Marcella Bona

charmless two-body B decays at BaBar

Study of the two-body charmless' B decays with the BaBar experiment

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XXXIII International Conference on High Energy Physics
Москва, Российская Федерация
July 27th 2006

ICHEP06, Heavy Quark Physics, July 27th, 2006

motivations

- Charmless two-body B decays are a very rich source of information for
 - + improving knowledge of fundamental parameters (weak phases and CP violation effects)
 - + constraining New Physics effects (several loop dominated decays)
 - + understanding B decays: all the diagram topologies enter in the amplitudes

A.Lazzaro
A.Telnov
@ CP violation

G.Hamel de Monchenault
@ Beyond the SM

- Perturbative calculation are possible in the limit $m_b \rightarrow \infty$ (QCD factorisation, pQCD, SCET..)

$$\langle B^0 | J_\mu J^\mu | K \pi \rangle = \langle B^0 | J_\mu | \pi \rangle \langle 0 | J^\mu | K \rangle (1 + O(\alpha_s)) + O\left(\frac{\Lambda_{QCD}}{m_b}\right)$$

- a clear demonstration that penguins do factorize is still missng: relevant contribution from charming penguins, confirmed by SCET.

a world of diagrams

Renormalization **G**roup
Invariant **q**uantities
(**B**uras & **S**ilvestrini,
hep-ph/9812392)

Charming and
GIM penguins (c-u)

Disconnected Annihilation

and a zoo of amplitudes

Charming Penguin $\sim \lambda^2$

$V_{us} V_{ub}^* \sim \lambda^4$

$$\begin{aligned}
 A(B^0 \rightarrow K^+ \pi^-) &= V_{ts} V_{tb}^* \times P_I(c) - V_{us} V_{ub}^* \times \{ \mathbf{E}_1 - \mathbf{P}_I^{GIM}(u-c) \} \\
 A(B^+ \rightarrow K^0 \pi^+) &= -V_{ts} V_{tb}^* \times P_I(c) + V_{us} V_{ub}^* \times \{ \mathbf{A}_1 - \mathbf{P}_I^{GIM}(u-c) \} \\
 \sqrt{2} \cdot A(B^+ \rightarrow K^+ \pi^0) &= V_{ts} V_{tb}^* \times P_I(c) - V_{us} V_{ub}^* \times \{ \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{A}_1 - \mathbf{P}_I^{GIM}(u-c) \} \\
 \sqrt{2} \cdot A(B^0 \rightarrow K^0 \pi^0) &= -V_{ts} V_{tb}^* \times P_I(c) - V_{us} V_{ub}^* \times \{ \mathbf{E}_2 + \mathbf{P}_I^{GIM}(u-c) \}
 \end{aligned}$$

Charming Penguin $\sim \lambda^3$

$V_{ud} V_{ub}^* \sim \lambda^3$

$$\begin{aligned}
 A(B^0 \rightarrow \pi^+ \pi^-) &= V_{td} V_{tb}^* \times P_I(c) - V_{ud} V_{ub}^* \times \{ \mathbf{E}_1 + \mathbf{A}_2 - \mathbf{P}^{GIM}(u-c) \} \\
 \sqrt{2} \cdot A(B^+ \rightarrow \pi^+ \pi^0) &= V_{ud} V_{ub}^* \times \{ \mathbf{E}_1 + \mathbf{E}_2 \} \text{ 🌲} \\
 \sqrt{2} \cdot A(B^0 \rightarrow \pi^0 \pi^0) &= -V_{td} V_{tb}^* \times P_I(c) - V_{ud} V_{ub}^* \times \{ \mathbf{E}_2 - \mathbf{A}_2 + \mathbf{P}_I^{GIM}(u-c) \}
 \end{aligned}$$

