

# Physics of the $B$ Factory Charmless Section

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# Outline

- Proposal for Section Structure
- Theoretical Input
- Collaborators/Contributors/Number of pages
- Overlaps with other sections
- Motivation, results and physics
- Future results and plans
- List of references

# Section Layout

The section structure is reasonably simple as results generally follow a common analysis plan:

- Motivation
- Theory
- Two-Body/Quasi-Two-Body
  - Results (perhaps broken down by helicity, VV, AV, etc.)
  - Interpretation/Discussion
- Three-body
  - Results
  - Interpretation/Discussion
- Summary/Look forward

# Theoretical Input

- Beneke as theorist
- Aim of section is to be a bridge between a post-graduate and the detailed literature.
- Naive and QCD Factorization
- Flavour SU(3)
- Perturbative QCD
- Soft Collinear Effective Theory
- G-Parity
- Polarization description
- Dalitz: assumes S-matrix and K-matrix is described elsewhere (e.g. Dalitz section)
- Dalitz:  $\kappa$ ,  $\sigma$ , LASS, higher mass states and non-resonant should also be described. Need to discuss breakdown between here and Dalitz section.
- There are competing predictions for various experimental modes; need to think how to report differences.

# Possible Discussion Points in text

- Two-body, quasi-two-body
  - AV v. VV v. VT etc.
  - G-Parity predictions
  - Explanation of theoretical  $B$ , asymmetry predictions
  - Table of predictions?
  - Explanation of polarization predictions
  - Overlap with ideas on extracting angles and potential for  $B$  Factory
  - Flavour asymmetry
  - Charge asymmetry
  - K-matrix (if not previously described)
  - Triple Product correlations (e.g. in  $\phi K^*$ )
- Three-body
  - Explanation of theoretical predictions
  - Table of predictions?
  - Backgrounds
  - Model dependence
  - Overlap with Dalitz section
- General
  - Combining results

## Contributors/Overlaps/Reporting

- Beneke as theorist but may need other input.
- Can re-use many of the angles' people.
- Many possible BaBar people have been identified
- No Belle section co-editor. Would be useful to have Belle input, especially for Dalitz interpretation.
- Large overlaps with angle sections. Need to discuss with angle section editors how to allocate papers (or parts thereof).
- This section will describe many of the selection criteria used in angles' section. Therefore, section may be larger than previously expected.
- Unlikely to be able to report on all results (or all models).
- Tables will be large (e.g. BaBar and Belle results, Naive and QCD Factorization predictions).
- Number of pages: 20 but at the moment some large error on this

# Motivation, results and physics

Following pages tabulate the known papers.

- BaBar papers as far back as 2005 from SPIRES (90 papers)
- Belle papers from start of experiment (76 papers)
- Tables that follow are not fully updated (intended to show what papers reported  $\mathcal{B}$ , Dalitz results, CP and overlap with CKM angles).
- Probably (definitely) some missing (e.g. three-body Baryonic B-decays from Belle)
- Many papers have been superceded
- Overlap with other analyses
- I have not read all the papers (recently)!
- List of references at the end of these slides or in the agenda web-page.

# General Papers

Decay	<i>BABAR</i>	Belle	$\mathcal{B}$	Dalitz	<i>CP</i>	CKM
General 3B	[1]	[2]				
General 2B/Q2B	[3]	[4, 5, 6]				
General Dalitz	[7]					

- Reference numbers refer to papers listed in accompanying slides on web-page.
- Number of papers: 7
- Useful example of condensed reporting
- Probably not a primary source.

