# 11th International Workshop on Charm Physics (CHARM 2023)

Monday, 17 July 2023 - Friday, 21 July 2023

Hörsaalzentrum Unteres Schloss

# Book of Abstracts

# Contents

**Parallel A / 1**

# Understanding charm with LCSR using $D^* \to D\gamma$ decays.

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The distribution amplitudes (DAs) are the universal non-perturbative elements that enter the description of processes involving strong interactions in frameworks like light cone sum rules (LCSR). For light quark systems, they are formulated using the properties of conformal symmetry. However, for heavy quark systems, one faces different challenges. The most important quantities of interest for these systems are the inverse moments of the DAs. There exist several models for these DAs using heavy quark symmetry, and the model parameters are related to the inverse moments. Therefore, having better control over these parameters will help in probing the structure of the hadronic system.
In this talk, I will try to shed some light on these issues and will discuss a possible solution using the experimental data of $D_q^* \to D_q\gamma$ (q=u,d,s) decays. We will compute the model parameters of D-meson DAs by comparing the experimental value of $D_q^* D_q\gamma$ coupling to the one obtained using Light Cone Sum Rules. I will show how such an estimation provides better and complementary results for these unknown parameters.

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**Parallel A / 4**

# Resummation and renormalization of kinematical effects in \chi_c and \chi_b hadroproduction

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We investigate the renormalization properties of the shape function formalism for inclusive production of $P$-wave heavy quarkonia, which arises from resumming a class of corrections coming from kinematical effects associated with the motion of the heavy quark and antiquark pair relative to the quarkonium. Such kinematical effects are encoded in the nonperturbative shape functions, which are normalized to the corresponding nonrelativistic QCD long-distance matrix elements. By using the known ultraviolet divergences in the matrix elements, we derive the large-momentum asymptotic behavior of the shape functions. This strongly constrains the form of the shape functions and significantly reduces the dependence on the nonperturbative model. Based on these results we show that the shape function formalism at loop level can be useful in taming the threshold logarithms at large transverse momentum, and at small transverse momentum the kinematical corrections reduce the sizes of $\chi_c$ and $\chi_b$ cross sections which may improve agreement with measurements.

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**Parallel A / 5**

## Exclusive weak decays of strange-charm mesons with the LCSRs form factors

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In this presentation i will first talk about the recent QCD LCSRs calculation of $D_s^* \to \phi$ helicity form factors and discuss the experiment potential of discovering exclusive $D_s^*$ weak decays, then i will discuss the width effect in the $D_s \to f_0(\to \pi^+\pi^-)l\nu$ decay.

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**Parallel B / 6**

## Cross-section measurements and search for vector states at cms energies 4-5 GeV

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In recent years, BESIII has accumulated tens of 1/fb electron-positron colliding data samples at cms energies from 4 to 5 GeV. Cross-section measurements are performed with specific final states to search for vector charmonium(-like) states. I shall present three corresponding recent results in this talk. It includes: 1) cross-sections of e+ e- -> Ks Ks J/psi from 4.13 to 4.95 GeV, in which Y(4230) is observed and there is an evidence of a new vector charmonium-like state Y(4710); 2) cross-sections of e+ e- -> D*0 D*+ pi- from 4.19 to 4.95 GeV, where three enhancements around 4.20, 4.47 and 4.67 GeV has been observed; 3) helicity amplitude analysis of e+ e- -> pi+ pi- omega has been performed from 4.0 to 4.6 GeV, Born cross-sections of two body intermediate states have been presented and an evidence of a resonance state around 4.2 GeV is found.

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**Parallel B / 7**

## Studies of chi_cJ and psi decays at BESIII

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n this talk, four recent measurements of chi_cJ or psi decays at BESIII will be presented. In contains: 1) Using 448 million psi(3686) events collected with the BESIII detector, the process psi(2S) -> phi Ks Ks has been observed for the first time, and the branching fraction is determined; 2) Using the same data sample, the branching fractions of the decays chi_cJ -> phi phi (J=0,1,2) have been measured most precisely, and the polarization parameters of chi_cJ -> phi phi have been determined for the first time via a helicity amplitude analysis; 3) Utilizing 2700 million psi(3686) events collected by the BESIII detector, the decays chi_cJ -> Omega+ anti-Omega- (J=0,1,2) have been observed for the first time with high significance, respectively, via the radiative decays of psi(3686) -> gamma chi_cJ. The relevant branching fractions have been provided. 4) The process e+ e- -> eta J/psi at a center-of-mass energy 3.773 GeV is observed for the first time, its Born cross-section is measured, and the branching fraction of psi(3770) -> eta J/psi is determined by a combined fit with the cross-sections at other energy points, after considering the interference effect for the first time.

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**Parallel A / 8**

## Light QCD exotics at BESIII

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Using the world's largest samples of J/psi and psi(3686) events produced in e+e- annihilation, BESIII is uniquely positioned to study light hadrons in radiative and hadronic charmonium decays. In particular, exotic hadron candidates including multiquark states, hybrid mesons and glueballs can be studied in high detail. Recent highlights on the light exotics searches, including the observation of an iso-scalar spin-exotic 1-+ state η1(1855) in J/ψ⟶γηη′, the observation of X(2600) in J/ψ⟶γπ+π-η′ and a PWA of Jpsiàgamma KsKspi0, will be presented.

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**Parallel A / 9**

## Search for BSM rare charm decays at BESIII

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The BESIII experiment has collected 2.6B psi(2S) events and 10B J/psi events. The huge data sample provide an excellent chance to search for rare processes in charmonium and charm meson decays. In this talk, we report the recent search for J/psi->Dˆ-e+nu_e, psi(2S)->Lambda_c anti-Sigmaˆ-. In addition, LFV process J/psi->e tau/e mu & BNV/LNV process Dˆ0->p e/n e, and the FCNC process Dˆ0 -> piˆ0 nu \bar{nu} is also searched at BESIII.

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**Parallel A / 11**

## Rare charm decays to dark photon and Axion-like particle at BESIII

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The BESIII experiment is a symmetric e+e- collider operating at c.m. energy from 2.0 to 4.95 GeV. With the world's largest data set of J/psi (10 Billion), psi(2S) (2.6 Billion), and about 25 fb-1 scan data from 3.77 to 4.95 GeV, we are able to search various dark sectors produced in e+e- annihilation and meson decay processes. In this talk, we report the search for dark photon candidate in e+e- ->gamma A'with invisible decay. The invisible decay of a light Higgs boson A0 in J/psi->gamma A0, dark sectors in Lambda/Lambda_c invisible decay processes are also searched. Axion-like particles (ALPs) are pseudo-Goldstone bosons arising from some spontaneously broken global symmetry, addressing the strong CP or hierarchy problems. The BESIII experiment has collected 10 Billion J/psi and 2.6 Billion psi(2S) events, which is the largest J/psi & psi(2S) data set in the world. With these data, the BESIII experiment searches for an Axion-like particle with mass in o(GeV) scale in J/psi-> gamma a, with a->gamma gamma.

