fraction can be valuable for the calculation of the fragmentation function for a virtual lepton to split into a J/ψ meson, as well as for the evaluation of potential backgrounds to Higgs decays into quarkonia or searches for new physics. The data sample of proton-proton collisions at a center-of-mass energy of 13 TeV corresponds to an integrated luminosity of 35.9 fb^{-1} accumulated.

3.1.3 Top quark flavour changing neutral currents and dipole moments through three and four-top quark productions at the LHC

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In this work, the top quark changing neutral current (FCNC) interactions is studied through the process of the three-top production at the center-of-mass energy of 14 TeV. We also investigate the anomalous top quark chromoelectric and chromomagnetic dipole moments through the four-top-quarks production signal at the center-of-mass energy of 13 TeV. We demonstrate that these processes are powerful tools to constrain the top quark FCNC couplings and the top dipole moments.

3.1.4 Charm physics at BESIII

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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: (1) the measurement of form-factors and decay constants using leptonic and semileptonic final states, (2) results from partial-wave analyses and (3) a selection of branching fraction measurements of hadronic final states. Furthermore, (4) an accurate measurement of the cross-section $e^+e^- \rightarrow D\bar{D}$ is presented.

3.2.1 Study of charm hadroproduction and tau neutrino production at CERN SPS

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The DsTau project has been proposed at the CERN SPS to study production and decay of charmed hadron using nuclear emulsion with a 50 nm spatial resolution. The precise knowledge of charm hadroproduction is essential for the accurate prediction of tau neutrino flux in a high-intensity proton beam dump experiment. The DsTau project aims to detect about 1,000 $D_s \rightarrow \tau$ decays in $2.3 \cdot 10^8$ proton interactions in tungsten target. The precise measurement of D_s differential cross section will reduce the systematic uncertainty to few percent in ν_τ charged-current interactions. Results from the test beam exposure at CERN in 2016-2017 will be presented together with a prospect for a pilot run in 2018 and finally a physics run in 2021.

3.2.2 Flavour Anomalies in Rare Decays at LHCb

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Rare decays are powerful probes for Physics beyond the Standard Model (SM), as new particles can have a large impact on physics observables. Recent results on lepton universality tests and measurements of branching fractions and angular distributions of rare $b \rightarrow sll$ decays have shown tensions with the SM predictions. The LHCb experiment is ideally suited for the study of these flavour anomalies, due to its large acceptance, precise vertexing and powerful particle identification capabilities. The latest results from LHCb on the flavour anomalies will be presented and their interpretation will be discussed.

3.2.3 Tests of lepton universality with semitauonic b-quark decays

Mark Smith

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In the Standard Model, the three charged leptons are identical copies of each other, apart from mass differences. Experimental tests of this feature in semileptonic decays of b-hadrons are highly sensitive to New Physics particles which preferentially couple to the 2nd and 3rd generations of leptons. This talk will review the latest lepton universality tests in semileptonic $b \rightarrow c$ transitions at LHCb.

3.2.4 Measurement of hadronic cross sections with the BaBar detector

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A program of measuring the light hadrons production in exclusive e^+e^- to 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 $e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0$, $K_S^0 K^+\pi^-\pi^0$, $K^0 K^0\pi^0$, $K^0 K^0\pi^0\pi^0$, and $K^0 K^0\eta$. The first reaction gives the main uncertainty on the total hadronic cross section in the energy region between 1 and 2 GeV, while the other processes, together with previous results, complete the studies of the final states with two neutral or charged kaons.

3.2.5 Models for lepton flavour non-universality in B decays

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A number of recent anomalies in decays of B mesons hint at possible new physics which treats different generations of leptons differently. Many models have been proposed to address some or all of the anomalies via lepton non-universal interactions. I will give an overview of some of these models, focussing on aspects that they have in common, as well as methods to distinguish them from each other with future measurements.

3.3.1 Search for muoproduction of the $X(3872)$ at COMPASS

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Exotic charmonium-like states have been observed by various experiments in the last 15 years, but their nature is still debated. Photo-(muo)production is a new promising instrument to study them. COMPASS, a fixed target experiment at CERN, analyzed the full set of the data collected with a muon beam between 2002 and 2011, covering the range from 7 GeV to 19 GeV in the centre-of-mass energy of the virtual photon-nucleon system. A signal in the mass spectrum of $J/\psi \pi^+\pi^-$ with a statistical significance of 5.3σ was observed in the reaction $\mu^+N \rightarrow \mu^+(J/\psi \pi^+\pi^-)\pi^\pm N'$. Its mass and width are consistent with those of the $X(3872)$. The shape of the $\pi^+\pi^-$ mass distribution from the observed decay into $J/\psi \pi^+\pi^-$ is different from previous observations for $X(3872)$. The observed signal may be interpreted as a possible evidence of a new charmonium state. It could be associated with a neutral partner of $X(3872)$ with $C = -1$ predicted by a tetraquark model. The details of the analysis will be reported.

3.3.2 Hadron Spectroscopy at BESIII

Malte Albrecht

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The BESIII experiment, located at the symmetric electron positron collider BEPCII in Beijing, is successfully operating since 2008 and has collected large data samples at center-of-mass energies above 4 GeV in the past few years. The analysis of these samples has resulted in a number of surprising discoveries with respect to the "XYZ-states". In this talk, we highlight recent results of the hadron spectroscopy program, especially of the findings in the XYZ-sector at BES III.

3.3.3 Heavy Quarkonia: the Beauty and the Beasts

George Rupp

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Heavy-quark mesons represent excellent laboratories to probe low-energy QCD. The main reason is the large number of heavy quarkonia lying below their lowest OZI-allowed decay thresholds, thus showing up as very narrow states. This makes it far easier to study them on the lattice, dispensing with the necessity to describe them as resonances, by using Luescher's method or its generalisations.

Nevertheless, being quasi-bound states does not necessarily mean that a description as pure quark-antiquark mesons is realistic, as virtual loops involving open-charm or open bottom mesons may contribute to the quarkonium mass and wave function. A paradigmatic case is the axial-vector charmonium state $X(3872)$, as recently confirmed on the lattice. On the other hand, above open-charm or open-bottom thresholds the picture becomes dramatically more complicated, as besides unitarisation contributions there may appear non-resonant threshold enhancements that can lead to misinterpretations in terms of genuine resonances.