## $a_1(1260)$ , $a_0$ and $b_1$

- AV decays compared with VV, VT etc.
- No predictions for  $\mathcal{B}$  when  $B$  Factory started.
- Naive and QCD factorization models give different order of magnitude for  $\mathcal{B}$ .
- Tree diagrams favour decays with  $\pi$  but disfavour decays with  $K$ ; penguin diagrams do the opposite.
- Major results:  $\mathcal{B}$ , assymmetries and longitudinal polarization.
- G-parity forbids  $b_1\pi$ .
- Direct CP, Flavour asymmetries in  $b_1$ .
- Follow very similar techniques
- Overlaps: Some/all of  $a_1(1260)$  can be in  $\phi_2/\alpha$  section
- $a_1(1260)$  paper uses K-matrix formulism.
- Number of papers: 12
- Table of results needed.

$a_1(1260)$ ,  $a_0$  and  $b_1$

Decay	<i>BABAR</i>	Belle	$\mathcal{B}$	Dalitz	$CP$	CKM
$a_1^\pm(1260) \pi^\pm$	[8, 9]					
$a_1^\pm(1260) \pi^0, a_1^0(1260) \pi^+$	[10]					
$a_1^+(1260) K^0, a_1^-(1260) K^+$	[11]					
$a_1^\pm(1260) \pi^\mp$	[12, 13]					
$a_1^\pm(1260) \rho^\mp$	[14]					
$a_0^+ \pi^0$	[15]					
$a_0\pi, a_0 K, \eta\rho^0, \eta f_0(980)$	[16]					
$b_1\rho, b_1 K^*$	[17]					
$b_1 K^0, b_1^0 K^0, b_1 \pi^0$	[18]					
$b_1\pi, b_1 K$	[19]					

- Tests of:
  - QCD Factorization
  - Flavour SU(3)
  - Perturbative QCD
  - Soft Collinear Effective Theory
- Main results:  $\mathcal{B}$ , polarization (VV, VT), charge asymmetries
- Follow very similar techniques
- How to order? Probably in  $\eta$ ,  $\eta'$ , and  $\omega$  sections
- Overlaps with angles's section e.g.  $\eta'$  modes.
- Number of papers: 30
- Some papers have been superceded
- Large table of results

# $\eta, \eta', \omega$ final states

Decay	BABAR	Belle	$\mathcal{B}$	Dalitz	CP	CKM
$\eta\eta, \eta\eta'$	[20, 21]					
$\eta\rho^+, \eta\eta', \eta' \pi^0, \omega\pi^0$	[22, 23]					
$\eta K^\pm, \eta\pi^\pm$	[24]					
$\eta K, \eta\pi$		[25]				
$\eta K^*, \eta\rho$	[26]	[27, 28]				
$\eta K_s^0, \eta\eta, \eta' \eta', \eta\phi, \eta' \phi$	[29]					
$\eta\pi^+, \eta K^+, \eta\rho^+, \eta' \pi^+$	[30]					
$\eta' K, \eta'\pi$	[24]	[31, 32, 33, 34, 35]				
$\eta' (\rho, K^*, \phi, \omega, \eta')$		[36]				
$\eta' K^*, \eta' \rho^+$	[37]					
$\eta' \eta' K$	[38]					
$\omega K, \omega\pi$	[39, 24]	[40, 41, 42]				
$\omega (K^*, \rho, \omega, \phi, f_0(980))$	[43, 44]	[45]				
$K_s^0 (\omega, \eta', \pi^0)$	[46, 47]					

## $\phi$ results

- Vector-Vector polarization
- Left-handed couplings → New Physics
- $\phi\phi$  OZI suppressed → any enhancement could be New Physics.
- $\phi\phi K$   $CP$  asymmetry in Standard Model is zero → any  $CP$  asymmetry could be New Physics.
- Includes two-body, quasi-two-body and three-body results
- Group together or split among two and three-body results.
- Number of papers: 14

# $\phi$ results

Decay	BABAR	Belle	$\mathcal{B}$	Dalitz	$CP$	C
$\phi K_s^0 \pi^0, \phi K^+ \pi^-$	[48]					
$\phi K^+ \pi^-$	[49]					
$\phi K^*$	[50]	[51, 52]				
$\phi\phi, \phi\rho, \phi f_0(980), f_0(980) f_0(980)$	[53]					
$\phi K_1^+, \phi K_2^{*\pm}$	[54]					
$\phi\phi K, \phi\phi K_s^0$	[55]	[56]				
$\phi\pi^0, \phi\pi^+$	[57]					
$\phi K_s^0$	[58]	[59, 60, 34]				

