Theoretical progress On Heavy Flavor Physics

Selected topics& personal perspective

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Milestones in heavy flavor physics since 2000

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First observation of CPV in baryon decays	2025
First observation of CPV in D-meson decays	2019
First observation of doubly heavy baryons	2017
First observation of heavy pentaquark	2015
First observation of direct CPV	2004
CPV in B-meson system	2001
	2000

Experimental progresses

Milestones in heavy flavor physics since 2000

Experimental progresses	Year
First observation of CPV in baryon decays	2025
First observation of CPV in D-meson decays	2019
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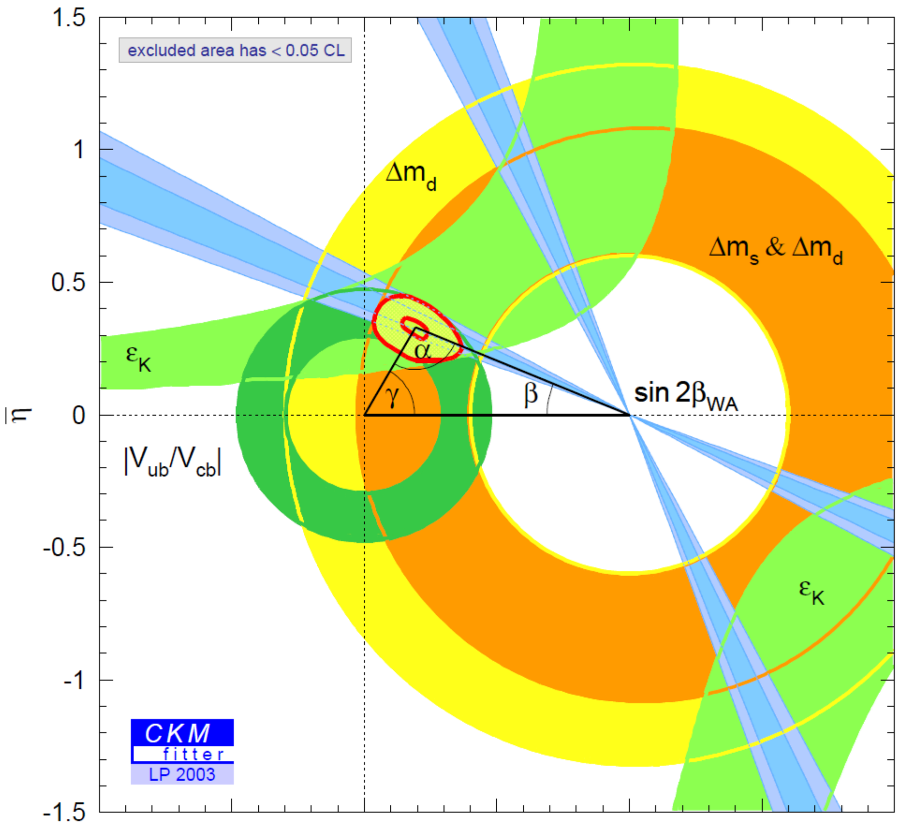
First observation of direct CPV	2004
CPV in B-meson system	2001
	2000

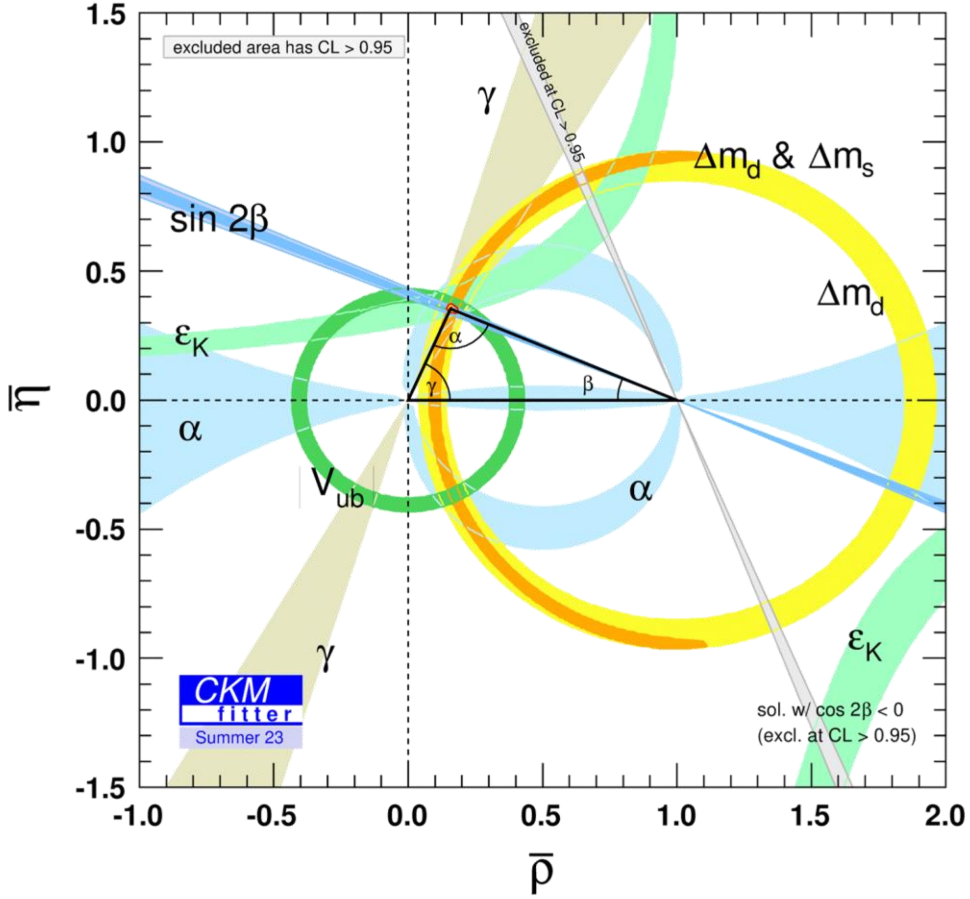
Theoretical progresses (2000): QCDF PQCD SCET

