Conference on Flavour Physics and CP violation (FPCP) 2020

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Book of Abstracts
Contents

Lunch .................................................. 1
FPCP 2021 Fudan, Shanghai .................................. 1
Theory overview of multiquark states .................................. 1
Hadronic molecules with heavy quarks .................................. 1
Results from BESIII ........................................ 1
Results from the LHC ........................................ 1
Results from the B factories .................................... 1
Theory of strange decays ..................................... 2
Status of lattice calculations for strange processes ................. 2
Results from NA62 ......................................... 2
Results from KOTO ......................................... 2
Results from LHCb ......................................... 2
Latest results on g-2 ........................................ 2
Status of (g-2) theory ....................................... 2
Status of MEGIII and Mu3e at PSI .............................. 3
b -> sll decays: what we learned and what we still hope to learn .................. 3
Theory status of radiative b decays ................................ 3
Recent progress on Form Factors and Charm loop uncertainties ....... 3
Experimental status on b->s(d) mumu transitions .................... 3
Experimental status on LFU tests in b->s(d)ll transitions ............... 3
Experimental status of radiative b decays ............................ 3
Status of b->sll and b->sgamma global fits .......................... 4
|Vib| measurements in SL b decays ................................ 4
neutron EDM: latest results and prospects ........................................ 8
Future of flavour ............................................................................. 8
Results from NOVA and T2K ............................................................ 8
Status of current neutrino paradigm ............................................... 9
Experimental status on neutrinoless double-beta decays .................. 9
Sterile neutrinos ............................................................................. 9
ICECUBE and Km3NET ................................................................. 9
Theoretical status of flavour production at hadron colliders ............. 9
Experimental status of flavour production at hadron colliders ......... 9
Rare tau decays ............................................................................. 9
Hadronic charm meson decays at BESIII ....................................... 10
Light meson decays at BESIII ......................................................... 10
XYZ at BESIII .............................................................................. 10
PROBING OF MULTIQUARKS STRUCTURE IN HADRON AND HEAVY ION COLLISIONS ........................................................................ 11
Latest results in neutron EDM at PSI ............................................. 12
Nuclear PDFs: status and prospects ............................................. 12
p-A experimental overview ............................................................. 12
p-A experimental overview ............................................................. 12
HI results from the LHC ................................................................. 12
Probing NP in four-fermion interactions with dipole processes ...... 12
Bs->JPsi Phi potential at CEPC ....................................................... 13
Comments on the LHCb angular analysis of B→K* μ+μ− ............... 13
Recent results from charged-current semileptonic B decays at LHCb .. 13
Enhanced production of multi-strange hadrons in high-multiplicity proton-proton collisions ......................................................... 13
Recent Searches for Hidden-Sector Particles with BABAR .......... 14
Rare and forbidden decays of D^{0} meson ..................................... 14
τ → μ lepton flavor universality in Υ(3S) decays at the BABAR experiment ................................................................. 14
Study of resonant-states production in e^+e^- annihilation in the energy region around 2.2 GeV ......................................................... 15
ATLAS results on Heavy Flavour production and decay (including rare processes) 20
CKM matrix at Belle II 20
Belle II highlights on first B Physics results 21
Charm and charmonium at Belle II 21
τ physics results and prospects at Belle II 21
Results and Prospects of Radiative and Electroweak Penguin Decays at Belle II 21
Status and Future development of the Full Event Interpretation Algorithm at Belle II 21
CMS Measurement of prompt open charm production cross sections in proton-proton collisions at 13 TeV 21
Flavour on a forward detector at 50 and 100 TeV 22
FPCP International Advisory Committee meeting 22
FPCP 2020 22
FPCP 2022 site selection 22
Lunch

Closeout and announcement of FPCP 2021 (Fudan, Shanghai)

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Multiquarks & co.

