Univerza v Ljubljani

THE UNIVERSITY OF TOKYO

Flavour Physics at B-factories and Hadron Colliders

Part 6.5: b -> sss decays

Peter Križan

University of Ljubljana and J. Stefan Institute

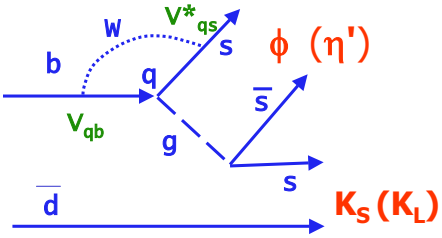
Contents

Why is b->sss so exciting?

Measurements of CP violation in b->sss

b->sss decays

Pure penguin diagrams



$$A(s\bar{s}s) = V_{cb}V_{cs}^{*}(P_s^c - P_s^t) + V_{ub}V_{us}^{*}(P_s^u - P_s^t).$$

$V_{cb}V_{cs}^{*}=A\lambda^2$ $V_{ub}V_{us}^{*}=A\lambda^4(\rho-i\eta)$

First term dominates ->

λ same as for $J/\psi K_S$

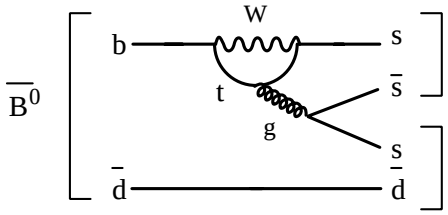
$$\lambda_{\phi K_S} = \eta_{\phi K_S}\left(\frac{V_{tb}^{*}V_{td}}{V_{tb}V_{td}^{*}}\right)\left(\frac{V_{cd}^{*}V_{cb}}{V_{cd}V_{cb}^{*}}\right)$$

$$\mathrm{Im}(\lambda_{\phi K_S}) = \sin 2\phi_1 = \sin 2\beta$$

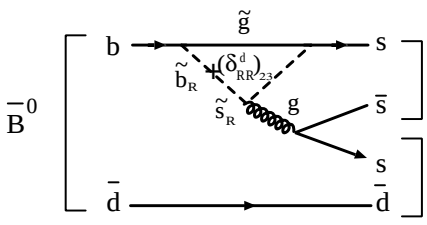
b->sss decays

However:

BR(B^0 -> η' K^0) = 5.8 10^{-5} considered unexpectedly large



Contribution from new physics, i.e. in addition to the normal diagram also exotic contributions (e.g. SUSY particles in the loop)?



Could show up as a modification to the asymmetry parameters S_f and A_f.

CP asymmetry

Prediction: to the leading order
$\mathcal{S}_f=-\eta_f \sin 2\phi_1$ $\mathcal{A}_f=0$

$$a_{f_{CP}} = \frac{2\,\mathrm{Im}(\lambda_{f_{CP}})}{1+|\lambda_{f_{CP}}|^2}\sin(\Delta m t) + \frac{|\lambda_{f_{CP}}|^2-1}{|\lambda_{f_{CP}}|^2+1}\cos(\Delta m t)$$

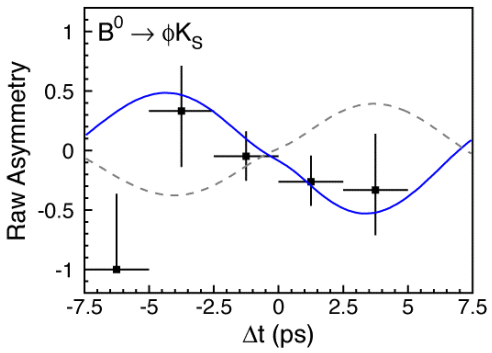
$\mathcal{S}_f$ $\mathcal{A}_f$

Result of 2003 (140/fb): surprise!

Measurement: points with error bars.

