Hadronic B Decays at Belle

EPS HEP 2013 Stockholm - Results on $B^0 \to \phi K^*$ and $B^0 \to K^+ K^- \pi^0$

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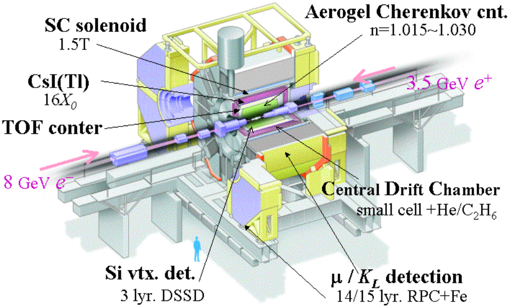
INSTITUT FÜR EXPERIMENTELLE KERNPHYSIK (IEKP)

Outline

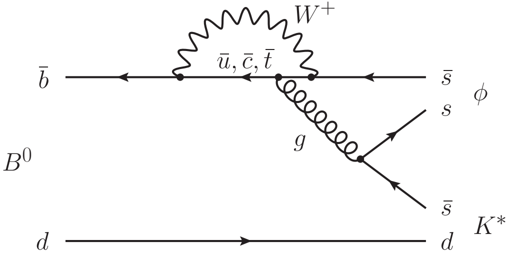
1. Angular analysis of $B^0 \to \phi K^*$ decays and search for *CP* violation
   - First presentation today!
   - Planned to be submitted to PRD soon
2. Evidence for the decay $B^0 \to K^+K^-\pi^0$
   - V. Gaur *et al.* (Belle Collaboration), PRD **87**, 091101(R) (2013)

Belle Experiment

- Detector at the asymmetric e^+e^- collider KEKB in Tsukuba, Japan
- KEKB operates mainly on the $\Upsilon(4\mathrm{S})$ resonance
- $\Upsilon(4\mathrm{S})$ decays almost entirely into $B\bar{B}$ pairs, thus KEKB is a B-factory
- $\int \mathcal{L} \approx 711\,\mathrm{fb}^{-1}$ with $(772 \pm 11) \times 10^6$ $B\bar{B}$ pairs recorded on $\Upsilon(4\mathrm{S})$
- Both analyses presented in this talk are using the full Belle data sample



$B^0 \to \phi K^*$ - Motivation

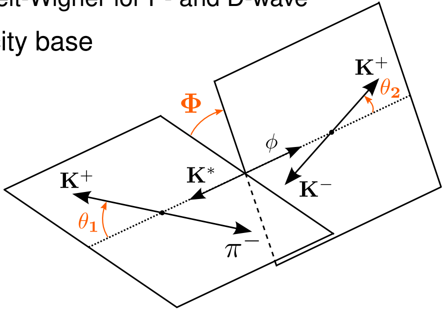


- Decay via $b \to s$ penguin transition in the SM
- Dominant long. polarization fraction expected from QCD factorization
- Longitudinal polarization fractions are puzzling:

  $B^0 \to \phi K^*(892)^0$ $f_L = 0.45 \pm 0.05 \pm 0.02$ (Belle PRL**94**,221804(2005))
  $f_L = 0.494 \pm 0.034 \pm 0.013$ (BaBar PRD**78**,092008(2008))
  $B^0 \to \phi K_2^*(1430)^0$ $f_L = 0.901^{+0.046}_{-0.058} \pm 0.037$ (BaBar PRD**78**,092008(2008))
- Negligible *CP* violation expected in the SM

$B^0 \to \phi K^*$ - Analysis strategy

- Partial wave analysis of $B^0 \to \phi K^*$ with $K^* \to K^+\pi^-$ being
  - scalar $(K\pi)_0^*$ (S-wave, J=0)
  - vector $K^*(892)^0$ (P-wave, J=1)
  - tensor $K_2^*(1430)^0$ (D-wave, J=2)
- Analysis restricted to $K^+\pi^-$ invariant mass less than 1.55 GeV
  - LASS model for S-wave component (includes $K_0^*(1430)^0$)
  - relativistic spin-dependent Breit-Wigner for P- and D-wave
- Angular distributions in the helicity base
- Simultaneous fit to B^0 and $\bar{B}^0$
- In total giving rise to 26 real parameters that can be measured in the $B^0 \to \phi K^*$ system



