Analysis of charmless B decays in Factorization Assisted Topological amplitude approach

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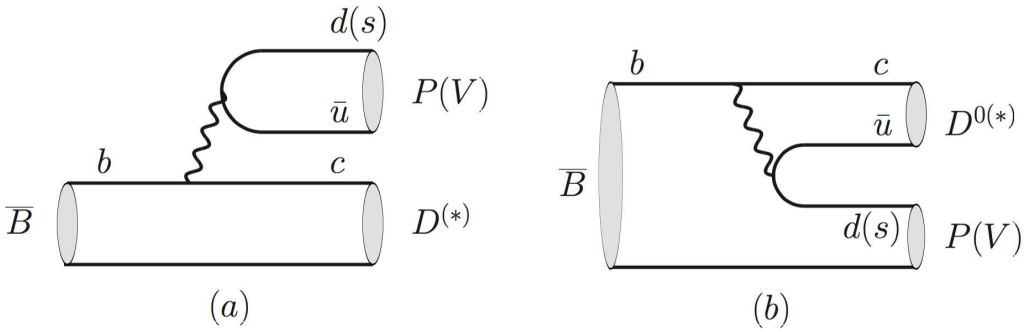
Based on work collaborated with Cai-Dian Lu and Qi-An Zhang

Outline

- Introduction/Motivation
- Factorization Assisted Topological Amplitude approach
- Numerical results for $B \to PP$,PV decays and Analysis
- Summary

Rich physics in hadronic B decay

- Be important for testing the standard model.
  - Exploration of CP violation via the interference of tree and penguin contributions;
  - Direct access to the parameters of CKM matrix;
- FCNC processes be sensitive to signals of new physics.
- The BarBar and Bell experiments and LHCb experiment have made great efforts in studying B decays information in the past decades.



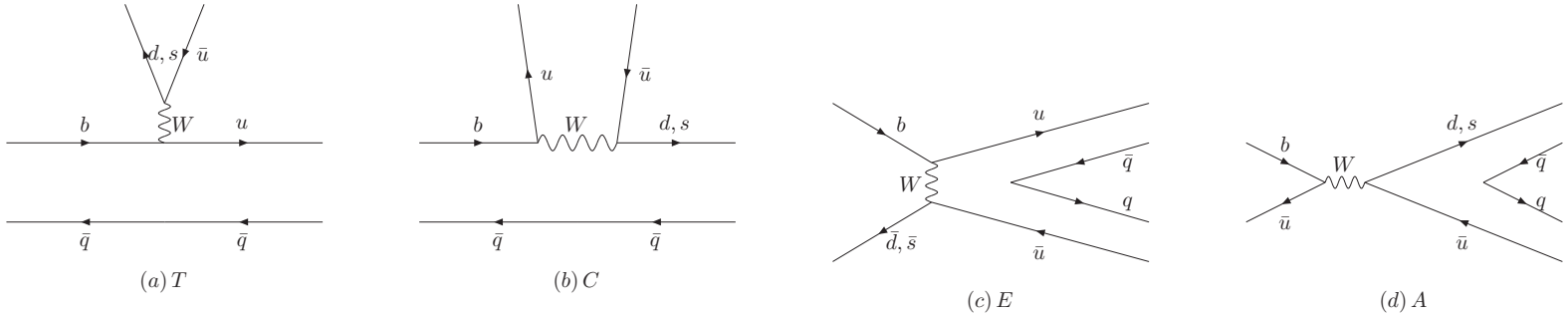
⋆ Non-leptonic B decays are complicated on account of strong interaction effects.

QCD-methods based on factorization work well for the leading power of $1/m_b$ expansion

- Perturbative QCD approach based on $k_T$factorization;
  Keum, Li, Sanda, 00'; Lu, Ukai, Yang, 00'
- collinear QCD Factorization approach;
  Beneke, Buchalla, Neubert, Sachrajda, 99'
- Soft-Collinear Effective Theory.
  Bauer, Pirjol, Stewart, 01'

⋆ Unavailable for $1/m_b$ power corrections
Work well for most of charmless B decays, except for $\pi\pi$ and πK puzzle etc.

Topological diagrammatic approach[Cheng, Chiang and Kuo 2015]



1. Distinct by weak interaction and flavor flows with all strong interaction encoded, including non-perturbative ones.
2. Amplitudes with strong phases extracted from data.
3. Based on flavor $SU(3)$ symmetry. $SU(3)$ **breaking effect was lost**.
4. $B \to PP$, VP and PV fitted separately, $13 + 19 = 32$ parameters. **Less predictive** *(Phys. Rev. D* **91**, *no. 1, 014011 (2015).)*

- Improved by Factorization Assisted Topological amplitude (FAT)approach.
  - ⋆ keep flavor $SU(3)$ symmetry breaking effect.
  - ⋆ further reducing the number of free parameters by fitting all the decay channels

