$B \to \pi K, \pi K^*$ and ρK Decays ：

CP Violation and Implication for New Physics

Based on: JHEP 0809 (2008) 038.

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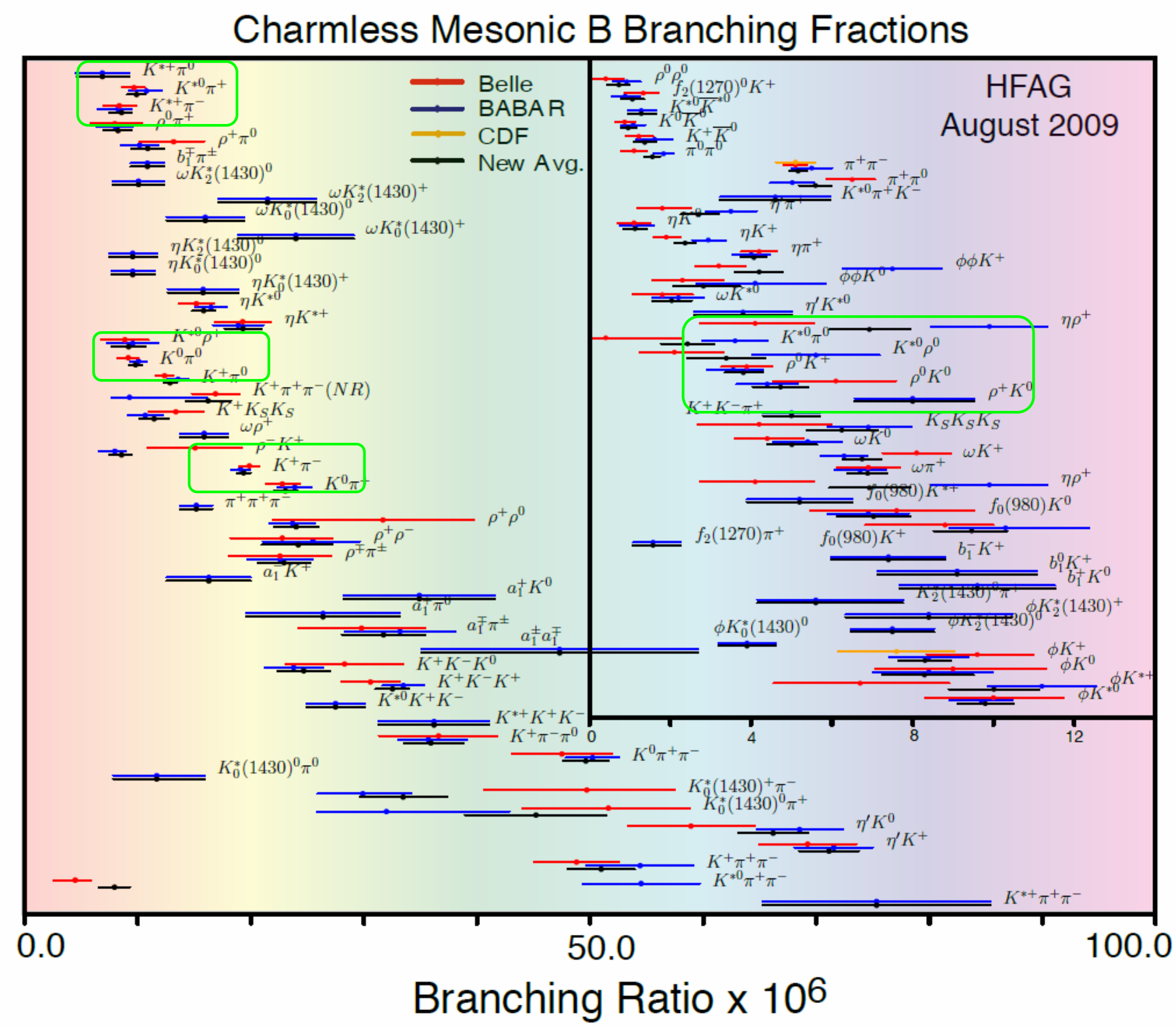
高能物理学会第八届全国代表大会 2010.4.18 南昌大学