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**Parallel A / 12**

## Charmed meson decays at BESIII

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BESIII has collected 2.93 and 7.33 fb$^{-1}$ of $e^+e^-$ collision data samples at 3.773 and 4.128-4.226 GeV, which provide the largest dataset of $DD^-$ and $D_sD_s$ pairs in the world, respectively.
In this talk, we will report the updated measurements of $|V_{cs}|$ in $D_s^+ \to \tau^+\nu$ and the form factor

studies in $D_s^+ \to K^+K^-e^+\nu$ and $\pi^+\pi^-e^+\nu$. In addition, we will report the most updated amplitude analyses of Cabibbo-favored and -suppressed $D_s$ decays at BESIII, including the observation of a new $a_0$-like state at 1.817 GeV, the branching fraction measurements of $D$ mesons decay involving $K_L^0$ and multiple kaons/pions, and the doubly Cabibbo-suppressed decay $D_0 \to K^+\pi^-\pi^0$. We will also report the improved measurement of the strong-phase difference in quantum-correlated $DD$ decays. Finally, we will introduce prospect on measurements of charmed meson hadronic decays with the coming 20 fb$^{-1}$ at 3.773 GeV data collected by BESIII.

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**Parallel A / 13**

## Charmed baryon decays

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BESIII has collected 4.5 fbˆ-1 of e+e- collision data between 4.6 and 4.7 GeV. This unique data offers ideal opportunities to study Lambda_c+ decays. We will report the partial wave analysis of Lambda_c+ -> Lambda pi+ pi0 and the observations of Cabibbo-suppressed Decays Lambda_c+ decays, including Λ+c ⟶ nπ+ etc. In addition, we will report the form factor measurement in Lambda_c+ -> Lambda e+ nu, the observation of Lambda_c+->p K-e+nu, and improved measurement of Lambda_c+->Xe+nu.

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**Parallel A / 14**

## R value measurements at BESIII

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At BESIII, the R value is measured with a total of 14 data points with the corresponding c.m. energy going from 2.2324 to 3.6710 GeV.
The statistical uncertainty of the measured R is less than 0.6%. Two different simulation models, the LUARLW and a new Hybrid generated, are used and give consistent detection efficiencies and initial-state-radiation corrections. An accuracy of better than 2.6% below 3.1 GeV and 3.0% above is achieved in the R values.

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**Plenary** / **15**

## The progress of Super Tau Charm Facility in China

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The proposed STCF is a symmetric electron-positron beam collider designed to provide e+e− interactions at a centerof-mass energy from 2.0 to 7.0 GeV. The peaking luminosity is expected to be 0.5×10ˆ35 cm−2s−1. STCF is expected to deliver more than 1 ab−1 of integrated luminosity per year. The huge samples could be used to make precision measurements of the properties of XYZ particles; search for new sources of CP violation in the strange-hyperon and tau−lepton sectors; make precise independent mea-surements of the Cabibbo angle (theta)c) to test the unitarity of the CKM matrix; search for anomalous decays with sensitivities extending down to the level of SM-model expectations and so on. In this talk, the physics interests will be introduced as well as the the recent progress on the project R&D.

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**Parallel A** / **16**

## Towards determination of the weak and strong phases in neutral D-meson decays into K*+-K-+

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We study the effects of $D^0$-$\bar{D}^0$ mixing and CP violation in $D^0 \to K^{*\pm}K^{\mp}$ decays and their CP-conjugated processes. We find that both the $D^0$-$\bar{D}^0$ mixing parameters and the strong-interaction phase difference between $\bar{D}^0 \to K^{*\pm}K^{\mp}$ and $D^0 \to K^{*\pm}K^{\mp}$ transitions can be determined from the time-dependent measurements of these decay modes. In particular, it is possible to determine these physical quantities from the time-independent measurements of coherent $(D^0\bar{D}^0) \to (K^{*\pm}K^{\mp})(K^{*\pm}K^{\mp})$ decays on the $\psi(3770)$ and $\psi(4140)$ resonances at a super-$\tau$-charm factory. Provided the CP-violating phase of $D^0$-$\bar{D}^0$ mixing is significant in an underlying scenario beyond the standard model, it can also be extracted from the $K^{*\pm}K^{\mp}$ events.

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**Parallel A / 17**

# Charm-flavor-conserving weak decays of charmed baryons: A story that has lasted 30 years

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Three decades ago, heavy-flavor-conserving (HFC) weak decays of heavy baryons such as $\Xi_Q \to \Lambda_Q \pi$ and $\Omega_Q \to \Xi_Q \pi$ for $Q = c, b$ had been studied
within the framework that incorporates both heavy-quark and chiral symmetries.
HFC decays have two great advantages: (1) S-wave can be evaluated reliably using current algebra, and (2) if the heavy quark in the HFC process behaves as a spectator, then the $P$-wave amplitude of $\Xi_Q \to \Lambda_Q \pi$ will vanish. In the b sector, HFC decay was first measured by LHCb in 2014 and it was well understood. However, HFC decay in the charm sector, namely, $\Xi_c \to \Lambda_c \pi$ was not measured until 2020. The theoretical prediction
of its branching fraction is too small compared to experiment. The puzzle was finally resolved recently. It takes thirty years to fully understand the underlying mechanism for charm-flavor-conserving weak decays of charmed baryons.

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**Parallel A / 18**

# Doubly charmed baryon decays in the quark model

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In 2022, doubly charmed baryon hadronic weak decay Ξ_ccˆ{++}⟶Ξ_cˆ('+) πˆ+ was first observed by LHCb and its branching fraction relative to Ξ_ccˆ{++}⟶Ξ_c+ π+ was reported. In this talk we will introduce the study of charmed baryon decays Ξ_ccˆ{++}⟶Ξ_cˆ('+) πˆ+ within the framework of the nonrelativistic quark model (NRQM). Factorizable amplitudes in terms of transition form factors, while nonfactorizable amplitudes arising from the inner W emission are evaluated in the pole model combining current algebra and expressed in terms of baryonic matrix elements and axial-vector form factors. All the nonperturbative parameters are then calculated in NRQM, relying on the harmonic oscillator parameters α_ρ and α_λ for the ρ- and λ-mode excitation. The measured ratio between the two decay modes can be well explained and decay asymmetries are predicted to be -0.78 and -0.89 for Ξ_cˆ+ πˆ+ and Ξ_cˆ('+) πˆ+, respectively. A comparison with other works will also be made.

