

全国第十八届重味物理和 CP 破坏研讨会 (HFCPV 2021)

Wednesday, 10 November 2021 - Sunday, 14 November 2021

暨南大学

Book of Abstracts

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CP violating dark photon kinetic mixing and Type-III Seesaw

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The hypothetical dark photon portal connecting the visible and dark sectors of the Universe has received considerable attention in recent years, with a focus on CP-conserving kinetic mixing between the Standard Model (SM) hypercharge gauge boson and a new $U(1)_X$ gauge boson. In the effective field theory context, one may write down non-renormalizable CP-violating kinetic mixing interactions involving the X and $SU(2)_L$ gauge bosons. We construct for the first time a renormalizable model for CP-violating kinetic mixing that induces CP-violating non-Abelian kinetic mixing at mass dimension five.

The model grows out of the type-III seesaw model, with the lepton triplets containing right-handed neutrinos playing a crucial role in making the model renormalizable and providing a bridge to the origin of neutrino mass. This scenario also accommodates electron electric dipole moments (EDM) as large as current experimental bound, making future EDM searches an important probe of this scenario.

Presentation type:

Oral

1

Charged Lepton Flavor Violation at the EIC

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We present a comprehensive analysis of the potential sensitivity of the Electron-Ion Collider (EIC) to charged lepton flavor violation (CLFV) in the channel $ep \rightarrow \tau X$, within the model-independent framework of the Standard Model Effective Field Theory (SMEFT).

We compute the relevant cross sections to leading order in QCD and electroweak corrections and perform simulations of signal and SM background events in various τ decay channels, suggesting simple cuts to enhance the associated estimated efficiencies.

To assess the discovery potential of the EIC in τ - e transitions, we study the sensitivity of other probes of this physics across a broad range of energy scales, from $pp \rightarrow e\tau X$ at the Large Hadron Collider to decays of B mesons and τ leptons, such as $\tau \rightarrow e\gamma$, $\tau \rightarrow e\ell^+\ell^-$, and crucially the hadronic modes $\tau \rightarrow eY$ with $Y \in \{\pi, K, \pi\pi, K\pi, \dots\}$.

We find that electroweak dipole and four-fermion semi-leptonic operators involving light quarks are already strongly constrained by τ decays, while operators involving the c and b quarks present more promising discovery potential for the EIC. An analysis of three models of leptoquarks confirms the expectations based on the SMEFT results. We also identify future directions needed to maximize the reach of the EIC in CLFV searches:

these include an optimization of the τ tagger in hadronic channels, an exploration of background suppression through tagging b and c jets in the final state, and a global fit by turning on all SMEFT couplings, which will likely reveal new discovery windows for the EIC.

Presentation type:

Oral

3

Testing leptogenesis at the LHC and future muon colliders: a Z' scenario**Authors:** 威刘¹; 柯盼谢²¹ 南京理工大学² *Department of Physics and Astronomy, University of Nebraska, Lincoln***Corresponding Author:** wei.liu@njust.edu.cn

If the masses of at least two generations of right-handed neutrinos (RHNs) are near-degenerate, the scale of leptogenesis can be as low as ~ 100 GeV. In this work, we study probing such resonant leptogenesis in the $B-B-L$ model at the LHC and future multi-TeV muon colliders via the process $Z' \rightarrow NN \rightarrow l\pm l\pm + \text{jets}$, with Z' the $U(1)_{B-L}$ gauge boson and N the RHN. The same-sign dilepton feature of the signal makes it almost background-free, while the event number difference between positive and negative leptons is a hint for CP violation, which is a key ingredient of leptogenesis. We found that resonant leptogenesis can be tested at the HL-LHC for $M_{Z'}$ up to 12 TeV, while at a 10 (30) TeV muon collider the reach can be up to $M_{Z'} \sim 30$ (100) TeV via the off-shell production of Z' .

Presentation type:

Oral

4

From topological amplitude to rescattering dynamics**Author:** di wang¹¹ 湖南师范大学**Corresponding Author:** wangdi@hunnu.edu.cn

We proposed a theoretical framework to correlate the topological diagram at quark level and rescattering dynamics at hadron level. In this framework, both the hadronic triangle diagram, and the quark diagram, which is the intermediate form between topological diagram and triangle diagram, are expressed in the tensor form. The coefficient of each triangle diagram can be derived from the quark diagram. The completeness of the quark diagram is confirmed by the quark substructure meson-meson scattering. Taking $D \rightarrow K\pi$ and $D \rightarrow \pi\pi$ decays as examples, we present our framework in detail. We find the total long-distance amplitudes extracted from quark diagrams are consistent with the ones derived from the chiral lagrangian. The Isospin relations in the $D \rightarrow K\pi$ and $D \rightarrow \pi\pi$ decays are kept in terms of triangle diagram. Under the $SU(3)_F$ symmetry, the long-distance contributions in the C , E and T^{LP} diagrams have definite proportional relation, $L(C) : L(E) : L(T^{LP}) = -2 : 1 : 1$. If the $SU(3)_F$ symmetry breaks into the Isospin symmetry, this relation is broken.

The long-distance contributions in the T and A diagrams are only arisen from the $SU(3)_F$ breaking effects.
And there are no triangle diagram like long-distance contributions in other topologies.
Besides, the conclusions about the D meson decays under the $SU(3)_F$ symmetry can be generalized to the B meson decays under the $SU(4)_F$ symmetry.

Presentation type:

Oral

5

重味物理的新机遇：重子物理

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综述性报告。

Presentation type:

Oral

6

$\Lambda_b \rightarrow p$ transition form factors in the perturbative QCD

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In this work, we calculated the $\Lambda_b \rightarrow p$ transition form factors in the perturbative QCD (PQCD) approach. Contributions beyond leading-twist light-cone distribution amplitudes (LCDAs) of both proton and Λ_b baryon are systematically investigated. The results are consistent with other methods. The dominant contributions of form factors F_1 , F_2 , G_1 and G_2 come from the twist-5 LCDAs of proton and the twist-4 LCDA of Λ_b baryon, while for those of F_3 and G_3 , coming from both twist-4 LCDAs of proton and Λ_b baryon. We found that the higher power corrections are much more important compared with the leading power in the decay of heavy baryon.