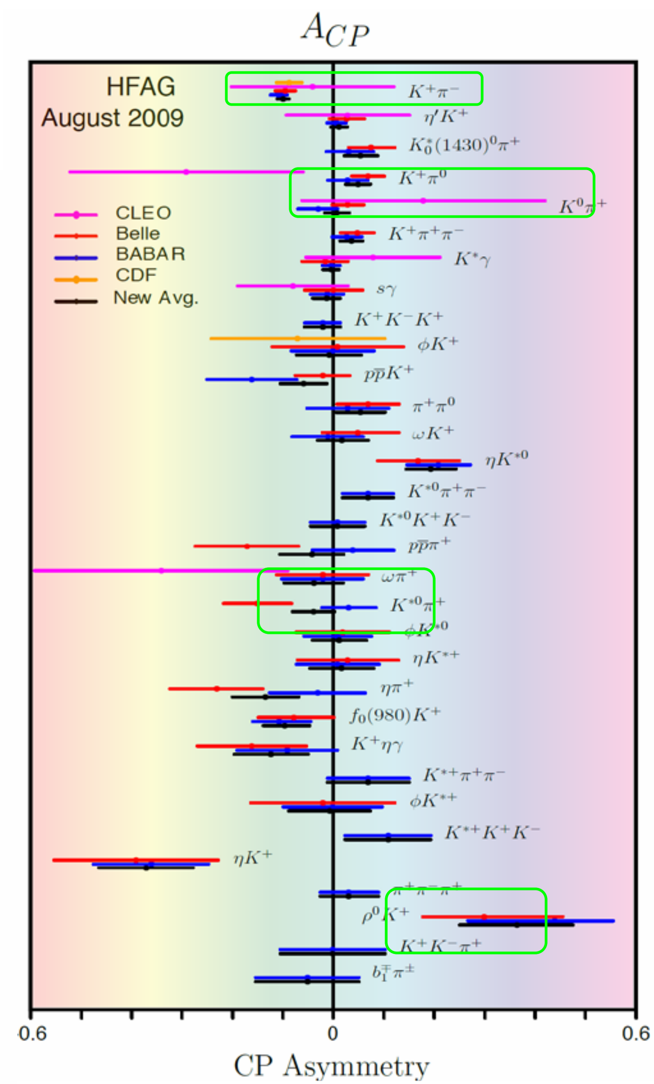
Outline

- Introduction
- Recalculation with dynamical gluon propagator
- The effects of new (pseudo-)scalar couplings
- Summary

▪ Introduction

88 modes > 4σ





Puzzles in charmless B decays

- Polarization Puzzles
- $\pi\pi$, πK Puzzles
- New phase in $B_s - \bar{B}_s$ mixing
- FB Asymmetry in $B \to K^* \mu\mu$

……

JHEP 0706: 038, 2007

JHEP 0809: 038, 2008
JHEP 0905: 056, 2009
arXiv: 1003. 6051 [hep-ph]

JHEP 1002: 082, 2010

arXiv: 1002. 2758 [hep-ph] (accepted by **JHEP**)

$B \to \pi K, \pi K^*$ **and** ρK **Decays ：**

CP Violation and Implication for New Physics
JHEP 0809 (2008) 038
Qin Chang, Xin-Qiang Li, Ya-Dong Yang

These decays are correlated:
increasing tension
between Th. & Exp.

The measurements:

Belle *Nature* **452** (2008) 332

$$A_{\rm CP}(B^-\to K^-\pi^0)\equiv\frac{\Gamma(B^-\to K^-\pi^0)-\Gamma(B^+\to K^+\pi^0)}{\Gamma(B^-\to K^-\pi^0)+\Gamma(B^+\to K^+\pi^0)}=+0.07\pm0.03\pm0.01,$$

$$A_{\rm CP}(\bar{B}^0\to K^-\pi^+)\equiv\frac{\Gamma(\bar{B}^0\to K^-\pi^+)-\Gamma(B^0\to K^+\pi^-)}{\Gamma(\bar{B}^0\to K^-\pi^+)+\Gamma(B^0\to K^+\pi^-)}=-0.094\pm0.018\pm0.008.$$

The difference:

$$\Delta A\equiv A_{\rm CP}(B^-\to K^-\pi^0)-A_{\rm CP}(\bar{B}^0\to K^-\pi^+)=0.164\pm0.037$$

at 4.4 σ

The average of BABAR, Belle, CDF & CLEO

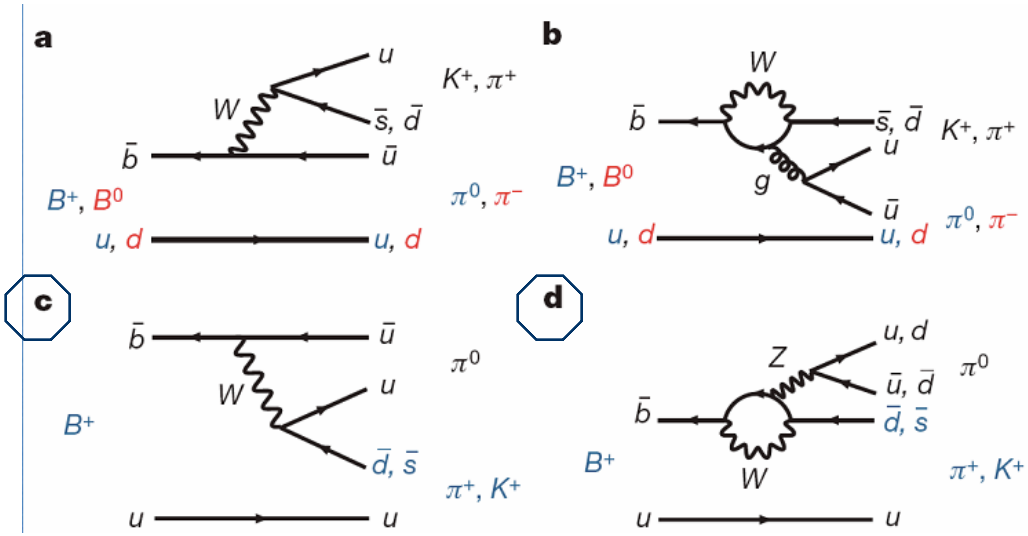
$$A_{\rm CP}(B^-\to K^-\pi^0)=0.050\pm0.025\,,$$

$$A_{\rm CP}(\bar{B}^0\to K^-\pi^+)=-0.097\pm0.012,$$

$$\Delta A=0.147\pm0.028$$

at 5.3 σ

The SM expectations:



$$A_{CP}(B^- \to K^- \pi^0)$$
$$A_{CP}(\bar{B}^0 \to K^- \pi^+)$$

Should be very close

Theoretical predictions so far

$$\begin{cases} A_{CP}(B_u^- \to \pi^0 K^-)_{QCDF} = -3.6\%\,, \\ A_{CP}(\bar{B}_d^0 \to \pi^+ K^-)_{QCDF} = -4.1\%\,; \end{cases} \quad QCDF\ Scenario\ S4$$