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Strangeness / 9

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Strangeness / 10

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Strangeness / 11

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Strangeness / 12

Results from KOTO

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Strangeness / 13

Results from LHCb

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Charged Leptons / 14

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Charged Leptons / 15

Status of (g-2) theory

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Charged Leptons / 16

Status of MEGIII and Mu3e at PSI

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b→s(d) ll and other rare b decays / 17

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b→s(d) ll and other rare b decays / 18

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b→s(d) ll and other rare b decays / 19

Recent progress on Form Factors and Charm loop uncertainties

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b→s(d) ll and other rare b decays / 20

Experimental status on b→s(d) mumu transitions

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b→s(d) ll and other rare b decays / 21

Experimental status on LFU tests in b→s(d)ll transitions

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b→s(d) ll and other rare b decays / 22

Experimental status of radiative b decays
b→s(d) ll and other rare b decays / 23

Status of b→sll and b→sgamma global fits
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Semileptonic b decays / 24

|Vib| measurements in SL b decays
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Semileptonic b decays / 25

SL B decays from Belle

Semileptonic b decays / 26

LFU tests in SL b decays
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Semileptonic b decays / 27

SL form factors in lattice QCD
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Semileptonic b decays / 28

Semileptonic b decays
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Charm / 29

CPV in charm
Charm / 30

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Charm / 31

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Charm / 32

**Charm results from hadron machines**

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Charm / 33

**Charm results from LHCb**

high - PT / 34

**Flavor physics at high pT**

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high - PT / 35

**Higgs Flavor**

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high - PT / 36

**Top physics at the LHC**
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high - PT / 37

Higgs results from the LHC
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high - PT / 38

Searches for Z’ and LQ at the LHC
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CPV in B decays / 39

Experimental status of CPV in Bs and Bd mixing
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CPV in B decays / 40

Measurement of hadronic inputs for gamma at BESIII
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CPV in B decays / 41

Experimental status of gamma
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CPV in B decays / 42

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CPV in B decays / 43
Status of CKM fits

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CPV in B decays / 44

TH2 (UTFit)

CPV in B decays / 45

Experimental status of CPV in B-> 3h

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CPV in B decays / 46

Experimental status of CPV in B->4h

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CPV in B decays / 47

Latest lattice inputs to B mixing parameters

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CPV in B decays / 48

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Future of flavour / 51

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Future of flavour / 52
Future colliders

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Future of flavour / 53

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Future of flavour / 54

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Future of flavour / 55

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Future of flavour / 56

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Future of flavour / 57

neutron EDM: latest results and prospects

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Future of flavour / 58

Future of flavour

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Neutrinos / 60

Results from NOVA and T2K

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Neutrinos / 61

Status of current neutrino paradigm

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Neutrinos / 62

Experimental status on neutrinoless double-beta decays

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Neutrinos / 63

Sterile neutrinos

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Neutrinos / 64

ICECUBE and Km3NET

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Flavour production / 65

Theoretical status of flavour production at hadron colliders

Flavour production / 66

Experimental status of flavour production at hadron colliders

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Hadronic charm meson decays at BESIII

Author: Jingzhi Zhang

BESIII has collected data samples corresponding to luminosities of 2.93 fb$^{-1}$ and 3.19 fb$^{-1}$ at center-of-mass energies of 3.773 and 4.178 GeV, respectively. The data set collected at 3.773 GeV contains quantum-correlated $D^0\bar{D}^0$ pairs that allow access to the phase differences between amplitudes. We report the measurements of strong phase differences in $D^0$ decays, including $K^0S/L\pi^+\pi^-$, which can reduce the gamma/phi3 measurement systematic uncertainty at LHCb and Belle II. In addition, we report the measurements of the absolute branching fractions and the amplitude analyses of $D^+$, $D^0$, and $D_s$ decays.

Light meson decays at BESIII

Author: Jingzhi Zhang

Due to the high production rate of light mesons in $J/\psi$ decays, the high statistics sample of 1.3 billion $J\psi$ events provide an ideal lab to investigate the decay dynamics of light mesons, in particular for $\eta$ and $\eta'$ decays. Recently the BESIII experiment made significant progresses in $\eta$ and $\eta'$ decays, including their hadronic and rare decays, which will be reported in this talk.

XYZ at BESIII

Author: Jingzhi Zhang

From 2011, BESIII has taken about 20 fb$^{-1}$ data samples at center of mass energies from 3.8 to 4.6 GeV, containing 21 energy points with luminosity larger than 400 pb$^{-1}$. This makes the study of vector states $Y$, charged states $Z$, $X$ states, as well as the connections between them through transition processes possible. Using these data samples, new information about $X(3872)$ decays, $Y$
states from open-charm final states, hidden-charm final states, and light hadron final states will be presented.