In the present talk, I shall briefly review several controversial charmonium and bottomonium states, explaining first the remarkable beauty of $X(3872)$, and presenting next a personal interpretation of e.g. $X(4260)$, $X(4660)$, and $\Upsilon(10580)$.

3.3.4 Searches for heavy neutral lepton production and lepton flavour violation in kaon decays at the NA62 experiment

Patrizia Cenci

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Searches for heavy neutral lepton (HNL) production in charged kaon decays using the data collected by the NA62 experiment at CERN are reported. Upper limits are established on the elements of the extended neutrino mixing matrix for heavy neutral lepton mass in the range 130-450 MeV, improving on the results from previous HNL production searches. The status and prospects of searches for lepton flavour and lepton number violation in kaon decays at the NA62 experiment is also presented.

3.3.5 KLEVER: An experiment to measure $\text{BR}(K_L \rightarrow \pi^0 \nu \bar{\nu})$ at the CERN SPS

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Branching ratio (BR) measurements of the $\Delta S = 1$ neutral current decays $K \rightarrow \pi \nu \bar{\nu}$ can constrain unitarity and thereby test for new physics. Different models of new physics predict different rates for the charged and neutral modes, $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ and $K_L \rightarrow \pi^0 \nu \bar{\nu}$, respectively. The NA62 experiment at the CERN SPS is currently collecting data with the objective of measuring $\text{BR}(K^+ \rightarrow \pi^+ \nu \bar{\nu})$ to a precision of 10%. We are designing the KLEVER experiment to measure $\text{BR}(K_L \rightarrow \pi^0 \nu \bar{\nu})$ to $\sim 20\%$ using a high-energy neutral beam, also at the CERN SPS, starting in LHC Run 4. The boost from the high-energy beam facilitates photon detection and consequently the rejection of background channels with additional photons, such as $K_L \rightarrow \pi^0 \pi^0$. However, this arrangement also enhances the potential for other backgrounds, such as

$\Lambda \rightarrow n\pi^0$, and the challenge of vetoing at small-angles photons from other K_L decays amidst an intense flux of beam-related (soft) photons and neutrons. We present results of design studies intended to determine how well such challenges can be met and to estimate the sensitivity of a measurement.

3.4.1 New insights into the anomalous magnetic moment of the muon

Marina Krstic Marinkovic

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Anomalous magnetic moment of the muon (muon g-2) is one of the most precisely measured quantities in particle physics and it provides a stringent test of the standard model. Moreover, the experiments at Fermilab and J-PARC aim to decrease the experimental error in the muon g-2 by a factor of four. Hence a similar reduction of the theory error is desirable in order to be able to resolve the current discrepancy between the experimental measurement of the muon g-2 and its theoretical prediction, and potentially gain insight into new physics. The dominant sources of the uncertainty in the theoretical prediction of the muon g-2 are the errors of the hadronic contributions. This talk will briefly review recent progress in the lattice computation of the hadronic contributions to the muon g-2, in particular hadronic vacuum polarization (HVP). I will discuss the main sources of uncertainties in the current computations and challenges associated with reducing these uncertainties. Finally, an alternative approach for the hybrid computation of the HVP from the space-like experimental data and the lattice is outlined. This work is part of another boundary-moving measurement of the most fascinating ingredient of the muon g-2: MUonE, which is proposed as a part of the CERN's Physics Beyond Colliders initiative.

3.4.2 Charm Mixing and CPV

Giulia Tuci

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LHCb has collected the world's largest sample of charmed hadrons. This sample is used to measure $D^0 - \bar{D}^0$ mixing and to search for direct and indirect CP violation. New measurements from several decay modes are presented.

3.4.3 Search for Vector-like Quarks

Steffen Henkelmann

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Vector-like quarks appear in many theories beyond the Standard Model as a way to cancel the mass divergence for the Higgs boson. The current status of the ATLAS searches for the production of vector-like quarks will be reviewed for proton-proton collisions at 13 TeV. This presentation will address the analysis techniques, in particular, the selection criteria, the background modeling and the related experimental uncertainties.

3.4.4 CP violation in B decays to charmonia at LHCb

Giovanni Cavallero

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Precision measurements of CP violating observables in b hadron decays with charmonia in the final state are powerful probes to search for physics effects beyond the Standard Model. The most recent results on CP violation in the decay, mixing and interference of b hadrons obtained by the LHCb Collaboration will be presented, with particular focus on results obtained exploiting the data collected during the Run 2 of LHC. These results represent the world's best constraints, some of which are world-first measurements, of the CP violating phase ϕ_s .

4.1.1 Flavour anomalies

Elena Graverini

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The concept of lepton universality, where the three lepton families are equivalent except for their mass, is a cornerstone prediction of the Standard Model (SM), which can be violated in models beyond the SM by new physics particles that couple preferentially to the second and third generation leptons. In the last few years, hints of lepton universality violation have been observed in both tree-level $b \rightarrow cl\nu$ and rare $b \rightarrow sl\ell$ decays. These results, combined with the tensions observed in angular and branching fraction measurements of rare semileptonic decays, point to a coherent pattern of anomalies that could represent the first observation of Physics beyond the SM. This presentation will review the anomalies registered by LHC experiments as well as B factories, and will give an outlook for the near future.

4.1.2 Building models for B-physics anomalies

Dario Buttazzo

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Several different experiments show evidences of Lepton Flavour Universality violation in semi-leptonic B meson decays, both in charged and neutral currents. These anomalies can be interpreted in terms of new short-distance interactions that involve mainly the third generation of fermions. I will first discuss the present status of the anomalies, and their connection to other low- and high-energy observables, in a model-independent way, adopting an Effective Field Theory approach based on a CKM-like flavour structure. I will then extend the analysis to a few simple UV completions with different types of mediator, discussing the main issues that have to be faced in each case. A few models emerge, which look capable of accommodating both charged- and neutral-current anomalies consistently with all the experimental bounds, with associated flavour and high- p_T signatures within the reach of present and future experiments.