Nucl. Phys. B 675 (2003) 333

$$\begin{cases} A_{CP}(B_u^- \to \pi^0 K^-)_{PQCD} = (-1^{+3}_{-5})\%\,, \\ A_{CP}(\bar{B}_d^0 \to \pi^+ K^-)_{PQCD} = (-9^{+6}_{-8})\%\,; \end{cases} \quad pQCD$$

Phys. Rev. D 72 (2005) 114005

No difference!

$$\begin{cases} A_{CP}(B_u^- \to \pi^0 K^-)_{SCET} = (-11 \pm 9 \pm 11 \pm 2)\%\,, \\ A_{CP}(\bar{B}_d^0 \to \pi^+ K^-)_{SCET} = (-6 \pm 5 \pm 6 \pm 2)\%. \end{cases} \quad SCET$$

Phys. Rev. D 74 (2006) 014003

Possible Implications

The mismatch may be due to:

★ Our current limited understanding of strong dynamics involved in hadronic B decays, say, strong phase

★ Equally, new physics

▪ Recalculation with dynamical gluon propagator

Scheme I:

$$\int_0^1 \frac{dx}{x} \to X_A = (1+\rho_A e^{i\phi_A}) \ln\frac{m_B}{\Lambda_h}, \qquad \int_0^1 dy \frac{\ln y}{y} \to -\frac{1}{2}(X_A)^2$$

$\rho_A \leq 1$ and ϕ_A unrestricted

Scheme II:

We modify QCDf with
dynamical gluon propagator

supported by recent studies with
Lattice QCD simulations,
Schwinger-Dyson eq.

J. M. Cornwall prescription:

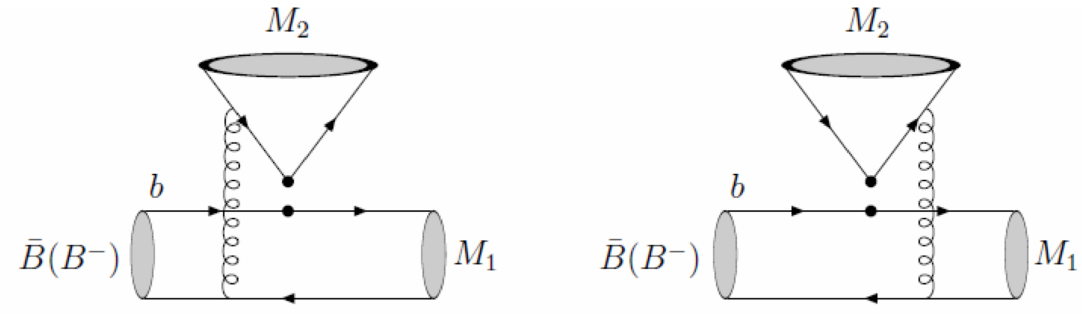
$$D(q^2) = \frac{1}{q^2 - M_g^2(q^2) + i\epsilon}$$

$$\alpha_s(q^2) = \frac{4\pi}{\beta_0 \ln\left(\frac{q^2+4M_g^2(q^2)}{\Lambda_{QCD}^2}\right)}$$

$$M_g^2(q^2) = m_g^2 \left[\frac{\ln\left(\frac{q^2+4m_g^2}{\Lambda_{QCD}^2}\right)}{\ln\left(\frac{4m_g^2}{\Lambda_{QCD}^2}\right)}\right]^{-\frac{12}{11}}$$

Phys. Rev. D 26 (1982) 1453;
Phys. Rev. D 44 (1991) 1285;

Hard spectator scattering contributions



Space-like

$$H_i(M_1M_2) = \frac{B_{M_1M_2}}{A_{M_1M_2}} \int_0^1 dx\,dy\,d\xi \frac{\alpha_s(q^2)}{\xi} \Phi_{B1}(\xi)\Phi_{M_2}(x) \times \left[\frac{\Phi_{M_1}(y)}{\bar{x}(\bar{y} + \omega^2(q^2)/\xi)} + r_\chi^{M_1} \frac{\phi_{m_1}(y)}{x(\bar{y} + \omega^2(q^2)/\xi)} \right],$$

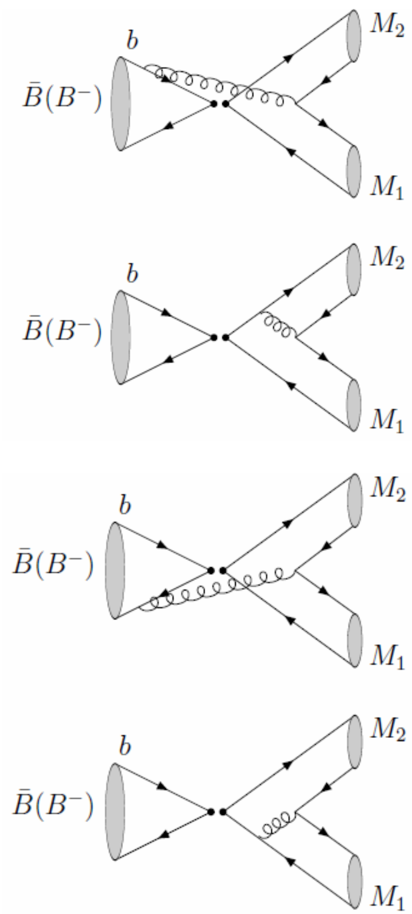
Real

for the contributions of operators $Q_{i=1-4,9,10}$,

$$H_i(M_1M_2) = -\frac{B_{M_1M_2}}{A_{M_1M_2}} \int_0^1 dx\,dy\,d\xi \frac{\alpha_s(q^2)}{\xi} \Phi_{B1}(\xi)\Phi_{M_2}(x) \times \left[\frac{\Phi_{M_1}(y)}{x(\bar{y} + \omega^2(q^2)/\xi)} + r_\chi^{M_1} \frac{\phi_{m_1}(y)}{\bar{x}(\bar{y} + \omega^2(q^2)/\xi)} \right],$$

for $Q_{i=5,7}$, and $H_i(M_1M_2) = 0$ for $Q_{i=6,8}$.