Presentation type:

Oral

7

Global determination of two-meson distribution amplitudes from three-body B decays

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We perform a global analysis of three-body charmless hadronic decays $B \rightarrow V P_3 \rightarrow P_1 P_2 P_3$ in the perturbative QCD (PQCD) approach, where V denotes an intermediate vector resonance, and P_i , $i = 1, 2, 3$, denote final-state pseudoscalar mesons. Fitting the PQCD factorization formulas at leading order in the strong coupling α_s to measured branching ratios and direct CP asymmetries, we determine the Gegenbauer moments in two-meson distribution amplitudes (DAs) for the meson pairs $P_1 P_2 = \pi\pi, K\pi, KK$. The fitted Gegenbauer moments are then employed to make predictions for those observables, whose data are excluded in the fit due to larger experimental uncertainties. A general consistency between our predictions and data is achieved, which hints the validity of the PQCD formalism for the above three-body B meson decays and the universality of the nonperturbative two-meson DAs. The obtained two-meson DAs can be applied to PQCD studies of other multibody B meson decays involving the same meson pairs. We also attempt to determine the dependence of the Gegenbauer moments on the meson-pair invariant mass, and demonstrate that this determination is promising, when data become more precise.

Presentation type:

Oral

8

Operator Correlation in Electroweak Scattering at LHC

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We study the new physics effects within Standard Model Effective Field Theory(SMEFT) in electroweak scattering channels, such as vector boson scattering, di-boson production and so on. Since we can obtain a set of operators when we integrated out the heavy degree of freedom, we should consider the operators correlation of SMEFT in a physical processes, rather than assuming that only one operators is dominant in scattering. In this case, the correlated behaviors will give us some hints about UV complete theory in “bottom-up” framework.

Presentation type:

Oral

9

$\Lambda_b \rightarrow pK$ decay in the perturbative QCD

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We improved the framework of the perturbative QCD (PQCD) approach and calculated the branching ratio and direct CP violation of $\Lambda_b \rightarrow pK$ decay. We concentrate on the contributions beyond leading power, and find that the higher power corrections are much more important compared with the leading power in the decay of heavy baryon. Power counting is valid in the case of infinite scale, while practical calculations are performed under finite scale, such as m_b scale. This causes a situation that enhancements from end-point regions of high-twist LCDAs may overcome the power suppression.

Presentation type:

Oral

10

CP violation of b-baryons

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With the help of helicity amplitude approach, many observable of CP violation and polarization are analysed for b-baryon in the framework of angular distribution.

Presentation type:

Oral

11

Test of quantum nonlocality via vector meson decays to KS KS

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In the system of a pair of quantum-entangled neutral kaons from meson decays, when one kaon collapses into the K_S state, the other will collapse instantaneously into the K_L state, due to entanglement and nonlocality. However, if the alternative hypothesis is correct and there's a time window during which one kaon is unaware that the other has decayed, some quantum mechanically prohibited $K_S K_S$ (CP-violation state) decays may occur. We calculate the branching ratios of $K_S K_S$ in vector meson decays under locality hypothesis and compare them with experimental results. We show that the branching ratio of $J/\psi \rightarrow K_S K_S$ under locality assumption is already excluded by the BESIII experimental upper limit. Additional experimental results are proposed to perform this test in the future.

doi: 10.1142/S0217751X21501785

Presentation type:

Oral

12

Understanding the charged heavy quarkoniumlike states in chiral effective field theory

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We generalize the framework of chiral effective field theory to study the interactions of the isovector $D^* \bar{D}^{(*)}$ and $B^* \bar{B}^{(*)}$ systems up to the next-to-leading order, in which the long-, mid-, and short-range force contributions as well as the S - D wave mixing are incorporated. Based on the Lippmann-Schwinger equation, we fit the invariant mass distributions of the elastic channels measured by the BESIII and Belle Collaborations. Our results indicate that the four charged charmoniumlike and bottomoniumlike states $Z_c(3900)$, $Z_c(4020)$ and $Z_b(10610)$, $Z_b(10650)$ can be well identified as the $D\bar{D}^*$, $D^*\bar{D}^*$ and $B\bar{B}^*$, $B^*\bar{B}^*$ molecular resonances. The bound state explanations are vetoed in our framework. Our study favors the Z_c and Z_b states are the twin partners under the heavy quark symmetry.

Presentation type:

Oral

13

On the uncharted b-flavored CKM unitarity triangle

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Some fine differences between the twin \bar{s} -flavored unitarity triangles are calculated by means of a generalized Wolfenstein parametrization of the CKM matrix, and a possible way to experimentally establish the uncharted one is briefly discussed. In addition, the four-zero textures of Hermitian quark mass matrices with an up-down parallelism are considered to understand the salient features of quark flavor mixing and CP violation.

Presentation type:

Oral

14

Partial-wave CP asymmetries, an observable for multi-body decay of heavy hadron

Authors: Xin-Heng Guo¹; Zhen-Hua Zhang²¹ *Beijing Normal University*² *University of South China***Corresponding Author:** zhenhua_zhang@163.com

A novel observabel-Partial-wave CP asymmetry- are introduced. This observable is applicable to multi-body decays of heavy hadrons with arbitrary spin configurations in both initial and final states, and with any number of particles in the final state. It is especially applicable for CPV investigations in multi-body decays of heavy baryons.