$B^0 \to \phi K^*$ - Definitions

Parameter	Definition	$\phi(K\pi)_0^*$ $J=0$	$\phi K^*(892)^0$ $J=1$	$\phi K_2^*(1430)^0$ $J=2$
$\mathcal{B}_J$	$\frac{1}{2}(\bar{\Gamma}_J + \Gamma_J)/\Gamma_{\text{total}}$	$\mathcal{B}_0$	$\mathcal{B}_1$	$\mathcal{B}_2$
f_{LJ}	$\frac{1}{2}(\lvert\bar{A}_{J0}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 + \lvert A_{J0}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2)$	–	f_{L1}	f_{L2}
$f_{\perp J}$	$\frac{1}{2}(\lvert\bar{A}_{J\perp}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 + \lvert A_{J\perp}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2)$	–	$f_{\perp 1}$	$f_{\perp 2}$
$\phi_{\parallel J}$	$\frac{1}{2}(\arg(\bar{A}_{J\parallel}/\bar{A}_{J0}) + \arg(A_{J\parallel}/A_{J0}))$	–	$\phi_{\parallel 1}$	$\phi_{\parallel 2}$
$\phi_{\perp J}$	$\frac{1}{2}(\arg(\bar{A}_{J\perp}/\bar{A}_{J0}) + \arg(A_{J\perp}/A_{J0}) - \pi)$	–	$\phi_{\perp 1}$	$\phi_{\perp 2}$
δ_{0J}	$\frac{1}{2}(\arg(\bar{A}_{00}/\bar{A}_{J0}) + \arg(A_{00}/A_{J0}))$	–	δ_{01}	δ_{02}
$\mathcal{A}_{CPJ}$	$(\bar{\Gamma}_J - \Gamma_J)/(\bar{\Gamma}_J + \Gamma_J)$	$\mathcal{A}_{CP0}$	$\mathcal{A}_{CP1}$	$\mathcal{A}_{CP2}$
$\mathcal{A}_{CPJ}^0$	$\frac{\lvert\bar{A}_{J0}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 - \lvert A_{J0}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2}{\lvert\bar{A}_{J0}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 + \lvert A_{J0}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2}$	–	$\mathcal{A}_{CP1}^0$	$\mathcal{A}_{CP2}^0$
$\mathcal{A}_{CPJ}^\perp$	$\frac{\lvert\bar{A}_{J\perp}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 - \lvert A_{J\perp}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2}{\lvert\bar{A}_{J\perp}\rvert^2/\sum\lvert\bar{A}_{J\lambda}\rvert^2 + \lvert A_{J\perp}\rvert^2/\sum\lvert A_{J\lambda}\rvert^2}$	–	$\mathcal{A}_{CP1}^\perp$	$\mathcal{A}_{CP2}^\perp$
$\Delta\phi_{\parallel J}$	$\frac{1}{2}(\arg(\bar{A}_{J\parallel}/\bar{A}_{J0}) - \arg(A_{J\parallel}/A_{J0}))$	–	$\Delta\phi_{\parallel 1}$	$\Delta\phi_{\parallel 2}$
$\Delta\phi_{\perp J}$	$\frac{1}{2}(\arg(\bar{A}_{J\perp}/\bar{A}_{J0}) - \arg(A_{J\perp}/A_{J0}) - \pi)$	–	$\Delta\phi_{\perp 1}$	$\Delta\phi_{\perp 2}$
$\Delta\delta_{0J}$	$\frac{1}{2}(\arg(\bar{A}_{00}/\bar{A}_{J0}) - \arg(A_{00}/A_{J0}))$	–	$\Delta\delta_{01}$	$\Delta\delta_{02}$

- Overview and definition of the 26 real parameters
- $\Delta\phi_{00} = \frac{1}{2}\arg(A_{00}/\bar{A}_{00})$ only accessible in $B^0/\bar{B}^0 \to \phi K_S^0 \pi^0$