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**Parallel B / 19**

## Charmonia production in heavy ion collisions

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We study charmonia in heavy ion collisions by focusing on the production of charmonium states from charm and anti-charm quarks in a quark-gluon plasma by recombination. Starting from the investigation on the internal structure, or the wave function of charmonium states we discuss the yield and transverse momentum distributions of charmonium states produced in heavy ion collisions. We argue that the wave function distribution plays a significant role, especially, in the production of charmonium states, leading to the transverse momentum distribution of the ψ(2S) meson as large as that of the J/ψ meson. We discuss further the anisotropic flow, or elliptic and triangular flow of charmonium states using the transverse momentum distribution of charmonium states. We find that the internal structure differences as well as feed-down contributions of charmonium states are averaged out for elliptic and triangular flow, resulting in similar elliptic and triangular flow for all charmonium states. Based on our evaluation of elliptic and triangular flow of charmonium states we also discuss the quark number scaling of elliptic and triangular flow for charmonium states in heavy ion collisions.

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**Parallel B / 21**

## Spin polarization and correlations in electron-positron annihilations into charm baryon-antibaryon pair

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A baryon-antibaryon pair from electron-positron annihilation is a simple spin entangled system that can be used for studies of time-like electromagnetic form factors, baryon decays and test of discrete symmetries.
A modular approach [Phys.Rev.D 99 (2019) 056008] where the complete angular distributions in such processes are conveniently obtained using products of real-valued matrices representing the initial spin-entangled baryon-antibaryon state and the weak decay sequences. These matrices can be easily rearranged to many decay scenarios.
The approach is being used in several high-profile multidimensional maximum likelihood analyses to study production and decays of strange baryon-antibaryon pairs from $J/\psi$, $\psi(2S)$ and continuum at the BESIII experiment [e.g. Nature 606 (2022) 7912, 64]. The method has demonstrated a potential to significantly increase precision of the measurements. In some cases, such as the polarization of the hyperon-antihyperon pair from charmonia decays, it was a prerequisite to reveal the effects that were averaged out in previous studies.

The formalism describes also the production of charm baryon-antibaryon pairs in electron-positron annihilations. Recently we have included modules that describe baryon semileptonic decays and other processes [arXiv:2302.07665]. Strategies for the studies of the charm baryon-antibaryon pair production and decays will be presented. The formalism is relevant for BESIII and the next generation electron-positron tau-charm factories as well as for the ISR type experiments at BelleII.

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**Parallel B** / **22**

# Analysis of heavy baryon lifetimes

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We study the inclusive decay widths of the singly heavy baryon using the improved bag model in which the unwanted center-of-mass motion is removed. We discuss the running of the baryon matrix elements and compare the results with the non-relativistic quark model (NRQM). We find that while the numerical values of two-quark operator elements are compatible with the literature, those of the four-quark ones deviate largely. In particular,the heavy quark expansion holds well in the bag model for four-quark operator matrix elements but badly broken in the NRQM. We find an excellent agreement between theory and experiment for the bottom-baryon lifeimes. For charmed baryons, the calculated decay widths confirm that the established new hierarchy of $\tau(\Xi_c^+) > \tau(\Omega_c^0) > \tau(\Lambda_c^+) > \tau(\Xi_c^0)$
originates from dimension-7 four-quark operators. We recommend to measure some semileptonic inclusive branching fractions in the forth-coming experiments to discern different approaches.

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**Parallel A** / **24**

# Probing invisibles with rare charm decays

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We study rare charm decays with missing energy to probe light degrees of freedom.
Specifically, we investigate axion-like particles and light $Z'$ bosons with dark fermions.
We also consider EFT models with light neutrinos of both chiralities.
Observables of both charm mesons and baryons are examined to assess their sensitivity and potential to probe NP.
We find that the missing energy distribution of $\Lambda_c \to p\nu\bar{\nu}$ can signal the presence of right-handed

neutrinos in addition to the left-handed ones of the SM.
We further constrain the NP models by utilizing the upper limits on $D^0 \to invisible$ and $D^0 \to \pi^0 + invisible$ and work out predictions for 2-body and 3-body kinematics of $\Lambda_c \to p + invisible$.

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**Parallel A** / **25**

## Inclusion of S-wave dynamics in rare D meson decays and NP tests

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Rare charmed meson decays are a promising canvas for New Physics signatures to appear, being by definition very suppressed in the SM and since previous studies have identified observables that are free from SM contributions. In light of the extended amount of recently released LHCb data, a better control over the SM dynamics is imperative for a comparison to the experimental observables and for disentangling potential NP effects. The mass distributions of the rare decays $D^0 \to \pi^+\pi^-\mu^+\mu^-$ exhibit sharp resonant peaks. In this work we thus examine the aforementioned decays in the SM, using as a starting point the framework of resonance-mediated quasi-two-body topologies, implementing factorisation for the vector resonances. On the other hand, wider intermediate resonances could also give significant contributions, as manifested for instance in the related semileptonic decays of $D$ mesons, where the scalar resonance $f_0(500)$, also known as $\sigma$, has been observed by BESIII ; we then include said resonance in our calculation. With the inclusion of $\sigma$ the differential decay rate sees a dramatic improvement in the comparison to experiment in the region of low invariant mass of the pion pair. Furthermore, we are able to predict a number of angular observables comparable to the LHCb values. Finally, we propose a series of observables that are easy to implement experimentally and would single out the effect of the $\sigma$ in the SM process, as well as new null tests that can arise from the interference of NP with the $\sigma$.

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**Parallel B** / **26**

## Inclusive production of J/ψ, ψ(2S), and Υ states in pNRQCD

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Under some assumptions on the hierarchy of relevant energy scales, we compute the nonrelativistic QCD (NRQCD) long-distance matrix elements (LDMEs) for inclusive production of J/ψ, ψ(2S), and Υ states based on the potential NRQCD (pNRQCD) effective field theory. Based on the pNRQCD

formalism, we obtain expressions for the LDMEs in terms of the quarkonium wavefunctions at the origin and universal gluonic correlators, which do not depend on the heavy quark flavor or the radial excitation. This greatly reduces the number of nonperturbative unknowns and substantially enhances the predictive power of the nonrelativistic effective field theory formalism. We obtain improved determinations of the LDMEs for J/ψ, ψ(2S), and Υ states thanks to the universality of the gluonic correlators, and obtain phenomenological results for cross sections and polarizations at large transverse momentum that agree well with measurements at the LHC.