Presentation type:

Oral

15

Systematics of the heavy flavor hadronic molecules

Author: 侃陈¹**Co-authors:** Lu Meng¹; Shi-Lin ZHU¹; 波王²; 锐陈³¹ *Peking University*² 河北大学³ 北京大学**Corresponding Author:** chenk_10@pku.edu.cn

With a quark level interaction, we give a unified description of the loosely bound molecular systems. Using the Pc states as inputs to fix the interaction strength of light quark-quark pairs, we reproduce the observed Pcs and Tcc states and predict another narrow T'cc state with quantum numbers $J=1, I=0$. If we require a satisfactory description of

the Tcc and Pc states simultaneously, our framework prefers the assignments of the Pc(4440) and Pc(4457) as the $[\Sigma_c \bar{D}]_{J=1/2}^{I=1/2}$ and $[\Sigma_c \bar{D}]_{J=3/2}^{I=1/2}$ states, respectively. We propose the isospin criterion to explain naturally why the experimentally observed Tcc, Pc, and Pcs molecular candidates prefer the lowest isospin numbers. We also predict the loosely bound states for the bottom di-hadrons.

Presentation type:

Oral

16

Study of $P_{cs}(4459)$ state

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The LHCb collaboration has reported recently the charm-strange pentaquark states found in the $J/\psi\Lambda$ mass distribution, called as the $P_{cs}(4459)$ state. Based on the constraints of the heavy quark spin symmetry combined with the local hidden gauge symmetry, we investigate the $\bar{D}^{(*)}\Xi_c^{(*,\prime)}$ interactions, together with $J/\psi\Lambda$ and other coupled channels, using a coupled channel approach. With this approach, before the experimental findings, we had made some predictions for them. Using the experimental results, one can determine the free parameters, a_μ in the loop functions. From the poles found in the second Riemann sheets, we dynamically reproduce the $P_{cs}(4459)$ state in the coupled channel interactions, which may be a degenerate state, analogous to the one of $P_c(4450)$ before. Furthermore, our results also made some more predictions for further experimental studies.

Presentation type:

Oral

17

Un-binned Angular Analysis of $B \rightarrow D^* \ell \nu$ and the Right-handed Current

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In this work, we perform a sensitivity study of an un-binned angular analysis of the $B \rightarrow D^* \ell \nu$ decay, including the contributions from the right-handed current. We show that the angular observable can constrain very strongly the right-handed current without the intervention of the yet unsolved V_{cb} puzzle.

Presentation type:

Oral

18

$D_s^* \rightarrow \phi$ form factors and the exclusive D_s^* weak decays

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We present the QCD calculation of the $D_s^* \rightarrow \phi$ helicity form factors from the light-cone sum rules approach, with which we study the exclusive D_s^* weak decays and discuss the experimental potential.

Presentation type:

Oral

19

Freeze-in self-interacting dark matter in warped extra dimension

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A classically scale-invariant scalar singlet can be a MeV-scale dark matter, with a feeble Higgs portal coupling at $O(10^{-10})$. Besides, an $O(0.1)$ self-interaction coupling could further serve to alleviate the small-scale problems in the Universe. We show that, such a dark matter candidate can naturally arise in the warped extra dimension, with the huge span of parameter space predicted well within $O(1)$ fundamental parameters.

Presentation type:

Oral

21

$\rho - \omega$ mixing contribution to the measured CP asymmetry of $B^\pm \rightarrow \omega K^\pm$

Author: zhen-hua zhang¹

Co-author: sheng yang²

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We study the CP asymmetry of $B^\pm \rightarrow \omega K^\pm$ with the inclusion of the $\rho - \omega$ mixing mechanism. It is shown that the CP asymmetry of $B^\pm \rightarrow \omega K^\pm$ experimentally measured (A_{CP}^{exp}) and conventionally defined (A_{CP}^{con}) are in fact different, which relation can be illustrated as $A_{CP}^{exp} = A_{CP}^{con} + \Delta A_{CP}^{\rho\omega}$, with $\Delta A_{CP}^{\rho\omega}$ the $\rho - \omega$ mixing contribution to A_{CP}^{exp} . The numerical value of $\Delta A_{CP}^{\rho\omega}$ is extracted from the experimental data of $B^\pm \rightarrow \pi^+ \pi^- K^\pm$ and is found to be comparable with A_{CP}^{exp} , hence, non-negligible. The conventionally defined CP asymmetry, A_{CP}^{con} , is obtained from the value of A_{CP}^{exp} and $\Delta A_{CP}^{\rho\omega}$, and is compared with the theoretical calculations in the literature.

Presentation type:

Oral

22

LHCb 上的味反常

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我将报告 LHCb 实验上味反常 (Flavour anomaly) 相关的测量。

Presentation type:

Oral

23

Fully heavy tetraquark $b\bar{c}b\bar{c}$

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We study the existence of fully-heavy hidden-flavor $b\bar{c}b\bar{c}$ tetraquark states with various $J^{PC} = 0^{\pm+}, 0^{--}, 1^{\pm\pm}, 2^{++}$, by using the moment QCD sum rule method augmented by fundamental inequalities. Using the moment sum rule analyses, our calculation shows that the masses for the S-wave positive parity $b\bar{c}b\bar{c}$ tetraquark states are about 12.2 – 12.4 GeV in both $[3_c]_{bc} \otimes [3_c]_{\bar{b}\bar{c}}$ and $[6_c]_{bc} \otimes [6_c]_{\bar{b}\bar{c}}$ color configuration channels. Except for two 0^{++} states, such results are below the

thresholds $T_{\eta_c\eta_b}/T_{\Upsilon\psi}$ and $T_{B_cB_c}$, implying that these S-wave positive parity $bc\bar{b}\bar{c}$ tetraquark states are probably stable against the strong interaction. For the P-wave negative parity $bc\bar{b}\bar{c}$ tetraquarks, their masses in the $[\mathbf{3}_c]_{bc} \otimes [\mathbf{3}_c]_{\bar{b}\bar{c}}$ channel are around 12.9 – 13.2 GeV, while a bit higher in the $[\mathbf{6}_c]_{bc} \otimes [\mathbf{6}_c]_{\bar{b}\bar{c}}$ channel. They can decay into the $c\bar{c} + b\bar{b}$ and $c\bar{b} + b\bar{c}$ final states via the spontaneous dissociation mechanism, including the $J/\psi\Upsilon$, $\eta_c\Upsilon$, $J/\psi\eta_b$, $B_c^+B_c^-$ channels.