4.1.4 Supersymmetric Features of Hadron Physics and other Novel Properties of Quantum Chromodynamics from Light-Front Holography and Superconformal Algebra

Stan Brodsky

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A fundamental question in hadron and nuclear physics is how the mass scale for protons and other hadrons emerges from QCD, even in the limit of zero quark mass. I will discuss a new approach to the origin of the QCD mass scale and color confinement based on "light-front holography", a formalism which relates the bound-state amplitudes in the fifth dimension of AdS space to the boost-invariant light-front wavefunctions describing the structure of hadrons in physical space-time. The result is a set of Poincaré-invariant bound-state wave equations which incorporate quark confinement and predict many observed spectroscopic and dynamical features of hadron physics, such as linear Regge trajectories with identical slope in both the radial quantum number and the internal orbital angular momentum.

Generalizing this procedure using superconformal algebra leads to a unified Regge spectroscopy of meson, baryon, and tetraquarks, including remarkable supersymmetric relations between the masses of mesons and baryons. The pion bound-state, although composite, is massless for zero quark mass. One also can predict nonperturbative hadronic observables such as structure functions, transverse momentum distributions, and the distribution amplitudes defined from the hadronic light-front wave functions.

The analytic behavior of the QCD coupling controlling quark and gluon interactions at large and small distances is also determined. The result is an effective coupling defined at all momenta with a transition mass scale which sets the interface between perturbative and nonperturbative hadron dynamics. One also obtains a relation between the perturbative QCD mass scale and hadron masses. I will also briefly discuss how conformal constraints lead to the elimination of the renormalization scale ambiguity for perturbative QCD calculations.

4.2.1 Status of the MEG experiment at PSI

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Searches for charged lepton flavour violations (CLFV) are considered to be extremely sensitive probes of possible new physics beyond the Standard Model. The MEG experiment at PSI has recently obtained the strictest experimental upper limit on the $\mu \rightarrow e\gamma$ decay ($\text{BR} < 4.2 \cdot 10^{-13}$) and is currently being upgraded in order to improve this measurement by one order of magnitude. In this talk I will briefly review the compelling theoretical reasons for performing this measurement, I will present the current status of the MEG upgrade in detail and I will compare its sensitivity goal with the other CLFV searches around the world.

4.2.2 Heavy Flavour Production at LHCb

Fabio Ferrari

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This presentation summarizes recent progress on heavy production at LHCb, including associated pair production, charmonium in jets and polarization observables. New results obtained from pp collisions at $\sqrt{s} = 13$ TeV will be presented.

4.2.3 Quarkonium production at 13 TeV

Cristina Biino

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A wide range of studies of Quarkonium production and spectroscopy are performed by the CMS experiment. Events are selected from muons pairs, and the final state includes hadrons and photons. The identification of secondary vertices allows for the separation of prompt and non prompt charmonium production. Recent results obtained using 13 TeV data are presented, including the production of $\Upsilon(1S)$ pairs. Differential production cross sections are compared to measurements at 7 and 8 TeV.

4.2.4 Production of b-hadrons and CKM matrix elements using semileptonic decays

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Exclusive semileptonic b-hadron decays with large branching fractions and controllable theoretical uncertainties, allow precise determinations of the CKM matrix elements, $|V_{ub}|$ and $|V_{cb}|$, and the study of the perturbative QCD effects, which is important for the whole LHCb physics programme. Measurements of the CKM element $|V_{ub}|$ at LHCb take advantage of the large production of Λ_b baryons and B_s mesons, as well as form complementary approaches, like searches for leptonic decays as $B^+ \rightarrow 3\mu\nu$. Studies of perturbative QCD effects include the determination of the asymmetry between particles and antiparticles in the heavy flavour production rates and fragmentation functions for the various hadron species, which are essential inputs to CP violation and branching ratio measurements. At the same time, novel experimental techniques are used to measure the fraction of semileptonic B^+ to charm meson decays, in order to improve the understanding of the inclusive charm semileptonic rate and the background description for analyses exploiting exclusive $b \rightarrow c$ and $b \rightarrow u$ transitions. The latest LHCb results on CKM matrix element determination and perturbative QCD effects are presented.

4.2.5 b hadron production, spectroscopy and properties at CMS

Stefano Argirò

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Precise measurements of production and properties of hadrons containing a b quark, performed using data collected by the CMS experiment at the LHC, are reported. These are important to investigate underlying mechanisms in QCD describing heavy quarks. The dependences on transverse momentum and rapidity are investigated. Comparisons with theory expectations and among different collision energies are provided.

5.1.1 Open heavy-flavour measurements in heavy-ion collisions at the LHC

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Due to their large masses, charm and beauty quarks are produced primarily in the initial stages of heavy-ion collisions, and not through thermal processes at later stages, and their annihilation rate is negligible. They therefore serve as excellent probes of the strongly interacting medium ("Quark-Gluon Plasma") that is produced in central heavy-ion collisions at the LHC, as they are created before the formation of the QGP and experience the full evolution of the system. In order to fully understand this system, it is necessary to also make precise measurements in smaller systems (pp and p-Pb collisions), which respectively serve as a baseline to constrain pQCD calculations and provide information about initial-state (or cold nuclear matter) effects in nuclear collisions. Multiple techniques are employed to study open heavy-flavour hadron production in the LHC experiments. Inclusive heavy-flavour production is measured by studying the spectra of muons and electrons from semileptonic decays, with the possibility to separate the contributions from charm and beauty quarks. Further to this, open heavy-flavour hadrons are also reconstructed in their hadronic decay channels, giving access to the full kinematics of the original particle. This talk will present an overview of the latest measurements of open heavy-flavour production in heavy-ion collisions at the LHC.

5.1.2 Heavy quarkonium production in high-multiplicity pp, pA and AA collisions

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The eikonal model for pp elastic amplitude, supplemented with the AGK unitarity cutting rules underestimates the J/ψ production rate in high multiplicity pp collisions. The effect of mutual boosting of the saturation scale in such events significantly increases the yield of charmonium in a good accord with data. Multiple interactions in pA collisions not only suppress, but also enhance production of J/ψ and $\psi(2S)$, offering an explanation for the observed puzzling energy dependence of the nuclear effects between RHIC and LHC. Multiple interactions are especially intensive in nuclear collisions. Charmonium production is significantly enhanced by initial state multiple interactions in AA collisions due to busted saturation scales in the colliding nuclei. At the same time, final state interactions of the produced Q-Qbar dipoles propagating through a hot medium (QGP) can break them up due to Debye screening (melting) and color exchanges with the medium (absorption). This process is described with the Lorentz boosted Schroedinger equation, derived specifically for heavy quarkonia.