Experimental progresses

Theoretical progresses

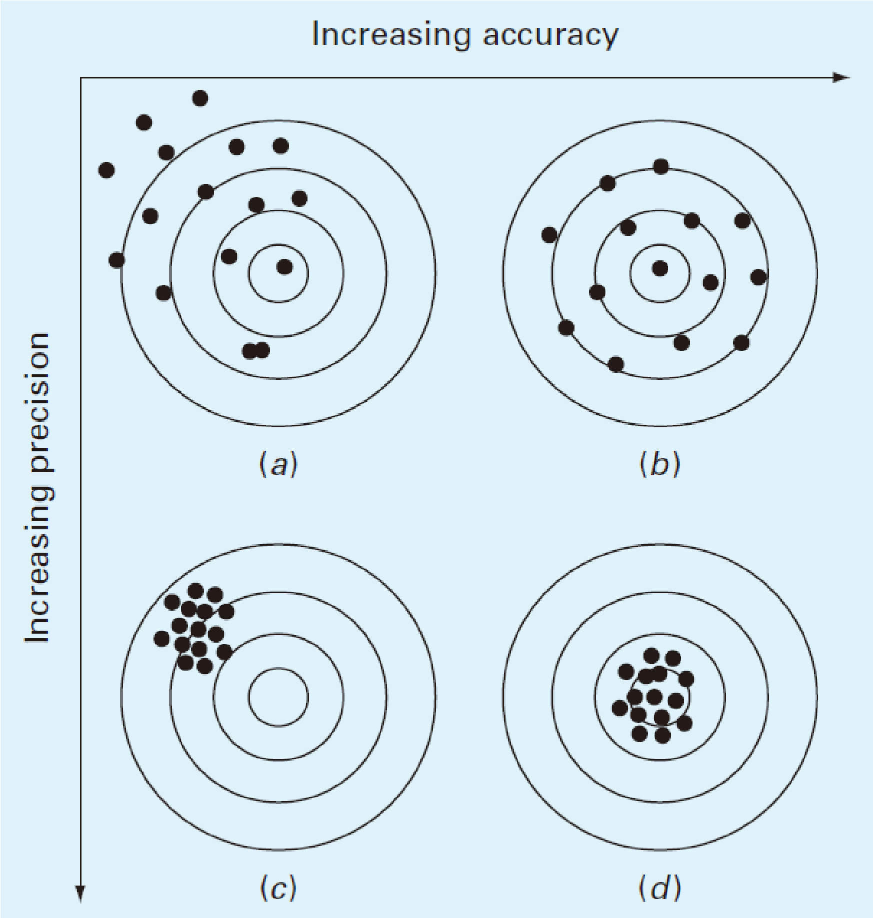
Era of precision measurement





High precise theoretical prediction is required

High Precision + High Accuracy



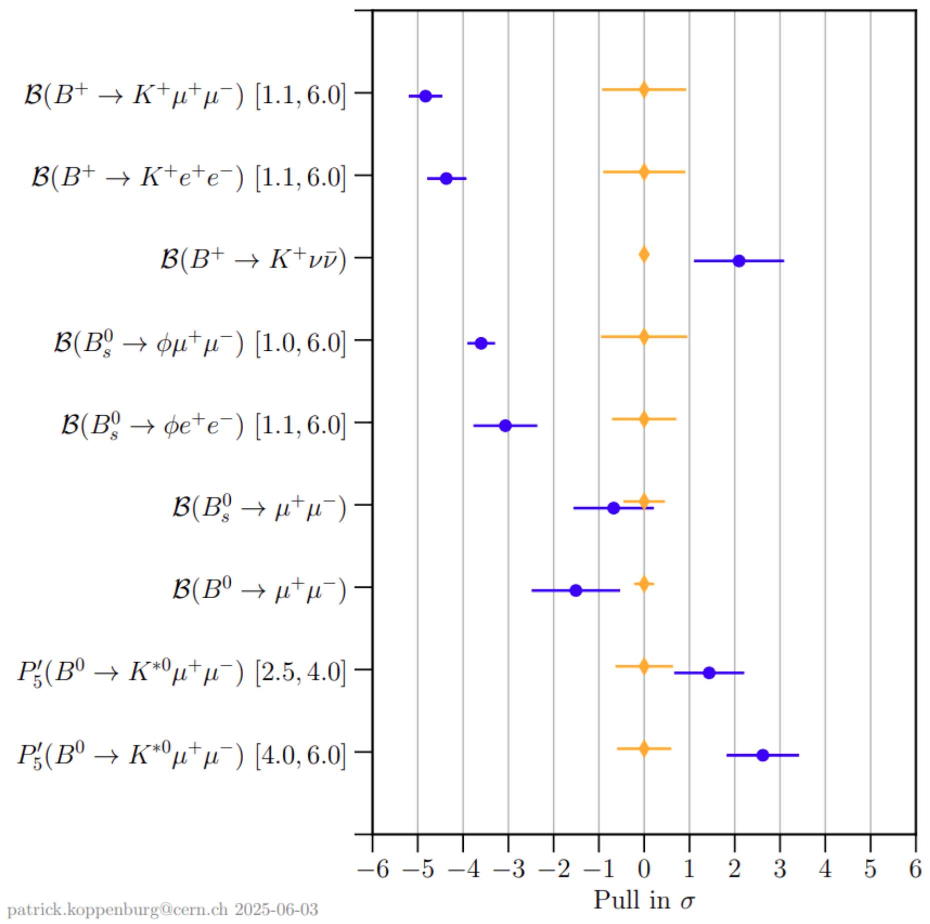
Reduce uncertainty of input parameters

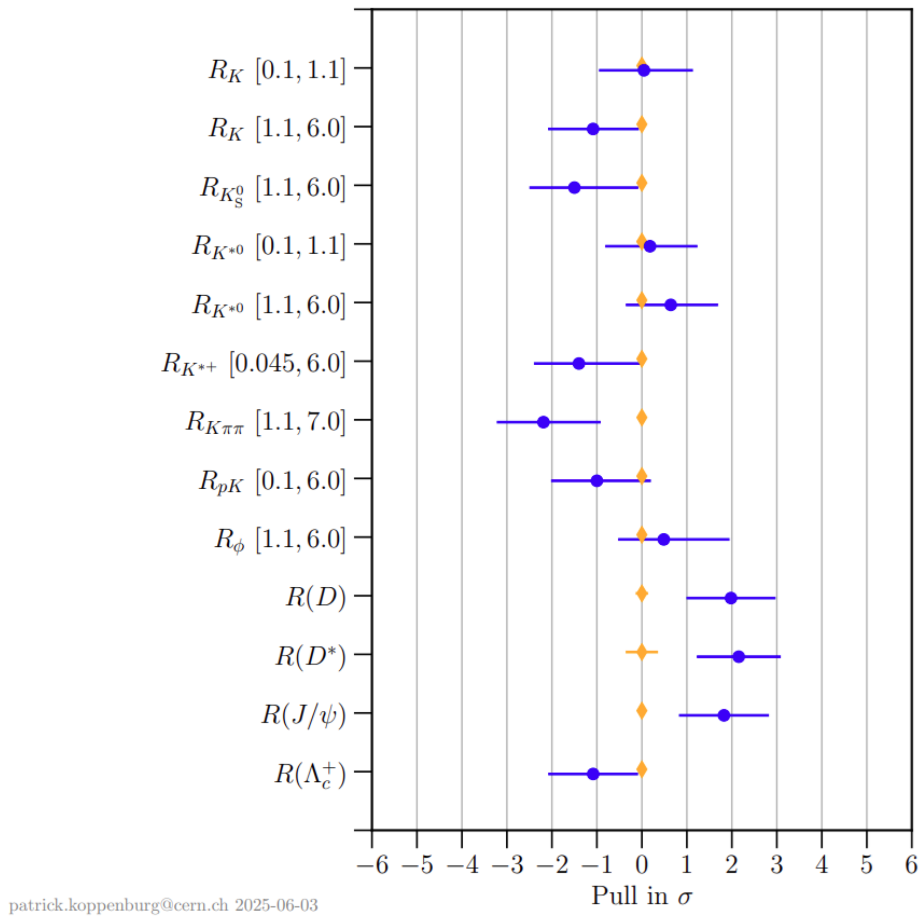
Reduce scale dependence of the observables

Systematically including more contributions

Flavor anomaly

http://www.koppenburg.ch/anomalies.html





Scrutinize the SM predictions

Test NP models

Puzzles in nonleptonic two-body B decays

$B \to \pi\pi$ puzzle

$$Br(B^0 \to \pi^0\pi^0) = (1.55 \pm 0.16) \times 10^{-6}$$

Much larger than expected. NNLO hard function does not work.