Standard Model predictions: dotted

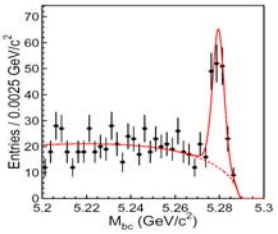
Result of the unbinned likelihood fit: blue curve



Measure: S=-0.96±0.50, expect S= $\sin 2\phi_1$=+0.731 ± 0.056

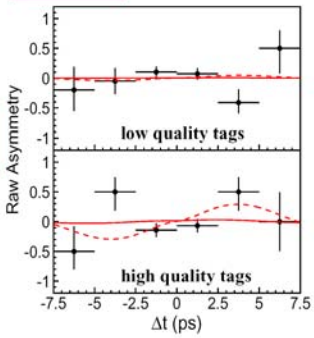
not conclusive -> need more data

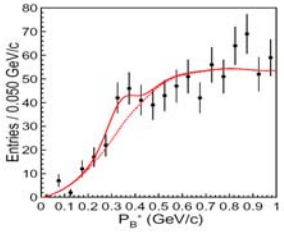
Asymmetry in B->ϕK_S and ϕK_L



$B^0 \to \phi K_S$ $(CP = -1)$
$N = 139 \pm 14$, 63% pure

$B^0 \to \phi K^0$:



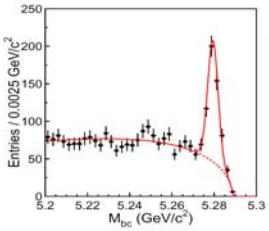


$B^0 \to \phi K_L$ $(CP = +1)$
$N = 36 \pm 15$, 17% pure

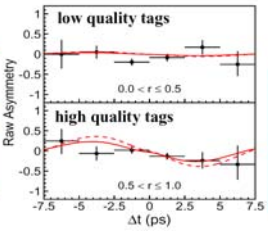
recently published

$\sin(2\phi_1) = +0.06 \pm 0.33 \pm 0.09$, $A = +0.08 \pm 0.22 \pm 0.09$

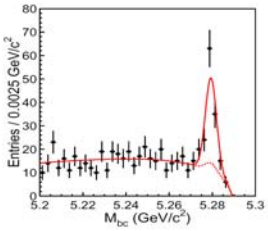
Asymmetry in B -> $K^+ K^- K_S$ and $f^0(980)$ K_S



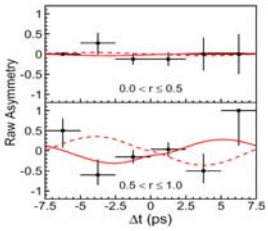
$B^0 \to K^+K^-K_S$
$(CP = +1$ mostly$)$
$N = 399 \pm 28$
56% pure



$\sin(2\phi_1) =$
$+0.49 \pm 0.18 \pm 0.04$
$A =$
$-0.08 \pm 0.12 \pm 0.07$



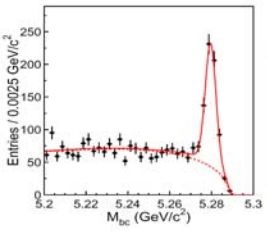
$B^0 \to f_0(980)K_S$
$(CP = +1)$
$N = 94 \pm 14$
53% pure



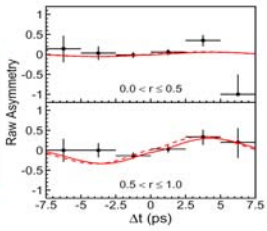
$\sin(2\phi_1) =$
$-0.47 \pm 0.41 \pm 0.08$
$A =$
$-0.39 \pm 0.27 \pm 0.08$

recently published

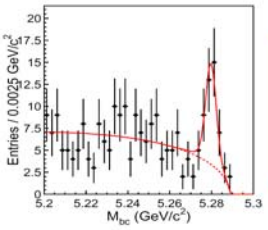
Asymmetry in B->η'K_S and ωK_S



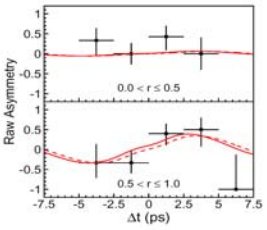
$B^0 \to \eta' K_S$
$(CP = -1)$
$N = 512 \pm 27$
61% pure