Charming Penguin $\sim \lambda^3$

$V_{ud} V_{ub}^* \sim \lambda^3$

$$\begin{aligned}
 A(B^0 \rightarrow K^+ K^-) &= -V_{td} V_{tb}^* \times P_I(c) - V_{ud} V_{ub}^* \times \mathbf{A}_2 \text{ 👻} \\
 A(B^+ \rightarrow K^+ K^0) &= -V_{td} V_{tb}^* \times P_I(c) + V_{ud} V_{ub}^* \times \{ \mathbf{A}_1 - \mathbf{P}_I^{GIM}(u-c) \} \\
 A(B^0 \rightarrow \bar{K}^0 K^0) &= -V_{td} V_{tb}^* \times P_I(c) - V_{ud} V_{ub}^* \times \{ \mathbf{P}_I^{GIM}(u-c) \}
 \end{aligned}$$

a scary world:

charmless two-body B decays at BaBar

Channel	Cl.	E_1 1	E_2 $\frac{1}{N}$	EA_2 $\frac{1}{N^2}$	A_2 $\frac{1}{N}$	P_1 $\frac{1}{N}$	P_2 $\frac{1}{N^2}$	P_3 $\frac{1}{N^2}$	P_1^{GIM} $\frac{1}{N}$	P_2^{GIM} $\frac{1}{N^2}$	P_3^{GIM} $\frac{1}{N^2}$	P_4 $\frac{1}{N^3}$	P_4^{GIM} $\frac{1}{N^3}$
$B_d \rightarrow D^- \pi^+$	A	λ^2	—	—	λ^2	—	—	—	—	—	—	—	—
$B_d \rightarrow \bar{D}^0 \pi^0$	A	—	λ^2	$[\lambda^2]$	λ^2	—	—	—	—	—	—	—	—
$B_d \rightarrow D^- K^+$	B	λ^3	—	—	—	—	—	—	—	—	—	—	—
$B_d \rightarrow \bar{D}^0 K^0$	B	—	λ^3	—	—	—	—	—	—	—	—	—	—
$B_d \rightarrow D^0 K^0$	B	—	λ^3	—	—	—	—	—	—	—	—	—	—
$B_d \rightarrow D_s^+ \pi^-$	B	λ^3	—	—	—	—	—	—	—	—	—	—	—
$B_d \rightarrow J/\psi K^0$	C	—	λ^2	—	—	—	λ^2	—	—	λ^4	—	—	—
$B_d \rightarrow D_s^+ D^-$	C	λ^2	—	—	—	λ^2	—	—	λ^4	—	—	—	—
$B_d \rightarrow \pi^0 \pi^0$	D	—	λ^3	$[\lambda^3]$	λ^3	λ^3	$[\lambda^3]$	λ^3	λ^3	$[\lambda^3]$	λ^3	$[\lambda^3]$	$[\lambda^3]$
$B_d \rightarrow \pi^+ \pi^-$	D	λ^3	—	—	λ^3	λ^3	—	λ^3	λ^3	—	λ^3	—	—
$B_d \rightarrow D^+ D^-$	D	λ^3	—	—	λ^3	λ^3	—	λ^3	λ^3	—	λ^3	—	—
$B_d \rightarrow \pi^0 J/\psi$	D	—	λ^3	λ^3	—	—	λ^3	—	—	λ^3	—	$[\lambda^3]$	$[\lambda^3]$
$B_d \rightarrow K^+ \pi^-$	E	λ^4	—	—	—	λ^2	—	—	λ^4	—	—	—	—
$B_d \rightarrow K^0 \pi^0$	E	—	λ^4	—	—	λ^2	$[\lambda^2]$	—	λ^4	$[\lambda^4]$	—	—	—
$B_d \rightarrow K^0 \phi$	E	—	—	—	—	λ^2	λ^2	—	λ^4	λ^4	—	—	—
$B_d \rightarrow K^0 \bar{K}^0$	F	—	—	—	—	λ^3	—	λ^3	λ^3	—	λ^3	—	—
$B_d \rightarrow \phi \pi^0$	F	—	—	λ^3	—	—	λ^3	—	—	λ^3	—	$[\lambda^3]$	$[\lambda^3]$
$B_d \rightarrow \phi \phi$	F	—	—	—	—	—	—	λ^3	—	—	λ^3	λ^3	λ^3
$B_d \rightarrow D_s^- K^+$	G	—	—	—	λ^2	—	—	—	—	—	—	—	—
$B_d \rightarrow \bar{D}^0 J/\psi$	G	—	—	λ^2	λ^2	—	—	—	—	—	—	—	—
$B_d \rightarrow \bar{D}^0 \phi$	G	—	—	λ^2	—	—	—	—	—	—	—	—	—
$B_d \rightarrow K^+ K^-$	G	—	—	—	λ^3	—	—	λ^3	—	—	λ^3	—	—
$B_d \rightarrow D_s^+ D_s^-$	G	—	—	—	λ^3	—	—	λ^3	—	—	λ^3	—	—
$B_d \rightarrow D^0 \bar{D}^0$	G	—	—	—	λ^3	—	—	λ^3	—	—	λ^3	—	—