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**Parallel B / 27**

# Determination of the CKM angle γ and the D meson mixing and CP-violating parameters in a Bayesian framework

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In the last few years, $D^0 - \overline{D^0}$ mixing has become a true benchmark for the Standard Model thanks to the precision reached by modern experiments. Charm mixing may reveal signals of heavy New Physics since it happens through Flavour Changing Neutral Currents, which are absent at the tree level and GIM-suppressed at the loop level in the Standard Model.
The most promising observables in this regard are the two phases $\phi_f^M$ and $\phi_f^\Gamma$ controlling CP violation in the neutral $D$ meson system.
Therefore, we performed a simultaneous combination of beauty and charm measurements to determine the $D^0 - \overline{D^0}$ mixing and CP-violating parameters, together with the angle $\gamma$ of the Unitary Triangle.
At the current level of experimental precision, the final state dependence of $\phi_f^M$ and $\phi_f^\Gamma$ can be safely neglected, employing the so-called *approximate universality*, allowing them to be approximated by the phases $\phi_2^M$ and $\phi_2^\Gamma$.
The latter are defined with respect to the direction of the dominant U-spin ($\Delta U = 2$) contribution to the dispersive and absorptive parts of the antimeson-meson transition amplitude.

The sensitivity to $\phi_2^M$ and $\phi_2^\Gamma$ is provided by combinations of $D^0$ meson time-dependent decay rates. However, these observables rely on several unknown hadronic parameters.
Thus, we considered also measurements concerning the beauty sector, such as the so-called Gronau-London-Wyler, Atwood-Dunietz-Soni and Giri-Grossman-Soffer-Zupan observables obtained from $B$ meson decay chains (i.e. $B \to [X]_D h$, with $X, h$ hadrons), as well as time-dependent decay rates of processes like $B_q^0 \to \overline{B_q^0} \to D_q h$, with $q = d, s$.

This improved the precision of the fit, while allowing us to determine the CKM angle $\gamma$.
We fit the parameters in a Bayesian framework, generalizing the 2021 LHCb combination.

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**Parallel B / 28**

## Incorporating final-state interactions in the prediction of direct CP violation in charm-meson two-body decays

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The Kobayashi-Maskawa (KM) mechanism predicts that a single parameter must be responsible for CP-violating phenomena in different quark flavour sectors of the Standard Model (SM). Despite this minimal picture, challenged by non-SM physics, the KM mechanism has been so far verified in the bottom and strange sectors, but lacks tests in the complementary charm sector. For the sake of this, urgent theoretical progress is needed in order to provide an estimate in the SM of the recent measurement by LHCb of direct CP violation in charm-meson two-body decays, which will be significantly improved by new data expected from LHCb and Belle II. It is necessary to take into account rescattering effects for a meaningful theoretical account of the amplitudes involved in such category of observables, as signaled by the presence of large strong phases. We discuss the computation of the latter effects based on dispersion relations. We use the measured values of the branching ratios to help in selecting the non-perturbative inputs, from which we predict values for the CP asymmetries.

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**Parallel B** / **29**

## The new Belle II charm-flavor tagger

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Charm physics, involving a heavy up-type quark, offers a pathway to search for new particles and couplings beyond the Standard Model complementary to that of B physics. Measurements of CP violation and mixing play a key role in this program. We present a novel algorithm that identifies the flavor of neutral charm mesons at the time of production. This algorithm effectively doubles the sample size for many measurements of CP violation and flavor mixing at Belle II, which in the past have relied on charm mesons originating from D* decays.

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**Plenary** / **30**

## Measurements of charm lifetimes at Belle II

**Author:** Alan Schwartz[1]

**Co-author:** Sven Vahsen [2]

[1] *University of Cincinnati*

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Charm physics, involving a heavy up-type quark, offers a pathway to search for new particles and couplings beyond the Standard Model complementary to that of B physics. A program based on precision measurements of charm lifetimes is now underway at Belle II, and benefits from the detector's outstanding vertexing performance and low-background environment. Recent results from measurements of $D_s$ meson and $\Omega_c$ baryon lifetimes are presented.

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**Parallel B / 31**

## Towards the physical charmonium spectrum with improved distillation

**Author:** Juan Andres Urrea Nino[1]

**Co-authors:** Francesco Knechtli [1]; Tomasz Korzec [1]; Michael Peardon [2]

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[2] *Trinity College Dublin*

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A recently proposed modification to the widely used distillation framework yields a substantial improvement in the calculation of the spectrum of charmonium with different $J^{PC}$ at almost no additional computational cost compared to the standard distillation framework. This improved variant is now used to calculate the charmonium spectrum in an $N_f = 3+1$ ensemble at the SU(3) light flavour symmetric point ($m_\pi \approx 420$ MeV), physical charm quark mass and fine lattice spacing ($a \approx 0.043$ fm). The resulting charmonium operators yield a much better overlap with the energy eigenstates compared to standard distillation, showing that the proposed method is suitable for close-to-physical setups. We compare the spectrum and mass splittings of charmonium below threshold to their values in nature and find good agreement in most cases.

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**Parallel B / 32**

## Three-Body Unitary Coupled-Channel Analysis on eta(1405/1475)

**Author:** Satoshi Nakamura[1]

[1] *Shandong University*

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The recent BESIII data on $J/\psi \to \gamma(K_S K_S \pi^0)$, which is significantly more precise than earlier $\eta(1405/1475)$-related data, enables quantitative discussions on $\eta(1405/1475)$ at the previously unreachable level. We conduct a three-body unitary coupled-channel analysis of experimental Monte-Carlo outputs for radiative $J/\psi$ decays via $\eta(1405/1475)$: $K_S K_S \pi^0$ Dalitz plot distributions from the BESIII, and branching ratios of $\gamma(\eta\pi^+\pi^-)$ and $\gamma(\gamma\pi^+\pi^-)$ final states relative to that of $\gamma(K\bar{K}\pi)$. Our model systematically considers (multi-)loop diagrams and an associated triangle singularity, which is critical in making excellent predictions on $\eta(1405/1475) \to \pi\pi\pi$ lineshapes and branching ratios. The $\eta(1405/1475)$ pole locations are revealed for the first time. Two poles for $\eta(1405)$ are found on different Riemann sheets of the $K^*\bar{K}$ channel, while one pole for $\eta(1475)$. The $\eta(1405/1475)$ states are described with two bare states dressed by continuum states. The lower bare state would be an excited $\eta'$, while the higher one could be an excited $\eta^{(\prime)}$, hybrid, glueball, or their mixture. This work presents the first-ever pole determination based on a manifestly three-body unitary coupled-channel framework applied to experimental three-body final state distributions (Dalitz plots). This presentation is based on arXiv:2212.07904 to appear in Phys. Rev. D.