# $B \rightarrow hh$ ( $h = \pi^0, \pi^\pm, K^0, K^\pm$ ) final states

- $\mathcal{B}$  reported here?
- What about  $CP$ ?
- Majority should appear in  $\phi_2/\alpha$  section but not all?
- Follow similar but not exactly the same techniques
- Number of papers: 29 (but many updates).

Decay	<i>BABAR</i>	Belle	$\mathcal{B}$	Dal
$K_s^0 \pi^0, K^0 \pi^0$	[61, 62]	[63]		
$K^0 K^+, K^0 \bar{K}^0, K^0 \pi^+, K^0 K^0, K^+ \bar{K}^0$	[64, 65]	[66, 67]		
$K^+ \pi^-$	[68, 69]	[70]		
$\pi^+ \pi^-$	[69, 71]	[72, 73, 74, 75]		
$K\pi, \pi\pi$		[76, 77, 78, 79]		
$KK$		[80, 81, 77, 79]		
$\pi^0 \pi^0, \pi^\pm \pi^0, K^\pm \pi^0$	[82, 83]	[84, 85]		
$hh$		[86]		
$K_1(1270)\pi, K_1(1400)\pi$	[8]			

## $\rho\rho$ results

Can probably all go in  $\phi_2/\alpha$  section but... polarization an important measurement.

Decay	BABAR	Belle	$\mathcal{B}$	Dalitz	$CP$	CKM
$\rho^+ \rho^0$	[87, 88]	[89]				
$\rho^0 \rho^0$	[90, 91, 92]	[93]				
$\rho^+ \rho^-$	[94, 95]	[96, 97, 98]				
$\rho\rho$	[99]					

# $\rho h(h = \pi K$ results

- $\rho\pi$  can all go in  $\phi_2/\alpha$  section
- $\rho K^*, \rho K\pi$  could be grouped with  $K^*$  results.
- Number of papers: 16

Decay	BABAR	Belle	$\mathcal{B}$	Dalitz	$CP$	CKM
$(\rho\pi)^0$	[100, 101]	[102, 103, 104, 105]				
$\rho\pi$		[106]				
$\rho^+ \pi^0$	[107]	[108]				
$\rho^+ K_s^0$	[109]					
$\rho^0 K_s^0$	[110]					
$\rho^0 K^+$		[111]				
$\rho^- K^+$		[112]				
$\rho^+ K^*$	[113]	[114]				
$\rho^0 K^+ \pi^-$		[115]				

# $K^*K^*$ , $K^*h$ , $K^*hh$ results

- Main results: VV Polarization,  $\mathcal{B}$ .
- $K^{*0} \chi_{c0}$  forbidden as a quark level process.
- Factorization predictions and interpretations.
- BaBar v. Belle significances for resonances v. non-resonant results.
- Implications for  $\phi_3/\gamma$ .
- Number of papers: 10

Decay	BABAR	Belle
$K^{*0} K$	[116]	
$\bar{K}^{*0} K^{*+}$	[117, 118]	
$K^{*0} \chi_{c0}, K^{*+} \chi_{c0}$	[119, 120]	
$K^{*0} \bar{K}^{*0}, K^{*0} K^{*0}$	[121]	[122]
$K^{*+} K^{*-}$	[123]	
$K^{*0} K^+ K^-, K^{*0} \pi^+ K^-, K^{*0} K^+ \pi^-, K^{*0} \pi^+ \pi^-$	[124]	
$K^{*+} K^+ K^-, K^{*+} \pi^+ K^-, K^{*+} K^+ \pi^-, K^{*+} \pi^+ \pi^-$	[125]	

# Three-Body and Dalitz decays

- Very many results from each paper
- Need a lot of space to report results for each decay ( $\mathcal{B}$ , fit fraction, phase, amplitude, theory predictions, model dependence, etc.)
- Important interpretation of results
- Number of papers: 31
- Some overlap with quasi-two body results and angles section.