Buras & Silvestrini
hep-ph/9812392

×3

experimentalists are not less scary:

experimental techniques:

- we fight light $\bar{q}q$ background with the use of the shape of the event: the signal is spherical, while the continuum component is jet-like

+ shape variables are used in linear combination (Fisher discriminant) or Neural Network.

+ We can cut on the final variable or parameterize it to be included in the fit

- B-candidate selection through kinematic variables:

+ ΔE and m_{ES}

to be used in the fit

$$m_{ES} = \sqrt{E_{\text{beam}}^2 - p_B^2}$$

- particle identification:

+ K/ π separation crucial in the momentum region $1.5 < p < 4.5 \text{ GeV}/c$

+ 4σ at $2\text{GeV}/c$ and 2.5σ at $4\text{GeV}/c$

isotropic shape

Legendre Moments (L_0, L_2)
Sphericity, $\cos\theta_B$

$$\Delta E = E_B^* - \frac{\sqrt{s}}{2}$$

BaBar results: $\pi\pi$, $K\pi$ and KK

227 million $\bar{B}B$
BaBar-PUB-06/047

- improved statistics asks for radiative corrections

✚ to extract the non-radiative BR:

$$E_{\gamma}^{\max} = M_B - m_{h^+} - m_{h^-}$$

$$\Gamma_{P_1 P_2}^{\text{incl}}(E^{\max}) = \Gamma(H \rightarrow P_1 P_2 + n\gamma) \big|_{\sum E_{\gamma} < E^{\max}} = \Gamma_{P_1 P_2} + \Gamma_{P_1 P_2 + n\gamma}(E^{\max})$$

$$\Gamma_{P_1 P_2}^{\text{incl}}(E^{\max}) = \Gamma_{P_1 P_2}^0 G_{P_1 P_2}(E^{\max})$$

where $E_{\gamma}^{\max}$ is the intrinsic energy resolution, or else the minimum energy for which we can distinguish the photon

- in MC: PHOTOS produces $h^+h^- + n\gamma$, $E_{\gamma}^{\max}$ depends on phase space
- efficiency from MC, we obtain $\text{BR}(B \rightarrow h^+h^- + n\gamma)$
 - ✚ not useful for phenomenology: extrapolation of non-radiative BR clear only for small E_{γ} [scalar QED valid up to $O(E_{\gamma}^{\max}/M_B)$]
 - ✚ not clean from the experimental point of view: is PHOTOS able to reproduce the whole phase space?

- ΔE is related to $E_{\gamma}^{\max}$ so we consider events with $|\Delta E| < X$:

✚ we obtain $\text{BR}(B \rightarrow h^+h^- + n\gamma) \big|_{E_{\gamma} < E_{\max}}$ since $X = f(E_{\gamma}^{\max})$

- from MC: estimate of difference between a ΔE cut and a E_{γ} cut

1.0-2.6%

Mode	$\text{BR}_{E_{\gamma}(\text{MeV})}(10^{-6})$	$G(E_{\gamma}^{\max})$	$\text{BR}^0(10^{-6})$
$\pi^+\pi^-$	$5.4 \pm 0.4 \pm 0.3_{150}$	0.935 ± 0.005	$5.8 \pm 0.4 \pm 0.3$
$K^+\pi^-$	$18.6 \pm 0.6 \pm 0.6_{105}$	0.944 ± 0.005	$19.7 \pm 0.6 \pm 0.6$
K^+K^-	$< 0.40_{59}$	0.952 ± 0.005	< 0.40

Baracchini,
Isidori
Phys.LettB633
309-313, 2006

BaBar results: $\pi\pi$, $K\pi$ and KK

- **updated** results for all BRs
- ✚ $\bar{K}^0 K^0$ and $K^0 K^+$ have now statistical significance $>5\sigma$