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**Parallel A** / **33**

## Combined analysis of D^+,D^0\to \bar{K}\pi\pi decays using isospin symmetry analyticity and unitarity

**Author:** Bachir Moussallam[1]

[1] *IJCLab,Université Paris-Saclay*

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We discuss some applications of isospin symmetry in the Cabibbo favoured $D \to \bar{K}\pi\pi$ decays. These processes are important for precision testing of the Standard Model and for hadronic physics. Combining isospin symmetry with a dispersive reconstruction theorem we derive a representation in terms of one-variable functions which allows one to predict all the $D \to \bar{K}\pi\pi$ amplitudes given inputs from one $D^+$ mode and one $D^0$ mode. From this, using dispersion relations and unitarity, we derive a set of Khuri-Treiman type integral equations which enable to take three-body rescattering effects into account. These could be more significant in D than in K or B decays. A first test of this approach is presented using experimental results on the $D^+ \to K_S\pi^0\pi^+$ and the $D^0 \to K_S\pi^-\pi^+$ modes.

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**Plenary** / **34**

## Status of Intrinsic Charm

**Author:** Ramona Vogt[1]

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A nonperturbative charm production contribution, known as intrinsic charm, has been speculated since the 1980s. While it has yet to be satisfactorily proven, there have been recent tantalizing hints. Several experiments, either taking data or planned, could proivde definitive evidence in the next few years. Recent experiments that have taken $J/\psi$ and $D$ meson data include SeaQuest at Fermilab and SMOG at LHCb.
Future experiments such as NA60+ are in an energy regime where the intrinsic charm quark signature could be large and unmistakeable.

In this talk, the status of intrinsic charm is reviewed and model comparisons are made to available data, see also Refs. [1-3].

[1] R. Vogt, Limits on Intrinsic Charm Production from the SeaQuest Experiment, Phys. Rev. C **103** (2021), 035204.

[2] R. Vogt, Contribution from Intrinsic Charm Production to Fixed-Target Interactions at the LHC, submitted to Phys. Rev. C.

[3] R. Vogt, Energy dependence of intrinsic charm production: Determining the best energy for observation, Phys. Rev. C **106** (2022) 025201.

[†]This work was performed under the auspices of the U.S.\ DoE by LLNL under Contract DE-AC52-07NA27344 and supported by LDRD projects 21-LW-034 and 23-LW-036.

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**Parallel B** / **35**

# Iso-Scalar States from Lattice QCD

**Authors:** Jacob Finkenrath[1]; Roman Höllwieser[1]; Francesco Knechtli[1]; Tomasz Korzec[1]; Michael Peardon[2]; Juan Andres Urrea Nino[1]

[1] *Bergische Universität Wuppertal*

[2] *Trinity College Dublin*

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Spectroscopy in the iso-scalar channels that contain charmonia, glueballs, light mesons and multi-particle states, poses a big challenge for lattice QCD calculations. One of the reasons is the presence of notoriously noisy and expensive quark-disconnected contributions to the correlation functions. We present modern techniques, based on “distillation”, which allow us to investigate the mixing between charmonia and glueballs.

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**Parallel A** / **36**

# Insights into the $T_{cc}^+$ tetraquark in a constituent quark model picture

**Author:** Pablo García Ortega[1]

**Co-authors:** Jorge Segovia [2]; David R. Entem [3]; Francisco Fernández [4]

[1] *Universidad de Salamanca*

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The LHCb collaboration announced in 2021 the discovery of a new tetraquark-like state, named $T_{cc}^+$. The $T_{cc}^+$ is reminiscent of the $X(3872)$, which is a candidate for a loosely-bound $D\bar{D}^*$+h.c. molecule; however, we are now dealing with an open-charmed state which radically changes its nature and makes it explicitly exotic. In this talk, the recently discovered $T_{cc}^+$ is evaluated as a $DD^*$ molecular structure in the $J^P = 1^+$ sector [1]. A coupled-channel calculation in the charged basis, considering the $D^0D^{*+}$, $D^+D^{*0}$ and $D^{*0}D^{*+}$ channels, is carried out in the framework of a constituent quark model that has successfully described other molecular candidates in the charmonium spectrum such as the $X(3872)$. The $T_{cc}^+$ is found to be a $D^0D^{*+}$ molecule ($87\%$) with a binding energy of 387 keV/c$^2$ and a width of $81$ keV, in agreement with the experimental measurements. The quark content of the state forces the inclusion of exchange diagrams to handle indistinguishable quarks between the $D$ mesons, which are found to be essential for binding the molecule. The $D^0D^0\pi^+$ line shape, scattering lengths and effective ranges of the molecule are also analysed and found to be in agreement with the LHCb analysis. We search for further partners of the $T_{cc}^+$ in other charm and bottom sectors, finding different candidates. In particular, in the charm sector we find a shallow $J^P = 1^+$ $D^+D^{*0}$ molecule ($83\%$), called $T'_{cc}$, just $1.8$ MeV above the $T_{cc}^+$ state. In the bottom sector, we find an isoscalar and an isovector $J^P = 1^+$ bottom partners, which are $BB^*$ molecules lying $21.9$ MeV/c$^2$ ($I = 0$) and $10.5$ MeV/c$^2$ ($I = 1$), respectively, below the $B^0B^{*+}$ threshold.

[1] P.G.Ortega, J.Segovia, D.R.Entem and F.Fernandez, "Nature of the doubly-charmed tetraquark Tcc+ in a constituent quark model", Phys. Lett. B 841 (2023), 137918 [arXiv:2211.06118 [hep-ph]].