$B \to \pi K$ puzzle

$$\Delta A_{CP} = A_{CP}(B^- \to K^-\pi^0) - A_{CP}(B^0 \to K^-\pi^+) = (11.3 \pm 1.2)\%$$

9 σ deviation from isospin limit.

$B \to KK$ puzzle

$$R_{KK}^{sd} = \left|\frac{V_{td}}{V_{ts}}\right|^2 \frac{\Gamma(B_s \to K^0\bar{K}^0)}{\Gamma(B_d \to K^0\bar{K}^0)} = 0.62 \pm 0.14$$

Over 3σ deviation from SM prediction.

$B \to D_q^{(*)} L$ puzzle

$$R_{s(L)}^{(*)} = \frac{\Gamma\left(\bar{B}_{(s)}^0 \to D_{(s)}^{(*)+} L^-\right)}{\mathrm{d}\Gamma\left(\bar{B}_{(s)}^0 \to D_{(s)}^{(*)+} \ell^- \nu_\ell\right) / dq^2|_{q^2=m_L^2}}$$

Power suppressed contribution is required.

$R_\pi^{(*)}, R_K, R_{s\pi}$: Over 4σ deviation from SM prediction.

Bottom hardon decays: The multi-scale problem

NP scale	EW scale	Heavy quark scale	Intermediate scale	Hadronization scale
TeV or beyond	m_W	$m_b(m_c)$	$\sqrt{m_b\Lambda}, m_c$	Λ
$\mathcal{L}_{NP}$	$\mathcal{L}_{SM} + \mathcal{L}_{D>4}$	$\mathcal{H}_{eff} = \frac{G_F}{\sqrt{2}}\sum_i C_i O_i + \sum_i C_i' O_i'$	SCET-I	Low energy QCD HQET, SCET-II

$$\langle f|O_i|B\rangle = \mathcal{A}_{LP} + O\left(\frac{\Lambda}{m_b}, \frac{\Lambda}{E_f}\right)$$

Factorization

- Perturbation： matching, resummation, evolution
- Nonperturbation： Lattice simulation, sum rules…

Precision calculation in B meson decays

- QCD corrections to the perturbative functions

- QED corrections

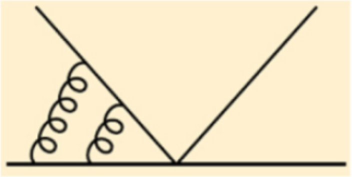
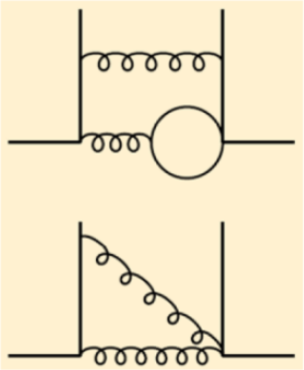
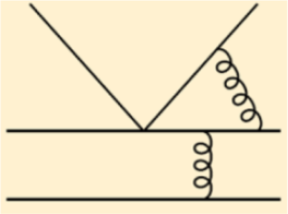
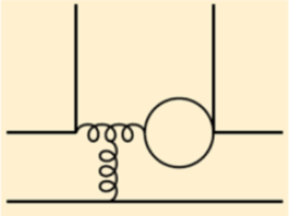
  See Si-Hong's talk

- Power corrections

- Nonperturbations functions and parameters

Two-loop corrections to QCDF hard function

$$\langle M_1 M_2 | O_i | \bar{B} \rangle = F^{B\to M_1} T_i^I \otimes \phi_{M_2} + T_i^{II} \otimes \phi_B \otimes \phi_{M_1} \otimes \phi_{M_2} + \mathcal{O}(\Lambda/m_b)$$

$\mathcal{O}(\alpha_s^2)$	 Bell '07, '09 Beneke, Huber, Li '09 Huber, Krankl, Li '16	 Kim, Yoon '11 Bell, Beneke, Huber, Li '15, '20	 Beneke, Jager '05 Kivel '06, Pilipp '07	 Beneke, Jager '06 Jain, Rothstein, Stewart '07

$B \to \pi^0 \pi^0$: strong cancellation between T_i^I and T_i^{II}

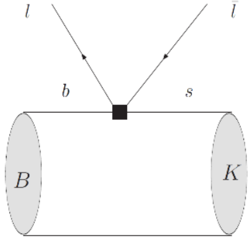
$B \to \pi K$: strong cancellation between tree and penguin operators

$B \to D_q^{(*)} L$: small real part

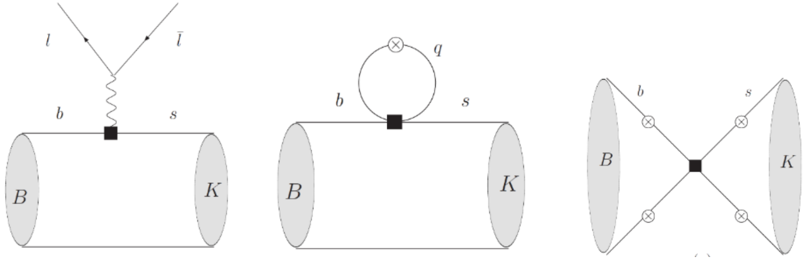
Power correction?   New Physics?

One-loop correction to annihilation contribution to $B \to P\ell^+\ell^-$

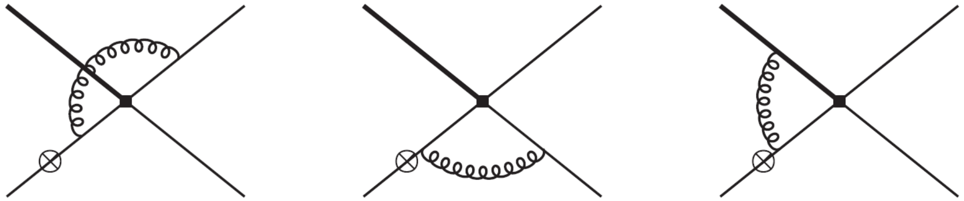
$$\mathcal{A}_{SM}^{local}(\bar{B} \to P\ell^+\ell^-) = \frac{G_F \alpha_{em} V_{tb} V_{tD}^*}{\sqrt{2}\pi}\left[C_9 L_V^\mu + C_{10} L_A^\mu\right] F_\mu^{B\to P}$$



$$\mathcal{A}_{SM}^{nonlocal}(\bar{B} \to P\ell^+\ell^-) = \frac{G_F \alpha_{em}}{\sqrt{2}\pi}\frac{L_V^\mu}{q^2}\{V_{tb}V_{tD}^*\left[2im_b C_7 F_{T\mu}^{B\to P} + 16\pi^2 H_\mu^{(t)}\right] + V_{ub}V_{uD}^*\, 16\pi^2 H_\mu^{(u)}\}$$



