Observations of $\Lambda_b^0 \to \Lambda K^+\pi^-$ and $\Lambda_b^0 \to \Lambda K^+K^-$ decays and searches for other Λ_b^0 and Ξ_b^0 decays to $\Lambda h^+h'^-$ final states

Motivation

- Λ_b and Ξ_b have been discovered but not many decays modes have been studied – especially charmless ones.
- Decays can offer insight into harmonization mechanisms
- CP violation has been observed in charmless B-decays ➔ look for CP violation in charmless Λ_b decays
- Looked for Λ_b and Ξ_b to ΛK^+K^-, $\Lambda\pi^+\pi^-$, $\Lambda K^\pm\pi^\pm$ with Λ_b to Λ_C (-> $\Lambda\pi^+$) π^- as control and normalization channel
- Measure phasespace integrated CP violation for Λ_b to ΛK^+K^- and $\Lambda K^\pm\pi^\pm$
- Analyses done for 2011, 2012a, 2012b independently as well as for long and downstream reconstruction of $\Lambda \rightarrow p\pi^-$

Signal observation

Signal: double Crystal ball
Cross-feed bkg: double Crystal ball

Combinatorial bkg: exponential

Partially reconstructed bkg: ARGUS convolved with Gaussian

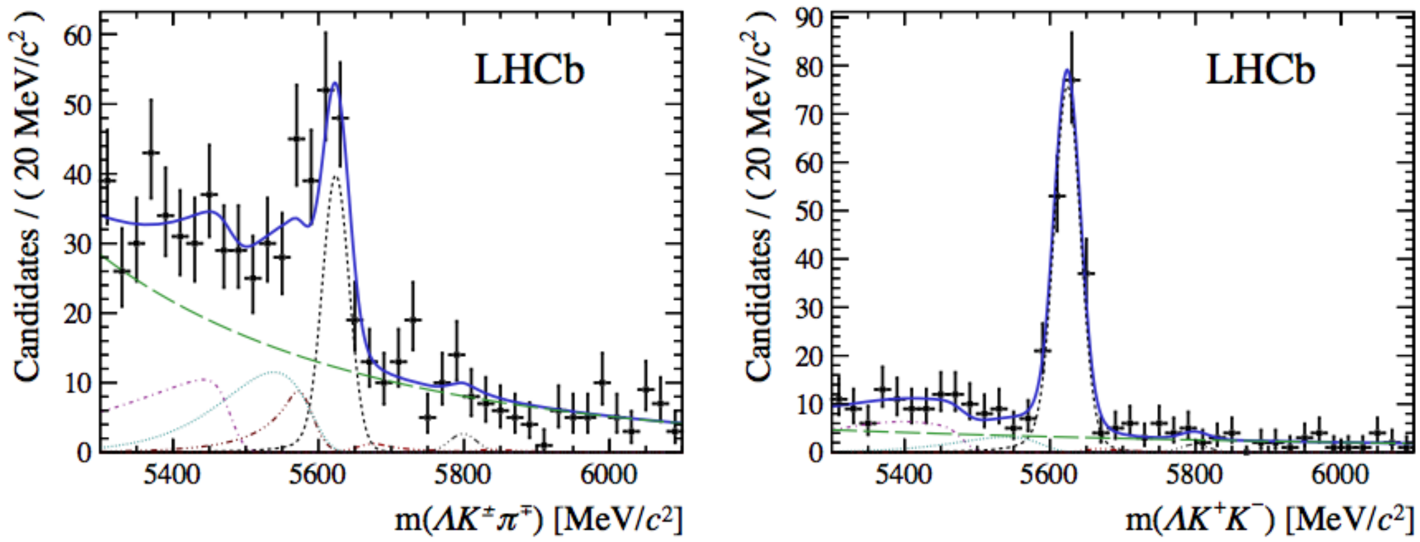

Figure 2: Results of the fit for the (left) $\Lambda K^{\pm}\pi^{\mp}$ and (right) $\Lambda K^{+}K^{-}$ final states, for all subsamples combined. Superimposed on the data are the total result of the fit as a blue solid line, the Λ_b^0 (Ξ_b^0) decay as short a dashed dark grey line, cross-feed as dot-dashed red lines, the combinatorial background as a long-dashed green line, and partially reconstructed background components with a missing soft photon or neutral pion as double dot-dashed purple and cyan dotted lines, respectively.