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**Parallel B / 37**

# Charmonium and glueballs including light hadrons

**Authors:** Francesco Knechtli[1]; Jacob Finkenrath[1]; Juan Andres Urrea Nino[1]; Roman Höllwieser[2]; Tomasz Korzec[1]

[1] *Bergische Universität Wuppertal*

[2] *University of Wuppertal*

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We study charmonium and glueballs on $N_f = 3+1$ lattice ensembles using distillation as a smearing for the quark fields. The novelty of our study is the inclusion of light hadrons into which these states can decay. We present preliminary results for the hyperfine splitting of the low-lying charmonium states by including disconnected diagrams together with light flavor mixing.

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**Parallel A / 38**

## Model-independent searches for direct CP violation in charm decays

**Author:** Marco Gersabeck[None]

**Co-author:** Keri Vos [1]

[1] *Maastricht University*

**Corresponding Authors:** kerivos@gmail.com, marco.gersabeck@cern.ch

Currently, it is not clear whether the observed level of CP violation in the charm system can be accommodated within the SM, and further measurements are needed. Multi-body charm decays are powerful tools to search for CP violation through interference of intermediate resonances which may lead to local asymmetries in the phase space. LHCb is successfully exploring model-independent approaches to probe local CP violation in hadronic multi-body decays. This talk presents the most recent results of LHCb on this topic.

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**Plenary / 39**

## Charmed meson and baryon spectroscopy

**Author:** Patrick Spradlin[None]

**Co-author:** Keri Vos [1]

[1] *Maastricht University*

**Corresponding Author:** patrick.spradlin@cern.ch

Charmed meson and baryon spectroscopy gives insight into QCD at low energies from a unique perspective. Recently, the discovery of many previously unobserved charmed states and precise measurements of their properties have been made. This talk reports the latest work on the spectroscopy of charmed hadrons at LHCb and other key experiments in the field.

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**Plenary / 40**

## D mixing, indirect CPV and charm hadron lifetimes

**Author:** Adam Davis[None]

**Co-author:** Keri Vos [1]

[1] *Maastricht University*

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LHCb has collected the world's largest sample of charmed hadrons. This sample is used to measure $D^0 - \overline{D}^0$ mixing, search for $CP$ violation in mixing and interference and measurements of charm-baryon lifetimes. New measurements from several decay modes are presented, as well as prospects for future sensitivities.

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**Plenary** / **41**

## Hadronic charm decays and direct CP-violation at LHCb

**Author:** Evelina Gersabeck[1]

**Co-author:** Keri Vos [2]

[1] *University of Manchester*

[2] *Maastricht University*

**Corresponding Author:** evelina.gersabeck@cern.ch

LHCb has collected the world's largest sample of charm hadrons. This sample is used to measure direct $CP$ violation in $D$ mesons and charm baryons. The latest measurements from several decay modes are presented, as well as prospects for future sensitivities.

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**Plenary** / **42**

## Rare leptonic and semileptonic charm decays at LHCb

**Author:** Daniel Unverzagt[None]

**Co-author:** Keri Vos [1]

[1] *Maastricht University*

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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. This talk presents the latest searches for and measurements using rare charm decay processes with leptons in the final state.

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**Parallel B / 43**

## Search for CP violation at Belle by measuring T-odd triple-product asymmetries

**Author:** Longke Li[1]

**Co-author:** Alan Schwartz [2]

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[2] *University of Cincinnati*

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$CP$ violation in charm decays is predicted to be very small, only $\sim 10^{-3}$ or less. Thus, observing significant $CP$ violation could indicate new physics beyond the Standard Model. The Belle experiment has searched for $CP$ violation in charm decays by measuring an asymmetry about zero for the $T$-odd triple product $\vec{p}_1 \cdot (\vec{p}_2 \times \vec{p}_3)$, where $\vec{p}_1$, $\vec{p}_2$, and $\vec{p}_3$ are the momenta of three final-state particles produced in a four-body decay. The difference between this asymmetry for $D$ decays and that for $\overline{D}$ decays is $CP$-violating and proportional to $\sin\phi\cos\delta$, where $\phi$ and $\delta$ are the weak and strong phase differences, respectively, between two contributing amplitudes. Such $CP$ violation is largest for $\delta = 0$, which differs from the $CP$ asymmetry in partial decay widths: the latter is proportional to $\sin\phi\sin\delta$ and thus vanishes as $\delta \to 0$. Belle has used its full data set of over 900 fb$^{-1}$ to search for a triple-product $CP$ asymmetry in the following four-body decays: $D^0 \to K^0_S\,K^0_S\pi^+\pi^-$, $D^+ \to K^+K^0_S\pi^+\pi^-$, $D^+_s \to K^+K^0_S\pi^+\pi^-$, $D^+ \to K^0_S\,K^+K^-\pi^+$, $D^+ \to K^+K^-\pi^+\pi^0$, $D^+ \to K^+\pi^-\pi^+\pi^0$, $D^+ \to K^-\pi^+\pi^+\pi^0$, $D^+_s \to K^+\pi^-\pi^+\pi^0$, and $D^+_s \to K^+K^-\pi^+\pi^0$. Here we report the results of these searches.

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**Parallel B / 44**

## $D$-meson mixing from lattice QCD

**Author:** Felix Erben[1]

[1] *University of Edinburgh*

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The mixing of neutral $D$ mesons is the least understood of all neutral meson mixing processes. Both in experiment and theory, the mixing of $K, B, B_s$ mesons is known to a much higher precision. In this talk I will present results of a lattice calculation on the short-distance contribution to $D$-meson mixing, whose matrix elements are important inputs for various models beyond the Standard Model, and can be used to constrain effects of new physics within the process of $D$ mixing.

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**Parallel A / 45**

# Precise determination of the decay rates of $\eta_c \to \gamma\gamma$, $J/\psi \to \gamma\eta_c$ and $J/\psi \to \eta_c e^+e^-$ from lattice QCD

**Authors:** Brian Colquhoun[1]; Laurence Cooper[1]; Christine Davies[1]; G. Peter Lepage[2]

[1] *University of Glasgow*

[2] *Cornell University*

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We present results from our calculation of decays rates for $\eta_c \to \gamma\gamma$, $J/\psi \to \gamma\eta_c$ and $J/\psi \to \eta_c e^+e^-$ in lattice QCD with the effect of u, d, s and c quarks in the sea for the first time. We use the Highly Improved Staggered Quark formulism, four values of the lattice spacing and sea u/d quarks down to their physical values. Our results are accurate at the 1-2% level and are therefore now more accurate than results from experiment. We find $\Gamma(\eta_c \to \gamma\gamma) = 6.788(45)_{\rm fit}(41)_{\rm syst}$ keV, which agrees well with experimental results for $\gamma\gamma \to \eta_c \to K\overline{K}\pi$. This is in tension with the global PDG fit at the $4\sigma$ level, however, and we therefore advise this fit is revisited. We find $\Gamma(J/\psi \to \gamma\eta_c) = 2.219(17)_{\rm fit}(18)_{\rm syst}(24)_{\rm expt}(4)_{\rm QED}$ keV, which agrees well with results from CLEO. Finally, we predict $\Gamma(J/\psi \to \eta_c e^+e^-) = 0.01349(21)_{\rm latt}(13)_{\rm QED}$ keV. We compare our results with other theoretical approaches, while simple relationships between form factors and the $J/\psi$ decay constant in the nonrelativistic limit are also tested.