Annihilation contributions



$$A_1^i = \pi \int_0^1 dx dy \alpha_s(q^2) \Big\{ \Big[\frac{\bar{x}}{(\bar{x}y - \omega^2(q^2) + i\epsilon)(1 - x\bar{y})} + \frac{1}{(\bar{x}y - \omega^2(q^2) + i\epsilon)\bar{x}} \Big] \Phi_{M_1}(y)\Phi_{M_2}(x) + \frac{2}{\bar{x}y - \omega^2(q^2) + i\epsilon} r_\chi^{M_1} r_\chi^{M_2} \phi_{m_1}(y)\phi_{m_2}(x) \Big\},$$

$$A_1^f = A_2^f = 0,$$

$$A_2^i = \pi \int_0^1 dx dy \alpha_s(q^2) \Big\{ \Big[\frac{y}{(\bar{x}y - \omega^2(q^2) + i\epsilon)(1 - x\bar{y})} + \frac{1}{(\bar{x}y - \omega^2(q^2) + i\epsilon)y} \Big] \Phi_{M_1}(y)\Phi_{M_2}(x) + \frac{2}{\bar{x}y - \omega^2(q^2) + i\epsilon} r_\chi^{M_1} r_\chi^{M_2} \phi_{m_1}(y)\phi_{m_2}(x) \Big\},$$

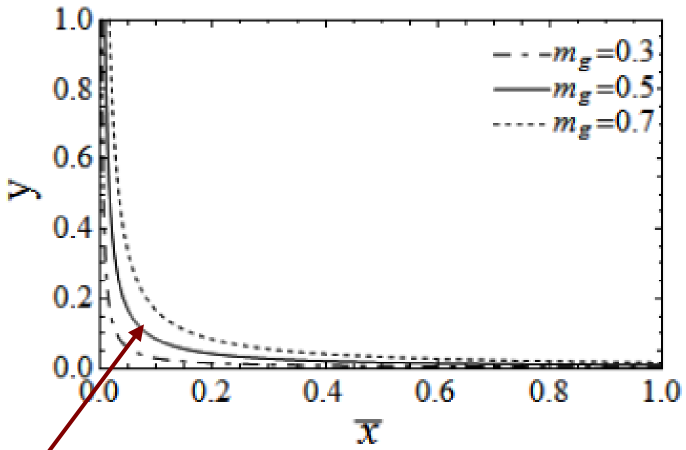
$$A_3^i = \pi \int_0^1 dx dy \alpha_s(q^2) \Big\{ \frac{2\bar{y}}{(\bar{x}y - \omega^2(q^2) + i\epsilon)(1 - x\bar{y})} r_\chi^{M_1} \phi_{m_1}(y)\Phi_{M_2}(x) - \frac{2x}{(\bar{x}y - \omega^2(q^2) + i\epsilon)(1 - x\bar{y})} r_\chi^{M_2}(x)\phi_{m_2}(x)\Phi_{M_1}(y) \Big\},$$

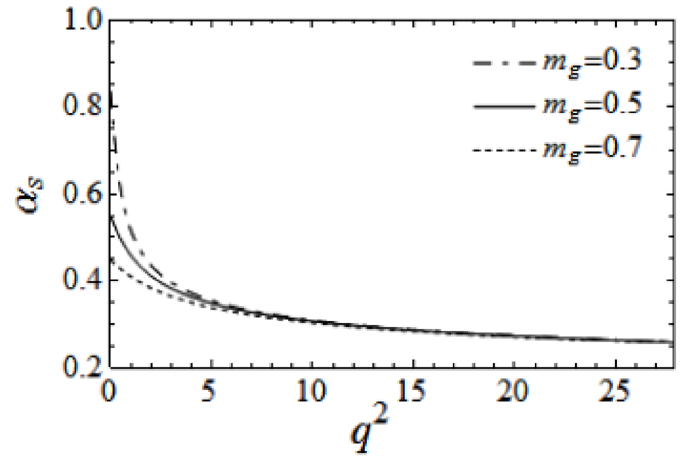
$$A_3^f = \pi \int_0^1 dx dy \alpha_s(q^2) \Big\{ \frac{2(1+\bar{x})}{(\bar{x}y - \omega^2(q^2) + i\epsilon)\bar{x}} r_\chi^{M_1} \phi_{m_1}(y)\Phi_{M_2}(x) + \frac{2(1+y)}{(\bar{x}y - \omega^2(q^2) + i\epsilon)y} r_\chi^{M_2}(x)\phi_{m_2}(x)\Phi_{M_1}(y) \Big\},$$

Time-like

Imaginary

Typically, $m_g = 500 \pm 200$ MeV





cancellations

For space-like, it furnishes a cut-off
For time-like, it crosses real states, therefore, strong phases