$\sin(2\phi_1) =$
$+ 0.65 \pm 0.18 \pm 0.04$
$A =$
$- 0.19 \pm 0.11 \pm 0.05$



$B^0 \to \omega K_S$
$(CP = -1)$
$N = 31 \pm 7$
56% pure

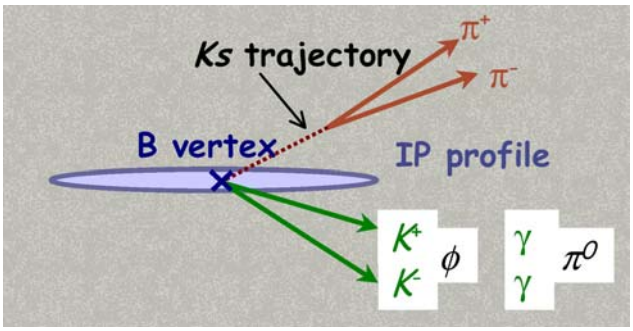


$\sin(2\phi_1) =$
$+ 0.75 \pm 0.64^{+0.13}_{+0.16}$
$A =$
$+ 0.26 \pm 0.48 \pm 0.15$

recently published

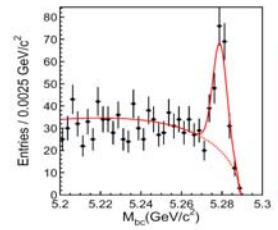
Vertex reconstruction in B -> K_S K_S K_S and π^0 K_S

No charged track from the B decay point: extrapolate the K_S direction from the $\pi^+\pi^-$ vertex.

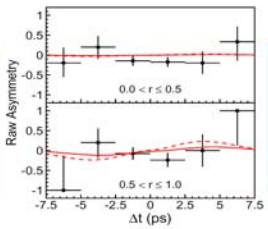


Check the method by measuring the asymmetry in B->J/ψK_S channel, use only K_S for vertex determination (instead of two leptons from J/ψ) -> OK!

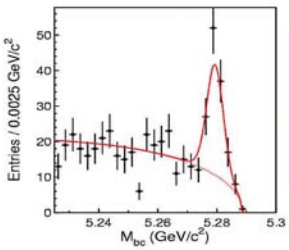
Asymmetry in B -> K_S K_S K_S and π^0 K_S



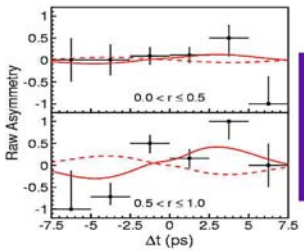
$B^0 \to \pi^0 K_S$
$(CP = -1)$
$N = 251 \pm 24$
55/17% pure