74

PROBING OF MULTIQUARKS STRUCTURE IN HADRON AND HEAVY ION COLLISIONS

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The spectroscopy of charmonium-like mesons with masses above the $2m_{D}$ open charm threshold has been full of surprises and remains poorly understood \cite{1}. The currently most compelling theoretical descriptions of the mysterious XYZ mesons attribute them to hybrid structure with a tightly bound $cc\bar{c}$ diquark \cite{2} or $cq(cq)\bar{c}$ tetraquark core \cite{3-5} that strongly couples to $S$-wave $DD\bar{c}$ molecular like structures. In this picture, the production of a XYZ states in high energy hadron collisions and its decays into light hadron plus charmonium final states proceed via the core component of the meson, while decays to pairs of open-charmed mesons proceed via the $DD\bar{c}$ component. These ideas have been applied with some success to the XYZ states \cite{2}, where a detailed calculation finds a $cc\bar{c}$ core component that is only above 5% of the time with the $DD\bar{c}$ component (mostly $D_{0}D_{0}\bar{c}$) accounting for the rest. In this picture these states are composed of three rather disparate components: a small charmonium-like $cc\bar{c}$ core with $r_{rms} \leq 1$ fm, a larger $D^{+}D^{-}$ component with $r_{rms} \approx \hbar/(2\mu_{D^{+}D^{-}})^{1/2} \approx 1.5$ fm and a dominant component $D_{0}D_{0}\bar{c}$ with $r_{rms} \approx \hbar/(2\mu_{D_{0}D_{0}})^{1/2} > 9$ fm spatial extent. Here $\mu_{D^{+}D^{-}}$ and $\mu_{D_{0}D_{0}}$ denote the reduced mass for the $D^{+}D^{-}$ ($D_{0}D_{0}\bar{c}$) system and the relevant binding energy $|m_{D^{+}} + m_{D^{-}} - M_{X}(3872)|$ ($B^{+} = 8.2$ MeV, $B^{0} < 0.3$ MeV). The different amplitudes and spatial distributions of the $D^{+}D^{-}$ and $D_{0}D_{0}\bar{c}$ components ensure that the $X(3872)$ is not an isospin eigenstate. Instead it is mostly $I = 0$, but has a significant ($\approx 25\%$) $I = 1$ component.

In the hybrid scheme, XYZ mesons are produced in high energy proton-nuclei collisions via its compact ($r_{rms} \leq 1$ fm) charmonium-like structure and this rapidity mixes in a time $\left(\hbar/\delta M\right)$ into a huge and fragile, mostly $D_{0}D_{0}\bar{c}$, molecular-like structure. $\delta M$ is the difference between the XYZ meson mass and that of the nearest $cc\bar{c}$ state pole core state, which we take to be that of the $\chi_{c1}(2P)$ pure charmonium state which is expected to lie about 20~30 MeV above $M_{X}(3872)$ \cite{6,7}. In this case, the mixing time, $c_{Mix} \approx 10$ fm, is much shorter than the lifetime of $X(3872)$ which is $c_{\tau_{X(3872)}} > 150$ fm \cite{8}.

The experiments with proton-proton and proton-nuclei collisions with $\sqrt{s}_{NN}$ up to 26 Gev and luminosity up to $10^{32}$ cm$^{-2}$s$^{-1}$ planned at NICA are well suited to test this picture for the $X(3872)$ and other XYZ mesons. In near threshold production experiments in the $\sqrt{s}_{NN} = 8$ GeV energy range, XYZ mesons can be produced with typical kinetic energies of a few hundred MeV (i.e. with $\psi' \approx 0.3$). In the case of $X(3872)$, its decay length will be greater than 50 fm while the distance scale for the $cc\bar{c}$ $\rightarrow D_{0}D_{0}^{*}$ transition would be $2 \sim 3$ fm. Since the survival probability of an $r_{rms}$ $\approx 9$ fm "molecular" inside nuclear matter should be very small, XYZ meson production on a nuclear target with $r_{rms}$ $\approx 5$ fm or more (A $\sim 60$ or larger) should be strongly quenched. Thus, if the hybrid picture is correct, the atomic number de-pendence of XYZ production at fixed $\sqrt{s}_{NN}$ should have a dramatically different behavior than that of the $\psi'$, which is long lived compact charmonium state. The current experimental status of XYZ mesons together with hidden charm tetraquark can-didates and present simulations what we might expect from A-dependence of XYZ mesons in proton-proton and proton-nuclei collisions are summarized.

