

PENTAQUARK SEARCH IN BEAUTY LAMBDA TO CHARMED SIGMA DECAYS USING LHCb RUN3 DATA

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Charmed pentaquark states (P_c^+) have first been observed by LHCb collaboration in 2015 in $\Lambda_b^0 \rightarrow J/\psi p K^-$ decay channel [1]. P_c^+ states have not yet been observed in other channels. $\Sigma_c^+ \bar{D}^{(*)0}$ systems are interesting for pentaquark search because they have the same quark content as $J/\psi p$ system ($uudc\bar{c}$) and their inertial masses are very close to the observed P_c^+ masses. $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^{(*)0} K^-$ decay channels have not yet been analysed for pentaquark signals. Observation of P_c^+ signals in these channels or determination of signal upper limits would help constrain theoretical models that are currently unable to unambiguously describe the observed P_c^+ states.

The aim of this doctoral research is to analyse $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^0 K^-$ decay channel for P_c^+ signals using LHCb Run3 data. This research topic branches off from Mindaugas Šarpis thesis where $\Lambda_b^0 \rightarrow \Lambda_c^+ \bar{D}^{*0} K^-$ decay channel was analysed using LHCb Run2 data [2]. A quark diagram that summarizes different possible $\Lambda_b^0 \rightarrow P_c^+ K^-$ decay channels is shown in Fig. 1.

One of the challenges of this research will be to isolate $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^0 K^-$ decay channel in LHCb Run3 data. This channel has a major overlap with $\Lambda_b^0 \rightarrow \Lambda_c^+ \bar{D}^{*0} K^-$ channel in Λ_b^0 invariant mass spectrum. One approach to address this issue will be to utilize Monte Carlo (MC) event generator results for the overlapping decay channels and train a classifier model on experimental data in the narrow regions where the MC generated overlap is minimal. Analysis of $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^{*0} K^-$ decay channel is also considered. These decays produce additional neutral particles (π_0 or γ) that are not efficiently detected. This results in $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^{*0} K^-$ signal being shifted towards lower energies than $\Lambda_b^0 \rightarrow \Sigma_c^+ \bar{D}^{(*)0} K^-$ signal in the mass spectrum, avoiding signal overlap. The neutral particles can be reconstructed later by utilizing *Extended Cone Closure* method, introduced by Šarpis [2].

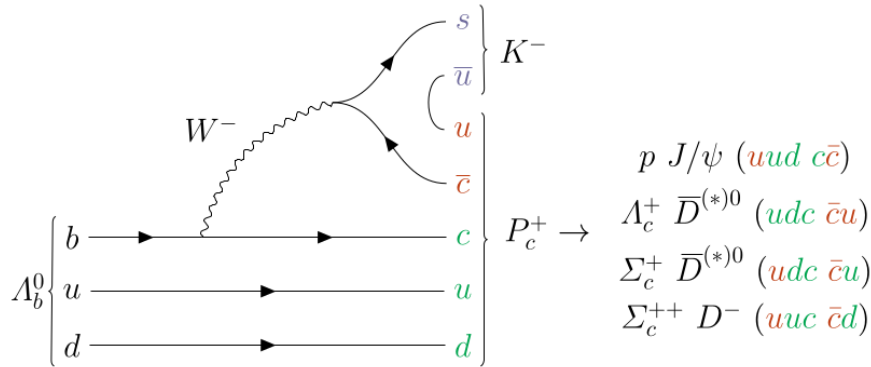


Fig. 1. Quark diagram of potential $\Lambda_b^0 \rightarrow P_c^+ K^-$ decay channels.

[1] LHCb collaboration, R. Aaij et al., Observation of J/ψ resonances consistent with pentaquark states in $\Lambda_b^0 \rightarrow J/\psi p K^-$ decays, Physical Review Letters, vol. 115, no. 7, p. 072001, 2015.
[2] M. Šarpis, Pentaquark Search in $\Lambda_b^0 \rightarrow \Lambda_c^+ \bar{D}^{*0} K^-$ Decays and LHCb Open Data Release, PhD Thesis, University of Bonn, Bonn, Germany, 2023.