Results for Branching ratios ×10$^{(-6)}$

Decay Mode	QCDF $m_g = 0.3$	QCDF $m_g = 0.7$	QCDF $m_g = 0.45 \sim 0.55$	Experiment data
$B_u^- \to \pi^- \overline{K}^0$	44.4	16.8	23.17 ± 3.28	23.1 ± 1.0
$B_u^- \to \pi^0 K^-$	23.4	9.3	12.50 ± 1.65	12.9 ± 0.6
$\overline{B}_d^0 \to \pi^+ K^-$	44.7	16.3	22.71 ± 3.27	19.4 ± 0.6
$\overline{B}_d^0 \to \pi^0 \overline{K}^0$	21.2	7.3	10.50 ± 1.63	9.9 ± 0.6
$B_u^- \to \pi^- \overline{K}^{*0}$	28.3	5.2	8.90 ± 1.59	10.0 ± 0.8
$B_u^- \to \pi^0 K^{*-}$	15.2	3.4	5.25 ± 0.83	6.9 ± 2.3
$\overline{B}_d^0 \to \pi^+ K^{*-}$	28.7	5.3	9.13 ± 1.68	10.6 ± 0.9
$\overline{B}_d^0 \to \pi^0 \overline{K}^{*0}$	13.4	1.9	3.89 ± 0.82	2.4 ± 0.7
$B_u^- \to \rho^- \overline{K}^0$	31.8	5.6	10.27 ± 1.96	$8.0^{+1.5}_{-1.4}$
$B_u^- \to \rho^0 K^-$	14.9	2.5	4.81 ± 0.94	$3.81^{+0.48}_{-0.46}$
$\overline{B}_d^0 \to \rho^+ K^-$	38.6	8.0	13.42 ± 2.31	$8.6^{+0.9}_{-1.1}$
$\overline{B}_d^0 \to \rho^0 \overline{K}^0$	21.0	4.8	7.53 ± 1.25	$5.4^{+0.9}_{-1.0}$

$m_g = 500 \pm 200$ MeV ↔ 500 ± 50 MeV

The known ratios

Our results | **Measurements**

$$R_c \equiv 2\left[\frac{Br(B^- \to \pi^0 K^-)}{Br(B^- \to \pi^- K^0)}\right] = 1.08 \pm 0.30, \quad \longleftrightarrow \quad 1.12 \pm 0.10$$

$$R_n \equiv \frac{1}{2}\left[\frac{Br(\bar{B}^0 \to \pi^+ K^-)}{Br(\bar{B}^0 \to \pi^0 K^0)}\right] = 1.08 \pm 0.32, \quad \longleftrightarrow \quad 0.98 \pm 0.09$$

So far, so good.

However, CPA……

Results for CPAs $\times 10^{(-2)}$

Decay Mode	QCDF $m_g=0.3$	QCDF $m_g=0.7$	QCDF $m_g=0.45\sim0.55$	Experiment data
$B_u^- \to \pi^-\overline{K}^0$	0.06	0.19	0.10 ± 0.08	0.9 ± 2.5
$B_u^- \to \pi^0 K^-$	-11.6	-8.3	-10.85 ± 0.84	5.0 ± 2.5
$\overline{B}_d^0 \to \pi^+ K^-$	-11.0	-11.4	-12.38 ± 0.69	-9.7 ± 1.2
$\overline{B}_d^0 \to \pi^0\overline{K}^0$	2.5	0.1	1.39 ± 0.35	-14 ± 11
$B_u^- \to \pi^-\overline{K}^{*0}$	0.3	-0.0	0.16 ± 0.16	-11.4 ± 6.1
$B_u^- \to \pi^0 K^{*-}$	-27.0	-34.1	-41.20 ± 6.69	4 ± 29
$\overline{B}_d^0 \to \pi^+ K^{*-}$	-27.2	-47.6	-47.58 ± 8.42	-10 ± 11
$\overline{B}_d^0 \to \pi^0\overline{K}^{*0}$	3.9	2.1	4.67 ± 1.14	-9^{+32}_{-23}
$B_u^- \to \rho^-\overline{K}^0$	0.1	1.2	0.53 ± 0.21	-12 ± 17
$B_u^- \to \rho^0 K^-$	28.1	49.7	46.27 ± 5.94	37 ± 11
$\overline{B}_d^0 \to \rho^+ K^-$	19.3	31.5	31.40 ± 4.63	15 ± 13
$\overline{B}_d^0 \to \rho^0\overline{K}^0$	-4.2	0.2	-3.26 ± 1.29	-2 ± 29

Fine

In sharp contrast to the Exp., *i.e.*, we can not resolve the difference of CPA

So far, what we get:

★ nice match for 12 branching ratios with ONE parameter

★ bad match for one CPV

"πK puzzle" still exists

Suspect:

New Physics ?

▪ The effects of (pseudo-)scalar couplings

We explore new physics effects in a model independent way

The general four-quark **tensor operators**

$$O_T^q = \bar{s}\sigma_{\mu\nu}(1+\gamma_5)b \otimes \bar{q}\sigma^{\mu\nu}(1+\gamma_5)q\,, \quad O_T^{\prime q} = \bar{s}_i\sigma_{\mu\nu}(1+\gamma_5)b_j \otimes \bar{q}_j\sigma^{\mu\nu}(1+\gamma_5)q_i$$

×

(pseudo-)scalar operators

$$\mathcal{H}_{\rm eff}^{\rm NP} = \frac{G_F}{\sqrt{2}} \sum_{q=u,d} |V_{tb}V_{ts}^*| e^{i\delta_S^q} \left[C_{S1}^q O_{S1}^q + C_{S8}^q O_{S8}^q \right] + {\rm h.c.}$$

$$O_{S1}^u = \bar{s}(1+\gamma_5)b \otimes \bar{u}(1+\gamma_5)u \qquad O_{S8}^u = \bar{s}_i(1+\gamma_5)b_j \otimes \bar{u}_j(1+\gamma_5)u_i$$

$$O_{S1}^d = \bar{s}(1+\gamma_5)b \otimes \bar{d}(1+\gamma_5)d \qquad O_{S8}^d = \bar{s}_i(1+\gamma_5)b_j \otimes \bar{d}_j(1+\gamma_5)d_i,$$

i.e., scalar FCNCs

In the scanning, all theoretical inputs and Exp. uncertainties are included

Constraints & Resolutions

We subdivided this NP in five cases:

- Case I: $b \to su\bar{u}$ operators O^u_{S1} and O^u_{S8},
- Case II: $b \to sd\bar{d}$ operators O^d_{S1} and O^d_{S8},
- Case III: $b \to sd\bar{d}$ operator O^d_{S1} solely,
- Case IV: only color singlet operators O^u_{S1} and O^d_{S1},
- Case V: all the operators O^u_{S1}, O^u_{S8}, O^d_{S1} and O^d_{S8}.