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**Parallel B / 46**

# Charm meson and charm-meson molecule in an expanding hadron gas

**Authors:** Eric Braaten[1]; Roberto Bruschini[1]; Liping He[2]; Kevin Ingles[1]; Jun Jiang[3]

[1] *Ohio State University*

[2] *Universität Bonn*

[3] *Shandong University*

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We study the time evolution of the number of charm mesons after the kinetic freeze-out of the hadron gas produced by a central heavy-ion collision. The $\pi D^* \to \pi D^*$ reaction rates have t-channel singularities that give contributions inversely proportional to the thermal width of the $D$. The ratio of the $^0$ and $^+$ production rate can differ significantly from those predicted using the measured $D^*$ branching fractions.
We then study the thermal correction to the propagator of a loosely bound charm-meson molecule in a pion gas to next-to-leading order in the heavy-meson expansion. The correction comes primarily from the complex thermal energy shift of the charm-meson constituents. The remaining correction gives a tiny decrease in the binding energy of the molecule and a tiny change in its thermal width. These results are encouraging for the prospects of observing $(3872)$ and $T_{cc}(3875)$ in the expanding hadron gas produced by heavy-ion collisions.

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**Plenary** / **47**

## Charm Physics: From Standard Model to New Physics

**Author:** Svjetlana Fajfer[1]

[1] *University of Ljubljana and J.Stefan Institute*

**Corresponding Author:** svjetlana.fajfer@ijs.si

We consider theoretical frameworks used in charm physics.
First, we briefly review the approaches and results of the Standard Model used in the processes with the charm quark.
Then we discuss possibilities to search for a theory behind the Standard Model.

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**Parallel A** / **48**

## Correlating New Physics Effects in Semileptonic $\Delta C = 1$ and $\Delta S = 1$ Processes

**Authors:** Svjetlana Fajfer[1]; Jernej F. Kamenik[2]; Arman Korajac[3]; Nejc Košnik[2]

[1] *University of Ljubljana and J.Stefan Institute*

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We present constraints on the left-handed dimension-6 interactions that contribute to semileptonic and leptonic decays of $K$, $D$, pions and to nuclear beta decay. We employ the flavour covariant description of the effective couplings, identify universal CP phases of New Physics and derive constraints from decay rates and CP-odd quantities. As a result, we can predict the maximal effects of such flavoured NP in $D$ decays from stringent $K$ decay constraints and vice-versa.

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**Plenary** / **50**

## Tau Lepton Physics

**Author:** Antonio Pich[1]

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**Corresponding Author:** antonio.pich@ific.uv.es

Precise measurements of the lepton properties provide stringent tests of the Standard Model. The large mass of the tau makes also possible to perform accurate QCD studies and search for violations of lepton flavour in many kinematically-allowed decay modes. The present status of tau physics and the prospects for future improvements will be discussed.

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**Plenary** / **51**

## Charmonia in Media

**Author:** Krista Smith[1]

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The J\$\psi$ meson, discovered simultaneously in 1974 at Brookhaven National Laboratory and the Stanford Linear Accelerator, remains a focus of great interest today to physicists worldwide. J/$\psi$ analyses are published regularly in heavy-ion physics that range from elliptic flow in $p$A and AA collisions to ratios of J/$\psi$ and its excited state the $\psi$(2S), as well as photo-production, nuclear modification, multiplicity, and polarization measurements. Many aspects of charmonia and its interactions in heavy-ion collisions remain challenging for experimentalists and theorists alike. This talk will discuss and compare the most recent experimental results on charmonia from the ALICE, ATLAS, CMS, LHCb, PHENIX, and STAR Collaborations with current theoretical predictions.

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**Plenary** / **53**

## Hadronic charm decays and CP Violation

**Author:** Fu-Sheng Yu[1]

[1] *Lanzhou University*

**Corresponding Author:** yufsh@lzu.edu.cn

Direct CP violation in the charm sector

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**Parallel B** / **54**

## Recent spectroscopy studies at Belle

**Author:** Elisabetta Prencipe[1]

**Co-author:** Dmytro Meleshko [1]

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**Corresponding Author:** dmytro.meleshko@exp2.physik.uni-giessen.de

The analyses of states with double cs content and the search for exotics have recently gained much attention. The Belle experiment collected roughly 1 ab-1 integrated luminosity data. While Belle II data-taking is in progress, we have performed a new search for exotic states and cross-section measurements with the full Belle data sets. Here we review the recent analysis of:
a) e+e'−>Ds(*)+D_sJ- + c.c. from both Y(2S) decays and continuum production at 10.52 GeV, using the Belle detector at KEKB;
b) the analysis of e+e- −>eta J/psi + c.c. and search for double charmonium states;
c) the study of e+e- −>D_s+D_sj(2317) and e+e- −> D_s+D_sj(2460) + anything else, in the continuum. Born cross-sections are evaluated, and a possible confirmation of the states seen in the invariant mass system of J/psiphi by LHCb in B decays has been investigated.

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**Parallel B** / **55**

## Performance of LHCb Upgrade I in Run III

**Author:** Giulia Tuci[None]

**Co-author:** Keri Vos [1]

[1] *Maastricht University*

**Corresponding Author:** giulia.tuci@cern.ch

LHCb has played a major role in charm physics over the last years analysing data recorded during Run I and Run II. Recently, the LHCb detector has undergone a series of major upgrades. This talk will include the first performance results from the new LHCb detector in Run III and a brief look into the future charm physics program of the collaboration.

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**Plenary** / **56**

## Semi-leptonic decays of charmed hadrons

**Author:** Keri Vos[1]

[1] *Maastricht University*

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The theoretical description for charm decays is notoriously challenging. In this respect, semi-leptonic decays are excellent probes as they are at least easier to describe than their nonleptonic counterparts.