Annihilation diagrams contribute at leading power



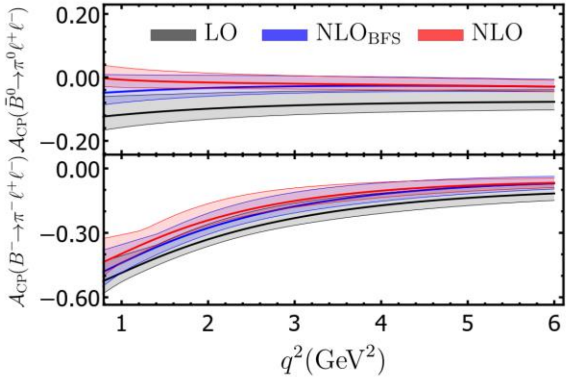
$$\mathrm{T}_{P,\mathrm{anni}}^{(u,t)}(q^2) = -\frac{\pi^2}{N_c}\frac{\tilde{F}_B f_P}{m_B}\sum_{m=\pm}\int_0^\infty \frac{d\omega}{\omega}\int_0^1 du\, T_{P,m}^{t,u}(\omega,u,\mu)\phi_{B,m}(\omega,\mu)\phi_P(u,\mu)$$

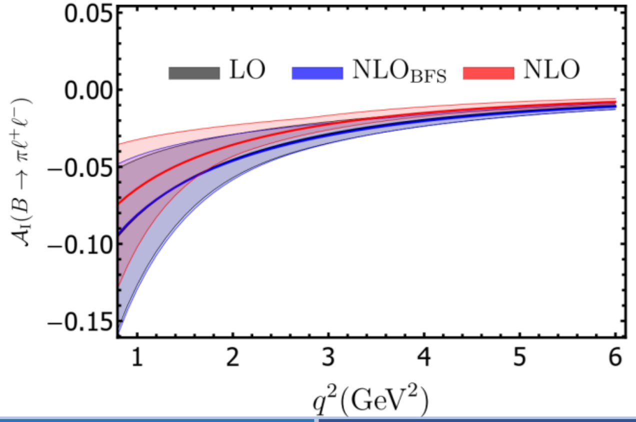
$$\downarrow$$

$$\sum C_i H_i \otimes J_m$$

$\mathrm{QCD} \to \mathrm{SCET_I} \to \mathrm{SCET_{II}}$

[Huang, YLS, Wang, Wang, PRL 134 (2025) 9, 091901]





QCD correction to other hard exclusive processes

- Two-loop QCD corrections to Pion electro-magnetic form factors

  [Chen, Chen, Feng, Jia, PRL 132 (2024)20, 201901]

  [Ji, Shi, Wang, Wang, Wang, PRL 134 (2025)22, 221901] See Ye-Fan's talk

- Two-loop QCD corrections to Pion-photon form factors

  [Gao, Huber, Ji, Wang, PRL 128 (2022)06, 062003]

- High-order QCD corrections to production and decay of heavy quarkonium

  [Li, Huang, Sang, arXiv: 2506.16317] See Cong Li's talk

  [Sang, Feng, Jia, Mo, Pan, Zhang, PRL 131 (2023)16, 161904]

  [Sang, Feng, Jia, Mo, Zhang, PLB 843 (2023)138057]

  [Zhang, Sang, Zhang, PRL 129 (2022)20, 201901]

  [Feng, Jia, Mo, Sang, Zhang, PLB 850 (2024)138506]

  [Feng, Jia, Sang, PRL 119 (2017)25, 252001]

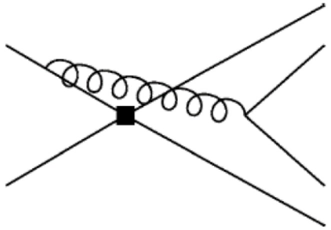
- One-loop QCD corrections to Nucleon form factors

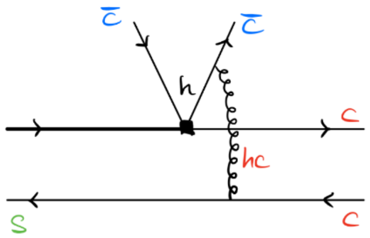
  [Huang, Shi, Wang, Zhao, PRL 135 (2025)9, 091901]

  [Chen, Chen, Feng, Hu, Jia, arXiv: 2406.19994]

Power Corrections: annihilation topology in nonleptonic B decays

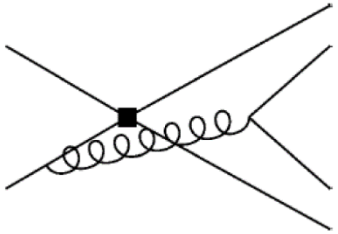
- Annihilation VS HSS: power suppression





- Endpoint singularity

$$A_1^{ib} \supset \int_0^1 dxdy \frac{\phi_1(x)\phi_2(y)}{\bar{x}^2 y}$$



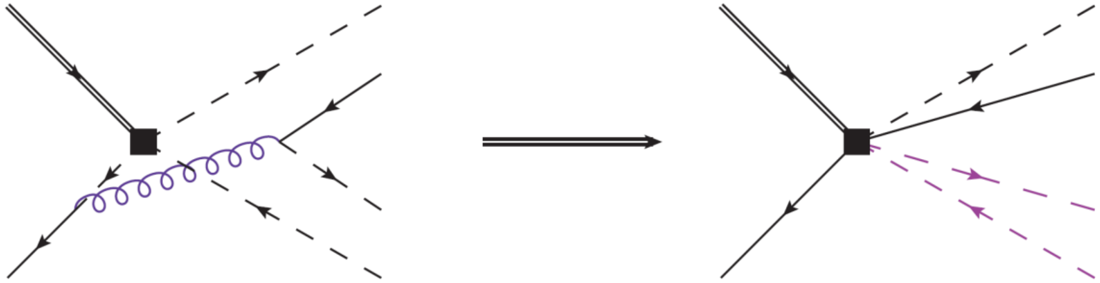
	Momentum fractions	b quark-emission	light quark-emission
Hard gluon	$x \sim 1, \bar{x} \sim 1, dx \sim 1$ $y \sim 1, \bar{y} \sim 1, dy \sim 1$	1	1
Hard-collinear gluon	$x \sim 1, \bar{x} \sim \lambda, dx \sim \lambda$ $y \sim 1, \bar{y} \sim 1, dy \sim 1$	λ	**1**
Soft gluon	$x \sim 1, \bar{x} \sim \lambda, dx \sim \lambda$ $y \sim \lambda, \bar{y} \sim 1, dy \sim \lambda$	λ^3	λ

Hard-collinear gluon exchange is at the same power with hard gluon exchange!