5.1.3 Production of open charm and beauty states in pPb collisions with LHCb

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A rich set of open heavy flavour states is observed by LHCb in pPb collisions data collected at 5 and 8.16

TeV nucleon-nucleon center-of-mass energy. Results include the new measurements of production of beauty hadrons in pA collisions through cleanly reconstructed exclusive decays. Open charm states include the Λ_c baryon, that was also observed in pA collisions for the first time by LHCb.

5.1.4 Possible effect of mixed phase and deconfinement upon spin correlations in the $\Lambda\bar{\Lambda}$ pairs generated in relativistic heavy-ion collisions

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Spin correlations for the $\Lambda\Lambda$ and $\Lambda\bar{\Lambda}$ pairs, generated in relativistic heavy-ion collisions, and related angular correlations at the joint registration of space-parity nonconserving hadronic decays of two hyperons are theoretically analyzed. The correlation tensor components can be derived by the method of "moments" - averaging the combinations of trigonometric functions of proton (antiproton) flight angles over the double angular distribution of flight directions for products of two decays. The properties of the "trace" of correlation tensor (a sum of 3 diagonal components), determining the angular correlations and the relative fractions of the triplet and singlet states of respective pairs, are discussed. In this talk, spin correlations in the $\Lambda\Lambda$ and $\Lambda\bar{\Lambda}$ systems are generally studied within the model of one-particle sources, implying that correlations vanish at enough large relative momenta. However, under these conditions (especially at ultrarelativistic energies), for the $\Lambda\bar{\Lambda}$ pair the two-particle (quark-antiquark and two-gluon) annihilation sources start playing a noticeable role and lead to the difference of the correlation tensor from zero. Such a situation may arise, e.g., when the system passes through the "mixed phase" and - due to the multiple production of free quarks and gluons in the process of deconfinement - the number of two-particle sources strongly increases.

5.2.1 The Belle II Experiment: Status and Prospects

Alberto Martini

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The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB energy-asymmetric e^+e^- collider. The accelerator has already successfully completed the first phase of commissioning in 2016. First electron positron collisions in Belle II are expected for April 2018. The design luminosity of SuperKEKB is $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab^{-1} of data, a factor of 50 more than the Belle experiment. This large data set will be accumulated with low backgrounds and high trigger efficiencies in a clean e^+e^- environment. This talk will review the detector upgrade, the achieved detector performance and the plans for the commissioning of Belle II.

5.2.2 Studies of exotics states in heavy flavour in ATLAS

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Searches for, and measurements of exotic states are studied with the ATLAS detector. The latest results on exotic tetraquark and pentaquark states involving heavy flavour are presented.

5.2.3 Search for exotics at NA62

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Fixed target experiments are a particularly useful tool in the search of very weakly coupled particles in the MeV-GeV range, which are of interest, e.g. as potential Dark Matter mediators. Owing to the high beam-energy and a hermetic detector coverage, NA62 also has the opportunity to directly search for a variety of long-lived beyond-the Standard Model particles, such as Axion-like Particles and Dark Photons. In this talk, we will review the status of this searches and give prospects for future data taking at NA62.

5.2.4 Experiments with low-energy kaons at the DAΦNE Collider

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The study of the antikaon nucleon system at very low energies plays a key role in the study of the strong interaction with strangeness, with important impact in particle and nuclear physics and astrophysics. Exotic atoms measurements, in particular kaonic hydrogen and deuterium, allow to determine the s-wave antikaon-nucleon isospin dependent scattering lengths. Taking advantage of the excellent quality kaon beam delivered by the DAΦNE collider in Frascati (Italy) combined with new experimental techniques, as fast and very precise X ray detectors, like the Silicon Drift Detectors, we have performed unprecedented measurements in the low-energy strangeness sector in the framework of SIDDHARTA and AMADEUS Collaborations. The most precise kaonic hydrogen measurement, together with an exploratory measurement of kaonic deuterium, were performed by SIDDHARTA. Presently, a major upgrade of the setup, SIDDHARTA-2 is being realized to perform a precise measurement of kaonic deuterium and of other exotic atoms. Preliminary results for the interaction of negatively charged kaons with various type of nuclei will be shown. The experiments at the DAΦNE collider represents an opportunity which is unique in the world in the strangeness sector.

5.2.5 Few-body quark dynamics for multiquarks

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In this talk I will review the most relevant aspects of our recent studies on multiquark spectroscopy regarding four and five quark systems. I will discuss the adequate treatment of the 4-body dynamics for the quark model picture of tetraquarks. I will derive lower and upper bounds that constrain the possibility of stable tetraquarks for some mass ratios and some color wave functions.

5.3.1 Double heavy tetraquarks and pentaquarks in lattice QCD

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We briefly review the lattice QCD studies of double heavy tetraquarks and pentaquarks in lattice QCD.

We address computations including static quarks, heavy quark actions, or dynamical quarks. We also address using the Born-Oppenheimer approximation in lattice QCD, and the study of resonances. We also mention how lattice QCD may calibrate hadronic models addressing exotic hadrons.

5.3.2 A meson-baryon molecular interpretation for some Ω_c^0 excited states

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The recent observation by the LHCb collaboration of five narrow Ω_c^0 excited resonances decaying into $\Xi_c^+ + K^-$ states [1] has triggered a lot of activity in the field of baryon spectroscopy aiming at understanding their inner structure, whether they can be understood within the quark-model picture, as more exotic multiquark states, or mainly qualify as dynamically generated quasi-bound states of an interacting meson-baryon pair. In this talk I will present the results of a recent work [2] where we explore the possibility that some of the observed excited Ω_c^0 resonances could correspond to pentaquark states, structured as meson-baryon molecules. The interaction of the low-lying pseudoscalar mesons with the ground-state baryons in the charm +1, strangeness -2 and isospin 0 sector is built from t-channel vector meson exchange, using effective Lagrangians. The resulting s-wave coupled-channel unitarized amplitudes show the presence of two structures with similar masses and widths to those of the observed $\Omega_c(3050)^0$ and $\Omega_c(3090)^0$. The important observation is that the identification of these resonances with the meson-baryon bound states found in this work would also imply assigning the values $1/2^-$ for their spin-parity.