# Three-Body and Dalitz decays

## Main Results

- $\mathcal{B}$
- Fit Fraction
- Amplitude
- Phase
- Upper limits
- Charge Asymmetries
- (Time-dependent asymmetries)
- Backgrounds

## Interpretation

- Implications of  $\mathcal{B}$ , Fit Fraction, Amplitude, Phase
- S-Matrix and K-Matrix
- Non-resonant backgrounds
- Higher Mass resonances
- S-Wave (LASS)
- $\kappa, \sigma$
- Extracting CKM angles

# Three-Body and Dalitz decays

Decay	<i>BABAR</i>	<i>Belle</i>	$\mathcal{B}$	Dalitz	$CP$	C
$K_s^0 \pi^- \pi^+$	[126, 127, 128]	[129, 130]				
$K_s^0 \pi^0 \pi^0$	[131]					
$K^\pm \pi^\mp \pi^0$	[132]			[112]		
$K^+ K^- \pi^+$	[133]					
$K^+ \pi^- \pi^-, K^- K^- \pi^+$	[134]					
$K^\pm \pi^\mp \pi^\pm$	[135, 136]			[111, 137]		
$K^+ K^- K^+$	[138]			[137]		
$\chi_{c0} K^+$				[139]		
$K^+ K^- K_s^0$	[140, 141, 58]			[142, 60, 34]		
$K_s^0 K_s^0 (\pi^0, \eta, \eta')$	[143]					
$K_s^0 K_s^0 \pi^+$	[144]					
$K_s^0 K_s^0 K_s^0$	[145, 146]			[147, 148]		
$\pi^+ \pi^+ \pi^-$	[149, 150]					

# Do these have a home?

Probably need to include three-body baryonic B-decays here.

Decay	BABAR	Belle	$\mathcal{B}$	Dalitz	$CP$	CKM
$p \bar{p} K^{*0}$			[151]			
$p \bar{p} K^+, p \bar{p} \pi^+$			[152]			
$p \bar{p}, \Lambda\bar{\Lambda}, p\bar{\Lambda}$			[153]			
$s\bar{s}$		[154]				

# Conclusion and Plans

- There are still many papers in the pipeline: BaBar VV modes, Belle and BaBar Dalitz updates.
- New papers can be included as and when they arrive.
- Need some theoretical input, interpretation. Liase with Beneke and charm section editor
- See following slides for References (or the agenda page for a better formatted version).
- Tentative plans before next meeting:
  - Discuss with angle section editors exact breakdown of papers.
  - Start discussion with theory contributor on the level of theoretical discussion and topics.
  - Start writing a first draft.



B. Aubert et al.

"Charmless hadronic three body  $B$  decays at *BABAR*".

*Int. J. Mod. Phys. A*24, 434–437, 2009.



A. Garmash et al.

Study of  $B$  meson decays to three-body charmless hadronic final states.

*Phys. Rev.*, D69:012001, 2004.



B. Aubert et al.

" $B$  Meson decays to quasi-two-body charmless final states at *BABAR*".

*Int. J. Mod. Phys. A*20, 3581–3583, 2005.



B. C. K. Casey et al.

Charmless hadronic two-body  $B$  meson decays.

*Phys. Rev.*, D66:092002, 2002.



B. C. K. Casey.

Rare  $B$  meson decays without charm from *Belle*.

*Int. J. Mod. Phys.*, A16S1A:452–457, 2001.



K. Abe et al.

Search for charmless two-body baryonic decays of  $B$  mesons.

*Phys. Rev.*, D65:091103, 2002.