Annihilation topology in nonleptonic B decays

- Separation of hard and hard collinear region

[Lü, YLS, Wang, Wang, NPB990(2023)116175]



$$\int_0^\infty d\omega\phi_B^+(\omega)\int_0^\Delta dx\int_0^1 dy\frac{\phi_1(x)\phi_2(y)}{\bar{x}^2 y}$$

$$+\int_0^\infty d\omega\phi_B^+(\omega)\int_\Delta^1 dx\int_0^1 dy\frac{\phi_1(x)\phi_2(y)}{\bar{x}^2 y}$$

$$\int_0^\infty d\omega_1\int_0^\infty d\omega_2\int_\Delta^1 dx\int_0^1 dyH(y)\phi_2(y)\frac{\Theta_{BM_1}(\omega_1,\omega_2)}{y\omega_2(\omega_2-\omega_1+i\epsilon)}$$

- The soft-collinear function

$$\Theta_{BM}(\omega_1,\omega_2)=\int dt\int ds e^{i(\omega_1 t-\omega_2 s)}\langle M(p)\big|[\bar{q}_s(tn)\Gamma_1 h_v(0)][\bar{\xi}_{\bar{c}}(0)\Gamma_2 q_{\overline{sc}}(sn)]\big|\bar{B}_q(P)\rangle$$

Annihilation topology in nonleptonic B decays

- The tree level approximation of the soft function

$$\Theta_{BM}(\omega_1,\omega_2)\Big|_{fac} = \phi_B^+(\omega_1)\phi_M\left(1-\frac{\omega_2}{m_B}\right)\theta\left(1-\frac{\omega_2}{m_B}\right)$$

- The factorization formula

$$\mathcal{G}_{B1} = \int_0^\infty d\omega\phi_B^+(\omega)\int_0^1 dxdy\frac{\phi_1(x)\phi_2(y)}{\bar{x}y(\bar{x}-\frac{\omega}{m_B}+i\epsilon)}$$

- Approximation result: asymptotic light meson DA, Exponential model for B meson

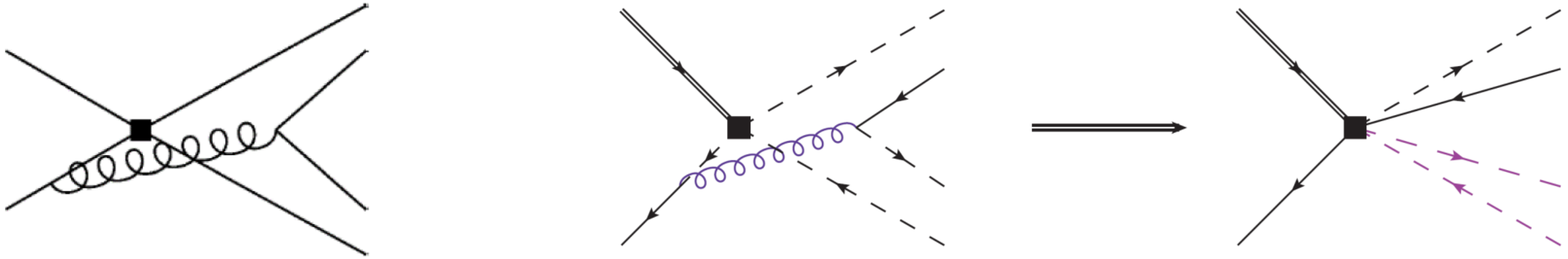
$$\mathcal{G}_{B1} \sim 18\left[\ln\frac{m_B}{\lambda_B}+\gamma_E-2-i\pi\right]$$

- Compared with QCDF

$$X_A \sim \left[1+\frac{\gamma_E-2-i\pi}{\ln\frac{m_B}{\lambda_B}}\right]\ln\frac{m_B}{\lambda_B} = (1+\rho_A e^{i\phi_A})\frac{m_B}{\Lambda_h}$$

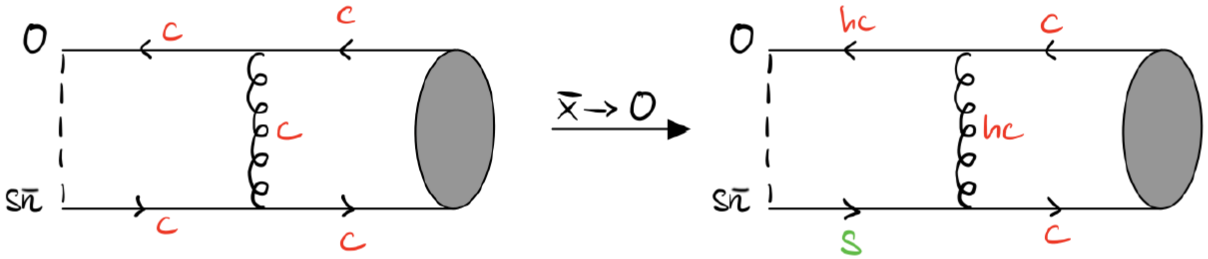
Annihilation topology in nonleptonic B decays

- Toward cancellation of the endpoint singularity



Contribution from six-quark operators in BBNS

Contribution from soft-collinear function

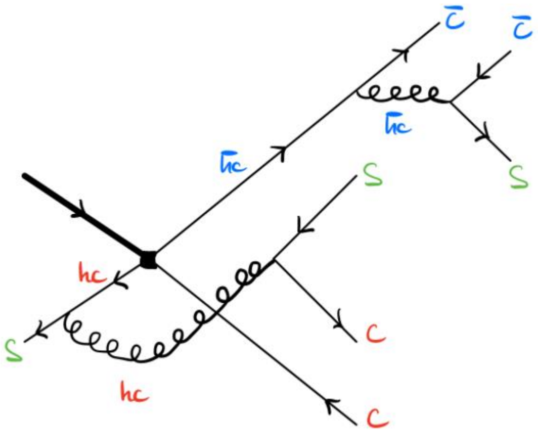


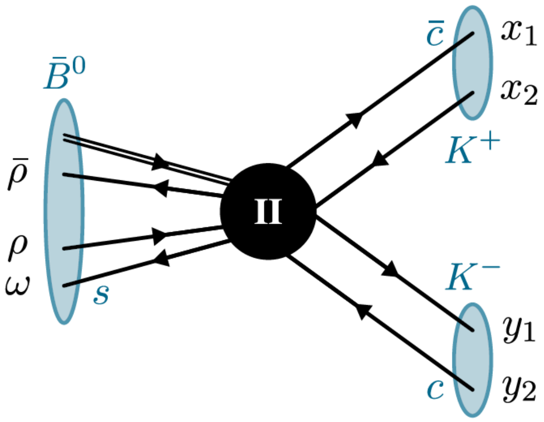
[Stillger, PHD Thesis, DOI: 10.25358/openscience-11523]

Refactorization:
Cancellation of the endpoint singularity arising from these two contributions.

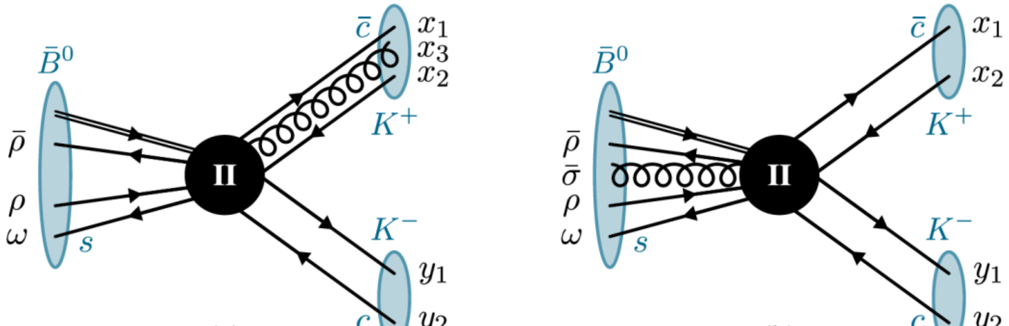
Annihilation topology in nonleptonic B decays