R.Aaij et al. [LHCb Col], Phys. Rev. Lett.118, no. 18, 182001 (2017)

G.Montaña, A.Feijoo and A.Ramos, arXiv:1709.08737

5.3.3 Searches for low-mass new-physics states at BaBar

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We report on the latest searches for low-mass states predicted in several dark-sector models, performed with the data collected by the BaBar detector at the PEP-II e^+e^- collider. In particular, we search for single-photon events in a sample corresponding to 53 fb^{-1} of e^+e^- collision data. We look for events with a single high-energy photon and a large missing momentum and energy, consistent with production of a spin-1 particle A' through the process $e^+e^- \rightarrow \gamma A'$, $A' \rightarrow \text{invisible}$. Such particles, referred to as "dark photons", are motivated by theories applying a U(1) gauge symmetry to dark matter. We find no evidence for such processes and set 90% confidence level upper limits on the coupling strength of $A' \rightarrow e^+e^-$ for a dark photon with a mass lower than 8 GeV. In particular, our limits exclude the values of the A' coupling suggested by the dark-photon interpretation of the muon g-2 anomaly, as well as a broad range of parameters.

We also present recent results on searches, in the full BaBar dataset, for light new particles predicted in many extensions of the Standard Model, such as axions in B decays, self-interacting or non-minimal dark forces, as well as hexaquark dark matter candidates.

5.3.4 Lepton flavour violation and rare decays at LHCb

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Lepton flavour violation and rare decays are excellent probes in search for physics beyond the SM. The LHCb experiment is well suited for the search for these decays due to its large acceptance and trigger efficiency, as well as its excellent invariant mass resolution and particle identification capabilities. Recent results on rare decays and searches for lepton-flavour violating decays from the LHCb experiment will be presented.

5.3.5 The Mu2e Experiment

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The Mu2e experiment at Fermilab will search for new phenomena by measuring the rate of muon to electron conversion in the field of a nucleus, $\mu N \rightarrow e N$. Data collection will begin in 2021 and will continue for three years. Ultimately, Mu2e will achieve a single-event sensitivity of 3×10^{-17} with < 0.5 background events. This equates to an experimental limit on the conversion rate of 8×10^{-17} at the 90%CL, which is a four-order-of-magnitude improvement over existing limits. A pulsed proton beam will be provided by the Fermilab booster, and a three-part solenoid will be used to produce, transport, and stop a muon beam on an Al target, whereafter the muons may interact and undergo conversion. The sensitivity requires that 10^{18} muons be stopped, which calls for the most intense muon beam ever made. The background requirement sets a strong constraint on the momentum resolution, which translates into stringent demands on detector performance. The major detectors consist of a precision, ultra low-mass straw-tube tracker, used for momentum reconstruction; a crystal calorimeter for enhanced PID; and an encasing multi-layer set of scintillation counters to veto false signals otherwise generated by cosmic muons. After Mu2e has concluded, accelerator improvements will provide 10X higher muon luminosity and a 10X improvement on the experimental limit, which, in the case of a signal, will allow us to probe the underlying physics.

5.4.1 Precision Tests of Fundamental Symmetries with Antihydrogen

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The ALPHA experiment, located at the Antiproton Decelerator at CERN, aims to study matter-antimatter asymmetries through precision measurements on antihydrogen atoms. CPT symmetry, a cornerstone of the Standard Model, requires that the atomic spectrum of antihydrogen and hydrogen be identical. The 1S-2S transition in particular, which is known in hydrogen with a relative precision of a few parts in 10^{15} , offers a high precision CPT test by comparison with anti hydrogen.

In this talk I will provide an overview of the ALPHA experiment and describe methods developed by the ALPHA collaboration to perform laser spectroscopy on antihydrogen atoms. I will also discuss recent results of the 1S-2S antihydrogen spectral line which was measured with a relative precision of 2 parts in 10^{12} . Finally, I will describe ALPHA-g, a new dedicated instrument being built by the ALPHA collaboration to study the Weak Equivalence Principle by measuring the gravitational acceleration of antihydrogen.

5.4.2 Status of the PADME experiment

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Among the theoretical models addressing the dark matter problem, the category based on a secluded sector is attracting increasing interest. The PADME experiment, at the Laboratori Nazionali di Frascati of INFN, is designed to be sensitive to the production of a low mass gauge boson A' of a new U(1) symmetry holding for dark sector particles. This "dark photon" is weakly coupled to the Standard Model photon, and it provides an experimental signature for one of the simplest implementations of the dark sector paradigm. The DAΦNE Beam-Test Facility at LNF will provide a high intensity, mono-energetic positron beam impinging on a low Z target. The PADME detector will measure with high precision the momentum of the photon, produced along with the A' boson in $e^+e^- \rightarrow \gamma A'$ annihilation in the target, thus allowing to measure the A' mass as the missing mass in the final state. This technique, particularly useful in case of invisible decays of the A' boson, will be exploited for the first time in a fixed target experiment. Simulation studies predict a sensitivity on the interaction strength (ϵ^2 parameter) down to 10^{-6} , in the mass region $1 \text{ MeV} < M_{A'} < 23.7 \text{ MeV}$.

5.4.3 Test of discrete symmetries with neutral kaons at KLOE-2

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The KLOE-2 experiment at the INFN Laboratori Nazionali di Frascati (LNF) completed its data-taking at the e^+e^- DAΦNE collider, which is implementing an innovative collision scheme based on a crab-waist configuration, and achieving the integrated luminosity goal of more than 5 fb^{-1} . KLOE-2 represents the continuation of KLOE with an upgraded detector and an extended physics program which includes neutral kaon interferometry and test of discrete symmetries among the main topics.

Entangled neutral kaon pairs produced at DAΦNE are a unique tool to test discrete symmetries and quantum coherence at the utmost sensitivity, in particular strongly motivating the experimental searches of possible CPT violating effects, which would constitute an unambiguous signal of a New Physics framework.