$B^0 \to \phi K^*$ - Selection and Fit

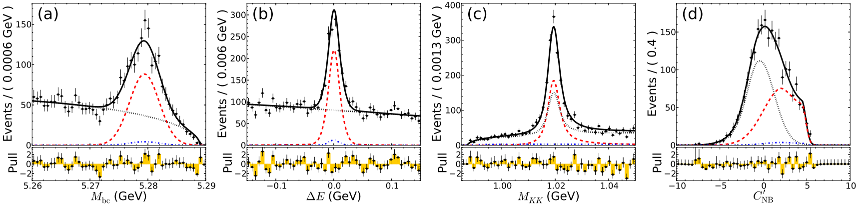
- Reconstruction of $B^0 \to \phi K^*$ with $\phi \to K^+K^-$ and $K^* \to K^+\pi^-$
- Cut based selection with neural network (NeuroBayes) based continuum $e^+e^- \to q\bar{q}$ ($q \in \{u, d, s, c\}$) background suppression
- 9D fit to B^0 and $\bar{B}^0$ using the observables

M_{bc}	beam-constraint mass
ΔE	energy difference
M_{KK}	K^+K^- invariant mass
C'_{NB}	continuum suppression network output
$M_{K\pi}$	$K^+\pi^-$ invariant mass
Φ, $\cos\theta_1$, $\cos\theta_2$	the three helicity angles
Q	charge of primary kaon from B

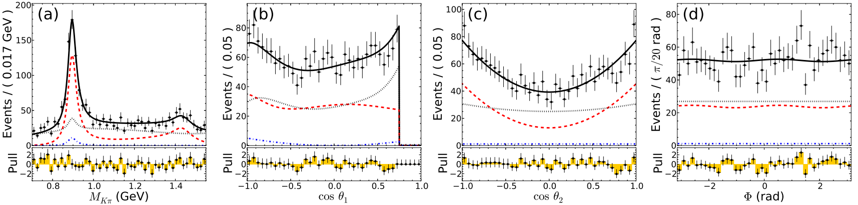
- With three components included in the fit
  - Signal
  - Peaking background from $B^0 \to f_0(980)K^*(892)^0$
  - Continuum background

$B^0 \to \phi K^*$ - Preliminary Results (Fit)

Total PDF
Continuum background
$B^0 \to f_0(980) K^*(892)^0$
$B^0 \to \phi K^*$



Projections on $M_{\rm bc}$ (a), ΔE (b), M_{KK} (c) and $C'_{\rm NB}$ (d), where in each plot a signal enhancing cut on the other three is applied, i. e. in (a) on (b), (c) and (d)



Projections on $M_{K\pi}$ (a), $\cos\theta_1$ (b), $\cos\theta_2$ (c) and Φ (d), where in each plot a signal enhancing cut on $M_{\rm bc}$, ΔE, M_{KK} and $C'_{\rm NB}$ is applied

$B^0 \to \phi K^*$ - Preliminary Results (Numbers)

Parameter	$\phi(K\pi)^*_0$ $J=0$	$\phi K^*(892)^0$ $J=1$	$\phi K^*_2(1430)^0$ $J=2$
$\mathcal{B}_J$ (10^{-6})	$4.3 \pm 0.4 \pm 0.3$	$10.4 \pm 0.5 \pm 0.5$	$5.5^{+0.9}_{-0.7} \pm 0.7$
f_{LJ}		$0.499 \pm 0.030 \pm 0.010$	$0.918^{+0.029}_{-0.060} \pm 0.008$
$f_{\perp J}$		$0.238 \pm 0.026 \pm 0.005$	$0.056^{+0.050}_{-0.035} \pm 0.006$
$\phi_{\parallel J}$ (rad)		$2.23 \pm 0.10 \pm 0.02$	$3.76 \pm 2.88 \pm 1.32$
$\phi_{\perp J}$ (rad)		$2.37 \pm 0.10 \pm 0.04$	$4.45^{+0.43}_{-0.38} \pm 0.07$
δ_{0J} (rad)		$2.91 \pm 0.10 \pm 0.04$	$3.53 \pm 0.11 \pm 0.12$
$\mathcal{A}_{CPJ}$	$0.093 \pm 0.094 \pm 0.015$	$-0.007 \pm 0.048 \pm 0.020$	$-0.155^{+0.152}_{-0.133} \pm 0.024$
$\mathcal{A}^0_{CPJ}$		$-0.030 \pm 0.061 \pm 0.006$	$-0.016^{+0.066}_{-0.051} \pm 0.004$
$\mathcal{A}^\perp_{CPJ}$		$-0.14 \pm 0.11 \pm 0.01$	$-0.01^{+0.85}_{-0.67} \pm 0.04$
$\Delta\phi_{\parallel J}$ (rad)		$-0.02 \pm 0.10 \pm 0.01$	$-0.02 \pm 1.08 \pm 0.99$
$\Delta\phi_{\perp J}$ (rad)		$0.05 \pm 0.10 \pm 0.02$	$-0.19 \pm 0.42 \pm 0.06$
$\Delta\delta_{0J}$ (rad)		$0.08 \pm 0.10 \pm 0.01$	$0.06 \pm 0.11 \pm 0.01$