Presentation type:

Oral

24

QED factorization for the leptonic B meson decays

Author: Si-Hong Zhou¹

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We extend the QED factorization effects on the leptonic B decays with light muon leptons to tauonic final states $\tau^+\tau^-$ using soft-collinear effective theory (SCET). This extension is necessary owing to the appearance of the large τ mass, which will lead to a different power counting in SCET and also different results. The enhanced electromagnetic effect from hard collinear contribution on $B_{d,s} \rightarrow \mu^+\mu^-$ found before will not exist. Only about 0.04% power-enhanced correction changes the branching fraction compared with 0.4% to $B_{d,s} \rightarrow \mu^+\mu^-$. In addition to hard collinear contribution, we provide a complete NLO electromagnetic corrections below the bottom mass scale μ_b to $B_{d,s} \rightarrow \tau^+\tau^-$ including one loop hard corrections. The one loop hard corrections are actually antisymmetric under the exchange of the hard collinear and hard anti-collinear sectors in the final states. In fact, the symmetry of higher-order hard QED corrections are not always valid beyond tree level. They depend on the number of vertex of \mathcal{L}_{QED} attached to lepton sector.

Presentation type:

Oral

25

$b \rightarrow sll$ angular analyses on CMS

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The FCNC process $b \rightarrow sll$ has been known as a sensitive probe of new physics. And recent angular analyses results of the process showed intriguing deviation from the SM prediction. Motivated by these evidence of new physics, more and more angular analyses are performed, based on data collected by CMS in LHC Run2. With a large amount of CMS Run2 data and updated analysing procedure, those new analyses are promising to present more striking results.

Presentation type:

Oral

26

SU(3) symmetry and its breaking effects in semileptonic heavy baryon decays

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We employ the flavor SU(3) symmetry to analyze semileptonic decays of anti-triplet charmed baryons ($\Lambda_c^+, \Xi_c^{+,0}$) and find that the experimental data on $\text{cal}B(\Lambda_c \rightarrow \Lambda \ell^+ \nu_\ell)$ implies $\mathcal{B}(\Xi_c^0 \rightarrow \Xi^- e^+ \nu_e) = (4.10 \pm 0.46)\%$ and $\mathcal{B}(\Xi_c^0 \rightarrow \Xi^- \mu^+ \nu_\mu) = (3.98 \pm 0.57)\%$. When this prediction is confronted with recent experimental results from Belle collaboration $\mathcal{B}(\Xi_c^0 \rightarrow \Xi^- e^+ \nu_e) = 1.31(04 \pm 07 \pm 38)\%$ and $\mathcal{B}(\Xi_c^0 \rightarrow \Xi^- \mu^+ \nu_\mu) = 1.27(06 \pm 10 \pm 37)\%$, it is found that the SU(3) symmetry is severely broken. We then consider the generic SU(3) breaking effects in these decays and find that the data can be accommodated in different scenarios but the breaking effects are inevitably large. In some interesting scenarios, we also explore the testable implications in these scenarios which can be tested with more data become available. Similar analyses are carried out for semileptonic anti-triplet beauty baryons to octet baryons and anti-triplet charmed baryons. The validity of SU(3) for these decays can also be examined when data become available.

Presentation type:

Oral

27

Time-reversal asymmetries and angular distributions in $\Lambda_b \rightarrow \Lambda V$

Authors: Chao-Qiang Geng¹; 刘佳韦 N^{one}

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We study the spin correlations to probe time-reversal (T) asymmetries in the decays of $\Lambda_b \rightarrow \Lambda V$ ($V = \phi, \rho^0, \omega, K^{*0}$). The eigenstates of the T-odd operators are obtained along with definite angular momenta. We obtain the T-odd spin correlations from the complex phases among the helicity amplitudes. We give the angular distributions of $\Lambda_b \rightarrow \Lambda(\rightarrow p\pi^-)V(\rightarrow PP')$ and show the corresponding spin correlations, where $P^{(\prime)}$ are the pseudoscalar mesons. Due to the helicity conservation of the s quark in Λ , we deduce that the polarization asymmetries of Λ are close to -1 . Since the decay of $\Lambda_b \rightarrow \Lambda\phi$ in the standard model (SM) is dictated by the single weak phase from the product of CKM elements, $V_{tb}V_{ts}^*$, the true T and CP asymmetries are suppressed, providing a clean background to test the SM and search for new physics. In the factorization approach, as the helicity amplitudes in the SM share the same complex phase, T-violating effects are absent. Nonetheless, the experimental branching ratio of $Br(\Lambda_b \rightarrow \Lambda\phi) = (5.18 \pm 1.29) \times 10^{-6}$ suggests that the nonfactorizable effects or some new physics play an important role. By parametrizing the nonfactorizable contributions with the effective color number, we

calculate the branching ratios and direct CP asymmetries. We also explore the possible T-violating effects from new physics.

Presentation type:

Oral

28

Top-quark rare decays $t \rightarrow cg(g)$ in the aligned two-Higgs-doublet Model

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We update the Standard Model predictions for the branching ratios of the top-quark rare decays $t \rightarrow cg(g)$ in the Standard Model and focus on evaluating the maximum they can be in the aligned two-Higgs-doublet model (A2HDM), their properties are also discussed briefly in the 2HDM with Z_2 symmetries. With the constraints on the alignment parameters from flavour observables, we find that the branching ratios of $t \rightarrow cg$ and $t \rightarrow cgg$ are in the same order and can reach about 3.79×10^{-9} and 6.80×10^{-9} in the A2HDM, respectively; while the branching ratio of $t \rightarrow cgg$ is nearly three orders of magnitude as large as the one of $t \rightarrow cg$ in the SM. Moreover, there are no significant enhancements in the 2HDM than that in the SM for these two decays. Compared with the measurements in the high-luminosity colliders in the near future, both the branching ratios of $t \rightarrow cg$ and $t \rightarrow cgg$ within the A2HDM are out of the sensitivity of the HL-LHC and FCC-hh.