The fitted branching ratios:

Decay Mode	Experiment data	NP Case I	Case II	Case III	Case IV	Case V
$B_u^- \to \pi^- \overline{K}^0$	23.1 ± 1.0	—	23.0 ± 1.0	22.9 ± 0.9	21.5 ± 0.3	22.4 ± 0.9
$B_u^- \to \pi^0 K^-$	12.9 ± 0.6	12.1 ± 0.4	12.8 ± 0.7	12.7 ± 0.6	12.1 ± 0.3	12.1 ± 0.4
$\overline{B}_d^0 \to \pi^+ K^-$	19.4 ± 0.6	20.2 ± 0.3	—	—	20.4 ± 0.2	20.1 ± 0.4
$\overline{B}_d^0 \to \pi^0 \overline{K}^0$	9.9 ± 0.6	9.0 ± 0.3	9.9 ± 0.6	10.0 ± 0.7	9.0 ± 0.2	9.1 ± 0.4
$B_u^- \to \pi^0 K^{*-}$	6.9 ± 2.3	4.2 ± 0.2	4.4 ± 0.4	4.4 ± 0.4	4.3 ± 0.3	4.3 ± 0.3
$\overline{B}_d^0 \to \pi^0 \overline{K}^{*0}$	2.4 ± 0.7	3.4 ± 0.3	3.5 ± 0.2	3.5 ± 0.2	3.1 ± 0.3	2.9 ± 0.2
$B_u^- \to \rho^- \overline{K}^0$	$8.0^{+1.5}_{-1.4}$	—	8.6 ± 0.7	8.6 ± 0.7	7.4 ± 0.4	7.1 ± 0.4
$B_u^- \to \rho^0 K^-$	$3.81^{+0.48}_{-0.46}$	3.4 ± 0.2	—	—	3.4 ± 0.2	3.4 ± 0.2
$\overline{B}_d^0 \to \rho^+ K^-$	$8.6^{+0.9}_{-1.1}$	9.7 ± 0.5	—	—	9.7 ± 0.5	9.8 ± 0.5
$\overline{B}_d^0 \to \rho^0 \overline{K}^0$	$5.4^{+0.9}_{-1.0}$	—	6.5 ± 0.4	6.5 ± 0.4	5.5 ± 0.3	5.4 ± 0.4

To leading order,

$B_u^- \to \pi^- \bar{K}^{*0}$ and $\bar{B}_d^0 \to \pi^+ \bar{K}^{*-}$ decays do not receive these NP contributions

The direct CP asymmetries:

Only Br as inputs

Decay Mode	Experiment data	Case I	Case II	NP Case III	Case IV	Case V
$B_u^- \to \pi^- \overline{K}^0$	0.9 ± 2.5	—	1.7 ± 2.9	2.0 ± 0.2	3.9 ± 1.0	3.2 ± 1.3
$B_u^- \to \pi^0 K^-$	5.0 ± 2.5	8.8 ± 6.4	1.1 ± 0.9	1.2 ± 0.9	2.8 ± 5.5	1.8 ± 1.3
$\overline{B}_d^0 \to \pi^+ K^-$	-9.7 ± 1.2	-5.7 ± 4.4	—	—	-10.0 ± 0.8	-9.2 ± 1.3
$\overline{B}_d^0 \to \pi^0 \overline{K}^0$	-14 ± 11	-18.6 ± 7.5	-12.8 ± 3.9	-12.6 ± 1.6	-10.2 ± 7.0	-8.2 ± 2.8
$B_u^- \to \pi^0 K^{*-}$	4 ± 29	4.2 ± 19.3	-8.1 ± 3.3	-8.0 ± 3.3	-4.9 ± 19.7	-13.2 ± 4.6
$\overline{B}_d^0 \to \pi^0 \overline{K}^{*0}$	-9^{+32}_{-23}	-61.7 ± 22.0	-49.9 ± 3.4	-49.8 ± 3.8	-52.8 ± 24.2	-47.0 ± 6.5
$B_u^- \to \rho^- \overline{K}^0$	-12 ± 17	—	-5.9 ± 10.9	-6.5 ± 0.8	-15.1 ± 4.2	-13.1 ± 5.9
$B_u^- \to \rho^0 K^-$	37 ± 11	32.8 ± 16.5	—	—	48.3 ± 3.5	43.9 ± 5.2
$\overline{B}_d^0 \to \rho^+ K^-$	15 ± 13	19.2 ± 12.9	—	—	31.9 ± 2.7	28.0 ± 4.1
$\overline{B}_d^0 \to \rho^0 \overline{K}^0$	-2 ± 29	—	-8.1 ± 8.1	-8.5 ± 0.9	-14.9 ± 3.0	-13.5 ± 4.4