B. Aubert et al.

"Dalitz plot analyses of charmless  $B$  decays".

*Int. J. Mod. Phys. A*20, 3559–3561, 2005.



B. Aubert et al.

"Measurement of branching fractions of  $B$  decays to  $K_1(1270)\pi$  and  $K_1(1400)\pi$  and the determination of the CKM angle alpha from  $B^0 \rightarrow a_1^\pm(1260) \pi^\mp$ ".

*Phys. Rev. D* 81, 052009, 2010.



B. Aubert et al.

"Observation and Polarization Measurement of  $B^0 \rightarrow a_1^+(1260) a_1^-(1260)$  decay".



B. Aubert et al.

"Evidence for charged  $B$  meson decays to  $a_1^\pm(1260)\pi^0$  and  $a_1^0(1260)\pi^\pm$ ".  
*Phys. Rev. Lett.* **99**, 261801, 2007.



B. Aubert et al.

"Observation of  $B^+ \rightarrow a_1^+(1260)K^0$  and  $B^0 \rightarrow a_1^-(1260)K^+$ ".  
*Phys. Rev. Lett.* **100**, 051803, 2008.



B. Aubert et al.

"Measurements of the  $CP$ -violating asymmetries in  $B^0 \rightarrow a_1^\pm(1260)\pi^\mp$  decays".  
*Phys. Rev. Lett.* **98**, 181803, 2007.



B. Aubert et al.

"Observation of  $B^0$  meson decay to  $a_1^\pm(1260)\pi^\mp$ ".  
*Phys. Rev. Lett.* **97**, 051802, 2006.



B. Aubert et al.

"Search for the decay  $B^0 \rightarrow a_1^\pm(1260)\rho^\mp$ ".  
*Phys. Rev. D* **74**, 031104, 2006.



B. Aubert et al.

"Search for the rare charmless hadronic decay  $B^+ \rightarrow a_0^+\pi^0$ ".  
*Phys. Rev. D* **77**, 011101, 2008.



B. Aubert et al.

"Search for neutral  $B$  meson decays to  $a_0\pi^0$ ,  $a_0K$ ,  $\eta\rho^0$  and  $\eta f_0(980)$ ".  
*Phys. Rev. D* **75**, 111102, 2007.



B. Aubert et al.

"Search for  $B$  meson decays to  $b_1\rho$  and  $b_1K^*$ ".  
*Phys. Rev. D* **80**, 051101, 2009.



B. Aubert et al.

"Observation of  $B^+ \rightarrow b_1^+ K^0$  and the search for  $B$  meson decays to  $b_1^0 K^0$  and  $b_1^- \pi^0$ ".  
*Phys. Rev. D* **78**, 011104, 2008.



B. Aubert et al.

"Observation of  $B$  meson decays to  $b_1 \pi$  and  $b_1 K$ ".  
*Phys. Rev. Lett.* **99**, 241803, 2007.



B. Aubert et al.

" $B$  meson decays to charmless meson pairs containing  $\eta$  or  $\eta'$  mesons".  
*Phys. Rev. D* **80**, 112002, 2009.



B. Aubert et al.

"Study of  $B$  meson decays with excited  $\eta$  and  $\eta'$  mesons".  
*Phys. Rev. Lett.* **101**, 091801, 2008.



B. Aubert et al.

"Observation of  $B^+ \rightarrow \eta \rho^+$  and search for  $B^0$  decays to  $\eta' \eta$ ,  $\eta \pi^0$ ,  $\eta' \pi^0$  and  $\omega \pi^0$ ".  
*Phys. Rev. D* **78**, 011107, 2008.



B. Aubert et al.

"Branching fraction limits for  $B^0$  decays to  $\eta' \eta$ ,  $\eta' \pi^0$  and  $\eta \pi^0$ ".  
*Phys. Rev. D* **73**, 071102, 2006.