Signal observation

Table 1: Signal yields for the various Λ_b^0 and Ξ_b^0 decay modes under investigation. The totals given here are simple sums and are not used in the analysis.

Mode	Run period	Yield Λ_b^0 downstream	Yield Λ_b^0 long	Yield Ξ_b^0 downstream	Yield Ξ_b^0 long
$\Lambda\pi^+\pi^-$	2011	10.2 ± 5.5	8.7 ± 4.7	-0.6 ± 2.4	4.9 ± 3.2
	2012a	9.1 ± 5.2	13.6 ± 5.7	5.3 ± 3.6	1.0 ± 2.6
	2012b	17.2 ± 7.1	6.2 ± 4.6	3.9 ± 4.0	4.1 ± 2.7
	Total	65.0 ± 13.5	**5.2σ**	18.6 ± 7.7	
$\Lambda K^\pm\pi^\mp$	2011	20.9 ± 6.4	8.2 ± 3.5	3.5 ± 3.7	-0.7 ± 2.4
	2012a	9.3 ± 3.7	1.7 ± 3.6	-0.1 ± 1.7	0.3 ± 1.5
	2012b	39.7 ± 8.9	16.9 ± 5.1	2.9 ± 4.5	-1.8 ± 1.5
	Total	96.7 ± 13.6	**8.5σ**	4.1 ± 6.9	
ΛK^+K^-	2011	32.3 ± 6.4	20.1 ± 4.6	0.6 ± 2.3	0.0 ± 0.6
	2012a	22.2 ± 5.3	15.9 ± 4.2	0.5 ± 2.4	0.0 ± 0.5
	2012b	60.5 ± 8.5	34.4 ± 6.1	3.0 ± 2.7	0.0 ± 0.6
	Total	185.4 ± 14.7	**20.5σ**	4.1 ± 4.4	
$(\Lambda\pi^+)_{\Lambda_c^+}\pi^-$	2011	78.1 ± 9.1	78.9 ± 9.2		
	2012a	45.0 ± 7.0	63.0 ± 8.3		
	2012b	115.3 ± 11.1	90.7 ± 9.8		
	Total	471.0 ± 22.5			

Branching ratios (limits)

Branching ratios determined using the normalization channel:

$$\frac{\mathcal{B}(\Lambda_b^0 \to \Lambda h^+ h'^-)}{\mathcal{B}(\Lambda_b^0 \to (\Lambda\pi^+)_{\Lambda_c^+}\pi^-)} = \frac{N(\Lambda_b^0 \to \Lambda h^+ h'^-)}{N(\Lambda_b^0 \to (\Lambda\pi^+)_{\Lambda_c^+}\pi^-)} \times \frac{\epsilon(\Lambda_b^0 \to (\Lambda\pi^+)_{\Lambda_c^+}\pi^-)}{\epsilon(\Lambda_b^0 \to \Lambda h^+ h'^-)},$$