Presentation type:

Oral

29

Probing neutrino magnetic moment at the Jinping neutrino experiment

Author: 保彪岳 ¹

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Neutrino magnetic moment (ν MM) is an important property of massive neutrinos. The recent anomalous excess at few keV electronic recoils observed by the XENON1T collaboration might indicate a $\sim 2.2 \times 10^{-11} \mu_B$ effective neutrino magnetic moment (μ_ν^{eff}) from solar neutrinos. Therefore, it is essential to carry out the ν MM searches at a different experiment to confirm or exclude such a hypothesis.

We study the feasibility of doing ν MM measurement with 4 kton active mass at Jinping neutrino experiment (Jinping) using electron recoil data from both natural and artificial neutrino sources. The sensitivity of μ_{ν}^{eff} can reach $< 1.2 \times 10^{-11} \mu_B$ at 90% C.L. with 10-year data taking of solar neutrinos.

Besides the abundance of the intrinsic low energy background ^{14}C and ^{85}Kr in the liquid scintillator, we find the sensitivity to ν MM is highly correlated with the systematic uncertainties of pp and ^{85}Kr . Reducing systematic uncertainties (pp and ^{85}Kr) and the intrinsic background (^{14}C and ^{85}Kr) can help to improve sensitivities below these levels and reach the region of astrophysical interest.

With a 3 mega-Curie (MCi) artificial neutrino source ^{51}Cr installed at Jinping neutrino detector for 55 days,

it could give us a sensitivity to the electron neutrino magnetic moment (μ_{ν_e}) with $< 1.1 \times 10^{-11} \mu_B$ at 90% C.L..

With the combination of those two measurements, the flavor structure of the neutrino magnetic moment can be also probed at Jinping.

Presentation type:

Oral

30

Prospects for discovering new physics in charm sector through low-energy scattering processes $e^-p \rightarrow e^-(\mu^-)\Lambda_c$

Author: Li-Fen Lai¹

Co-authors: Xin-Qiang Li¹; Xin-Shuai Yan¹; Ya-Dong Yang²

¹ Central China Normal University

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We explore the possibility of discovering new physics, particularly leptoquarks, through the low-energy scattering processes $e^-p \rightarrow e^-(\mu^-)\Lambda_c$ —both are accessible in an ep scattering experiment in the near future. In the framework of low-energy effective Lagrangian, we demonstrate that, compared with the conventional flavor-changing-neutral-current weak decays of charm hadrons and the dilepton productions at high-energy colliders, the low-energy scattering processes can provide more competitive potentials for hunting the NP. Meanwhile in specific LQ models, we show that promising event rates can be expected for both the scattering processes, and point out a potential path to distinguish the scalar and vector LQs.

Presentation type:

Oral

31

Studying the $b \rightarrow s\ell^+\ell^-$ Anomalies and $(g-2)_\mu$ in RPV-MSSM Framework with Inverse Seesaw

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Inspired by the recent experimental results which show deviations from the standard model (SM) predictions of $b \rightarrow s\ell^+\ell^-$ transitions, we study the R -parity violating minimal supersymmetric standard model (RPV-MSSM) extended by the inverse seesaw mechanisms. The trilinear R -parity violating terms together with the chiral mixings of sneutrinos induce the loop contributions to the $b \rightarrow s\ell^+\ell^-$ anomaly. We study the parameter space of the single-parameter scenario $C_{9,\mu} = -C_{10,\mu} = C_V$ and the double-parameter scenario (C_V, C_U) respectively, constrained by other experimental data such as $B_s - \bar{B}_s$ mixing, $B \rightarrow X_s\gamma$ decay, the lepton flavour violating decays, etc.. Both the single-parameter scenario and double-parameter scenario can resolve the long existed muon anomalous magnetic moment problem as well and allow the anomalous $t \rightarrow c\gamma$ transition to reach the sensitivity at the Future Circular hadron-hadron Collider (FCC-hh).

[arXiv:2105.06954]

Presentation type:

Oral

32

CP asymmetry in the angular distributions of $\tau \rightarrow K_S\pi\nu_\tau$ decays

Author: 陈丰之 ¹

Co-authors: Hong-Hao Zhang ²; Shi-Can Peng ³; Xin-Qiang Li ³; Ya-Dong Yang ³

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In this work, we proceed to study the CP asymmetry in the angular distributions of $\tau \rightarrow K_S\pi\nu_\tau$ decays within a general effective field theory framework including four-fermion operators up to dimension-six. It is found that, besides the commonly considered scalar-vector interference, the tensor-scalar interference can also produce a nonzero CP asymmetry in the angular distributions, in the presence of complex couplings. Using the dispersive representations of the $K\pi$ form factors as inputs, and taking into account the detector efficiencies of the Belle measurement, we firstly update our previous SM predictions for the CP asymmetries in the same four $K\pi$ invariant-mass bins as set by the Belle collaboration. Bounds on the effective couplings of the nonstandard scalar and tensor interactions are then obtained under the combined constraints from the CP asymmetries measured in the four bins and the branching ratio of $\tau^- \rightarrow K_S\pi^-\nu_\tau$ decay, with the numerical results given respectively by $\text{Im}[\hat{e}_S] = -0.008 \pm 0.027$ and $\text{Im}[\hat{e}_T] = 0.03 \pm 0.12$, at the renormalization scale $\mu = 2$ GeV in the $\overline{\text{MS}}$ scheme. Using these best-fit values, we also find that the distributions of the CP asymmetries can deviate significantly from the SM prediction in almost the whole $K\pi$ invariant-mass regions. The current bounds are still plagued by large experimental uncertainties, but will be improved with more precise measurements from the Belle II experiment as well as the proposed Tera-Z and STCF facilities.