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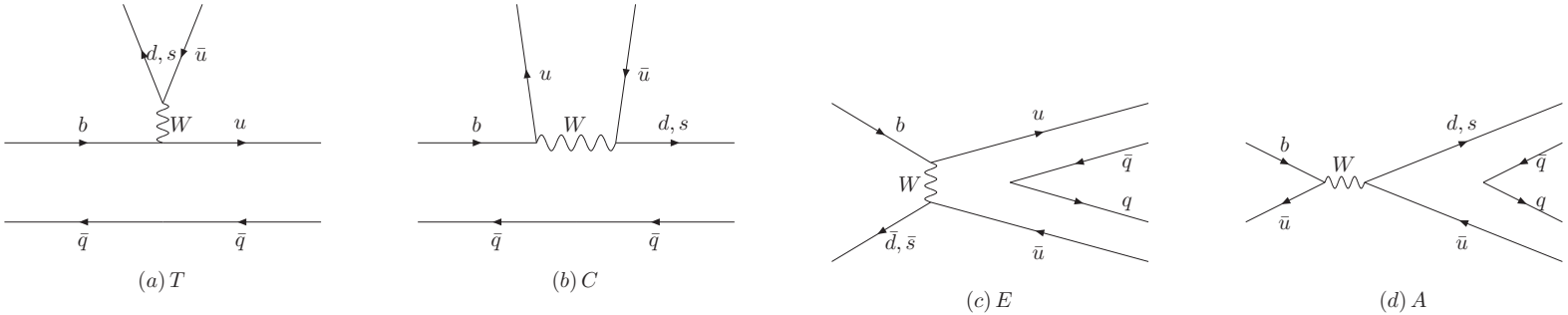

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Factorization Assisted Topological amplitude approach first applied in hadronic D decays

[H. n. Li, C. D. Lu and F. S. Yu, Phys. Rev. D **86**, *036012 (2012),Phys. Rev. D* **89**, *no. 5, 054006 (2014)]*

- ⋆ Was in great success to resolve the long-standing puzzle from the large difference of $D_0 \to \pi^+\pi^-$ and $D_0 \to K^+K^-$ branching fractions.
- ⋆ Also predicted 0.1% of direct CP asymmetry difference between them.

NEW *LHCb-PAPER-2015-055*
to be submitted to PRL

$$\Delta A_{CP\ \mathrm{prompt}} = (-0.10 \pm 0.08(\mathrm{stat}) \pm 0.03(\mathrm{syst}))\%$$

- "Analysis of Two-body Charmed B meson decays in Factorization Assisted Topological amplitude approach,"
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  - ⋆ with only 4 parameters and predict more than 100 modes.

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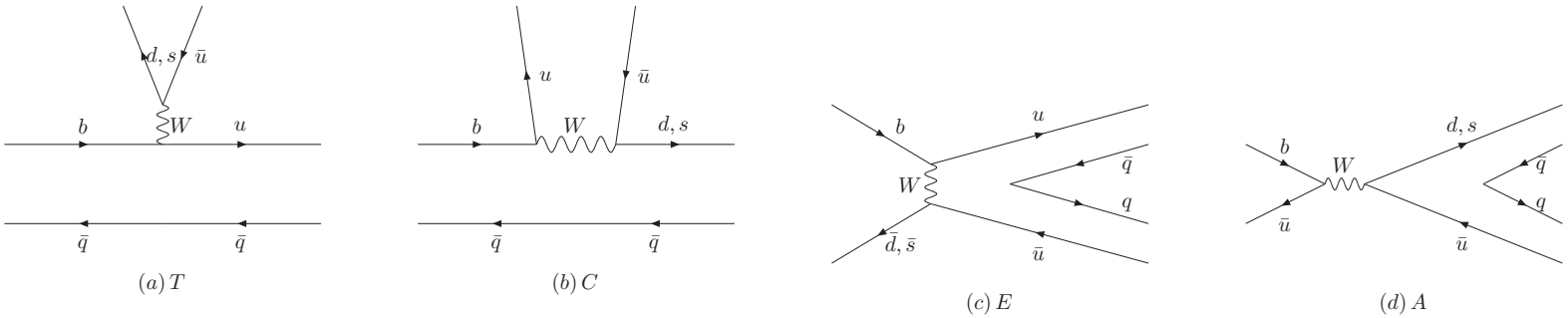
Factorization Assisted Topological amplitude approach in $B \to PP$, VP and PV decays



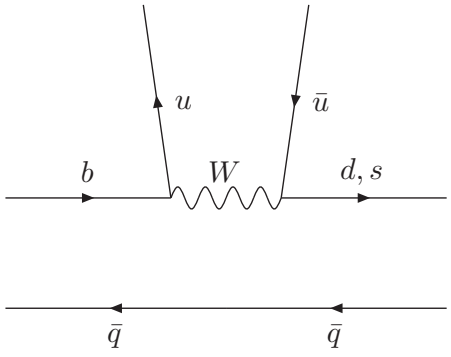
- Color-favored tree emission diagram (T)
- ⋆ It is proved factorization to all order of α_s expansion in soft-collinear effective theory.