Mode	N_S	ε (%)	$\mathcal{B}(10^{-6})$
$B^0 \rightarrow \pi^0 \pi^0$	140 ± 25	27.1 ± 1.7	$1.48 \pm 0.26 \pm 0.12$
$B^\pm \rightarrow \pi^\pm \pi^0$	572 ± 53	32.1 ± 1.8	$5.12 \pm 0.47 \pm 0.29$
$B^\pm \rightarrow K^\pm \pi^0$	1239 ± 52	26.8 ± 1.3	$13.3 \pm 0.56 \pm 0.64$
$B^+ \rightarrow K^0 \pi^+$	1072 ± 46	12.9 ± 0.4	$23.9 \pm 1.1 \pm 1.0$
$B^+ \rightarrow \bar{K}^0 K^+$	71 ± 19	12.6 ± 0.4	$1.61 \pm 0.44 \pm 0.09$
$B^0 \rightarrow K^0 \bar{K}^0$	32 ± 8	8.5 ± 0.3	$1.08 \pm 0.28 \pm 0.11$
$B^+ \rightarrow K^0 \pi^0$	425 ± 28	34.3 ± 1.3	$10.5 \pm 0.7 \pm 0.5$

event-weighted signal plots

signal-enhanced projection plots

event-weighted plots

347 million $\bar{B}B$
 BaBar-CONF-06/039
 BaBar-CONF-06/058
 BaBar-CONF-06/030

BaBar results: $\phi\pi$ and $\phi\pi^0$

232 million $\bar{B}B$
hep-ex/0605037

- estimate possible SM deviation of ϕK_S from the charmonium $\sin 2\beta$
- S-wave bkg extracted in the fit

Mode	N_S	ϵ (%)	$\mathcal{B}(10^{-7})$
$B^+ \rightarrow \phi\pi^+$	-1.5 ± 5.9	37.1 ± 0.1	< 2.4
$B^0 \rightarrow \phi\pi^0$	4.0 ± 3.5	29.5 ± 0.8	< 2.8

ωK and $\omega\pi$

232 million $\bar{B}B$
hep-ex/0603040

- charged channel: tree diagram also
- ωK^0 : penguin only
- statistical significance $> 8\sigma$

Mode	N_S	ϵ (%)	$\mathcal{B}(10^{-6})$
$B^+ \rightarrow \omega\pi^+$	274 ± 28	21.8	$6.1 \pm 0.7 \pm 0.4$
$B^+ \rightarrow \omega K^+$	266 ± 24	21.2	$6.1 \pm 0.6 \pm 0.4$
$B^0 \rightarrow \omega K^0$	100 ± 15	23.0	$6.2 \pm 1.0 \pm 0.4$

K^*K^0

232 million $\bar{B}B$
hep-ex/0606050

- first search for $\bar{K}^{*0}K^0$
- $b \rightarrow dss$ penguin
- SM prediction: $0.5 \cdot 10^{-6}$

	N_S	ϵ (%)	$\mathcal{B}(10^{-6})$
$BR(B^0 \rightarrow \bar{K}^{*0}K^0 + B^0 \rightarrow K^{*0}\bar{K}^0)$	$1.0^{+4.7}_{-3.9}$	2.2 ± 0.1	< 1.9

BaBar results: ηK^*

344 million $\bar{B}B$

$b \rightarrow s$ penguins BaBar-PUB-06/053

ηK^* and $\eta' K$ enhanced
 $\eta' K^*$ and ηK suppressed

$K^*(892)$, $K^*(1430)$:
 S-wave $(K\pi)_0^*$ and K_2^*

K^* decays: $K^+\pi^0$, $K_S\pi^+$, $K^+\pi^-$

$\eta' K^*$ and $\eta' \rho$

232 million $\bar{B}B$

BaBar-PUB-06/045

$\eta' \rho$: CKM suppressed trees
 expected $\eta' \rho^+ \sim 10^{-6}$ and $\eta' \rho^0 \sim 10^{-7}$