[arXiv:2107.12310]

Presentation type:

Oral

33

CP violation phase in BSM amplitudes

Author: xia wan¹

Co-authors: ke-yao feng ¹; you-kai wang ¹

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Firstly we define a CP violation phase ξ to quantify the mixture of CP -even and CP -odd states for Higgs boson in new physics beyond Standard Model. Then we show it explicitly in $H \rightarrow \gamma\gamma$, $H \rightarrow \gamma\ell\ell$ and $H \rightarrow 4\ell$ amplitudes. The analytical form gives a good explanation why the CP -violation phase could be observed in $H \rightarrow 4\ell$ process but not in $H \rightarrow \gamma\gamma$ and $H \rightarrow \gamma\ell\ell$ processes. Meanwhile, to study the relations of amplitudes, we find a new method of decomposing $H \rightarrow \gamma\ell\ell$ and $H \rightarrow 4\ell$ amplitudes into $H \rightarrow \gamma\gamma$ amplitudes. For a comparison, by using the on-shell approach we study the recursion relations of amplitudes and get a consistent result independently.

Presentation type:

Oral

34

CP violation phase in BSM amplitudes

Author: xia wan¹

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Firstly we define a CP violation phase ξ to quantify the mixture of CP -even and CP -odd states for Higgs boson in new physics beyond Standard Model. Then we show it explicitly in $H \rightarrow \gamma\gamma$, $H \rightarrow \gamma\ell\ell$ and $H \rightarrow 4\ell$ amplitudes. The analytical form gives a good explanation why the CP -violation phase could be observed in $H \rightarrow 4\ell$ process but not in $H \rightarrow \gamma\gamma$ and $H \rightarrow \gamma\ell\ell$ processes. Meanwhile, to study the relations of amplitudes, we find a new method of decomposing $H \rightarrow \gamma\ell\ell$ and $H \rightarrow 4\ell$ amplitudes into $H \rightarrow \gamma\gamma$ amplitudes. For a comparison,

by using the on-shell approach
we study the recursion relations of amplitudes and get a consistent result independently.

Presentation type:

Oral

35

申办 HFCPV 2022 报告

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南京师范大学申请承办全国第十九届重味物理和 CP 破坏研讨会 (HFCPV 2022)

Presentation type:

Oral

36

Deciphering Weak Decays of Doubly and Triply Heavy Baryons by SU(3) Analysis

Author: Xi-Ruo Zhang¹

Co-authors: Fei Huang²; Ji Xu¹

¹ *Zhengzhou University*

² *Shanghai Jiao Tong University*

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Baryons with three heavy quarks are the last missing pieces of the lowest-lying baryon multiplets in the quark model after the discovery of doubly heavy baryons. In this work, we study nonleptonic weak decays of triply heavy baryons $\Omega^{++}\{ccc\}$, $\Omega^{-}\{bbb\}$, $\Omega^{+}\{ccb\}$, and $\Omega^{0}\{cbb\}$. Decay amplitudes for various processes have been parametrized in terms of the SU(3) irreducible nonperturbative amplitudes. A number of relations for the partial decay widths can be deduced from these results that can be examined in future. Some decay channels and cascade decay modes which likely to be used to reconstruct the triply heavy baryons have been also listed.

Presentation type:

Poster

37

Studying NP effects in semileptonic $\Omega_b(\Sigma_b)$ decays

Author: 盛金环 ¹

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¹ An Yang Normal University

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We use the experimental measurements of the process $B \rightarrow D(D^*)$ to constrain the NP coupling parameters. Then Using the constrained NP coupling parameters, we report the numerical results and NP effects on various observables related to the processes $\Omega_b \rightarrow \Omega_c l \nu_l$ and $\sigma_b \rightarrow \Sigma_c l \nu_l$. Please see our paper: PRD102.055023(2020)

Presentation type:

Oral

38

Prospects of measuring $D \rightarrow K_1 l \nu$ @ LHCb & STCF

Author: Lingzhu Bian¹

¹ Wuhan University

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The angular distributions for the decay cascade $D \rightarrow K_1(1270, 1400)\ell^+\nu_\ell \rightarrow (K\pi\pi)\ell^+\nu_\ell (\ell = e, \mu)$ have been derived, and we found that the measurement of up-down asymmetry in $D \rightarrow K_1 e^+\nu_e \rightarrow (K\pi\pi)e^+\nu_e$ and angular distributions in $D \rightarrow K_1 \ell^+\nu_\ell \rightarrow (K\pi\pi)\ell^+\nu_\ell$ can help to determine the hadronic amplitude requested in $B \rightarrow K_1(\rightarrow K\pi\pi)\gamma$, which allows us to extract the photon polarization. Based on the first observation of the $D^0 \rightarrow K_1(1270)^- e^+\nu_e$ semileptonic decay currently presented at BESIII, we expect that the angular analysis on $D \rightarrow K_1 \ell^+\nu_\ell \rightarrow (K\pi\pi)\ell^+\nu_\ell (\ell = e, \mu)$ at LHCb and STCF can give us a precise determination of photon polarization in $b \rightarrow s\gamma$ transitions in combination with the $B \rightarrow K_1(1270)\gamma$ up-down asymmetry measurements.

Presentation type:

Oral

39

Production of Fully-Heavy Tetraquarks Using NRQCD Factorization

Authors: Deshan Yang¹; Feng Feng²; HUANG Yingsheng^{None}; Wen-Long Sang³; Yu Jia⁴; 佳囍张⁵; 小努 (Xiaonu) 熊 (Xiong)⁶

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We propose a model-independent approach to study the production of fully heavy tetraquark, based on NRQCD factorization. We investigate production processes of fully heavy tetraquark at LHC and B factory in this framework. Short-distance coefficients are calculated perturbatively owing to the asymptotic freedom. We adopt different models to estimate the long-distance matrix elements, leading to contradicting phenomenological predictions.

Presentation type:

Oral

40

C-even quarkonia production at JLab and EIC

Authors: Jia-Yue Zhang¹; Jichen Pan¹; Yu Jia¹; Zhewen Mo¹¹ *IHEP***Corresponding Author:** mozw@ihep.ac.cn

We study the C-even heavy quarkonium production processes. The charge odd J/ψ production process via gravitational interaction is also investigated. The nonperturbative nature of quarkonia is depicted by the NRQCD factorization framework. The predicted cross sections for $\chi_{c(b)1}$ are suppressed compared with their counterparts $\eta_{c(b)}$, $\chi_{c(b)0}$ and $\chi_{c(b)2}$, which can be explained by the Landau-Yang theorem. We propose that these production processes can be detected in the future JLab and EIC experiments.