$$
\begin{aligned}
T^{P_1 P_2} &= i\frac{G_F}{\sqrt{2}} V_{ub} V_{uq'} a_1(\mu) f_{p_2} (m_B^2 - m_{p_1}^2) F_0^{BP_1}(m_{p_2}^2), \\
T^{PV} &= \sqrt{2} G_F V_{ub} V_{uq'} a_1(\mu) f_V m_V F_1^{B-P}(m_V^2)(\varepsilon_V^* \cdot p_B), \\
T^{VP} &= \sqrt{2} G_F V_{ub} V_{uq'} a_1(\mu) f_P m_V A_0^{B-V}(m_P^2)(\varepsilon_V^* \cdot p_B),
\end{aligned} \tag{1}
$$

- ⋆ The $SU(3)$ breaking effect is automatically kept
- ⋆ No free parameter

- For other diagrams dominated by non-factorization contributions.
  - ⋆ We factorize out the decay constants and form factor to keep the $SU(3)$ breaking effect.
  - ⋆ we extract the amplitude and strong phase from experimental data by χ^2 fit.

- color-suppressed tree emission diagram(C)

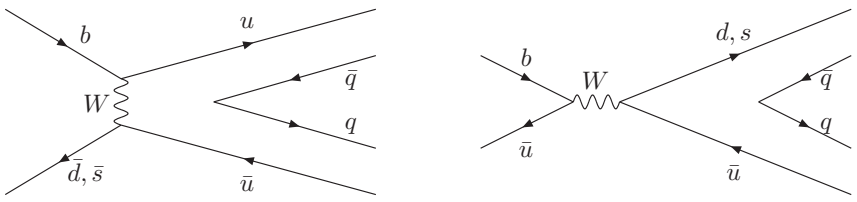


(b) C

$$
\begin{aligned}
C^{P_1P_2} &= i\frac{G_F}{\sqrt{2}}V_{ub}V_{uq'}\chi^C e^{i\phi^C} f_{p_2}(m_B^2 - m_{p_1}^2)F_0^{BP_1}(m_{p_2}^2),\\
C^{VP} &= \sqrt{2}G_F V_{ub}V_{uq'}\chi^C e^{i\phi^C} f_P m_V A_0^{B-V}(m_P^2)(\varepsilon_V^* \cdot p_B),\\
C^{PV} &= \sqrt{2}G_F V_{ub}V_{uq'}\chi^{C'} e^{i\phi^{C'}} f_V m_V F_1^{B-P}(m_V^2)(\varepsilon_V^* \cdot p_B),
\end{aligned}
\tag{2}
$$

⋆ χ^C and $e^{i\phi^C}$ and $\chi^{C'}e^{i\phi^{C'}}$ to distinguish cases in which the emissive meson is pseudo-scalar or vector respectively.

- The annihilation type diagrams(E and A)



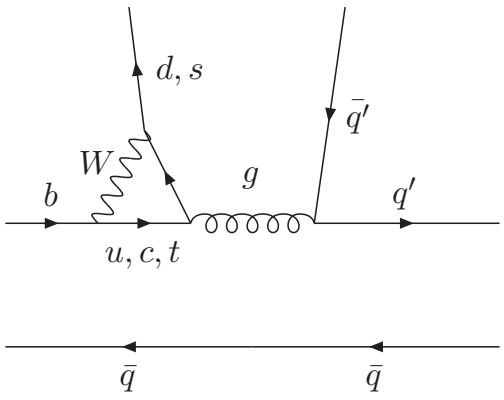
(c) E (d) A

⋆ W-exchange topology (E) is non-factorization in QCD factorization approach(NLO)

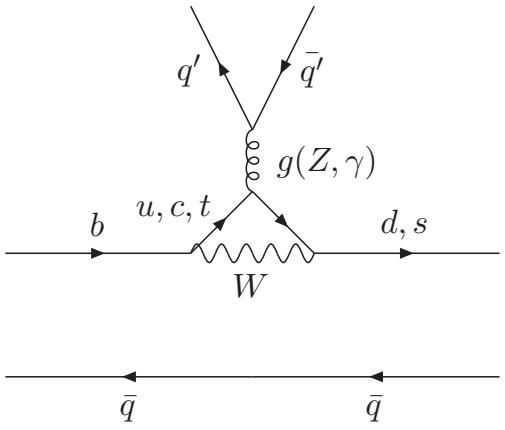
$$E^{P_1P_2} = i\frac{G_F}{\sqrt{2}}V_{ub}V_{uq'}\chi^E e^{i\phi^E} f_B m_B^2(\frac{f_{p_1}f_{p_2}}{f_\pi^2}),$$
$$E^{PV,VP} = \sqrt{2}G_F V_{ub}V_{uq'}\chi^E e^{i\phi^E} f_B m_V(\frac{f_P f_V}{f_\pi^2})(\varepsilon_V^* \cdot p_B), \qquad (3)$$

⋆ As discussed in conventional topological diagram approach, W-annihilation diagram (A) contribution is negligible.