- More contributions at the same power with 6-quark operators





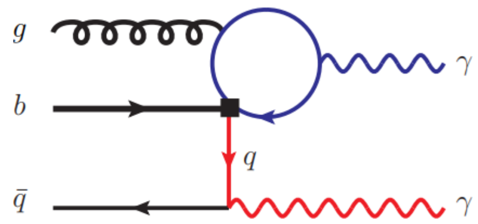
Additional gluon emission



(a) (b)

Power Corrections: Long distance quark loop

- Long distance quark loop in double radiative decays



- Power counting of quark mass:

$$\Lambda_{QCD} \ll m_c \sim m_b \qquad \text{or} \qquad m_c^2 \approx m_b \Lambda_{QCD}:$$

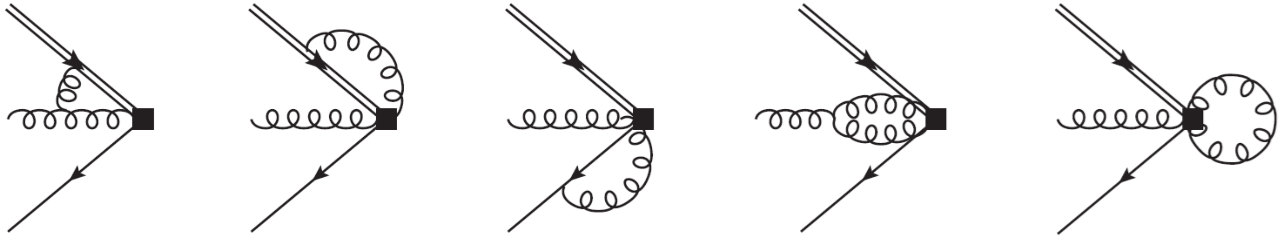
- B meson soft function 【Qin, YLS, Wang, Wang, PRL131 (2023) 9, 091902】

$$\langle 0|(\bar{q}_s S_n)(\tau_1 n) S_n^\dagger S_{\bar{n}}(0) S_{\bar{n}}^\dagger g_s G_{\mu\nu} S_{\bar{n}}(\tau_2 \bar{n}) \bar{n}^\nu n \cdot \gamma \gamma_\perp^\mu \gamma_5 S_{\bar{n}}^\dagger h_v(0)|\bar{B}_v\rangle = 2F_{\mathrm{B}}(\mu) m_B \int_{-\infty}^{\infty} d\omega_1 d\omega_2 \ \mathrm{e}^{-i(\omega_1\tau_1+\omega_2\tau_2)} \Phi_G(\omega_1,\omega_2,\mu)$$

- Renormalization and Evolution【Huang, Ji ,YLS, Wang ,Wang, PRL 133 (2024) 17, 171901】

The arguments are not positive-definite

See Yao Ji's talk



- Asymptotic behavior

$$\Phi_G(\omega_1 \to 0, \omega_2 \to 0, \mu) \propto \frac{\lambda_E^2 + \lambda_H^2}{6\omega_0^2} e^{V+2\gamma_E(a_1+a_2)} \left(\frac{\mu_0}{\omega_0}\right)^{a_1+a_2} \frac{1-e^{-i\pi a_2}}{4\pi^2} \Gamma(1+a_1)\Gamma(1+a_2)$$

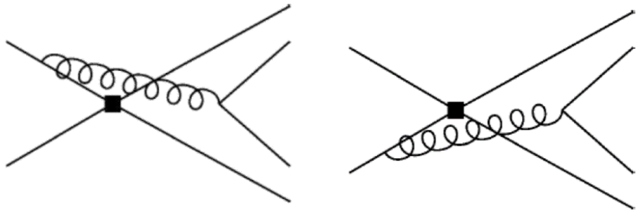
$$\Phi_G(\omega_1 \to \pm\infty, \omega_2 \to \pm\infty, \mu) \propto \frac{\lambda_E^2 + \lambda_H^2}{6\omega_0^2} e^{V+2\gamma_E(a_1+a_2)} \left(\frac{\mu_0}{\omega_0}\right)^{a_1+a_2} \left(\frac{\mu_0}{\pm\omega_1}\right)^{1+a_1} \left(\frac{\mu_0}{\pm\omega_2}\right)^{1+a_2}$$

Quark loops in pure annihilation type B decays

- Pure annihilation nonleptonic(charmless) B decays: symmetric flavor structure

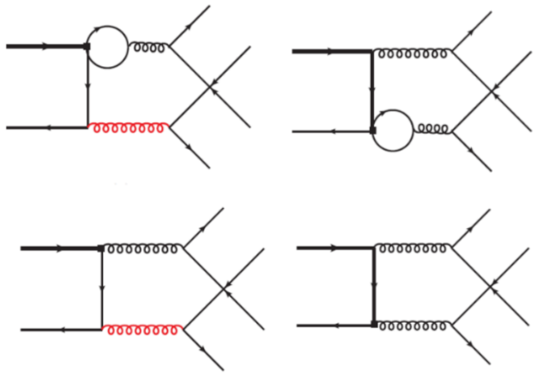
$\bar{B}_s \to \pi\pi, \rho\rho, \rho\omega, \omega\omega, \pi\rho, \pi\omega$ $\bar{B}_d \to K^+K^-, K^{*+}K^{*-}, \phi\phi, K^{*+}K^-, K^+K^{*-}$

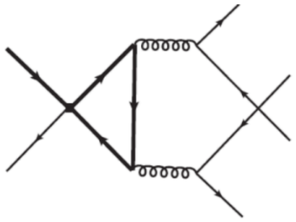
- Enhanced quark-loop contribution [Lü, YLS, Wang, Wang, NPB990(2023)116175]



$A = V_{tb}V_{td}^{*}P$

$\frac{\alpha_s}{4\pi}V_{ub}V_{ud}^{*}T$





	$\mathcal{A}_{CP}^{dir}$	$\mathcal{A}_{CP}^{mix}$
$\bar{B}_s \to \pi^+\pi^-, \pi^0\pi^0$	$-6.0^{+1.1}_{-2.5}$ $(-3.6^{+1.8}_{-3.1})$	$-4.2^{+21.4}_{-9.0}$ $(35.9^{+15.6}_{-11.2})$
$\bar{B}_s \to \rho_L^+\rho_L^-, \rho_L^0\rho_L^0$	$-4.2^{+0.7}_{-0.5}$ $(-1.9^{+0.7}_{-0.7})$	$-4.3^{+21.5}_{-9.0}$ $(35.9^{+15.6}_{-11.2})$
$\bar{B}_s \to \omega_L\omega_L$	$-4.6^{+1.2}_{-2.0}$ $(-2.6^{+1.6}_{-2.4})$	$-3.8^{+21.8}_{-9.7}$ $(35.9^{+15.6}_{-11.2})$
$\bar{B}_s \to \rho_L\omega_L$	0.0 ± 0.0 (0.0 ± 0.0)	$-71.0^{+6.3}_{-5.4}$ $(-71.0^{+6.3}_{-5.4})$
$\bar{B}_d \to K^+K^-$	$41.6^{+12.5}_{-12.3}$ $(38.7^{+13.2}_{-12.2})$	$-2.2^{+19.1}_{-26.4}$ $(-47.0^{+15.7}_{-18.8})$
$\bar{B}_d \to K_L^{*+}K_L^{*-}$	$36.7^{+16.0}_{-9.5}$ $(25.4^{+17.4}_{-11.1})$	$-1.4^{+19.7}_{-26.9}$ $(-47.0^{+15.7}_{-18.8})$
$\bar{B}_d \to \phi_L\phi_L$	$-39.7^{+6.1}_{-8.4}$ (0.0)	$27.8^{+5.7}_{-25.9}$ (0.0 ± 0.0)