Presentation type:

Oral

41

A Flavor Specific 2HDM and Flavor Anomalies

Author: 乔毅温 ¹**Co-authors:** Fanrong Xu ²; mengchao Zhang ³; 俊谋湛 ⁴¹ *Jinan university*² *Jinan University*³ *itp*⁴ 暨南大学**Corresponding Author:** qywen2016051133@stu2016.jnu.edu.cn

The 3.1σ R_K anomaly after Moriond 2021 and 3.3σ Δa_μ from Fermilab Muon g-2 Experiment implicate that the lepton flavor universality violation (LFUV) may play a role in the exploration of new

physics. Aiming at solving these flavor anomalies both in quark and lepton sectors, a specific Two-Higgs Doublet Model (2HDM) with particular U(1) gauge symmetry, which is designed to get rid of the redundancy in generic 2HDM-III Yukawa couplings, is proposed and investigated. Among three additional new particles in the flavor gauged 2HDM, FCNC processes can be induced by heavy neutral scalar and Z' only in down-type quark sector, which provide solutions to anomalies in $b \rightarrow s\ell\bar{\ell}$ and anomalous magnetic dipole moment (AMDM) for leptons. The charged Higgs, on the other hand, explains anomalies in $b \rightarrow c\ell\nu$ processes.

In this work, combining the latest experimental results of $R_{(K,K^*)}$ and $B_s \rightarrow \mu^+\mu^-$, the bounds of Wilson coefficients C_9^ℓ and C_s^ℓ emerged in FG2HDM, which are lepton flavor specific, can be obtained for the first time. By taking into account the FNAL muon g-2 new result with two-loop level full theoretical calculation, we can get the allowed parameter space of this UV-complete model.

Presentation type:

Poster

42

New physics in inclusive $\bar{B} \rightarrow X_c \tau^- \bar{\nu}_\tau$ decay including $\mathcal{O}(\Lambda_{QCD}^2/m_b^2)$ and $\mathcal{O}(\alpha_s)$ corrections

Author: 李媛媛¹

Co-authors: 李新强¹; 杨亚东¹; 赖丽芬¹

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Motivated by the $R(D^{(*)})$ anomalies observed in exclusive $\bar{B} \rightarrow D^{(*)} \tau^- \bar{\nu}_\tau$ decays, which might hint at the violation of the physics signal that couple non-universally to the three generations of leptons, we perform a detailed study of the physics effects in the inclusive $\bar{B} \rightarrow X_c \tau^- \bar{\nu}_\tau$ decay, including both $\mathcal{O}(\Lambda_{QCD}^2/m_b^2)$ independent effective field theory framework and in the popular leptoquark models, focusing on the behavior of side forward-backward asymmetry A_{FB} , the τ polarization P_τ , as well as the q^2 -dependent ratio of the $X_c \tau^- \bar{\nu}_\tau$ $d\Gamma/dq^2$ $d\Gamma(\bar{B} \rightarrow X_c \ell^- \bar{\nu}_\ell)/dq^2$, under different assumptions about the new-physics contributions. It is found that, under the combined constraints from the ratios $R(D^{(*)})$ and other relevant observables, the new-physics operators with different Dirac structures are insensitive to both the perturbative and non-perturbative corrections, in either the 1S or the kinetic scheme. Some observables in inclusive $\bar{B} \rightarrow X_c \tau^- \bar{\nu}_\tau$ decay are also found to be helpful for discriminating the different new-physics scenarios proposed to account for the $R(D^{(*)})$ anomalies.

Presentation type:

Oral

43

Power-aligned 2HDM: a correlative perspective on $(g-2)_{e,\mu}$

Author: Shaoping Li¹

Co-authors: Xin-Qiang Li²; 亚东杨²; 媛媛李³; 欣张⁴

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With the hypothesis of minimal flavor violation, we find that there exists a power-aligned relation between the Yukawa couplings of the two scalar doublets in the two-Higgs-doublet model with Hermitian Yukawa matrices. Within such a power-aligned framework, it is found that a simultaneous explanation of the anomalies observed in the electron and muon anomalous magnetic moments can be reached with TeV-scale quasi-degenerate Higgs masses, and the resulting parameter space is also phenomenologically safer under the B-physics, Z and τ decay data, as well as the current LHC bounds. Furthermore, the flavor-universal power that enhances the charged-lepton Yukawa couplings prompts an interesting correlation between the two anomalies, which makes the model distinguishable from the (generalized) linearly aligned and the lepton-specific two-Higgs-doublet models that address the same anomalies but in a non-correlative manner, and hence testable by future precise measurements.

Presentation type:

Oral

44

Linking $R_{K^{(*)}}$ anomalies to H_0 tension via Dirac neutrino

Author: Wen-Feng Duan¹**Co-authors:** Shaoping Li²; Xin-Qiang Li¹; 亚东杨¹¹ *Central China Normal University*² *CCNU***Corresponding Author:** dufewe@mails.ccnu.edu.cn

The recently updated measurements from LHCb have strengthened the deviation of R_K , implying a stronger hint at new physics beyond the Standard Model. We show in this paper that, the long-standing $R_{K^{(*)}}$ anomalies can be explained by Dirac neutrinos embedded in a two-Higgs-doublet model. The explanation induces a thermalized right-handed Dirac neutrino in the early Universe, which contributes as extra radiation to the Hubble expansion and prompts a shift of the effective neutrino number, N_{eff} . In mimicking the favored scenarios for solving the Hubble (H_0) tension, we show that the simultaneous explanation of $R_{K^{(*)}}$ and H_0 via one-flavor right-handed Dirac neutrino can be readily tested or ruled out by the upcoming H_0 confirmation.