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$
$B \rightarrow \eta' K^*$	5.6	$4.1^{+1.0}_{-0.9} \pm 0.5$
$B^0 \rightarrow \eta' K^{*0}$	4.3	$3.8 \pm 1.1 \pm 0.5$
$B^+ \rightarrow \eta' K^{*+}$	3.6	$4.9^{+1.9}_{-1.7} \pm 0.8 (< 7.9)$
$B^0 \rightarrow \eta' \rho^0$	0.3	$0.4^{+1.2+1.6}_{-0.9-0.6} (< 3.7)$
$B^0 \rightarrow \eta' f_0(980)_{\pi^+\pi^-}$	0.2	$0.1^{+0.6+0.9}_{-0.4-0.4} (< 1.5)$
$B^+ \rightarrow \eta' \rho^+$	3.2	$8.7^{+3.1+2.3}_{-2.8-1.3} (< 14)$

signal-enhanced projection plots

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$
$B^0 \rightarrow \eta K^{*0}(892)$	18.8	$16.5 \pm 1.1 \pm 0.8$
$B^+ \rightarrow \eta K^{*+}(892)$	13.0	$18.9 \pm 1.8 \pm 1.3$
$B^0 \rightarrow \eta (K\pi)_0^{*0}$	5.7	$11.0 \pm 1.6 \pm 1.5$
$B^+ \rightarrow \eta (K\pi)_0^{*+}$	5.9	$18.2 \pm 2.6 \pm 2.6$
$B^0 \rightarrow \eta K_2^{*0}(1430)$	5.3	$9.6 \pm 1.8 \pm 1.1$
$B^+ \rightarrow \eta K_2^{*+}(1430)$	3.5	$9.1 \pm 2.7 \pm 1.4$

event-weighted signal plots

BaBar results: $\eta^{(\prime)}\pi^0$ and $\eta'\eta$

- colour suppressed + penguins
- prediction from QCD fact and SCET $\sim 10^{-6}$
- estimate possible SM deviation of ηK_s from the charmonium $\sin 2\beta$

- investigated the final states:

$\eta \rightarrow \gamma\gamma, 3\pi$ and $\eta' \rightarrow \eta\pi\pi, \rho\gamma$

232 million $\bar{B}B$
hep-ex/0603013

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$
$B^0 \rightarrow \eta\eta'$	0.4	$0.2_{-0.5}^{+0.7} \pm 0.4 (< 1.7)$
$B^0 \rightarrow \eta\pi^0$	1.3	$0.6_{-0.4}^{+0.5} \pm 0.1 (< 1.3)$
$B^0 \rightarrow \eta'\pi^0$	1.4	$0.8_{-0.6}^{+0.8} \pm 0.1 (< 2.1)$

$\eta K^0, \eta\eta, \eta\phi, \eta'\phi$ and $\eta'\eta$

324 million $\bar{B}B$
BaBar-PUB-06/051

- all unseen
- prediction 10^{-6}
- PP BRs help for $\eta K/\eta'K$
- ΔS for $\eta'K^0$ and ϕK^0

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$
$B^0 \rightarrow \eta K^0$	3.5	$1.8_{-0.6}^{+0.7} \pm 0.1 (< 2.9)$
$B^0 \rightarrow \eta\eta$	3.0	$1.1_{-0.4}^{+0.5} \pm 0.1 (< 1.8)$
$B^0 \rightarrow \eta\phi$	0.0	$0.1 \pm 0.2 \pm 0.1 (< 0.6)$
$B^0 \rightarrow \eta'\phi$	0.5	$0.2_{-0.3}^{+0.4} \pm 0.1 (< 1.0)$
$B^0 \rightarrow \eta'\eta'$	1.8	$1.0_{-0.6}^{+0.8} \pm 0.1 (< 2.4)$

signal-enhanced projection plots

BaBar results: $\rho^{(0)}K^*$

- VV modes: **small f_L** 232 million $\bar{B}B$ from experiment hep-ex/0607057

- Cabibbo-suppressed trees + penguins (ρ^+K^{*0} pure penguin)