In this talk, I will focus on inclusive semi-leptonic charm decays. For these decays, one may hope that the heavy-quark expansion, a well-established tool in beauty decays, works to some extend. I will describe how to set up this framework and its challenges. One of these is the definition of a renormalon-free suitable charm mass. Finally, I discuss how to experimentally test whether or not the heavy-quark expansion works and which future experimental inputs are required to finally even extract CKM elements from these decays.

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**Plenary** / **57**

## Lattice Results for Semileptonic Decays of Charmed Hadrons

**Author:** William Jay[1]

[1] *MIT*

**Corresponding Author:** willjay@mit.edu

In this review talk, I will present the status of lattice calculations of semileptonic decays of charmed hadrons. I will review results from different collaborations and discuss how they lead to quantities of phenomenological relevance, including decay rates, CKM matrix elements, and lepton flavor universality ratios.

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**Plenary** / **58**

## Conference Summary

**Author:** Jonas Rademacker[1]

[1] *University of Bristol*

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Everything, everywhere, all at once.

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**Parallel A** / **59**

## A novel unbinned model-independent method to measure the CKM angle gamma in B+- –> DK+- decays with optimised precision

**Authors:** Evelina Gersabeck[1]; Jake Lane[2]; Jonas Rademacker[3]

[1] *University of Manchester*

[2] *Monash University and University of Manchester*

[3] *University of Bristol*

**Corresponding Author:** jonas.rademacker@bristol.ac.uk

We present a novel unbinned method to combine B −> DK and charm threshold data for the amplitude-model unbiased measurement of the CKM angle gamma in cases where the D meson decays to a three-body final state. The new unbinned approach avoids any kind of integration over the D Dalitz plot, to make optimal use the available information. We verify the method with simulated signal data where the D decays to K_S pi+ pi-. Using realistic sample sizes, we find that the new method reaches the statistical precision on gamma of an unbinned model-dependent fit, i.e. as good as possible and better than the widely used model-independent binned approach, without suffering from biases induced by a mis-modeled D decay amplitude. We expect the method to useful also in the study of charm mixing and the development of amplitude models, in particular the study of the phase motion across the Dalitz plot. See arXiv:2305.10787.

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**Plenary** / **60**

## Opening experimental talk

**Author:** Tara Nanut Petric[1]

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The talk will set the scene for the experimental reports of the programme. The various scientific topics will be mapped out with brief individual introductions touching on the respective main features. A zoomed-out view will (attempt to) arrange the pieces into an overall picture, spanning the past, present and future. Experimental methods will be examined through the lens of their advantages, challenges and potential. Links to theoretical work throughout the talk will endeavour to kick-off discussion topics among the attending community.

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**Plenary** / **61**

## Charmed hadron lifetimes and the status of D-Dbar mixing

**Author:** Blazenka Melic[1]

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We will review the latest theoretical predictions of charmed meson and baryon lifetimes and will summarize the status of D-Dbar mixing in the Standard Model.

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**Plenary** / **62**

## Overview of hadronic decays of the charmed hadrons

**Author:** Bai-Cian Ke[1]

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For charmed mesons, this presentation will report the recent amplitude analyses of Cabibbo-favored and -suppressed Ds decays by BESIII, including the observation of a new a0-like state at 1.817 GeV, the branching fraction measurements of D meson doubly Cabibbo-suppressed decay and decays involving KL0. In addition, LHCb recently performed many measurements of CP violation/asymmetry and searched for rare/forbidden decays of charmed mesons. Belle also introduced a new D0 flavor tag method.

For charmed baryons, this presentation will report the partial wave analysis of Lambda_c+ -> Lambda pi+ pi0 and the observations of Cabibbo-suppressed Decays Lambda_c+ decays by BESIII, observation of new Omega_c/Xi_c decays by LHCb, and observation of Lambda pi signals in the Lambda_c to Lambda 3pi decay by Belle.

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**Plenary** / **63**

## Meson and baryon spectroscopy with charm quarks from lattice QCD

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Spectroscopy studies on the lattice can provide valuable
insights through the investigation of states that are not well established experimentally, through the prediction of new states and by testing theoretical descriptions. The internal structure of these states can, in principle, be probed by determining their decay constants, form factors and so on. Mesons and baryons containing heavy quarks are actively being investigated, mirroring the large number of exotic hadrons discovered in this sector. I review recent lattice studies of hadrons containing charm quarks including non-standard states.

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**Plenary** / **64**

## Overview of leptonic and semi-leptonic decays of charmed hadrons

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In this report, I mainly overview the recent selected leptonic and semileptonic decays of charmed hadrons including D0, D+, Ds and L_c(L=Lambda), based on data samples collected by BESIII detector corresponding to luminosities of 2.93 fb-1, 7.33 fb-1 and 4.5 fb-1 above the threshold of DDbar, DsDs* and LcLcbar, respectively. By measuring the branching fractions , form factors and CKM matrix elements |Vcs(d)| via the decays of D(s) -> l (l=leptonic) v (l = e, mu), D(s) -> P(P=pseudoscalar) l v (l = e, mu), D(s) -> V(V=vector) l v (l = e, mu), D(s) -> S (S=scalar) l v (l = e, mu), D(s) -> A (A=axial-vector) l v (l = e, mu) and Lc -> B (B=baryon) (P) l v (l = e, mu), we are offered an opportunity to search for new physics by testing LFU and CKM matrix unity, and to test QCD models's predictions such as LQCD.

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**Plenary** / **65**

## Spectroscopy

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## XYZ from BESIII

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**Plenary** / **68**

## Future Experiment

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## Future Theory

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## TBA

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## Welcome

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**Parallel A** / **73**

## Dipion distribution amplitudes from the D-> pi pi l nu_l semileptonic decay

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The light-cone distribution amplitudes of two-pion states are universal hadronic objects involved in the factorization of heavy hadron decays or in the large momentum-transfer transitions with two pions in the final state. The leading twist-2 distribution amplitudes are parameterized in terms of the functions of the dipion invariant mass serving as coefficients in the Gegenbauer expansion. As a new method to determine these functions, we suggest to use the measurements of the $D \to \pi\pi\ell\nu_\ell$ semileptonic decay. The differential decay distributions are expressed in terms of the $D \to \pi\pi$ form factors, using for the latter the QCD light-cone sum rules in terms of dipion distribuiton amplitudes. As a first application of this method, we employ the available BESS-III data on $D^0 \to \pi^-\pi^0\ell^+\nu_\ell$ decay distribution and fit the first few Gegenbauer functions for the isospin-1 dipion distribution amplitudes.

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