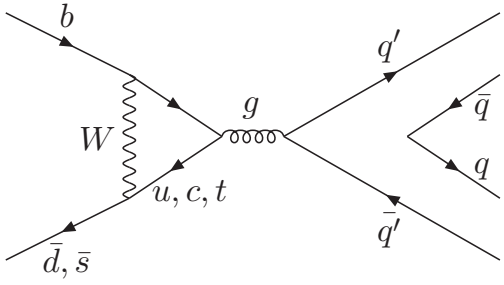
The penguin topological diagrams are grouped into QCD penguin and electro-weak penguin topologies.



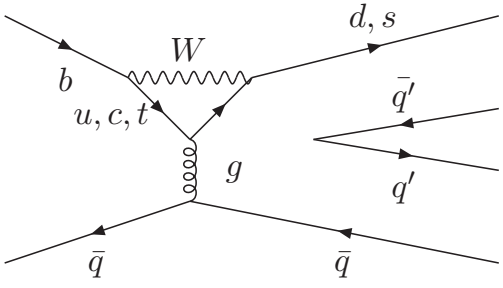
$(a)\ P$



$(b)\ P_C(P_{EW})$

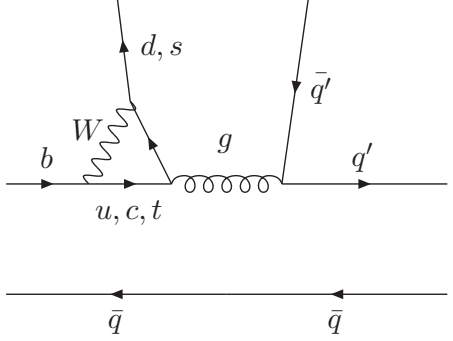


$(c)\ P_E$



$(d)\ P_A$

- color-favored penguin emission diagram (P)



$(a)\, P$

1. The leading contribution from topology Pdiagram is similar to diagram T, which is proved factorization in various QCD-inspired approaches.
2. "chiral enhanced" penguin contributions need to be fitted.

$$
\begin{aligned}
P^{PP} &= -i\frac{G_F}{\sqrt{2}}V_{tb}V_{tq'}^*[a_4(\mu)+\chi^P e^{i\phi^P} r_\chi] f_{p_2}(m_B^2-m_{p_1}^2)F_0^{BP_1}(m_{p_2}^2),\\
P^{PV} &= -\sqrt{2}G_F V_{tb}V_{tq'}^* a_4(\mu) f_V m_V F_1^{B-P} m_V^2(\varepsilon_V^*\cdot p_B),\\
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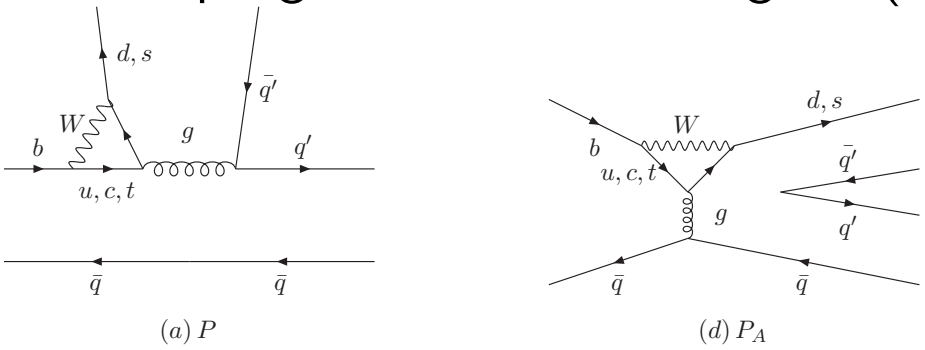
\end{aligned}
\tag{4}
$$

- power correction to P-penguin annihilation diagram (P_A)



⋆ P_A is similar with P and the difference is only at QCD not EW.

$$
\begin{aligned}
P^{PP} &= -i\frac{G_F}{\sqrt{2}}V_{tb}V_{tq'}^*[a_4(\mu)+\chi^P e^{i\phi^P} r_\chi]f_{p_2}(m_B^2-m_{p_1}^2)F_0^{BP_1}(m_{p_2}^2),\\
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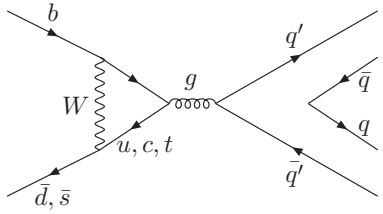
\end{aligned}
\tag{5}
$$

⋆ The contribution of P_A can be included in χ^P, except for $B\to PV$ decays, where we need two more parameters

