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Study of three-body charmless decays at LHCb

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Summary. — Charmless three-body B decays are of interest to measure CP asymmetry and also to search for possible new physics Beyond the Standard Model. Three-body baryonic decays offer the possibility to study intermediate resonances. The study performed at LHCb and the results obtained using the 2010 35 pb^{-1} data sample are presented.

PACS 13.25 – Decays of bottom mesons.

1. – Measurements of the relative branching fractions of the $B^+ \to p\bar{p}K^+$ decay channel including charmonium contributions

The measurements of the branching fractions of the $B^+ \to p\bar{p}K^+$, of the charmless component ($M_{p\bar{p}} < 2.85\,\mathrm{GeV}/c^2$) and of the charmonium contribution η_c: $\mathcal{B}(B^+ \to \eta_c K^+) \times \mathcal{B}(\eta_c \to p\bar{p})$ with respect to the J/ψ: $\mathcal{B}_{J/\psi} = \mathcal{B}(B^+ \to J/\psi K^+) \times \mathcal{B}(J/\psi \to p\bar{p})$ have been performed. The measurement relies only on the ratios of events and efficiencies with respect to the reference mode J/ψ: $\frac{\mathcal{BR}(\mathrm{mode})}{\mathcal{BR}_{J/\psi}} = \frac{N_{\mathrm{mode}}}{N_{J/\psi}} \times \frac{\epsilon_{J/\psi}}{\epsilon_{\mathrm{mode}}}$. The efficiencies have been determined using simulated events and the efficiency variation in the $M_{p\bar{p}}$ range has been corrected for. Since the final state for all the considered channels is the same, most of the systematic uncertainties cancel in the ratio. The selection uses a multivariate technique based on topological variables and on the particle identification information provided by the RICH detectors. The selected events are reported in fig. 1. The obtained branching fractions [1] are compatible with B-factories measurements but are statistically limited:

$$\mathcal{B}(B^\pm \to \eta_c K^\pm) \times \mathcal{B}(\eta_c \to p\bar{p})/\mathcal{B}_{J/\psi} = 0.71 \pm 0.20_{\mathrm{stat}} \pm 0.07_{\mathrm{syst}}$$
$$\mathcal{B}(B^\pm \to p\bar{p}K^\pm)_{M_{p\bar{p}}<2.85\,\mathrm{GeV}/c^2}/\mathcal{B}_{J/\psi} = 2.21 \pm 0.41_{\mathrm{stat}} \pm 0.24_{\mathrm{syst}}$$
$$\mathcal{B}(B^\pm \to p\bar{p}K^\pm)_{\mathrm{all}}/\mathcal{B}_{J/\psi} = 4.6 \pm 0.6_{\mathrm{stat}} \pm 0.5_{\mathrm{syst}}.$$

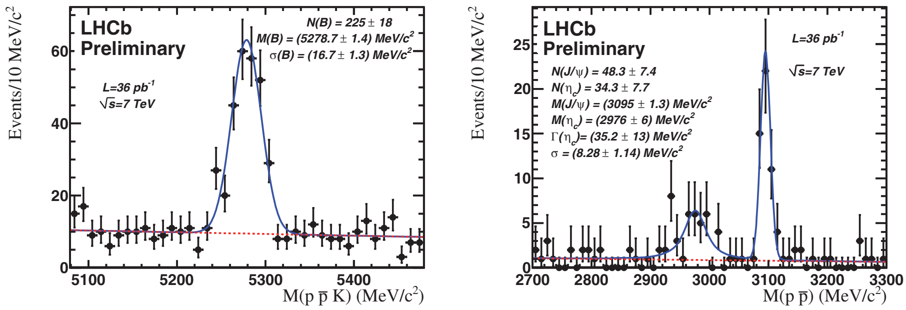

Fig. 1. – All B selected events (left) and $p\bar{p}$ events (right).

The 2011 available statistics, about $1\,\mathrm{fb}^{-1}$ of data collected in 2011, a factor 10 more with respect to B-factories, allows to perform more precise measurements of the branching fractions and to study more rare charmonium contributions $(\eta_c(2S), X(3872), \ldots)$ that have never been measured before.

2. – Relative branching ratio measurements of $B^+ \to K^+K^+K^-$ and $B^+ \to p\bar{p}K^+$ to $B^+ \to K^+\pi^+\pi^-$

Exploiting the topological similarities, a cut based inclusive selection has been used for all the considered channels (fig. 2). The measurement [2] is based on the ratio:

$$\frac{\mathcal{B}(B^+ \to h^+h^-h^+)}{\mathcal{B}(B^+ \to K^+\pi^+\pi^-)} = \frac{N_{\mathrm{hhh}}}{N_{K\pi\pi}} \times \frac{\epsilon^{acc}_{K\pi\pi}}{\epsilon^{acc}_{\mathrm{hhh}}} \times \frac{\epsilon^{reco\&sel}_{K\pi\pi}}{\epsilon^{reco\&sel}_{\mathrm{hhh}}} \times \frac{\epsilon^{trigger}_{K\pi\pi}}{\epsilon^{trigger}_{\mathrm{hhh}}} \times \frac{\epsilon^{PID}_{K\pi\pi}}{\epsilon^{PID}_{\mathrm{hhh}}}$$

The efficiency ratios have been estimated using simulated events except for the PID estimated using control samples. Acceptance, reconstruction, trigger and PID efficiency systematics have been evaluated. The obtained results are compatible with PDG values:

$$\mathcal{B}(B^+ \to K^+K^+K^-)/\mathcal{B}(B^+ \to K^+\pi^+\pi^-) = 0.52 \pm 0.03_{\mathrm{stat}} \pm 0.01_{\mathrm{syst}}$$
$$\mathcal{B}(B^+ \to p\bar{p}K^+)/\mathcal{B}(B^+ \to K^+\pi^+\pi^-) = 0.19 \pm 0.02_{\mathrm{stat}} \pm 0.02_{\mathrm{syst}}$$

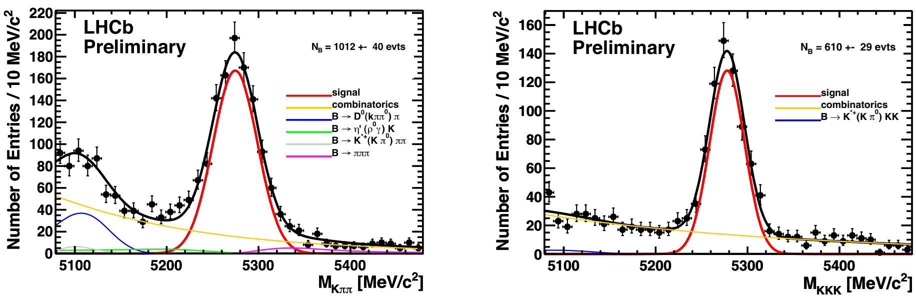

Fig. 2. – $B^+ \to K^+\pi^+\pi^-$ (left) and $B^+ \to K^+K^-K^+$ (right) events.

3. – Search of CP violation in $B^+ \to K^+\pi^+\pi^-$ and $B^+ \to K^+K^+K^-$

The $A_{\rm CP}(B^+ \to K^+\pi^+\pi^-)$ e $A_{\rm CP}(B^+ \to K^+K^+K^-)$ can be measured in the Dalitz Plot using the "Mirandizing" method [3] using 2011 data sample extracting the production and the detector asymmetry from control channels.

REFERENCES

[1] LHCb-CONF-2011-058.
[2] LHCb-CONF-2011-059.
[3] Bediaga I. *et al.*, *Phys. Rev. D*, **80** (2009) 096006.