Case I: C^u_{S1}, C^u_{S8}, δ^u_S

Case II: C^d_{S1}, C^d_{S8}, δ^d_S

Case III: C^d_{S1}, δ^d_S

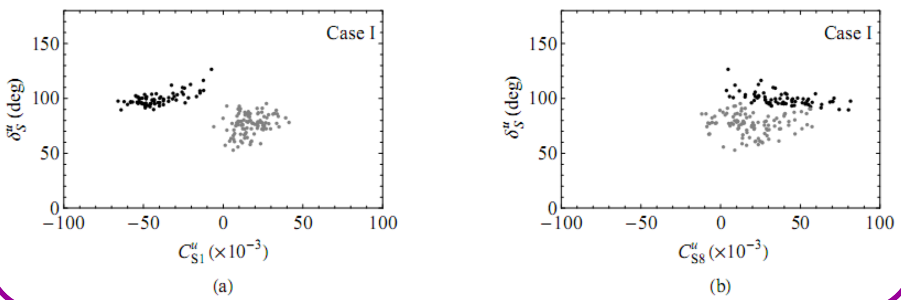
Case IV: C^u_{S1}, C^d_{S1}

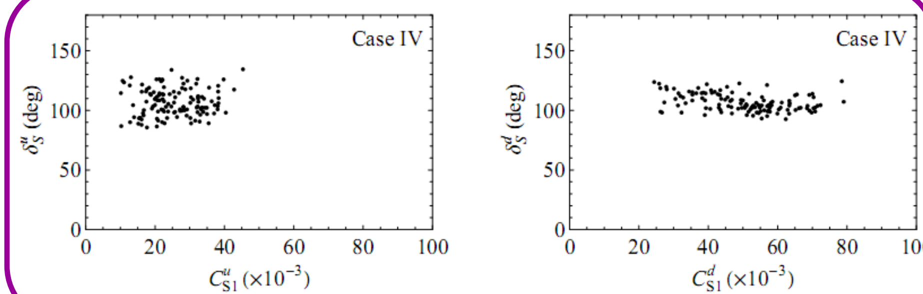
Case IV

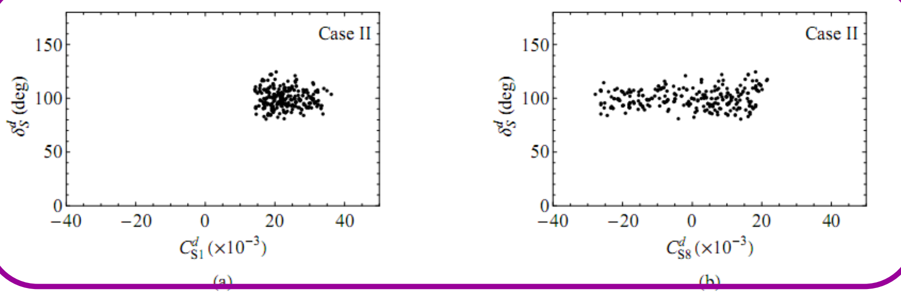
Theo. $\Delta A = 0.128 \pm 0.056$

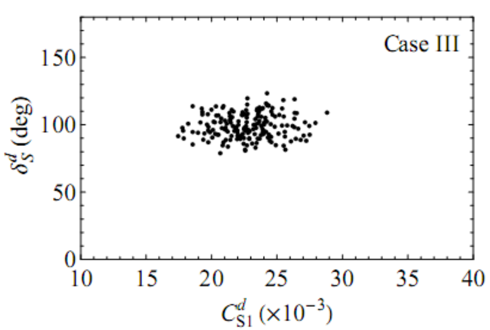
Exp. $\Delta A = 0.147 \pm 0.028$

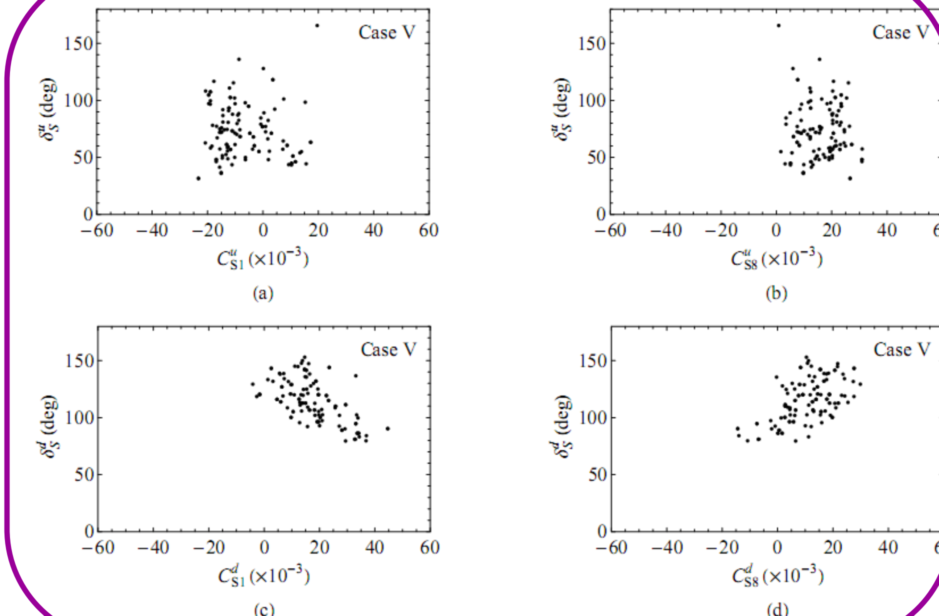
NP parameters' space











Numerical results

NP para.	Case I	Case II	Case III	Case IV	Case V
$C^u_{S1}(\times 10^{-3})$	-41.6 ± 13.4	—	—	25.8 ± 8.4	-6.7 ± 10.5
$C^u_{S8}(\times 10^{-3})$	38.7 ± 18.2	—	—	—	16.0 ± 7.1
δ^u_S	$99.5° \pm 6.1°$	—	—	$107.0° \pm 11.5°$	$73.0° \pm 23.8°$
$C^d_{S1}(\times 10^{-3})$	—	23.0 ± 5.1	22.8 ± 2.3	50.3 ± 12.8	17.5 ± 10.1
$C^d_{S8}(\times 10^{-3})$	—	-0.8 ± 13.7	—	—	10.5 ± 9.4
δ^d_S	—	$100.0° \pm 8.7°$	$99.3° \pm 9.2°$	$106.6° \pm 7.3°$	$114.7° \pm 18.6°$

$|C^u_{S1}| \approx |C^u_{S8}|$

Exotic !