$\sin(2\phi_1) =$
$+0.30 \pm 0.59 \pm 0.11$
$A =$
$-0.12 \pm 0.20 \pm 0.07$

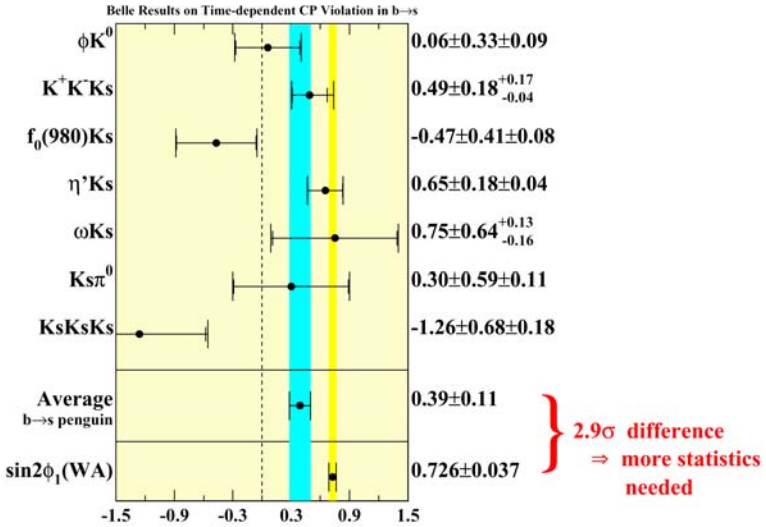


$B^0 \to K_S K_S K_S$
$(CP = +1)$
$N = 88 \pm 13$
53% pure

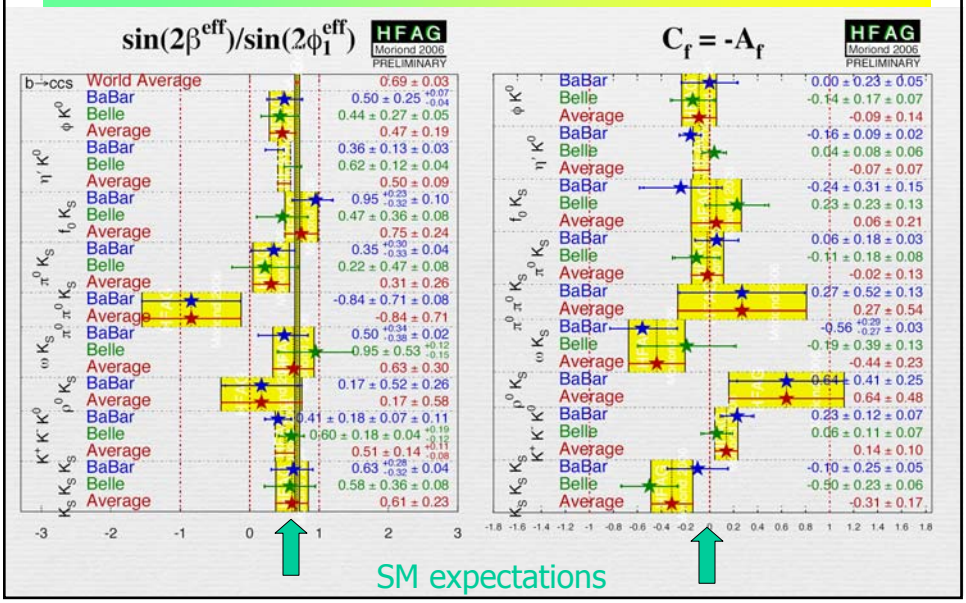


$\sin(2\phi_1) =$
$-1.26 \pm 0.68 \pm 0.18$
$A =$
$+0.54 \pm 0.34 \pm 0.08$

Summary of asymmetry measurements 2005



Summary of asymmetry measurements 2006



Exp. vs. theory

Plot

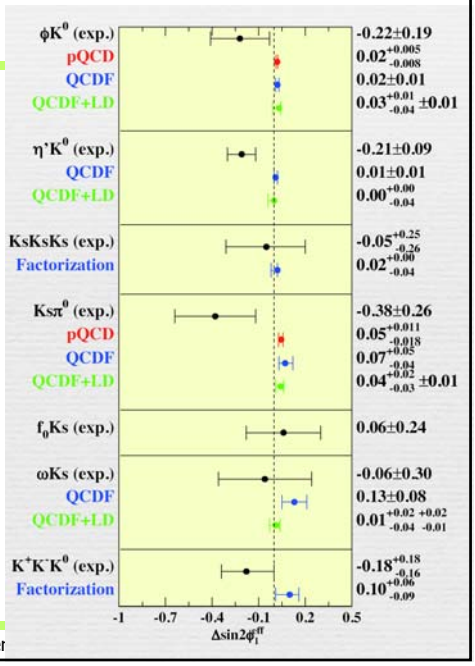
$\Delta\sin2\phi_1 = \sin2\phi_1^{eff} - \sin2\phi_1$

= measurements in b→qqs vs b→ccs

Theory predictions: all slightly >0

→ need more data

→ need more accurate theoretical predictions mode by mode



Backup slides

$B \to \eta' K_s$

η': not a pure ss state ->

appart from $P(V_{cb}V^*_{cs} \sim A\lambda^2)$ and $P(V_{ub}V^*_{us} \sim A\lambda^4(\rho - i\eta))$

also color and Cabbibo suppressed b → u
$T(V_{ub}V^*_{us} \sim A\lambda^4(\rho - i\eta))$