[Sheng, Chu, YLS, Zou, PRD111(2025)11,114029]

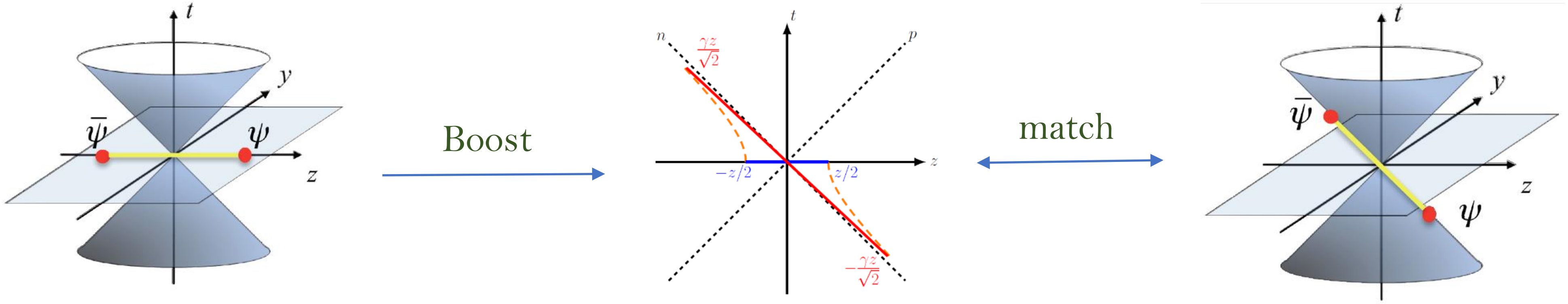
Nonperturbation function: LCDA

- The leading twist light-cone distribution amplitudes

$$\phi_\pi(u) = \frac{1}{if_\pi}\int \frac{dx^-}{2\pi} e^{-iux^-P^+}\langle \pi(P)|\bar{q}(x^-)\gamma\cdot n\gamma_5[x^-,0]q(0)|0\rangle$$

$$\phi_B(\omega) = \frac{1}{iF_B m_B n\cdot v}\int \frac{dt}{2\pi} e^{-i\omega t n\cdot v}\langle 0|\bar{q}(tn)\gamma\cdot n\gamma_5[tn,0]b_v(0)|\bar{B}(v)\rangle$$

- The Large momentum effective theory [Ji, 2013]



Quasi-PDA

$$\varphi^+(\xi,\mu) = \int_0^1 du\, H(\xi,u,\mu/P^z)\,\phi^+(u,\mu) + O\left(\frac{m_H^2}{(P^z)^2},\frac{\Lambda^2}{(uP^z,\bar{u}P^z)^2}\right)$$

- Generalized to Baryon LCDA & Lattice simulation: See Jun Hua's talk

Heavy meson LCDA

- The Quasi-DA of leading twist B meson 【Wang, Wang, Xu, Zhao, PRD102(2020) 011502】

$$iF_B m_B\, \varphi_B^+(\xi,\mu) = \int_{-\infty}^{+\infty} \frac{d\tau}{2\pi} e^{in_z\cdot v\xi\tau}\langle 0|(\bar{q}_s Y_s)(\tau n_z) n_z\cdot\ \gamma\gamma_5 (Y_s^\dagger\, h_v)(0)|\bar{B}(v)\rangle$$

- The **matching** $\varphi_B^+(\xi,\mu) = \int_0^{+\infty} d\omega H(\xi,\omega,\mathrm{n}_z\cdot v,\mu)\,\phi_B^+(\omega,\mu) + O\left(\frac{\Lambda}{n_z\cdot v\xi}\right)$

Effective heavy quark field on Lattice: Significant signal-to-noise problem

- B meson LCDA in QCD $\phi_B(u,m_b,\mu)$

Matching onto HQET B meson LCDA

Ishaq, Jia, Xiong, Yang, PRL125, 132001 (2020)
Zhao, Phys.Rev.D 101 (2020) 7, 071503
Beneke, Finauri, Vos, Wei, JHEP 09, 066 (2023)

$$\phi_B(u,m_b,\mu) = \begin{cases} J_{peak}(u,\omega)\otimes\varphi_B(\omega), u\sim\delta: & \text{peak region} \\ J_{tail}(u), \qquad u\sim 1: & \text{tail region}\end{cases}$$

Heavy meson LCDA

- Mass evolution

Wang, Xu, Zhang, Zhao, arXiv:2411.07101 [hep-ph]

$$\left[m_Q \frac{\partial}{\partial m_Q} - u\frac{\partial}{\partial u} - \left(1+\gamma(m_Q,\mu)\right)\right]\phi_H(u,m_Q,\mu)=0$$

$$\phi_H(u,m_Q,\mu) = U(m_Q,m_{Q_0},\mu)\phi(u m_Q/m_{Q_0})$$

Quasi D-LCDA → QCD D-LCDA → QCD B-LCDA → HQET B-LCDA

- D meson LCDA on Lattice — See Qi-An's talk

- Heavy meson shape function — See Ji Xu's talk

Heavy-to-light form factors

- QCD/SCET factorization formulae for mesonic form factor

$$F_{i,LP}^{B\to M}(E) = C_i^{(A0)}(E)\zeta_a(E) + \int_0^\infty \frac{d\omega}{\omega}\int_0^1 du\, C_i^{(B1)}(E,u) J_i(E,\omega)\phi_B^+(\omega)\phi_M(u)$$

- QCD/SCET factorization formulae for baryonic form factor [Wang, 2011].

$$F_{LP}^{\Lambda_b\to\Lambda}(E) = \int_0^\infty d\omega_1 d\omega_2 \int_0^1 du\, dv C_i^{(A0)}(E,u,v) J_i(E,\omega_i)\psi_{\Lambda_b}^{(2)}(\omega_1,\omega_2)\psi_{\Lambda}^{(3)}(u,v)$$

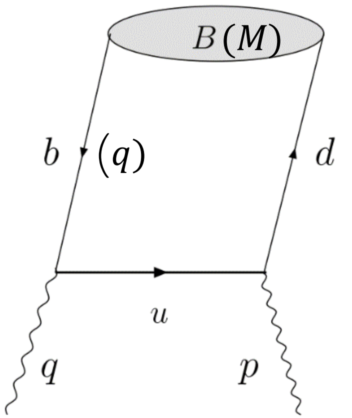
Leading power contribution; but numerically suppressed

- Lattice simulation: direct calculation of the QCD form factors

q^2: dependence: Rely on the extrapolation model
Large uncertainty at small q^2 region

LCSR for the heavy hadron transition form factors

- LCSR is a QCD inspired method for the large recoil region of the heavy-to-light form factors.