- BR and polarization parameters consistent with existing results
- All parameters related to direct *CP* violation consistent with zero

$B^0 \to \phi K^*$ - Preliminary Results (Numbers)

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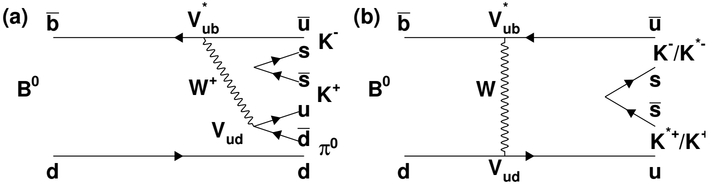
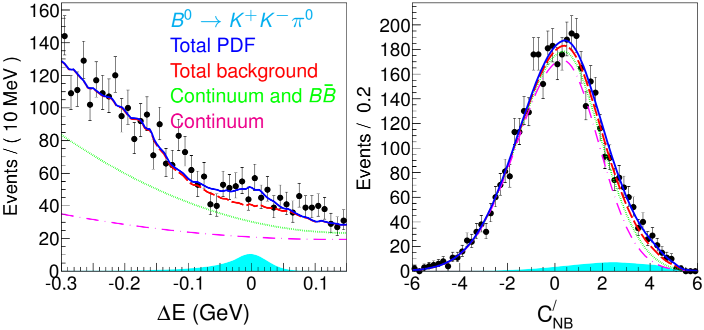
$B^0 \to K^+K^-\pi^0$ - Motivation



- Decay suppressed in the SM: CLEO limit $\mathcal{B} < 1.9 \times 10^5$ (PRL**89**,251801(2002))
- Contribution from color- and Cabibbo-suppressed $b \to u$ tree (a) and internal W exchange (b) transitions
- No information on potential resonance modes available
- BaBar (PRL**99**,221801(2007)) and LHCb (LHCb-CONF-2012-028) observed a structure in the K^+K^- invariant mass around $1.5\,\mathrm{GeV}/\mathrm{c}^2$ in $B^\pm \to K^+K^-\pi^\pm$

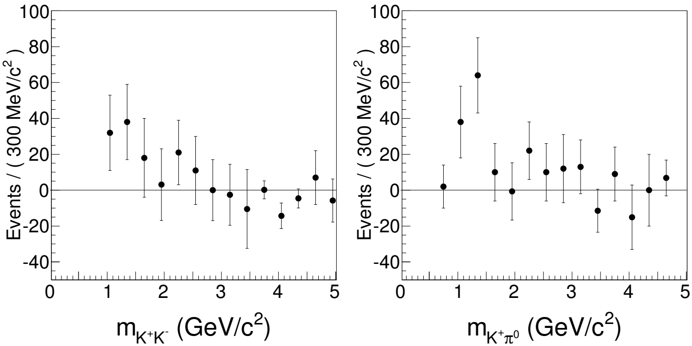
$B^0 \to K^+K^-\pi^0$ - Evidence for the decay



- Cut based selection with neural network (NeuroBayes) based continuum $e^+e^- \to q\bar{q}$ ($q \in \{u, d, s, c\}$) background suppression
- 2D fit of events in the $\pm 3\sigma$ region of beam-constraint B^0 mass M_{bc}
- Fit is using energy difference ΔE and network output C'_{NB}

$N_{\mathrm{sig}} = 299 \pm 83 \quad \mathcal{B}(B^0 \to K^+K^-\pi^0) = (2.17 \pm 0.60 \pm 0.24) \times 10^{-6} \quad 3.5\sigma$

$B^0 \to K^+K^-\pi^0$ - Resonant substructure



- Signal yield fitted in bins of $m_{K^+K^-}$ and $m_{K^+\pi^0}$
- No definite statement about low-mass structure seen in $m_{K^+K^-}$ by BaBar and LHCb
- Excess of events at around $m_{K^+\pi^0} = 1.4\,\mathrm{GeV/c^2}$
- Amplitude analysis and more statistics required $\to$ Belle II