Theoretical predictions: $10^{-9} – 10^{-7}$

$$\begin{aligned}
\mathcal{B}(\Lambda_b^0 \to \Lambda\pi^+\pi^-) &= (4.6 \pm 1.2\,(\text{stat}) \pm 1.4\,(\text{syst}) \pm 0.6\,(\text{norm})) \times 10^{-6},\\
\mathcal{B}(\Lambda_b^0 \to \Lambda K^+\pi^-) &= (5.6 \pm 0.8\,(\text{stat}) \pm 0.8\,(\text{syst}) \pm 0.7\,(\text{norm})) \times 10^{-6},\\
\mathcal{B}(\Lambda_b^0 \to \Lambda K^+K^-) &= (15.9 \pm 1.2\,(\text{stat}) \pm 1.2\,(\text{syst}) \pm 2.0\,(\text{norm})) \times 10^{-6},\\
\mathcal{B}(\Xi_b^0 \to \Lambda\pi^+\pi^-) \times f_{\Xi_b^0}/f_{\Lambda_b^0} &= (1.3 \pm 0.6\,(\text{stat}) \pm 0.5\,(\text{syst}) \pm 0.2\,(\text{norm})) \times 10^{-6},\\
&< 1.7\ (2.1) \times 10^{-6} \text{ at } 90\ (95)\,\%\text{ confidence level},\\
\mathcal{B}(\Xi_b^0 \to \Lambda K^-\pi^+) \times f_{\Xi_b^0}/f_{\Lambda_b^0} &= (-0.6 \pm 0.5\,(\text{stat}) \pm 0.3\,(\text{syst}) \pm 0.1\,(\text{norm})) \times 10^{-6},\\
&< 0.8\ (1.0) \times 10^{-6} \text{ at } 90\ (95)\,\%\text{ confidence level},\\
\mathcal{B}(\Xi_b^0 \to \Lambda K^+K^-) \times f_{\Xi_b^0}/f_{\Lambda_b^0} &< 0.3\ (0.4) \times 10^{-6} \text{ at } 90\ (95)\,\%\text{ confidence level}.
\end{aligned}$$

CP - Asymmetry

$$\mathcal{A}_{CP} = \mathcal{A}_{CP}^{\text{raw}} - \mathcal{A}_{\text{P}} - \mathcal{A}_{\text{D}}$$

$$\mathcal{A}_{CP}^{\text{raw}} = \frac{N_f^{\text{corr}} - N_{\bar{f}}^{\text{corr}}}{N_f^{\text{corr}} + N_{\bar{f}}^{\text{corr}}}$$

Bkg subtracted and efficiency corrected signal yields

Use control channel to get production and detection asymmetry since no CP-asymmetry is expected : A^{raw}_{CP}(control) = $A_P + A_D$

$$\begin{aligned}
\mathcal{A}_{CP}(\Lambda_b^0 \to \Lambda K^+\pi^-) &= -0.53 \pm 0.23\,(\text{stat}) \pm 0.11\,(\text{syst}) \\
\mathcal{A}_{CP}(\Lambda_b^0 \to \Lambda K^+K^-) &= -0.28 \pm 0.10\,(\text{stat}) \pm 0.07\,(\text{syst})
\end{aligned}$$

Smaller than 3σ ☹

Comments

1. Efficiencies for selection not listed.
2. Selection efficiency modeled in 5 variables: **2 Dalitz-masses, 3 helicities** ➔ the information about the last three should be in the contained in the first two + this assumes that individual track- p_T and η are correctly modeled in the MC
3. Cross-feed bkg modeled by double CB: shape determined with the help of "high statistics control sample" ➔ Need specifying and reference
4. Partially reconstructed bkg modeled by ARGUS convolved with Gaussian: What does this model?
5. Partially reconstructed bkg for control channel modeled by non-parametric density estimate: Why and from where?
6. Ξ_b ➔ ΛK^+K^- has very few events in signal region and therefor the signal yield is constrained to be non-negative: Lower fit-error is biased!
7. Fit model and stability is validated with '**pseudoexperiments**': more details
8. Dalitz-plot distributions of Λ_b➔ΛK^+K^- and Λ_b➔$\Lambda K^\pm\pi^\pm$ are obtained using the *sPlot* technique: Λ_b mass is correlated with position on Dalitz-Plot so maybe shouldn't be used?