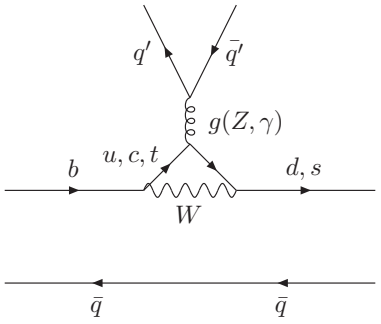
$$
P_A^{PV} = -\sqrt{2}G_F V_{tb}V_{tq'}^*\chi^{P_A}e^{i\phi^{P_A}} f_B m_V\left(\frac{f_P f_V}{f_\pi^2}\right)(\varepsilon_V^*\cdot p_B). \tag{6}
$$

- P_E diagram is argued smaller than P_A diagram, which can be ignored reliably in decay modes not dominated by it, except $B_s \to \pi^+\pi^-$decay.

$$Br(B_s \to \pi^+\pi^-) = (0.76 \pm 0.19) \times 10^{-6}$$



(c) P_E



(b) $P_C(P_{EW})$

- The flavor-singlet QCD penguin diagram P_C only contribute to the isospin singlet mesons η, η', ω and ϕ.

$$P_C^{PP} = -i\frac{G_F}{\sqrt{2}} V_{tb} V_{tq'}^* \chi^{P_C} e^{i\phi^{P_C}} f_{p_2}(m_B^2 - m_{p_1}^2) F_0^{BP_1}(m_{p_2}^2),$$

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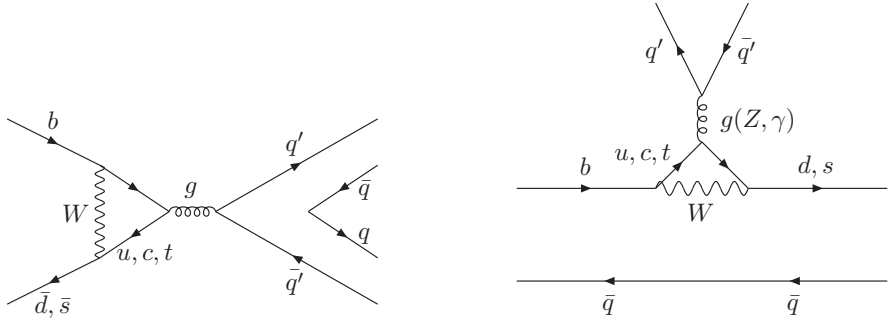

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- ⋆ All together we have 14 parameters to be fitted for all $B \to PP, PV$ and VP decays.
- ⋆ Recent update for $B \to PP$ channels with $\eta - \eta'$ mixing by Hsiao, Chang He, PRD93, 114002 (2016), have 12 parameters

- input parameters

V_{CKM} with the Wolfenstein parameters:

$$\lambda = 0.22537 \pm 0.00061, \quad A = 0.814^{+0.023}_{-0.024}$$

$$\bar{\rho} = 0.117 \pm 0.021, \quad \bar{\eta} = 0.353 \pm 0.013.$$

Table: The decay constants of light pseudo-scalar mesons and vector mesons (in unit of MeV).(5% uncertainty)

f_π	f_K	f_B	f_{B_s}	f_ρ	f_{K^*}	f_ω	f_ϕ
130	156	190	225	213	220	192	225

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Table: The transition form factors of B meson decays at q^2=0 and dipole model parameters(10 % uncertainty)

	$F_0^{B\to\pi}$	$F_0^{B\to K}$	$F_0^{B_s\to K}$	$F_0^{B\to\eta_q}$	$F_0^{B_s\to\eta_s}$
$F(0)$	0.27	0.29	0.25	0.21	0.30
α_1	0.50	0.53	0.54	0.52	0.53
α_2	-0.13	-0.13	-0.15	0	0
	$F_1^{B\to\pi}$	$F_1^{B\to K}$	$F_1^{B_s\to K}$	$F_1^{B\to\eta_q}$	$F_1^{B_s\to\eta_s}$
$F(0)$	0.27	0.29	0.25	0.21	0.30
α_1	0.52	0.54	0.57	1.43	1.48
α_2	0.45	0.50	0.50	0.41	0.46
	$A_0^{B\to\rho}$	$A_0^{B\to\omega}$	$A_0^{B\to K^*}$	$A_0^{B_s\to K^*}$	$A_0^{B_s\to\phi}$
$A(0)$	0.29	0.25	0.36	0.27	0.30
α_1	1.56	1.60	1.51	1.74	1.73
α_2	0.17	0.22	0.14	0.47	0.41

For the q^2 dependence of the transition form factors, we use the dipole parametrization:

$$F_i(q^2) = \frac{F_i(0)}{1 - \alpha_1 \frac{q^2}{M_{\rm pole}^2} + \alpha_2 \frac{q^4}{M_{\rm pole}^4}},$$