Summary

1. Angular analysis of $B^0 \to \phi K^*$ decays and search for *CP* violation
   - Partial wave analysis of $B^0 \to \phi K^*$
   - Branching fractions and polarization consistent with BaBar results

$$\mathcal{B}[B^0 \to \phi(K\pi)^*_0] = (4.3 \pm 0.4 \pm 0.3) \times 10^{-6}$$
$$\mathcal{B}[B^0 \to \phi K^*(892)^0] = (10.4 \pm 0.5 \pm 0.5) \times 10^{-6}$$
$$\mathcal{B}[B^0 \to \phi K^*_2(1430)^0] = (5.5^{+0.9}_{-0.7} \pm 0.7) \times 10^{-6}$$

   - Dominant long. polarisation fraction for $B^0 \to \phi K^*_2(1430)^0$

$$f_L = 0.918^{+0.029}_{-0.060} \pm 0.008$$

   - No evidence for *CP* violation
2. Evidence for the decay $B^0 \to K^+ K^- \pi^0$
   - First evidence of the decay with 3.5σ significance
   - $\mathcal{B}(B^0 \to K^+ K^- \pi^0) = (2.17 \pm 0.60 \pm 0.24) \times 10^{-6}$
   - No definite statement on the nature of the substructures $\to$ Belle II

BACKUP

$B^0 \to \phi K^*$ - Systematics BR

	$\phi(K\pi)^*_0$ $J=0$	$\phi K^*(892)^0$ $J=1$	$\phi K_2^*(1430)^0$ $J=2$
Track reconstruction	1.4	1.4	1.4
PID selection	3.3	3.3	3.4
C_{NB} requirement	0.7	0.7	0.7
MC statistics	0.5	0.5	0.5
ϕ branching fraction	1.0	1.0	1.0
K_2^* branching fraction	$\cdots$	$\cdots$	2.4
$N_{B\bar{B}}$	1.4	1.4	1.4
Total	4.1	4.1	4.8

$B^0 \to \phi K^*$ - Systematics Polarization and CP

Parameter	PDF	Accept.	SCF	KK	Interf.	Charge	Total
$N_{\rm sig}$	18.601	0.716	2.909	10.720	0.769	$\cdots$	21.691
FF_0	0.012	0.001	0.002	0.003	0.002	$\cdots$	0.013
$\mathcal{A}_{CP0}$	0.005	0.002	0.006	0.001	0.005	0.012	0.015
FF_1	0.010	0.004	0.001	0.004	0.002	$\cdots$	0.012
$\mathcal{A}_{CP1}$	0.002	0.001	0.003	0.002	0.016	0.012	0.020
FF_2	0.011	0.003	0.001	0.001	0.001	$\cdots$	0.012
$\mathcal{A}_{CP2}$	0.014	0.007	0.013	0.001	0.000	0.012	0.024
f_{L1}	0.002	0.008	0.002	0.005	0.002	$\cdots$	0.010
$f_{\perp 1}$	0.002	0.004	0.001	0.003	0.001	$\cdots$	0.005
$\phi_{\parallel 1}$	0.010	0.003	0.009	0.002	0.010	$\cdots$	0.017
$\phi_{\perp 1}$	0.010	0.003	0.013	0.004	0.037	$\cdots$	0.041
δ_{01}	0.041	0.008	0.006	0.007	0.011	$\cdots$	0.044
$\mathcal{A}^0_{CP1}$	0.001	0.001	0.003	0.001	0.005	$\cdots$	0.006
$\mathcal{A}^{\perp}_{CP1}$	0.002	0.002	0.004	0.001	0.008	$\cdots$	0.009
$\Delta\phi_{\parallel 1}$	0.004	0.002	0.005	0.001	0.005	$\cdots$	0.008
$\Delta\phi_{\perp 1}$	0.004	0.003	0.012	0.001	0.010	$\cdots$	0.016
$\Delta\delta_{01}$	0.002	0.002	0.006	0.001	0.001	$\cdots$	0.007
f_{L2}	0.007	0.002	0.003	0.000	0.000	$\cdots$	0.008
$f_{\perp 2}$	0.005	0.002	0.003	0.001	0.000	$\cdots$	0.006
$\phi_{\parallel 2}$	0.086	0.034	1.314	0.009	0.017	$\cdots$	1.317
$\phi_{\perp 2}$	0.063	0.020	0.010	0.007	0.013	$\cdots$	0.068
δ_{02}	0.114	0.028	0.010	0.002	0.002	$\cdots$	0.118
$\mathcal{A}^0_{CP2}$	0.003	0.000	0.002	0.000	0.000	$\cdots$	0.004
$\mathcal{A}^{\perp}_{CP2}$	0.027	0.010	0.030	0.010	0.002	$\cdots$	0.043
$\Delta\phi_{\parallel 2}$	0.146	0.033	0.979	0.010	0.017	$\cdots$	0.991
$\Delta\phi_{\perp 2}$	0.057	0.011	0.013	0.006	0.014	$\cdots$	0.062
$\Delta\delta_{02}$	0.006	0.002	0.009	0.001	0.003	$\cdots$	0.011