The correlation function

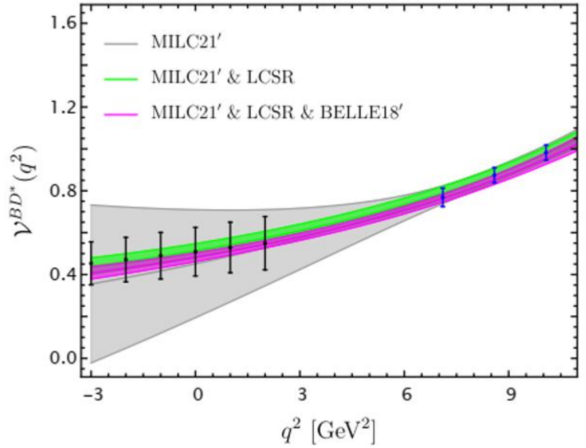
$$\langle 0|T\{J_{\text{weak}}(0), J_B(x)\}|\bar{B}(P)\rangle$$

or $$\langle \bar{M}(P)|T\{J_{\text{weak}}(0), J_M(x)\}|0\rangle$$

- Light meson LCSR
- B-meson LCSR(SCET sum rules).

Quark level OPE ⟺ Quark hadron duality ⟺ Hardon level Parame

- The correlation function can be calculated with standard QCD factorization technique.
  - B → πK form factors [Cui, Huang, YLS, Wang, Wang, *JHEP* 03 (2023) 140]
  - B → K^* form factors[Gao, Meißner, YLS, Li, *PRD* 112 (2025) 1, 1]
  - B → D form factors [Gao, Huber, Ji, Wang, Wang, Wei, JHEP 05 (2022) 024]
  - B → $D(D^*)$ form factors [Cui, Huang, Wang, Zhao, Phys.Rev.D 108 (2023) 7, 071504]

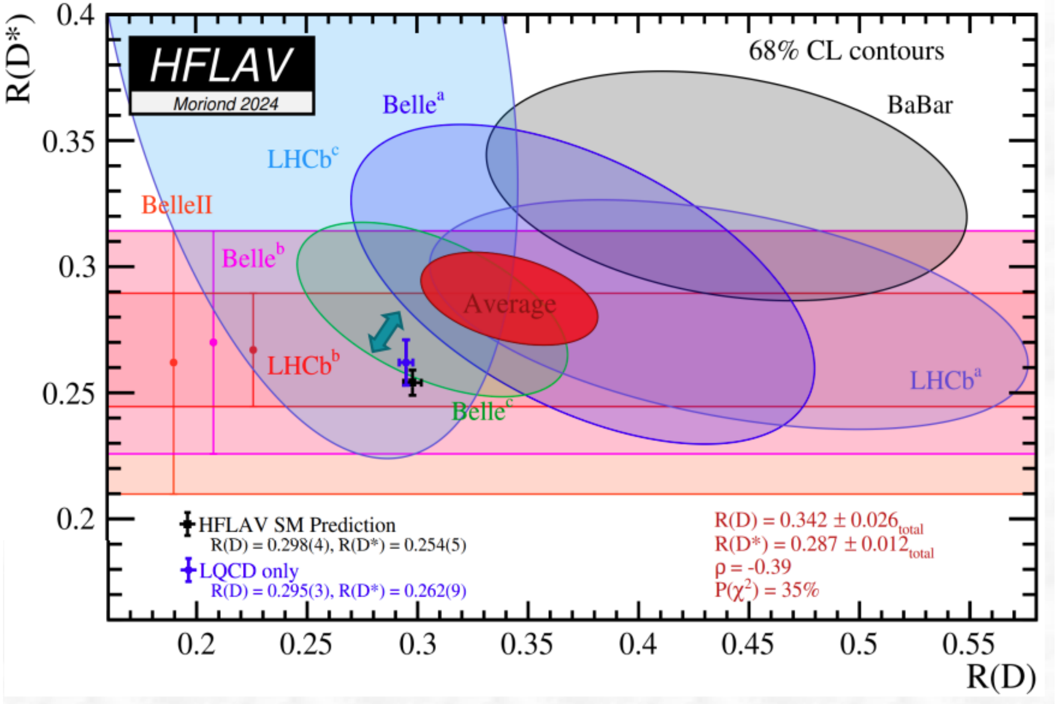


Combine Lattice data and LCSR results: reduce uncertainty

Flavor Anomaly

- $R(D)/R(D^*)$ Anomals： about 3.3 σ

$$R_D = \frac{\mathrm{Br}(\mathrm{B} \to D\tau\nu_\tau)}{\mathrm{Br}(\mathrm{B} \to D\ell\nu_\ell)} \qquad R_{D^*} = \frac{\mathrm{Br}(\mathrm{B} \to D^*\tau\nu_\tau)}{\mathrm{Br}(\mathrm{B} \to D^*\ell\nu_\ell)}$$



- Precise form factor prediction: Lattice+LCSR
- Structure independent QED correction **5% & 3%**

[Boer, Kitahara, Nisandzic, PRL. 120 (2018) 261804]

- Sum rules

[Blanke, Boer, Kitahara, Moscati, Nierste, Nišandžić, Phys.Rev.D 99 (2019) 7, 075006; Phys.Rev.D 100 (2019) 3, 03503]

$$\frac{R_H}{R_H^{SM}} = b\frac{R_P}{R_P^{SM}} + c\frac{R_V}{R_V^{SM}} + \delta_H(C_i)$$

[Duan, Iguro, Li, Watanabe, Yang, JHEP 07 (2025) 166]

- δ_H denotes the effects of new physics
- Heavy quark Symmetry: $b \sim \frac{1}{4}, \quad c \sim \frac{3}{4}$

Endo, Iguro, Mishima, Watanabe,
arXiv: 2506.16027, 2508.06322 , 2509.02006

CP violation in baryon decays

- Searching for direct CP violation in baryon decays: different from the mesonic case
  - Small CP violation in $\Lambda_b \to p\pi, pK$
  - Calculation with PQCD approach: Cancellation between S-wave and P-wave

【Han, Li, Li, YLS, Xiao, *EPJC* 82 (2022) 8, 686】 See Zhi-Tian's talk

【Han, Yu, Li, Li, Wang, Xiao, Yu, *PRL*134 (2025) 22, 221801】 See Jia-Jie's talk

- Other attempts

Triple product method for $\Lambda_b^0 \to p\pi^-\pi^+\pi^-$

Proposed by Lee & Yang to study parity (P) violation in hyperon decay $\Lambda \to p\pi^+$

【Wang, Qin, Yu, arXiv: 2411.18323】

- Multibody decays

Handle resonances → Using hadron scattering data

【Wang, Yu, Chin.Phys.C 48 (2024) 10, 101002】
【Yu, Lü, arXiv: Sci.Bull. 70 (2025) 2035-2036】

Topics not included

- Heavy hadron spectroscopy
- Inclusive decays of heavy hadrons
- Multi-body B decays & baryonic B decays in PQCD
- Symmetry analysis @ topology diagrams method
- Charm physics
- Testing new physics models in heavy flavor physics
- ……

Summary and Perspective

Experimental progresses	Year
First observation of CPV in baryon decays	2025
First observation of CPV in D-meson decays	2019
First observation of doubly heavy baryons	2017
First observation of heavy pentaquark	2015
First observation of direct CPV	2004
CPV in B-meson system	2001
	2000

QCDF PQCD SCET

Experimental progresses

Theoretical progresses