The status of the latest ongoing analyses on KLOE/KLOE-2 data using the most refined analyses tools will be presented and discussed:

- (i) measurement of the K_S^0 semileptonic charge asymmetry and tests of CP and CPT symmetry,
- (ii) test of Time reversal and CPT in transitions in $\phi \rightarrow K_S^0 K_L^0 \rightarrow \pi\nu, 3\pi^0, (2\pi)$ decays,
- (iii) search for the CP violating $K_S^0 \rightarrow 3\pi^0$ decay.

5.4.4 The Mu3e experiment

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The Mu3e experiment is targeting the search for charged lepton violation in the process $\mu^- \rightarrow e^+e^-e^+$ with a branching ratio sensitivity of 10^{-16} , which is four orders of magnitude better than the current best limit (SINDRUM 1988). For the first phase, the experiment will be operated with an existing intense muon beam line at the Paul Scherrer Institute, with muon stopping rates up to 10^8 muons/s. With these rates a

single event sensitivity of 2×10^{-15} can be achieved. To reach the target sensitivity, an upgrade of the existing beam line is planned. In order to suppress background, an excellent momentum and position resolution for low momentum electron and positron tracks are needed. For this a silicon pixel sensor (HV-MAPS), with extremely low material budget is developed. In addition, an excellent scintillator fiber and tile detectors are used to provide a precise timing information needed for suppressing the accidental background by a factor larger than two orders of magnitude. Currently the collaboration is finalizing the experiment design and planning the construction and commissioning phase. In this talk the status of the experiment is presented, and the latest developments from the three sub-detector systems.

6.1.1 Theoretical description of hadroproduction and production on nuclear targets of phi-mesons at very high energies

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We use the Quark-Gluon String Model to obtain a quantitatively good description of the ϕ meson production experimental data in hadron-nucleon collisions on the spectra of secondary ϕ , as well as on the ratios of ϕ/π^- and ϕ/K^- production cross sections, for a wide energy region. We also consider the experimental data on phi-meson production on nuclear targets, and we find that they present unusually small shadow corrections for the inclusive density in the midrapidity region. Finally, we present theoretical predictions for the LHC energies. Phys. Rev D90, 114019 (2014), and Phys. At. Nucl. 80, 1197 (2017).

6.1.2 Quarkonia produced in Heavy Ions from the ATLAS Experiment

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The observed quarkonia states in heavy ion collisions provide a powerful tool to probe the dynamics of the Quark Gluon Plasma. Measurements performed on the ground and excited quarkonia states, as well as their separation into prompt and non-prompt production mechanisms, reveal the effects of colour screening and colour recombination. In addition, quarkonium production rates, and their excited to ground states ratios, in lighter p+Pb collisions, are an interesting probe of cold nuclear matter effects. In this talk, the latest results of the ATLAS experiment at the LHC on these observables will be presented.

6.1.3 Novel mechanism for suppression of heavy had mesons in heavy ion collisions

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Production of heavy hadrons from fragmentation of heavy quarks represents an alternative way for study of manifestations and properties of a medium created after heavy ion collisions. The observed strong suppression of heavy had D and B mesons, produced with high transverse momenta p_T , is caused by final state interactions with the created dense medium. The space-time pattern of hadronization of a highly virtual

heavy quark is controlled by its vacuum radiation, which is ceased at a short time scale in accordance with perturbative QCD calculations and LEP measurements of the fragmentation functions. However, the production of a heavy hadrons lasts a long time scale due to prompt multiple breakups of these hadrons caused by the medium. This fact together with the specific shape of the heavy quark fragmentation functions allow to explain a strong suppression of D and B heavy mesons in a good accord with available data.

6.1.4 Open Charm measurements at the NA61 experiment at CERN SPS

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The strong interactions programme of the NA61/SHINE experiment at CERN SPS has been extended through the use of new silicon Vertex Detector which provides precise measurements of exotic particles with short lifetime. The detector was designed to meet the challenges of primary and secondary vertices reconstruction at high spatial resolution.

An initial version of the Vertex Detector called SAVD (Small Acceptance Vertex Detector) was installed last end of 2016, and data was from PbPb collisions was collected in 2016, for XeLa in 2017, as well as further PbPb collisions this year. First indication of a D_0 peak at SPS energies has been observed.

The physics motivation behind the open charm measurements will be discussed, as well as the analysis of collected data on open charm production and the future plans of open charm measurements in NA61/SHINE experiment related to the upgraded version of the vertex detector.

6.1.5 pA collisions in fixed-target mode at LHCb

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LHCb has the unique capability to study collisions of the LHC beams on fixed targets. Internal gas targets of Helium, Neon and Argon have been used so far. Updated results and prospects on soft particle production and open and hidden charm productions will be presented. The measurements are of great interest to cosmic ray physics. The charm production measurements provide crucial constraints on intrinsic charm and nuclear parton distribution functions at moderate and large Bjorken x .

6.2.1 Heavy quarks and chromo-electromagnetic field fluctuations: The Drag, Diffusion coefficient and Nuclear modification factor

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The heavy ion collisions in the RHIC at BNL and LHC at CERN aim to create a hot and densified deconfined state of QCD matter called Quark Gluon Plasma (QGP). Among the produced partons in such collisions, heavy quarks are mostly produced at the early stage from the initial fusion of the partons which makes them a good probe for the QGP. After their production, these heavy quarks will travel through the dense QGP medium and will start losing energy during their path of travel and as well as will be dragged

and diffused in the the QGP. They lose energy by elastic collisions and bremsstrahlung gluon radiations. These energy loss calculations are usually obtained by considering the QGP medium in an average manner and statistical field fluctuations of the QGP medium are ignored. The QGP being a statistical system of mobile color charge particles, one could characterize it by stochastic electromagnetic field fluctuations. The effect of this field fluctuations in the QGP leads to an energy gain of the traveling heavy quarks of all momenta and significant at the lower ones.

We have calculated the temperature dependent drag and diffusion coefficient of heavy quarks and nuclear modification factor (R_{AA}) of heavy mesons by considering the collisional and radiative energy loss of heavy quarks along with the energy gain due to field fluctuations. Our results are in good agreement with the experimentally measured R_{AA} of D and B mesons by ALICE and CMS experiments.