$B^0 \to \phi K^*$ - Model details 1

- Angular distribution

$$\frac{d^3\Gamma}{d\cos\theta_1 d\cos\theta_2 d\Phi} \propto |\sum_\lambda A_{J\lambda} Y_J^\lambda(\theta_1,\Phi) Y_1^{-\lambda}(-\theta_2,0)|^2$$

- Mass distribution (P- and D-wave):

$$R_J(m) = \frac{m_J\Gamma_J(m)}{(m_J^2-m^2)-im_J\Gamma_J(m)} = \sin\delta_J e^{i\delta_J}$$

$$\cot\delta_J = \frac{m_J^2-m^2}{m_J\Gamma_J(m)}$$

$$\Gamma_1(m) = \Gamma_1\frac{m_1}{m}\frac{1+r^2q_1^2}{1+r^2q^2}\left(\frac{q}{q_1}\right)^3$$

$$\Gamma_2(m) = \Gamma_2\frac{m_2}{m}\frac{9+3r^2q_2^2+r^4q_2^4}{9+3r^2q^2+r^4q^4}\left(\frac{q}{q_2}\right)^5$$

$B^0 \to \phi K^*$ - Model details 2

- Mass distribution (S-wave, LASS model):

$$R_0(m) = \sin\delta_0 e^{i\delta_0}$$

$$\delta_0 = \Delta R + \Delta B$$

ΔR represents a resonant contribution from $K_0^*(1430)^0$ while ΔB denotes a non-resonant contribution. The resonant part is defined as

$$\cot\Delta R = \frac{m_0^2 - m^2}{m_0\Gamma_0(m)},$$

where m_0 and Γ_0 are the resonance mass and width, and $\Gamma_0(m)$ is given by

$$\Gamma_0(m) = \Gamma_0\frac{m_0}{m}\left(\frac{q}{q_0}\right).$$

The non-resonant part is defined as

$$\cot\Delta B = \frac{1}{aq} + \frac{bq}{2}$$

where a is the scattering length and b is the effective range.

$B^0 \to \phi K^*$ - Model details 3

- Joined matrix element:

$$|\mathcal{M}|^2 = |\mathcal{A}_0\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right) + \mathcal{A}_1\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right) + \mathcal{A}_2\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right)|^2$$

$$\mathcal{A}_0\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right) = A_{00}\, Y_0^0(\theta_1, \Phi)\, Y_1^0(-\theta_2, 0) \times M_0(M_{K\pi})$$

$$\mathcal{A}_1\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right) = \sum_{\lambda=0,\pm1} A_{1\lambda}\, Y_1^{\lambda}(\theta_1, \Phi)\, Y_1^{-\lambda}(-\theta_2, 0) \times M_1(M_{K\pi})$$

$$\mathcal{A}_2\left(M_{K\pi}, \cos\theta_1, \cos\theta_2, \Phi\right) = \sum_{\lambda=0,\pm1} A_{2\lambda}\, Y_2^{\lambda}(\theta_1, \Phi)\, Y_1^{-\lambda}(-\theta_2, 0) \times M_2(M_{K\pi})$$

$B^0 \to \phi K^*$ - Model details 4

- Final partial width:

$$\frac{d^4\Gamma}{d\cos\theta_1 d\cos\theta_2 d\Phi dM_{K\pi}} = F_{M_{\phi K}}\left(M_{K\pi}\right) \times \frac{(1+Q)\times|\mathcal{M}^+|^2 + (1-Q)\times|\mathcal{M}^-|^2}{2\mathcal{N}}$$

where $\mathcal{M}^+$ ($\mathcal{M}^-$) is the matrix element for $B^0 \to \phi(K^+\pi^-)^*$ ($\bar{B}^0 \to \phi(K^-\pi^+)^*$), $Q = \pm 1$ depending on the charge of the primary charged kaon from the B meson and $\mathcal{N}$ is the overall normalization given by

