# 2025 粒子物理标准模型及新物理精细计算研讨会

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**Chair：李营 / 1**

## celestial massive amplitudes

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Here we discuss the 3pt celestial amplitude of two massive scalars and one massless scalar. In the massless limit $m \to 0$ for one of the massive scalars, the gamma function $\Gamma(1-\Delta)$ appears. By requiring the resulting amplitude to be well-defined, that is it goes to the 3pt amplitude of arXiv:2312.08597, the scaling dimension of this massive scalar has to be conformally soft $\Delta \to 1$. The pole $1/(1-\Delta)$ coming from $\Gamma(1-\Delta)$ is crucial for this massless limit. Without it the resulting amplitude would be zero. The phase factors in the massless limit of massive conformal primary wave functions, discussed in arXiv:1705.01027, plays an import and consistent role in the celestial massive amplitudes. Furthermore, the subleading orders $m^{2n}$ can also contribute poles when the scaling dimension is analytically continued to $\Delta = 1-n$ or $\Delta = 2$. This consistent massless limit only exists for dimensions belonging to the generalized conformal primary operators $\Delta \in 2 - \mathbb{Z}_{\geq 0}$ of massless bosons.

**Chair：曹庆宏 / 2**

## Complete computation of planar two-loop six-point massless integrals

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We compute all planar two-loop six-point massless integrals via canonical differential equations. The integral basis with uniform transcendentality is determined via the D-dimensional upgrading of dual conformal integrals and the Baikov representation analysis. The analytic boundary values are determined and all planar two-loop six-point massless planar are calculated as iterative integrals. This is a milestone of Feynman integral computation, and paves the way for two-loop six-point amplitude studies and the NNLO four-final-state precision computations.

**Chair：王玉明 / 3**

## An Analytic Computation of Three-Loop Five-Point Feynman Integrals

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We evaluate the **three-loop five-point** pentagon-box-box massless integral family in the dimensional regularization scheme, via canonical differential equation. We use tools from **computational algebraic geometry** to enable the necessary integral reductions. The boundary values of the differential equation are determined **analytically** in the Euclidean region. To express the final result,

we introduce a **new representation of weight six functions** in terms of one-fold integrals over the product of weight-three functions with weight-two kernels that are derived from the differential equation. **Our work paves the way to the analytic computation of three-loop multi-leg Feynman integrals.**

**Chair：马滟青 / 4**

## 双粲和全粲四夸克态在高能对撞机上间接产生机制的研究

**作者：** 鸿浩马 [1]

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X（3872），作为四夸克的候选者，其产生和衰变等性质被实验和理论广泛研究。我们在 NRQCD 框架下，通过 Higgs 和弱玻色子衰变研究了双粲紧致四夸克态的间接产生机制，并分别在 LHC 和 CEPC 上预言了其分支比和产生率等。基于共线因子化，利用两种碎裂函数方法，我们对全粲四夸克态的间接产生性质也进行了深入的研究。通过此报告将详细介绍近期我们关于四夸克态间接产生的理论研究工作。

**Chair：马滟青 / 6**

## Footprints of vector-like quark models

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Vector-like quarks (VLQs) are ubiquitous in many new physics models, such as grand unified theory, composite Higgs models, extra dimension theory, and so on. In minimal VLQ models, only seven types of representations can induce the mixing with standard model quarks. In non-minimal VLQ models, we can also introduce new scalar fields. The VLQ models can lead to rich phenomenology in electroweak precision observables, Higgs physics, flavour physics. In this talk, we will summarize our previous studies on the STU parameters, Higgs physics, and muon g-2 in the VLQ extended models.

**Chair：刘玉斌 / 7**

## Leptogenesis from symmetry non-restoration

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In this talk, I will present a Leptogenesis scenario, which does not need primordial B-L asymmetry in the early Universe, and does not need the existence of right-handed neutrinos. In this case,

the baryon asymmetry is generated by the requirement that the electron Yukawa interction enters thermal equilibrium after the quench of the electroweak sphaleron.