6.2.2 Rare Charm

Jolanta Brodzicka

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LHCb is playing a crucial role in the study of rare and forbidden decays of charm hadrons, which might reveal effects beyond the Standard Model. New searches for FCNC mediated processes and first asymmetry measurements in multibody final states with two leptons are presented.

6.2.3 Measurements of $R(D^{(*)})$ and other missing energy decays modes at Belle II

Mario Merola

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The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB energy-asymmetric e^+e^- collider. The accelerator has already successfully completed the first phase of commissioning in 2016 and first electron positron collisions in Belle II are expected for April 2018. The design luminosity of SuperKEKB is $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab^{-1} of data, a factor of 50 more than the Belle experiment. With this amount of data, decays sensitive to physics beyond the Standard Model can be studied with unprecedented precision. In this talk we will present our prospects for studying lepton non-universality with the modes $B \rightarrow D^{(*)}\tau\nu$. Prospects for other missing energy modes sensitive to physics beyond the Standard Model model such as $B^+ \rightarrow \tau^+\nu$ and $B \rightarrow K^{(*)}\nu\bar{\nu}$ will also be covered.

6.2.4 Rare B decays

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Rare B decays are an excellent probe of the physics beyond the Standard Model. In those highly suppressed processes, such as FCNC decays, the measurements are sensitive to contributions from new physics. In the last few years several new measures from LHC and B-factories experiments have been released with

impressive experimental precision. The most recent measurements of rare B-decays from the CMS collaboration will be presented.

6.3.1 Latest results from Daya Bay Reactor Neutrino Experiment

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The Daya Bay Reactor Neutrino Experiment consists of eight antineutrino detectors deployed in three underground halls at different distances from six 2.9 GWth nuclear reactors. The experiment started operations in December of 2011, and in 2012 reported a measurement of $\sin^2(2\theta_{13})$ with a significance better than 5σ . Since then, the experiment has accumulated the largest sample of reactor antineutrino candidates via the inverse beta decay (IBD) reaction. In this talk, the latest measurement of $\sin^2(2\theta_{13})$ will be presented, alongside other recent results from the experiment.

6.3.2 Results from the CUORE experiment

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The Cryogenic Underground Observatory for Rare Events (CUORE) is the first bolometric experiment searching for neutrinoless double beta decay that has been able to reach the 1-ton scale. The detector consists of an array of 988 TeO_2 crystals arranged in a cylindrical compact structure of 19 towers. The construction of the experiment and, in particular, the installation of all towers in the cryostat was completed in August 2016 and data taking started in spring 2017. In this talk we present the neutrinoless double beta decay results of CUORE from examining a total TeO_2 exposure of 86.3 kg yr, characterized by an effective energy resolution of 7.7 keV FWHM and a background in the region of interest of 0.014 counts/(keV kg yr). In this physics run, CUORE placed a lower limit on the decay half-life of $^{130}\text{Te} > 1.3 \cdot 10^{25}$ yr (90% C.L.). We then discuss the additional improvements in the detector performance achieved in 2018 and the latest update on the study of other rare processes in Tellurium and in the evaluation of the background budget.

6.3.3 SNO+ present results and prospects

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SNO+ has been taking data for one year, as a pure water Cherenkov detector, while preparing for filling scintillator and then loading 3900 kg of Tellurium to search for neutrinoless double beta decay. This talk will review the present results and prospects of SNO+, focusing on how the water commissioning phase extends the capabilities of previous Cherenkov detectors, and on the results that the available data provides for neutrino and other low background physics.

6.3.4 Solar Neutrino Results and Future Opportunities with Borexino

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The Borexino experiment, located in the Laboratori Nazionali del GranSasso in Italy and widely known for its rich Solar Neutrino physics program, has recently celebrated the 10 years of data taking. Among the achievements of Borexino experiment solar program are: a precision measurement of ${}^7\text{Be}$ neutrino flux with uncertainty of 3%, limit on its day/night asymmetry, first spectral measurement of pp-neutrinos, first evidence of mono-energetic pep neutrinos at 5σ , ${}^8\text{B}$ neutrinos detection with the lowest visible energy threshold of 3 MeV, observation of season modulation of the ${}^7\text{Be}$ solar neutrino rate at 3.8σ , and the best current limit on CNO neutrino flux.

Borexino is now in its high-purity Phase II data taking, thanks to intense purification campaigns of scintillator in 2010-11 that were very successful in further reducing the already low backgrounds. The advanced techniques of data analysis were improved, allowing to maximize the signal/noise ratio. The detector was thermally insulated in order to improve the fluid stability. As an outcome, quality of the data has significantly increased leading to new levels of sensitivity to all solar neutrino fluxes. This allows a more sensitive probe for CNO neutrinos relevant to the solar metallicity problem. The current results, and the future scientific opportunities for solar neutrino research will be discussed.

6.3.5 The ${}^{136}\text{Xe}$ neutrinoless double beta decay search with LZ

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Several radioactive isotopes are known to undergo double beta decay ($2\nu\beta\beta$), a type of rare decay in which two beta particles and two neutrinos are emitted simultaneously. But if neutrinos are Majorana particles, then these isotopes may also decay through a variant of the double beta decay in which no neutrinos are emitted. The search for this neutrinoless mode could shed some light on fundamental properties of neutrinos and their role in the asymmetry of matter and antimatter in the Universe today.

The LUX-ZEPLIN (LZ) experiment is a 7 active tonne liquid xenon TPC designed primarily to search for WIMPs, a leading candidate dark matter particle. Natural xenon contains 8.9% of the isotope ${}^{136}\text{Xe}$, a known double beta decay element, endowing LZ with sensitivity to the neutrinoless double beta decay mode comparable to current experiments.

Searches for this neutrinoless decay mode are performed by looking for an excess of events around the endpoint energy of the two-neutrino double beta decay mode of ${}^{136}\text{Xe}$. A complete background model of LZ was constructed in order to fully describe the backgrounds near the double beta decay Q value. The model includes radioactivity from detector materials and the laboratory walls, radon mixed in the xenon, neutrino interactions and the double beta decay signal of ${}^{136}\text{Xe}$ itself. In this talk I will present the model and provide an estimate of the sensitivity of LZ to neutrinoless double beta decay.