Global Fit for all $B \to PP, VP$ and PV decays

- 37 branching Ratios and 11 CP violation observations data are used for the fit.
- the best-fitted parameters as:

$$\begin{aligned}
\chi^C &= 0.48 \pm 0.06, & \phi^C &= -1.58 \pm 0.08, \\
\chi^{C'} &= 0.42 \pm 0.16, & \phi^{C'} &= 1.59 \pm 0.17, \\
\chi^E &= 0.057 \pm 0.005, & \phi^E &= 2.71 \pm 0.13, \\
\chi^P &= 0.10 \pm 0.02, & \phi^P &= -0.61 \pm 0.02. \\
\chi^{P_C} &= 0.048 \pm 0.003, & \phi^{P_C} &= 1.56 \pm 0.08, \\
\chi^{P'_C} &= 0.039 \pm 0.003, & \phi^{P'_C} &= 0.68 \pm 0.08, \\
\chi^{P_A} &= 0.0059 \pm 0.0008, & \phi^{P_A} &= 1.51 \pm 0.09,
\end{aligned} \tag{8}$$

with $\chi^2/\text{d.o.f} = 45.2/34 = 1.3$.

- ⋆ Large strong phase
- ⋆ This χ^2 per degree of freedom is smaller than the conventional flavor diagram approach.

Predict branching fractions for $B \to PP, VP$ and PV and CP violation.

Table: Branching fractions $(\times 10^{-6})$ of various $\bar{B} \to PP$ decay modes

Mode	Amplitudes	Exp	This work
$\pi^-\pi^0$	T, C, P_{EW}	$\star 5.5 \pm 0.4$	$5.08 \pm 0.39 \pm 1.02 \pm 0.02$
$\pi^-\eta$	T, C, P, P_C, P_{EW}	$\star 4.02 \pm 0.27$	$4.13 \pm 0.25 \pm 0.64 \pm 0.01$
$\pi^-\eta'$	T, C, P, P_C, P_{EW}	$\star 2.7 \pm 0.9$	$3.37 \pm 0.21 \pm 0.49 \pm 0.01$
$\pi^+\pi^-$	$T, E, (P_E), P$	$\star 5.12 \pm 0.19$	$5.15 \pm 0.36 \pm 1.31 \pm 0.14$
$\pi^0\pi^0$	$C, E, P, (P_E), P_{EW}$	$\star 1.91 \pm 0.22$	$1.94 \pm 0.30 \pm 0.28 \pm 0.05$
$\pi^0\eta$	$C, E, P_C, (P_E), P_{EW}$	< 1.5	$0.86 \pm 0.08 \pm 0.08 \pm 0.04$
$\pi^0\eta'$	$C, E, P_C, (P_E), P_{EW}$	1.2 ± 0.6	$0.87 \pm 0.08 \pm 0.10 \pm 0.03$
$\eta\eta$	$C, E, P_C, (P_E), P_{EW}$	< 1.0	$0.44 \pm 0.09 \pm 0.08 \pm 0.005$
$\eta\eta'$	$C, E, P_C, (P_E), P_{EW}$	< 1.2	$0.77 \pm 0.13 \pm 0.14 \pm 0.008$
$\eta'\eta'$	$C, E, P_C, (P_E), P_{EW}$	< 1.7	$0.38 \pm 0.05 \pm 0.07 \pm 0.003$
K^-K^0	P	$\star 1.31 \pm 0.17$	$1.32 \pm 0.04 \pm 0.26 \pm 0.01$
$K^0\bar{K}^0$	P	$\star 1.21 \pm 0.16$	$1.23 \pm 0.03 \pm 0.25 \pm 0.01$
$\pi^-\bar{K}^0$	P	$\star 23.7 \pm 0.8$	$23.2 \pm 0.6 \pm 4.6 \pm 0.2$
π^0K^-	T, C, P, P_{EW}	$\star 12.9 \pm 0.5$	$12.8 \pm 0.32 \pm 2.35 \pm 0.10$
ηK^-	T, C, P, P_C, P_{EW}	$\star 2.4 \pm 0.4$	$2.0 \pm 0.13 \pm 1.19 \pm 0.03$
$\eta' K^-$	T, C, P, P_C, P_{EW}	$\star 70.6 \pm 2.5$	$70.1 \pm 4.7 \pm 11.3 \pm 0.22$
π^+K^-	T, P	$\star 19.6 \pm 0.5$	$19.8 \pm 0.54 \pm 4.0 \pm 0.2$
$\pi^0\bar{K}^0$	C, P, P_{EW}	$\star 9.9 \pm 0.5$	$8.96 \pm 0.26 \pm 1.96 \pm 0.09$
$\eta\bar{K}^0$	C, P, P_C, P_{EW}	$\star 1.23 \pm 0.27$	$1.35 \pm 0.10 \pm 1.02 \pm 0.03$
$\eta'\bar{K}^0$	C, P, P_C, P_{EW}	$\star 66 \pm 4$	$66.4 \pm 4.5 \pm 10.6 \pm 0.21$