**Chair：马滟青 / 8**

## Unified interpretation of the muon g – 2 anomaly and 95 GeV excesses in the general next-to-minimal supersymmetric standard model

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We investigate three intriguing anomalies within the framework of the general next-to-minimal supersymmetric standard model. These anomalies include a significant deviation of the experimental results for the muon anomalous magnetic moment from its standard model prediction, with a confidence level of 5.1σ; a joint observation by the CMS and ATLAS Collaborations of a diphoton excess with a local significance of 3.1σ in the invariant mass distribution around 95.4 GeV; and a reported excess in the $b\bar{b}$ production at the Large Electron-Positron Collider with a local significance of 2.3σ. Through analytical and numerical analyses, we provide unified interpretations across an extensive parameter space that remain consistent with current experimental restrictions from data on the Higgs boson at 125 GeV, B-physics measurements, and dark matter observables, as well as existing searches for supersymmetry and extra Higgs bosons. We attribute the muon anomaly to loops involving muon-smuon-neutralino and muon- sneutrino-chargino interactions, while attributing the diphoton and $b\bar{b}$ excesses to the resonant production of a singlet-dominated scalar. These proposed solutions are poised for experimental tests at the high- luminosity LHC and future linear colliders.

**Chair：司宗国 / 9**

## Next-to-leading order QCD corrections to $B_c^* \to J/\psi$ form factors

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Within the framework of Non-Relativistic Quantum Chromodynamics (NRQCD) factorization, we calculate the next-to-leading order (NLO) perturbative QCD corrections to the form factors for the semileptonic decays of Bc*into J/ψ via (axial-)vector and (axial-)tensor currents. We obtain the complete analytical results for the form factors up to NLO, and provide their asymptotic expressions in the hierarchical heavy quark limit. The NLO corrections are found to be both significant and convergent in the relatively small squared transfer momentum （q2） region, while also reducing the dependence on the renormalization scale μ. Finally, the theoretical predictions for Bc → J/ψ form factors over the full q2 range are provided.

**Chair：王玉明 / 10**

## New version of NeatIBP: a novel tool for Feynman integral computation

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The integration-by-parts (IBP) reduction is one of the bottleneck steps in the evaluation of multi-loop Feynman integrals. NeatIBP is a program based on the syzygy method for IBP reduction. It generates much smaller IBP systems compared to traditional Laporta's algorithm, which helps reduce the computation cost of IBP reduction. In this talk, I will present the new version of NeatIBP. It is with multiple useful new features. These features include: the automated interface with the popular Feynman integral reduction software Kira, the implementation of IBP reduction using the idea of spanning cuts, the algorithm of syzygy vector simplification, and more. I will also introduce some recent works in amplitude computation that is supported by NeatIBP.

**Chair：杨茂志 / 11**

## Long-lived heavy neutral leptons from axionlike particles at the LHC and Belle II

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In hidden-sector models, axion-like particles (ALPs) can couple to heavy neutral
leptons (HNLs), leading to rich phenomenologies. We study ALPs produced from D- and B-meson decays via quark-favor-violating couplings, and decaying exclusively into a pair of HNLs which mix with active neutrinos. The ALP can be either short- or long-lived, depending on the masses of the ALP and the HNL, as well as the corresponding coupling strength. Such GeV-scale HNLs are necessarily long-lived given the current bounds on their mixing parameters. We assess the sensitivities of the LHC far detectors, SHiP, and Belle II, to the long-lived HNLs in such theoretical scenarios. We fnd that for currently allowed values of the ALP couplings, most of the LHC experiments can probe the active-sterile-neutrino mixing parameters multiple orders of magnitude beyond the present bounds, covering large parameter region targeted with the type-I seesaw mechanism, while the Belle II experiment can test the mixing parameters up to two orders of magnitude below the existing limits.

**Chair：王玉明 / 12**

## Categorizing representations of scalar SU(3)_f mesons by decays

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The scalar mesons are established for a long time, but their nature is still an open question. In this paper, we investigate the potential of categorizing their $SU(3)_f$ representations via $J/\psi \to SV$ and

$\gamma S$, offering a criterion that may illuminate this issue. Here, $S(V)$ denotes scalar (vector) mesons. Using the $SU(3)_f$ symmetry with the current data, we find that $f_0(500)$ and $f_0(980)$ are mostly made of singlet and octet $SU(3)_f$ representations, respectively, with the singlet-octet mixing angle of $\theta = (82.9 \pm 4.4)^\circ$. This conclusion is consistent with the caculations of the quark-antiquark ($q\bar{q}$) hypothesis. For the scalar mesons in the range of 1-2 GeV, we discuss the mixings between qq$^-$ and glueballs. Our numerical results suggest that $f_0(1710)$ is likely composed of the scalar glueball. We urge our experimental colleagues to measure $J/\psi \to \rho a_0(980, 1450, 1710), K^*(892)^\pm K^*(700, 1430, 1950)^\mp$ and $\omega f_0(500)$, which provide useful information in the SU(3)f analysis.