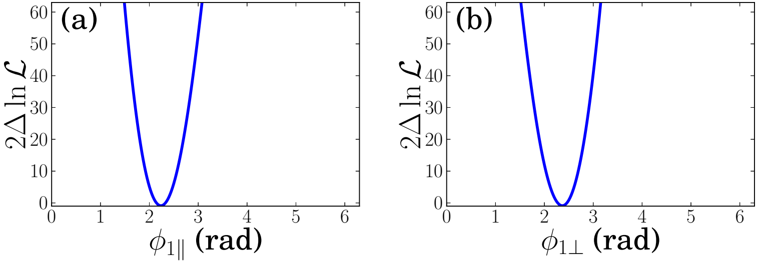
$$\mathcal{N} = \frac{1}{2}\int |\mathcal{M}^+|^2 \times F_{M_{\phi K}}\left(M_{K\pi}\right) d\cos\theta_1 d\cos\theta_2 d\Phi dM_{K\pi} + \frac{1}{2}\int |\mathcal{M}^-|^2 \times F_{M_{\phi K}}\left(M_{K\pi}\right) d\cos\theta_1 d\cos\theta_2 d\Phi dM_{K\pi}$$

$B^0 \to \phi K^*$ - Fit fractions per partial wave

Parameter	$\phi(K\pi)^*_0$ $J = 0$	$\phi K^*(892)^0$ $J = 1$	$\phi K^*_2(1430)^0$ $J = 2$
FF_J	$0.273 \pm 0.024 \pm 0.013$	$0.600 \pm 0.020 \pm 0.012$	$0.099^{+0.016}_{-0.012} \pm 0.012$
$\mathcal{B}_J$ (10^{-6})	$4.3 \pm 0.4 \pm 0.3$	$10.4 \pm 0.5 \pm 0.5$	$5.5^{+0.9}_{-0.7} \pm 0.7$

Sum of all fit fractions $FF_{\Sigma} = (97.2 \pm 0.7)\%$ with error being stat. only

$B^0 \to \phi K^*$ - Phase Ambiguity



Scan of the negative log likelihood as function of (a) $\phi_{\|1}$ and (b) $\phi_{\perp 1}$. One single discrete solution is found for each of the two phases.

$B^0 \to K^+K^-\pi^0$ - Systematics

Source	Uncertainties (%)	
Signal PDF	$+3.4$	-2.9
Generic $B\bar{B}$ PDF	$+2.4$	-3.1
Combinatorial background PDF	$+1.3$	-2.0
Peaking background PDFs	$+1.7$	-1.9
Fixed histogram PDF	$+1.7$	-2.0
Signal C'_{NB} functional dependence	$+2.3$	-2.3
Fixed SCF fraction	$+1.7$	-1.7
Fit bias	$+2.4$	-2.4
Continuum suppression	$+2.2$	-2.2
Requirement on M_{bc}	$+1.5$	-0.2
Kaon ID requirement	$+1.9$	-1.9
π^0 detection efficiency	$+4.0$	-4.0
Charged track reconstruction	$+0.7$	-0.7
Efficiency variation over Dalitz plot	$+7.5$	-7.5
Number of $B\bar{B}$ pairs	$+1.4$	-1.4
Total	$+11.1$	-11.3

$B^0 \rightarrow K^+K^-\pi^0$ - KK structure (BaBar and LHCb)

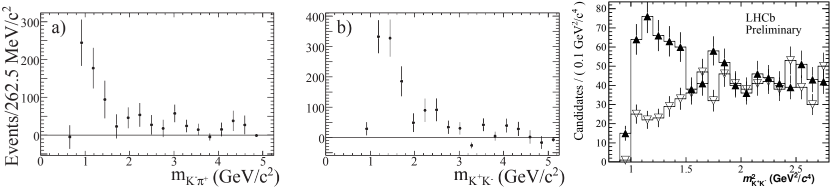


Figure: Two-body invariant mass projections from BaBar (left, center) and LHCb (right) analysis on $B^{\pm} \rightarrow K^+K^-\pi^{\pm}$