Presentation type:

Oral

45

QCD sum rules analysis of weak decays of doubly heavy baryons: the $b \rightarrow c$ processes

Author: 志鹏邢¹**Co-author:** 赵振兴²

¹ 上海交通大学² 内蒙古大学**Corresponding Author:** zpxing@sjtu.edu.cn

A comprehensive study of $b \rightarrow c$ weak decays of doubly heavy baryons is presented in this paper. The transition form factors as well as the pole residues of the initial and final states are respectively obtained by investigating the three-point and two-point correlation functions in QCD sum rules. Contributions from up to dimension-5 and dimension-6 operators are respectively considered for the two-point and three-point correlation functions. The obtained form factors are then applied to a phenomenological analysis of semi-leptonic decays.

Presentation type:

Oral

46

Renormalization-Group Equation Approach to Sterile Neutrino Mass Effect

Author: Shuge Zeng¹**Co-author:** Fanrong Xu ¹¹ *Department of physics, Jinan University, No. 601, Huang Pu Road, Guangzhou, 510632, P. R. China***Corresponding Author:** sgzeng@stu2021.jnu.edu.cn

The renormalization-group equation approach to neutrino mass effect involving sterile neutrino is developed in this work. A set of differential equations for the effective neutrino mixing matrix and the masses are derived completely when one generation of light sterile neutrino is considered, based on which the differential equations for oscillation probability are given analytically. The methodology is confirmed by comparing with previous results on the evolution of mixing matrix element with RGE approach in neutrino SM case. Taking JUNO and NOVA as examples of short- and long-baseline experiments, we give the oscillation probabilities numerically. We further apply the RGE method to solve solar neutrino problem and day-night asymmetries are predicted in both JUNO and Jinping neutrino experiment.

Presentation type:

Poster

47

Studying some baryon decays with the SU(3) flavor symmetry

Author: 王茹敏 ¹¹ 信阳师范学院**Corresponding Author:** ruminwang@163.com

1. Hyperon nonleptonic decays
2. Hyperon semileptonic decays $T_{\{8,10\}} \rightarrow T_8 \ell \bar{\nu}_\ell$
3. Baryon semileptonic decays $B_{1(1/2+)} \rightarrow B_{2(1/2+)} \ell^+ \ell^-$

Presentation type:

Oral

48

Heavy baryon two-body decays from light-cone sum rules

Author: Hua-Yu Jiang¹

Co-authors: Alexander Khodjamirian²; Fu-Sheng Yu³; Shan Cheng⁴

¹ *University of Lanzhou, University of Siegen*

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We systematically study the heavy baryon two-body decays by utilizing light-cone sum rules, for $\Lambda_b \rightarrow p\pi$ and pK , all the topologies (tree and penguin) are figured out in a three-point correlator scheme, then the branching fractions and CP-violation are achievable. Furthermore, we propose a two-point correlator scheme for comparison, part of the topologies are calculable in this scheme, which demonstrates some interesting properties.

Presentation type:

Oral

49

最低正宇称的 Ds 介子分析

Author: Jia-Jun Wu¹

¹ *IHEP*

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结合夸克模型和有效哈密顿量方法, 从格点数据中抽取了最低正宇称的四个 Ds 介子的性质。

Presentation type:

Oral

50

Predictions of observables in semileptonic $B_c \rightarrow J/\psi$

Authors: Cai-Dian Lu¹; Rui Lin Zhu²; Zhuoran Huang³; 儒英唐⁴

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With the latest lattice QCD calculations on form factors of $B_c \rightarrow J/\psi$, we use non-relativistic QCD to fit tensor form factors. Using the fitted form factors, we study different model-independent New physics scenarios and R_2 , U_1 , S_1 leptoquark model and give the predictions of $R_{J/\psi}(q^2)$, $P_\tau^{J/\psi}(q^2)$, $P_{J/\psi}(q^2)$ and $\mathcal{A}_{FB}^{J/\psi}(q^2)$ in allowed new physics scenarios and leptoquark model.

Presentation type:

Oral

51

中微子混合矩阵的幺正性检验

Author: Jiajie Ling¹

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中微子混合矩阵的幺正性检验是中微子振荡研究的核心问题之一。目前夸克 CKM 矩阵的混合检验已经非常精确，相比之下轻子的混合矩阵幺正性检验的误差还比较大，还有较大的改进空间。利用目前全球的中微子振荡实验数据，能够对中微子混合矩阵的元素和幺正性进行测量和限制。本报告将汇报中微子混合矩阵测量的最新结果。

Presentation type:

Oral

52

Searching for CPV induced sphaleron process at the early Universe

Author: Ligong Bian¹

¹ Chongqing University

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In this talk, I will share with you our recent study on CP violation induced sphaleron process at the early Universe.

Presentation type:

Oral

53

Study of $B_{\{u,d,s\}} \rightarrow K_0^*(1430)P$ and $K_0^*(1430)V$ decays within QCD factorization

We study the nonleptonic charmless $B_{\{u,d,s\}} \rightarrow K_0(1430)P(P=K,\pi)$ and $K_0(1430)V(V=K,\rho,\omega,\phi)$ decays. The amplitudes are calculated within the QCD factorization, and the non-perturbative quantities are evaluated by using a covariant light-front approach. The branching fractions and CP asymmetries of these decay modes are calculated, some decay modes are first predicted, and some useful relations based on $SU(3)$ flavor symmetry are discussed. Comparing the theoretical results with the current available experimental data, it is found that $K_0(1430)$ can be described as the lowest-lying p-wave state rather than the first excited one.

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Self-consistency and covariance of light-front quark models

We test the self-consistency and covariance of light-front quark model, and study the zero-mode issue via the decay constants of pseudoscalar (P), vector (V) and axial-vector (A) mesons, as well as the $P \rightarrow (S,P,V,A,T)$ and $V \rightarrow V$ weak transition form factors. A possible solution to the problems of the traditional covariant light-front quark model is discussed and confirmed numerically.

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Recent Experimental Progress in Heavy Flavor Physics

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Recent Theoretical Progress in Heavy Flavor Physics

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Highlights from LHCb

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Highlights from BESIII

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Hadronic decays of charmed mesons and baryons at BESIII

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