References

[8] The width of $X(3872)$ is experimentally constrained to be $\Gamma_{X(3872)} < 1.2$ (90% CL) in S.-K. Choi et al (Belle Collaboration), Phys. Rev. D 84, 052004 (2011)

75

Latest results in neutron EDM at PSI

Parallel session / 76

Nuclear PDFs: status and prospects

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Parallel session / 77

fix target and HI at LHCb

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Parallel session / 78

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Parallel session / 79

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80

Probing NP in four-fermion interactions with dipole processes

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Four-fermion effective interactions have played a major role in the formulation of the Standard Model (SM) of particle physics. Nowadays, they are of fundamental importance in establishing the viability of extensions of the SM, since this category of operators is sensitive to the flavor structure of New Physics (NP), including new sources of CP violation. Following the renormalization of four-fermion operators, they mix into dipole operators, thus inducing powerful constraints on their effective coupling constants (i.e., their Wilson coefficients). For many four-fermion operators, such mixing is absent at one-loop. Here, I would like to present the calculation of their leading-order two-loop mixing into dipoles, and the resulting phenomenological bounds on generic NP models that generate four-fermion effective interactions at energies much above the ElectroWeak scale.

Parallel session / 81

Bs→JPsi Phi potential at CEPC

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Parallel session / 82

Comments on the LHCb angular analysis of B→K* μ+μ−

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Recent results from charged-current semileptonic B decays at LHCb

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Recent results from semileptonic b→clnu and b→ulnu decays studied at 7 TeV, 8 TeV and 13 TeV centre-of-mass energy with the LHCb detector will be reported. These include the measurement of hadronic form-factors in the Bs→Ds’munu decay and the first observation of the B→ppbarmunu decay.

Flavour production / 85

Enhanced production of multi-strange hadrons in high-multiplicity proton-proton collisions

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Recent Searches for Hidden-Sector Particles with BABAR

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Many models of dark matter and hidden sectors predict new particles with masses below the electron weak scale. Low-energy electron-positron colliders such as BABAR are ideally suited to discover these hidden-sector particles. We present several recent BABAR searches for low-mass hidden-sector particles, including new searches for prompt and long-lived leptonically decaying hidden scalars produced in association with tau leptons. This search is sensitive to viable models that could account for the muon g−2 excess. We also present results a search for dark muonic forces, and for invisible particles produced in six-quark final states. These examples show the importance of B-factories in constraining and discovering new hidden-sector physics beyond the Standard Model.

Rare and forbidden decays of $D^0$ meson.

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We report the observation of the rare charm decay $D^0 \rightarrow K^- \pi^+ e^+ e^-$, a search for nine lepton-number-violating and three lepton-flavor-violating neutral charm decays of the type $D^0 \rightarrow h^- h^+ \ell^+ \ell^+$, and $D^0 \rightarrow h^- h^+ \ell^+ \ell^-$, and a search for seven lepton-number-violating decays of the type $D^0 \rightarrow X^0 e^\pm \mu^\mp$, where $h$ and $h'$ represent a $K$ or $\pi$ meson, $\ell$ and $\ell'$ an electron or muon, and $X^0$ a $\pi^0$, $K_{S}^0$, $K^*$, $\rho^0$, $\phi$, $\omega$, or $\eta$ meson. The results are based on 468 fb$^{-1}$ of $e^+ e^-$ collision data collected at or close to the $\Upsilon(4S)$ resonance with the BaBar detector at the SLAC National Accelerator Laboratory.