**Chair：吴兴刚 / 15**

## Novel approach to probing top-philic resonances with boosted four-top tagging

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We introduce a novel search strategy for heavy top-philic resonances that induce new contributions to four-top production at the LHC. We capitalize on recent advances in top-tagging performance to demonstrate that the final state, that is expected to be boosted based on current limits, can be fully reconstructed and exploited. Notably, our approach promises bounds on new physics cross sections that are a few to 60 times stronger than those obtained with existing searches showcasing its unprecedented effectiveness in probing top-philic new physics.

**Chair：李营 / 16**

## Search for Exotic Gauge Particles at the Future Colliders

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The study of exotic gauge bosons beyond the Standard Model have always been of great interest. Future muon colliders will have a significant advantage in discovering exotic particles. We study the properties of $Z'$ boson with the process of $\mu^+\mu^- \to q\bar{q}$, $\mu^+\mu^- \to l^+l^-$, $\mu^+\mu^- \to ZH$ and $\mu^+\mu^- \to W^+W^-$. Through studying the $\mu^+\mu^- \to W'^+W'^- \to e^+e^-n_e\bar{n}_e$ process, we explore the properties of $W'$ in the alternative left-right model as well.

**Chair：曹庆宏 / 18**

## 轴子物理：理论探索与实验探测

**Chair：曹庆宏 / 19**

## Precision Calculations for Hard Exclusive Reactions: An Everlasting Beautiful Journey

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**Chair：岳崇兴 / 20**

## Effective Field Theory from Scattering Amplitude View

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**Chair：岳崇兴 / 21**

## 矢量 Bc 介子与全粲四夸克态衰变过程的极化分析

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## Exclusive quarkonium production in Z decays

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**Chair：刘玉斌 / 23**

## D 介子单举衰变理论进展

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## Higgs physics highlights at the LHC experiments

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**Chair：吴兴刚 / 25**

## 重味夸克衰变的次次次领头阶微扰 QCD 修正

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## 轻赝标介子形状因子的微扰 QCD 计算进展

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**Chair：吴兴刚 / 27**

## Bs meson decays to even-parity charmed mesons

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**Chair：李营 / 28**

## 2HDMS 中的有限温自发 CP 破坏和重子不对称

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**Chair：王玉明 / 29**

## Next-to-next-to-leading order threshold soft function for tW production

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## Heavy meson DA from LQCD

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## 基于 QCD 因子化方案 $B \to \pi\pi$ 中色八重态的贡献

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**Chair：王建雄 / 33**

## Analytic decay width of the Higgs boson to massive bottom quarks at order alpha_sˆ3

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**Chair：王建雄 / 34**

## Loop corrections to tW production

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## Analytic results for Some types of Feyanman integrals at any loop order

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## Precision Gravitational Inspiral Dynamics from Feynman Integrals

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## 利用 QCD 求和规则研究五夸克态

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**Chair：杨茂志 / 38**

## 模味道框架下解决超对称 mu 问题及相关的模场稳定机制

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## Master integrals for two-loop gg->HH induced by light quark

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## The Effects of Early Kinetic Decoupling on the Dark Matter Relic Density

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## 非弹性暗物质模型的多手段协同探测

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**Chair：司宗国 / 42**

## b→c transition form factors in the perturbative QCD approach

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## QCD corrections of e^+ e^- to J/psi + c + cbar using the principle of maximum conformality

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## Probing the couplings of axion-like particle with leptons at future e^+e^− and e^−p colliders

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## Tree-level soft emission for two pairs of quarks

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## Asymptotic grand unification in SO(10) with one extra dimension

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## Gravitational Waves of GUT Phase Transition during Inflation

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## An explicit parameterization of minimal seesaw model

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## B 介子三体含粲半轻衰变的 QED 非因子化修正

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## Synergies in the Searches for Neutrino NSIs and Dark Matter

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