B. Aubert et al.

"Branching fraction and  $CP$ -violation charge asymmetry measurements for  $B$  meson decays to  $\eta K^\pm$ ,  $\eta \pi^\pm$ ,  $\eta' K$ ,  $\eta' \pi^\pm$ ,  $\omega K$  and  $\omega \pi^\pm$ ".  
*Phys. Rev. D* **76**, 031103, 2007.



K. Abe et al.

Improved measurements of branching fractions and  $CP$  asymmetries in  $B \rightarrow \eta h$  decays.  
*Phys. Rev.*, D75:071104, 2007.



B. Aubert et al.

"Measurement of the branching fractions and charge asymmetries in  $B$  decays to an  $\eta$  meson and a  $K^*$  meson".  
*Phys. Rev. Lett.* **97**, 201802, 2006.



C. H. Wang et al.

Measurement of charmless  $B$  Decays to  $\eta K^*$  and  $\eta \rho$ .  
*Phys. Rev.*, D75:092005, 2007.



F. Fang et al.

Measurement of branching fractions for  $B \rightarrow \eta_c K^{(*)}$  decays.  
*Phys. Rev. Lett.*, 90:071801, 2003.



B. Aubert et al.

"Searches for  $B^0$  decays to  $\eta K^0$ ,  $\eta \eta$ ,  $\eta' \eta'$ ,  $\eta \phi$ ,  $\eta' \phi'$ ".  
*Phys. Rev. D* **74**, 051106, 2006.



B. Aubert et al.

"Measurement of the branching fractions and charge asymmetries in  $B^+$  decays to  $\eta \pi^+$ ,  $\eta K^+$ ,  $\eta \rho^+$  and  $\eta' \pi^+$ , and search for  $B^0$  decays to  $\eta K^0$  and  $\eta \omega$ ".  
*Phys. Rev. D* **95**, 131803, 2005.



J. Schumann et al.

Evidence for  $B \rightarrow \eta' \pi$  and improved measurements for  $B \rightarrow \eta' K$ .  
*Phys. Rev. Lett.*, 97:061802, 2006.



K. F. Chen et al.

Measurement of CP-violating parameters in  $B \rightarrow \eta' K$  decays.  
*Phys. Lett.*, B546:196–205, 2002.



P. Chang et al.

Measurements of Branching Fractions and CP Asymmetries in  $B \rightarrow \eta h$  Decays.  
*Phys. Rev.*, D71:091106, 2005.



K. Abe et al.

Measurement of time-dependent CP-violating asymmetries in  $B^0 \rightarrow \phi K_S^0$ ,  $K^+ K^- K_S^0$  and  $\eta' K_S^0$  decays.



K. Abe et al.

Measurement of the branching fraction for  $B \rightarrow \eta' K$  and search for  $b \rightarrow \eta' \pi^+$ .

Phys. Lett., B517:309–318, 2001.



J. Schumann et al.

Search for  $B$  decays into  $\eta' \rho$ ,  $\eta' K^*$ ,  $\eta' \phi$ ,  $\eta' \omega$  and  $\eta' \eta^{(\prime)}$ .

Phys. Rev., D75:092002, 2007.



B. Aubert et al.

"Observation of  $B \rightarrow \eta' K^*$  and evidence for  $B^+ \rightarrow \eta' \rho^+$ ".

Phys. Rev. Lett. 98, 051802, 2007.



B. Aubert et al.

"Search for the  $B$  meson decays to  $\eta' \eta' K$ ".

Phys. Rev. D 74, 031105, 2006.



B. Aubert et al.

"Measurements of the  $CP$ -violating asymmetries and branching fractions in  $B$  decays to  $\omega K$  and  $\omega \pi$ ".

Phys. Rev. D 74, 011106, 2006.



C. M. Jen et al.

Improved measurements of branching fractions and  $CP$  partial rate asymmetries for  $B \rightarrow \omega K$  and  $B \rightarrow \omega \pi$ .