$|C^d_{S1}| > |C^d_{S8}|$

Color singlet dominated !

$C^d_{S1} \approx 2 \times C^u_{S1}$

Down type dominated !

Nontrivial NP weak phase!

Prediction

The mixing induced CPA in $\bar{B}^0 \to \pi^0 K_S$ and $\rho^0 K_S$

- insensitive to strong phase, more accurate in QCDF
- sensitive to New Physics (new weak phase)
- should be $\sin(2\beta)_{\psi K_S}$ in the SM

$$\mathcal{A}_f(t) = S_f \sin(\Delta m_d t) - C_f \cos(\Delta m_d t)$$

$$S_f = \mathcal{A}_{\rm CP}^{\rm mix} \qquad -C_f \equiv \mathcal{A}_{\rm CP}$$

$$A_{\rm CP}^{\rm mix}(\bar{B}^0 \to f) = \frac{2{\rm Im}\lambda_f}{1+|\lambda_f|^2} \qquad \lambda_f = -e^{-2i\beta}\bar{A}^{00}/A^{00}$$

$$\sin(2\beta) = \sin(2\beta)_{\Psi K_S} = 0.68 \pm 0.03$$

($\times 10^{-2}$)

Decay Mode	Experiment data	SM	NP Case I	NP Case II	NP Case III	NP Case IV	NP Case V
$\overline{B}_d^0 \to \pi^0 K_S$	38 ± 19	77 ± 4	45 ± 11	56 ± 5	57 ± 3	59 ± 9	62 ± 8
$\overline{B}_d^0 \to \rho^0 K_S$	61^{+25}_{-27}	66 ± 3	—	61 ± 6	61 ± 3	56 ± 3	57 ± 4

Old data at that time

ICHEP 08

BABAR $A_{CP}^{mix}(\bar{B}^0 \to \pi^0 K_S) = 0.55 \pm 0.20 \pm 0.03$

Belle $A_{CP}^{mix}(\bar{B}^0 \to \pi^0 K_S) = 0.67 \pm 0.31 \pm 0.08$

0.58 ± 0.17

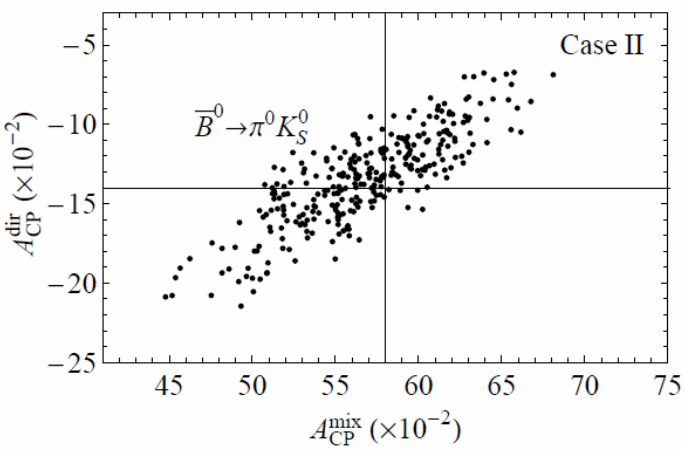
Now, HFAG

$$A_{CP}^{mix}(\pi^0 K_S) = 0.57 \pm 0.17$$

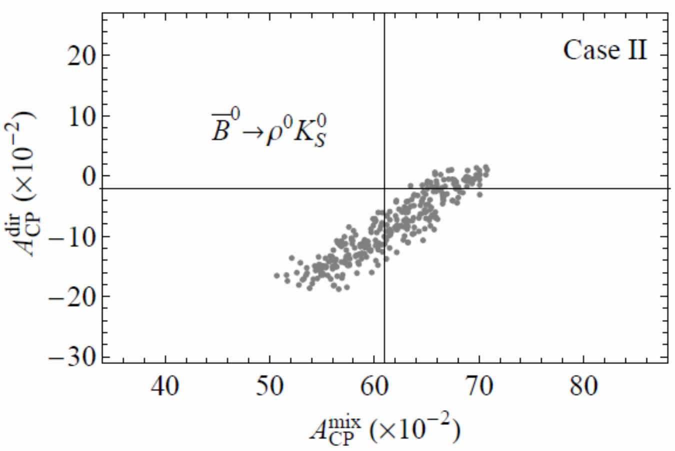
$$A_{CP}^{mix}(\rho^0 K_S) = 0.54^{+0.18}_{-0.21}$$

Compared with the new data, unexpected match!

Correlations:



(a)



(b)

- The correlations could be important to sign out new physics
- Need more accurate mixing-induced CP to confirm NP suspects

▪ Summary

● The knowns of QCD from Lattice and SD should be incorporated into the approaches for B decays

● Dynamical gluon mass could, at least, furnish the natural regulator of end-point div.

● Correlated decays point to NP in the EW penguin sector

● (pseudo-)scalar couplings are helpful for resolving "πK puzzle"

● More accurate measurements，especially mixing-induced CPV, are also needed to confirm or refute the NP hints

Thank you
for
your attention!