$\tau - \mu$ lepton flavor universality in $\Upsilon(3S)$ decays at the BABAR experiment

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We report on a precision measurement of the ratio $R_{\tau\mu} = BF(\Upsilon(3S) \rightarrow \tau^+ \tau^-)/BF(\Upsilon(3S) \rightarrow \mu^+ \mu^-)$ using data collected with the BABAR detector at the SLAC PEP-II $e^+ e^-$ collider. The measurement is based on a 28 fb$^{-1}$ data sample collected at a center-of-mass energy of 10.355 GeV/$c^2$ which corresponds to a sample 122 million $\Upsilon(3S)$ mesons. In order to estimate backgrounds from direct dilepton production we use 2.6 fb$^{-1}$ of data collected 30 MeV below the $\Upsilon(3S)$ resonance mass and 86 fb$^{-1}$ of data collected near the $\Upsilon(4S)$ resonance. The ratio is measured to $R_{\tau\mu} = 0.9662 \pm 0.0084 \pm 0.0135$ and is in agreement with the Standard Model prediction. Its uncertainty
is almost of magnitude smaller than the only previous measurement reported by the CLEO collaboration.

89

Study of resonant-states production in $e^+e^-$ annihilation in the energy region around 2.2 GeV

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Two vector resonances with a mass near 2.2 GeV/c$^2$ are presently known: the $\phi(2170)$ observed in several production processes, but seen to decay only to $\phi(1020)\rho(980)$, and the not well established $\rho(2150)$. Recently the BES-III experiment observed a clear interference pattern in the same energy region in $e^+e^-\to K^+K^-$, interpreted as a resonance with a mass of 2239 GeV and a width of 0.14 GeV. To shed light on the resonant states in this energy region we measure the reaction $e^+e^-\to K_SK_L$ with data collected with the BABAR detector, and analyse these data in conjunction with published BES-III data on $e^+e^-\to K^+K^-$ and BABAR data on $e^+e^-\to K^+K^-$, $\pi^+\pi^-$, $\pi^+\pi^-\eta$, $\pi^+\pi^-\omega$. This study supports the existence of an isovector resonance $\rho(2230)$ with mass $M = 2232 \pm 8 \pm 9$ MeV/c$^2$ and width $\Gamma = 133 \pm 14 \pm 4$ MeV/c$^2$, consistent with the resonance observed by BES-III.

90

SEARCH FOR EXOTIC DECAYS WITH NA62

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The NA62 experiment at the CERN SPS is designed to measure the branching ratio of the $K^+\to\pi^+\nu\nu$ decay, one of the best candidates to reveal indirect effects of new physics at the highest mass scales. NA62 took data in 2016-2018. The high-intensity fixed-target setup and detector performance make the NA62 experiment particularly suited for searches of new physics from faintly interacting particles in the MeV–GeV mass range: heavy-neutral leptons, axion-like particles, and others. The results from the analysis of data taken with dedicated setup and triggers developed to this purpose will be highlighted.

91

The search for proton and deuteron Electric Dipole Moments using storage rings

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The Standard Model (SM) of Particle Physics is not capable to account for the apparent matter-antimatter asymmetry of our Universe. Physics beyond the SM is required and is either probed by employing highest energies (e.g., at LHC), or by striving for ultimate precision and sensitivity (e.g., in the search for electric dipole moments). Permanent electric dipole moments (EDMs) of particles violate both time reversal (T) and parity (P) invariance, and are via the CPT-theorem also CP-violating. Finding a non-zero EDM would be a strong indication for physics beyond the SM, and pushing upper limits further provides crucial tests for any corresponding theoretical model. Up to now, EDM searches focused on neutral systems (neutrons, atoms, and molecules). Storage rings, however, offer the possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion in the ring. Direct searches of proton and deuteron EDMs bear the potential to reach sensitivities beyond 1E-29 e cm.

Since the Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons up to momenta of 3.7 GeV/c, it constitutes an ideal testing ground and starting point for such an experimental program. The collaboration is presently aiming at a first direct (precursor) measurement of the deuteron EDM in COSY, using an RF Wien filter that was specifically designed for that purpose. Beyond that, the technical design of a prototype EDM storage ring constitutes the next major milestone of the JEDI research program, which shall be addressed together with CERN in the framework of a newly formed CPEDM collaboration (Charged Particle Electric Dipole Moment collaboration).