- K^* in final states:

$$K^{*+} \rightarrow K^+\pi^0, K_s^+\pi^+,$$

$$K^{*0} \rightarrow K^+\pi^-$$

- 5σ for channel f_0K^{*+}

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$	f_L
$\rho^0 K^{*+}$	2.5	$3.6_{-1.6}^{+1.7} \pm 0.8 (< 6.1)$	$[0.9 \pm 0.2]$
$\rho^+ K^{*0}$	7.1	$9.6 \pm 1.7 \pm 1.5$	$0.52 \pm 0.10 \pm 0.04$
$\rho^- K^{*+}_{K^+\pi^0}$	1.6	$5.4_{-3.4}^{+3.8} \pm 1.6 (12.0)$	$[-0.18_{-1.74}^{+0.52}]$
$\rho^0 K^{*0}$	5.3	$5.6 \pm 0.9 \pm 1.3$	$0.57 \pm 0.09 \pm 0.08$
$f_0(980) K^{*+}$	5.0	$5.2 \pm 1.2 \pm 0.5$	—
$f_0(980) K^{*0}$	3.5	$2.6 \pm 0.6 \pm 0.9 (4.3)$	—

$\omega^{(0)}K^*$

233 million $\bar{B}B$ hep-ex/0605017

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$	f_L
$B^0 \rightarrow \omega K^{*0}$	2.4	$2.4 \pm 1.1 \pm 0.7 (< 4.2)$	$0.71_{-0.24}^{+0.27}$
$B^+ \rightarrow \omega K^{*+}$	0.4	$0.6_{-1.2-0.9}^{+1.4+1.1} (< 3.4)$	0.7 fixed

- still unseen
- will be good also for f_L

BaBar results: $\omega\rho$, $\omega\omega$, $\omega\phi$ and ωf_0

- and lots of other VV modes
- higher contribution from tree-diagram expected
- so f_L could be higher (à la $\rho\rho$)

233 million $\bar{B}B$
hep-ex/0605017

- measurement of $\omega\rho^+$ with 5.7σ statistical significance
- f_L is measured for $\omega\rho^+$

Mode	$\mathcal{S} (\sigma)$	$\mathcal{B} (10^{-6})$	f_L
$B^0 \rightarrow \omega\rho^0$	0.6	$-0.6 \pm 0.7^{+0.8}_{-0.3} (< 1.5)$	0.9 fixed
$B^0 \rightarrow \omega f_0$	2.8	$0.9 \pm 0.4^{+0.2}_{-0.1} (< 1.5)$	—
$B^+ \rightarrow \omega\rho^+$	5.7	$10.6 \pm 2.1^{+1.6}_{-1.0}$	$0.82 \pm 0.11 \pm 0.02$
$B^0 \rightarrow \omega\omega$	2.1	$1.8^{+1.3}_{-0.9} \pm 0.4 (< 4.0)$	0.79 ± 0.34
$B^0 \rightarrow \omega\phi$	0.3	$0.1 \pm 0.5 \pm 0.1 (< 1.2)$	0.88 fixed

BaBar results: $a_0^+\pi^0$, $a_1^+\pi^-$ and $a_1^+\rho^-$

predicted BR $\sim 2 \cdot 10^{-7}$

$a_0^+(980)\pi^0$

252 million $\bar{B}B$
hep-ex/0607064

BaBar result:
BR $< 1.3 \cdot 10^{-6}$ @ 90% CL

218 million $\bar{B}B$
hep-ex/0603050

$a_1^+(1260)\pi^-$

BaBar result @ 9.2σ

BR $= (33.2 \pm 3.8 \pm 3.0) \cdot 10^{-6}$

predicted BR $\sim 40 \cdot 10^{-6}$

$a_1^+(1260)\rho^-$

110 million $\bar{B}B$
hep-ex/0605024

BaBar result @ 0.95σ
BR $< 61 \cdot 10^{-6}$ @ 90% CL

conclusions:

charmless two-body B decays are a powerful source of information for the CKM parameters, for the CP asymmetries and last but not least for the understanding of the hadronic uncertainties.

- $\pi\pi$, $K\pi$ and KK : new BRs results including final state radiation.
Only the K^+K^- pure annihilation is missing.
- **observations** for ηK_2^{*0} , $\eta(K\pi)_0^*$, $\eta'K^*$, f_0K^{*+} , $\omega\rho^+$, $a_1^+\pi^-$..
- searches for $\phi\pi$, K^*K , ηK^0 , ωK^* .. etc..
- BaBar is producing an incredible amount of measurements
- now the ball can go back to the theorists! :)

Back up slides