Mode	Amplitudes	Exp	This work
$\pi^-\rho^0$	T, C', P, P_A, P_{EW}	$\star 8.3 \pm 1.2$	$8.6 \pm 1.81 \pm 1.38 \pm 0.03$
$\pi^-\omega$	$T, C', P, P'_C, P_A, P_{EW}$	$\star 6.9 \pm 0.5$	$6.78 \pm 1.46 \pm 1.09 \pm 0.02$
$\pi^-\phi$	P'_C, P_{EW}	< 0.15	$0.28 \pm 0.004 \pm 0.055 \pm 0.003$
$\pi^0\rho^-$	T, C, P, P_A, P_{EW}	$\star 10.9 \pm 1.4$	$12.9 \pm 0.73 \pm 2.30 \pm 0.12$
$\eta\rho^-$	$T, C, P, P_C, P_A, P_{EW}$	7.0 ± 2.9	$8.16 \pm 0.48 \pm 1.43 \pm 0.07$
$\eta'\rho^-$	$T, C, P, P_C, P_A, P_{EW}$	$\star 9.7 \pm 2.2$	$6.0 \pm 0.34 \pm 0.97 \pm 0.05$
$\pi^+\rho^-$	$T, E, P, (P_E), P_A$	$\star 14.6 \pm 1.6$	$12.4 \pm 0.64 \pm 3.20 \pm 0.38$
$\pi^-\rho^+$	$T, E, P, (P_E)$	$\star 8.4 \pm 1.1$	$6.04 \pm 0.47 \pm 1.70 \pm 0.25$
$\pi^0\rho^0$	$C, C', E, P, P_A, (P_E), P_{EW}$	$\star 2 \pm 0.5$	$1.32 \pm 0.47 \pm 0.09 \pm 0.14$
$\pi^0\omega$	$C, C', E, P, P_A, (P_E), P_{EW}$	< 0.5	$2.31 \pm 0.88 \pm 0.24 \pm 0.07$
$\pi^0\phi$	P'_C, P_{EW}	< 0.15	$0.13 \pm 0.002 \pm 0.025 \pm 0.001$
$\eta\rho^0$	$C, C', E, P, P_C, P'_C, P_A, (P_E), P_{EW}$	< 1.5	$4.41 \pm 1.15 \pm 0.39 \pm 0.17$
$\eta\omega$	$C, C', E, P, P_C, P'_C, P_A, (P_E), P_{EW}$	$0.94^{+0.40}_{-0.31}$	$0.89 \pm 0.30 \pm 0.08 \pm 0.09$
$\eta\phi$	P'_C, P_{EW}	< 0.5	$0.077 \pm 0.001 \pm 0.015 \pm 0.0008$
$\eta'\rho^0$	$C, C', E, P, P_C, P'_C, (P_E), P_{EW}$	< 1.3	$3.19 \pm 0.77 \pm 0.29 \pm 0.12$
$\eta'\omega$	$C, C', E, P, P_C, P'_C, (P_E), P_{EW}$	$1.0^{+0.5}_{-0.4}$	$0.95 \pm 0.21 \pm 0.05 \pm 0.06$
$\eta'\phi$	P'_C, P_{EW}	< 0.5	$0.05 \pm 0.0008 \pm 0.01 \pm 0.0005$
K^-K^{*0}	P, P_A	< 1.1	$0.59 \pm 0.06 \pm 0.10 \pm 0.01$
K^0K^{*-}	P		$0.44 \pm 0.03 \pm 0.09 \pm 0.004$
$K^0\bar{K}^{*0}$	P		$0.41 \pm 0.02 \pm 0.08 \pm 0.004$
$\bar{K}^0K^{*0}$	P, P_A		$0.55 \pm 0.05 \pm 0.09 \pm 0.01$
π^-K^{*0}	P, P_A	$\star 10.1 \pm 0.9$	$10.0 \pm 0.95 \pm 1.78 \pm 0.15$
π^0K^{*-}	T, C, P, P_A, P_{EW}	$\star 8.2 \pm 1.9$	$6.23 \pm 0.51 \pm 0.98 \pm 0.07$
ηK^{*-}	$T, C, P, P_C, P_A, P_{EW}$	$\star 19.3 \pm 1.6$	$17.3 \pm 0.8 \pm 2.4 \pm 0.3$
$\eta' K^{*-}$	$T, C, P, P_C, P_A, P_{EW}$	$4.8^{+1.8}_{-1.6}$	$3.31 \pm 0.44 \pm 0.38 \pm 0.13$
$K^-\rho^0$	T, C', P, P_{EW}	$\star 3.7 \pm 0.5$	$3.97 \pm 0.25 \pm 0.80 \pm 0.04$
$K^-\omega$	T, C', P, P'_C, P_{EW}	$\star 6.5 \pm 0.4$	$6.52 \pm 0.73 \pm 1.13 \pm 0.06$
$K^-\phi$	P, P'_C, P_A, P_{EW}	$\star 8.8 \pm 0.7$	$8.38 \pm 1.21 \pm 0.69 \pm 0.50$
$\bar{K}^0\rho^-$	P	$\star 8 \pm 1.5$	$7.74 \pm 0.47 \pm 1.55 \pm 0.07$
π^+K^{*-}	T, P, P_A	$\star 8.4 \pm 0.8$	$8.40 \pm 0.77 \pm 1.46 \pm 0.14$
$\pi^0\bar{K}^{*0}$	C, P, P_A, P_{EW}	$\star 3.3 \pm 0.6$	$3.35 \pm 0.36 \pm 0.65 \pm 0.08$
$\eta\bar{K}^{*0}$	C, P, P_C, P_A, P_{EW}	$\star 15.9 \pm 1$	$16.6 \pm 0.7 \pm 2.3 \pm 0.3$
$\eta'\bar{K}^{*0}$	$C, P, P_C, P'_C, P_A, P_{EW}$	$\star 2.8 \pm 0.6$	$3.0 \pm 0.5 \pm 0.3 \pm 0.1$
$K^-\rho^+$	T, P	$\star 7 \pm 0.9$	$8.27 \pm 0.44 \pm 1.65 \pm 0.07$
$\bar{K}^0\rho^0$	C', P, P_{EW}	$\star 4.7 \pm 0.4$	$4.59 \pm 0.34 \pm 0.79 \pm 0.04$
$\bar{K}^0\omega$	C', P, P'_C, P_{EW}	$\star 4.8 \pm 0.6$	$4.80 \pm 0.61 \pm 0.95 \pm 0.05$
$\bar{K}^0\phi$	P, P'_C, P_A, P_{EW}	$\star 7.3 \pm 0.7$	$7.77 \pm 1.12 \pm 0.64 \pm 0.46$