The talk will present the JEDI plans for the measurement of proton and deuteron EDMs, and discuss the various technical developments, and also show recent results.

This work is supported by an ERC Advanced-Grant of the European Union (srEDM, No. 694340).

### The KLOE-2 Experiment at DAPHNE

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The KLOE-2 experiment at DAΦNE, the LNF Frascati Φ-factory, has completed its data taking in 2018, collecting 5.5 fb-1 of integrated luminosity. The goal of KLOE-2 is to extend and expand the physics program of KLOE. The original ‘general purpose’ central detector, made by a large drift chamber - 4 m in diameter - surrounded by a lead/scintillating fibre electromagnetic calorimeter, has been upgraded with new sub-detectors, among which there is a cylindrical GEM detector to improve vertex reconstruction in the interaction region and two taggers to identify leptons diffused at small angles in gamma-gamma interactions.

The 8 fb-1 acquired with KLOE/KLOE-2 constitute a unique dataset of 24 billions Φ mesons produced. KLOE data analysis is still providing relevant results on K mesons’ properties, test of discrete symmetries, unitarity test of the CKM matrix, light meson properties, η decays, search for dark forces, hadronic cross section and its contribution to the muon anomalous magnetic moment. We will present the status of recent results and analysis in progress, as well as the KLOE-2 physics program.

Parallel session / 93

**τ-μ lepton flavor universality in Y(3S) decays at the BABAR experiment**
Parallel session / 94

The search for proton and deuteron Electric Dipole Moments using storage rings

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Parallel session / 95

Recent results from charged-current semileptonic B decays at LHCb

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Parallel session / 96

Light meson decays at BES III

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Parallel session / 97

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Parallel session / 98

Rare and forbidden decays of D0 meson

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Parallel session / 99

Hadronic charm meson decays at BESIII

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Parallel session / 100

Study of resonant-states production in e+e− annihilation in the energy region around 2.2 GeV

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Parallel session / 101

Probing of multiquark structure in hadron and heavy ion collisions

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Parallel session / 102

XYZ at BESIII

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Parallel session / 103

Study of resonant-states production in e+e− annihilation in the energy region around 2.2 GeV

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Parallel session / 104

Probing NP in four-fermion interactions with dipole processes

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Parallel session / 105

Search for Exotic decays in NA62

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Parallel session / 106

Recent Searches for Hidden-Sector Particles with BABAR
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Parallel session / 107

Baryogenesis and Dark Matter from B Mesons

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Parallel session / 108

Recent CMS results of a search for $\tau\rightarrow3\mu$ decays

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Parallel session / 109

Finding light DM with Deep Inelastic Scattering at the LHC

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Parallel session / 110

Searching for light scalars in rare B-decays into six muons

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Parallel session / 111

TauFV

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Parallel session / 112

Branching Fraction measurement of $B_0 \rightarrow D_0D_0\bar{b}K\pi$ at LHCb

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Measurement of the weak mixing phase $\phi_s$ through time-dependent CP violation in $B_s \rightarrow J/\psi \Phi$ decay in ATLAS

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Parallel session / 114

Search for CP violation in Higgs boson interactions at the ATLAS experiment

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Parallel session / 115

Recent highlights of top-quark physics with the ATLAS detector

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Parallel session / 116

Searching for leptoquarks with the ATLAS detector

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Parallel session / 117

Higgs boson couplings to bottom quarks at the ATLAS experiment

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Parallel session / 118

ATLAS results on Heavy Flavour production and decay (including rare processes)

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Parallel session / 119

CKM matrix at Belle II
Belle II highlights on first B Physics results

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Charm and charmonium at Belle II

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τ physics results and prospects at Belle II

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“Results and Prospects of Radiative and Electroweak Penguin Decays at Belle II

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Status and Future development of the Full Event Interpretation Algorithm at Belle II

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CMS Measurement of prompt open charm production cross sections in proton-proton collisions at 13 TeV

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Parallel session / 126

Flavour on a forward detector at 50 and 100 TeV

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127

FPCP International Advisory Committee meeting

Wellcome and introduction / 128

FPCP 2020

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129

FPCP 2022 site selection

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