6.4.1 CP-violation measurements in $B \rightarrow DX$ decays at LHCb

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Measurements of CP violation are a core part of the LHCb physics programme and provide sensitivity to angles of the CKM matrix as well as probing our understanding of the differences between matter and antimatter. A summary of recent LHCb results are presented, including the time-dependent $B^0 \rightarrow D\pi$ analysis which profits from the largest flavour tagged sample analysed by LHCb, the world's first observation of the $B_s \rightarrow DKK$ channel and analysis of its Dalitz structure and the world's most precise (first) measurements of the CP asymmetry in $B^+ \rightarrow D(s) + D^0$ decays.

6.4.2 CP violation in two- and quasi-two-body charmless B decays

Emmy Gabriel

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The amplitudes governing the decays of neutral b-hadrons to charmless two-body final states receive relevant contributions from $b \rightarrow d, s$ penguin topologies. New particles not foreseen in the SM that might appear in the loops as virtual contributions, have the potential to alter not only the CP asymmetries of these decays, and, in case of two vector mesons in the final state, the polarisation fractions and the triple-product asymmetries. The latest measurements of these quantities in charmless two- and quasi-two-body decays, performed by the LHCb experiments, are presented, with particular emphasis on the measurements of time-dependent CP asymmetries.

6.4.3 Status and perspectives of hyperon production and electromagnetic decays with HADES at FAIR

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The Hades spectrometer is a versatile detector device operating at SIS18 synchrotron at GSI Darmstadt with a vital list of results on strangeness production including $\Lambda(1405)$ and $\Sigma(1385)$ exclusive production cross-sections, Λ polarization, Λ -p correlation and Kaons in-medium. With the upgrade of the SIS18 synchrotron for the FAIR facility and the upgrade of HADES with a new Forward Detector, the experiment will have an unique opportunity to study also excited hyperon states. Between the others, production and electromagnetic decays of excited Λ and Σ hyperons states, Ξ^- cascade spectroscopy and Λ - Λ production and correlation are planned. We have studied the reconstruction feasibility using two benchmark channels of $\Lambda(1520) \rightarrow \Lambda e^+ e^-$ Dalitz decay and inclusive Ξ^- production in $pp \rightarrow \Xi^- K^+ K^+ p$ reaction. The Forward Detector consisting of a forward tracker made of PANDA straw tubes prototypes and a RPC time of flight detector and will enlarge HADES acceptance to forward angles (0.5 - 7°) important for Λ tagging. The magnetic field-free forward region will request employment of kinematical refit and neural networks analysis methods to perform particle identification. In this contribution highlights of strangeness production in p-p and p-A reactions will be presented together with perspectives for the future hyperon programme.

7.1.1 Determination of the CP Violation parameters at Belle II

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The Belle II experiment is a substantial upgrade of the Belle detector and will operate at the SuperKEKB energy-asymmetric e^+e^- collider. The accelerator has already successfully completed the first phase of commissioning in 2016 and first electron positron collisions in Belle II are expected for April 2018. The design luminosity of SuperKEKB is $8 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$ and the Belle II experiment aims to record 50 ab^{-1} of data, a factor of 50 more than the Belle experiment. In this presentation we report our prospects for the measurements of various CP violation parameters, e.g. the CKM matrix element magnitudes, UT angles and time-dependent measurements.

7.1.2 Precision physics with the Circular Electron Positron Collider

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Probing high-precision electroweak physics is a natural step to further test the Standard Model at the TeV-scale. The highest precision can be achieved from possible future e^+e^- linear or circular colliders (ILC, CLIC, FCC-ee, CEPC). These machines allow precise measurements of the Higgs boson properties, as well as the properties of the Z boson, W boson and top quark. Besides the possibility of direct discoveries, improvements on the current Standard Model parameters precision, such as the Higgs couplings, the W mass or the effective weak-mixing angle, will provide powerful probes for new physics.

This talk will focus on the circular collider option, and in particular, on the Circular Electron Positron Collider (CEPC) proposed to be built in China. We will provide an overview of the project, as described in the Conceptual Design Report, emphasizing the physics reach, as well as the detector and accelerator designs. The current R&D status and long-term plans, and issues such as international collaboration will also be addressed.

7.1.3 The SHiP experiment at CERN

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SHIP is a new general purpose fixed target facility, whose Technical Proposal has been reviewed by the CERN SPS Committee and by the CERN Research Board. The two boards recommended that the experiment proceeds further to a Comprehensive Design phase in the context of the new CERN Working group "Physics Beyond Colliders", aiming at presenting a CERN strategy for the European Strategy meeting of 2019. In its initial phase, the 400 GeV proton beam extracted from the SPS will be dumped on a heavy target with the aim of integrating 2×10^{20} pot in 5 years. A dedicated detector, based on a long vacuum tank followed by a spectrometer and particle identification detectors, will allow probing a variety of models with light long-lived exotic particles and masses below $O(10) \text{ GeV}/c^2$. The main focus will be the physics of the so-called Hidden Portals, i.e. search for Dark Photons, Light scalars and pseudo-scalars, and Heavy Neutrinos. The sensitivity to Heavy Neutrinos will allow for the first time to probe, in the mass range between the kaon and the charm meson mass, a coupling range for which Baryogenesis and active neutrino masses could also be explained. Another dedicated detector will study the neutrino cross-sections and their energy and angular dependence. Tau neutrino deep inelastic scattering cross sections will be measured with a statistics 1000 times larger than currently available, with the extraction of the F4 and F5 structure functions, never measured so far.

7.1.4 Flavour physics & beyond, a concluding overview

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Flavour physics stands today at an exciting forefront. Unprecedentedly large flavour-enriched data sets are allowing to reach high levels of precision and to explore new observables and rare sensitive processes. The large suite of precision measurements matching the expectation from the standard theory, the observation of its scalar, followed more recently by that of the Yukawa interaction, together with the negative outcome of the direct searches for new fundamental states, consolidate the Standard Model as an unexpectedly robust effective theory up to the TeV scale. At the same time, a coherent set of so-called flavour anomalies persistently emerge from the data, constituting a tantalising indication of the presence of New Physics. Explorations of the flavor sector in its many fronts are actively pursued and planned, which are bound to shed further light on the Standard Model and possibly reach beyond it in the near future.