Phys. Rev., D74:111101, 2006.



C. H. Wang et al.

Measurement of the branching fractions for  $b \rightarrow \omega K$  and  $B \rightarrow \omega \pi$ .

Phys. Rev., D70:012001, 2004.



R. S. Lu et al.

Observation of  $B^\pm \rightarrow \omega K^\pm$  decay.

Phys. Rev. Lett., 89:191801, 2002.



B. Aubert et al.

"Observation of  $B$  meson decays to  $\omega K^*$  and Improved Measurements for  $\omega\rho$  and  $\omega f_0(980)$ ".

*Phys. Rev. D* **79**, 052005, 2009.



B. Aubert et al.

" $B$  meson decays to  $\omega K^*$ ,  $\omega\rho$ ,  $\omega\omega$ ,  $\omega\phi$  and  $\omega f_0(980)$ ".

*Phys. Rev. D* **74**, 051102, 2006.



P. Goldenzweig et al.

Evidence for Neutral  $B$  Meson Decays to  $\omega K^{*0}$ .

*Phys. Rev. Lett.*, 101:231801, 2008.



B. Aubert et al.

"Measurement of the time-dependent  $CP$  asymmetry parameters in  $B^0$  meson decays to  $\omega K_S^0$ ,  $\eta' K_S^0$  and  $\pi^0 K_S^0$ ".

*Phys. Rev. D* **79**, 052003, 2009.



B. Aubert et al.

"Observation of  $CP$  violation in  $B^0 \rightarrow \eta' K^0$  decays".

*Phys. Rev. Lett.* **98**, 031801, 2007.



B. Aubert et al.

"Time-Dependent and Time-Integrated Angular Analysis of  $B^0 \rightarrow \phi K_S^0 \pi^0$  and  $B^0 \rightarrow \phi K^+ \pi^-$ ".

*Phys. Rev. D* **78**, 092008, 2008.



B. Aubert et al.

"Search for  $B^0 \rightarrow \phi(K^+ \pi^-)$  decays with large  $K^+ \pi^-$  invariant mass".

*Phys. Rev. D* **76**, 051103, 2007.



B. Aubert et al.

"Vector-Tensor and Vector-Vector decay amplitude analysis of  $B^0 \rightarrow \phi K^{*0}$ ".

*Phys. Rev. Lett.* **98**, 051801, 2007.



K. F. Chen et al.

Measurement of polarization and triple-product correlations in  $B \rightarrow \phi K^*$  decays.

*Phys. Rev. Lett.*, 94:221804, 2005.



K. F. Chen et al.

Measurement of branching fractions and polarization in  $B \rightarrow \phi K^{(*)}$  decays.  
*Phys. Rev. Lett.*, 91:201801, 2003.



B. Aubert et al.

"Searches for  $B$  meson decays to  $\phi\phi$ ,  $\phi\rho$ ,  $\phi f_0(980)$ ,  $f_0(980)f_0(980)$  final states".  
*Phys. Rev. Lett.* 101, 201801, 2008.



B. Aubert et al.

"Observation and polarization measurement of  $B^+ \rightarrow \phi K_1^\pm$  and  $B^+ \rightarrow \phi K_2^{*\pm}$ ".  
*Phys. Rev. Lett.* 101, 161801, 2008.



B. Aubert et al.

"Observation of  $B^0 \rightarrow \phi\phi K$  and evidence for  $B^0 \rightarrow \phi\phi K_S^0$  below  $\eta_c$  threshold".  
*Phys. Rev. Lett.* 97, 261803, 2006.



H. C. Huang et al.

Observation of  $B \rightarrow \phi\phi K$ .  
*Phys. Rev. Lett.*, 91:241802, 2003.



B. Aubert et al.

"Search for  $B^+ \rightarrow \phi\pi^+$  and  $B^0 \rightarrow \phi\pi^0$  decays".  
*Phys. Rev. D* 74, 011102, 2006.



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