Hierarchy

- $B \to \pi\pi$ and $B \to \pi\rho$

$$T^{\pi\pi} : C^{\pi\pi} : E^{\pi\pi} : P^{\pi\pi} = 1 : 0.47 : 0.29 : 0.32$$
$$T^{\rho\pi} : C'^{\pi\rho} : P^{\rho\pi} : P_{EW}^{\pi\rho} = 1 : 0.54 : 0.25 : 0.04$$
$$T^{\pi\rho} : C^{\rho\pi} : P^{\rho\pi} : P_{EW}^{\rho\pi} = 1 : 0.36 : 0.19 : 0.03.$$

$$T > C(C') > E \sim P > P_{EW}.$$

⋆ In agreement with those QCD inspired approaches

- $B \to \pi K$ and $B \to \pi K^*$

$$T^{\pi K} : C^{\pi K} : P^{\pi K} : P_{EW}^{\pi K} = 1 : 0.4 : 6.0 : 0.6$$
$$T^{\pi K^*} : C^{K^*\pi} : P^{\pi K^*} : P_A^{\pi K^*} : P_{EW}^{K^*\pi} = 1 : 0.37 : 2.87 : 1.44 : 0.52.$$

$$P > P_A > T > P_{EW} > C.$$

⋆ P_{EW} is even more larger than C

The long-standing puzzles of $\pi\pi$ branching ratios

Theoretically $Br(B^0 \to \pi^0\pi^0) < Br(B^0 \to \pi^0\rho^0) < Br(B^0 \to \rho^0\rho^0)$, but experimentally it is in the inverse order(sensitive to C).

- Although some power corrections to C topology were parameterized in QCDF, PQCD and SCET, it is not resolved completely in those factorization approaches.
- this inverse order can be understood only in the formalism of Glauber gluons, where extra phase was introduced for the pseudo-scalar meson (Goldstone boson) emission diagram.
- Flavor diagram $|T| \geq |C|$
- FAT(This work)

$$\pi^0 emission : \chi^C = 0.48 \pm 0.06, \quad \phi^C = -1.58 \pm 0.08,$$
$$\rho^0 emission : \chi^{C'} = 0.42 \pm 0.16, \quad \phi^{C'} = 1.59 \pm 0.17,$$

Mode	Amplitudes	Exp($\times 10^{-6}$)	This work($\times 10^{-6}$)	Flavor diagram
$\pi^0\pi^0$	$C, E, P, (P_E), P_{EW}$	$\star 1.91 \pm 0.22$	$1.94 \pm 0.30 \pm 0.28 \pm 0.05$	1.88 ± 0.42

Summary

- studied $B \to PP, PV$ in factorization assisted topological amplitude approach.
- T was in factorization without free parameters. P_{EW} was also included.
- For most other topological diagrams, the corresponding decay constants, form factors were factorized out from them before χ^2 fit assisted by factorization hypothesis to indicate the flavor $SU(3)$ breaking effect.
- Only 14 universal non-perturbative parameters to be fitted from all $B \to PP, PV$ decay channels. the χ^2 per degree of freedom is smaller than the conventional flavor diagram approach.
- predict branching fractions and CP asymmetry parameters of nearly 100 $B_{u,d}$ and B_s decay modes. The long-standing puzzles of $\pi\pi$branching ratios has been resolved consistently.

THANK YOU