Abstract

The charge conjugation parity (CP) symmetry states that laws of physics should be the same if a particle is changed with its antiparticle (charge conjugation symmetry) and its spatial coordinates undergo inversion (parity symmetry). However, the symmetry under CP transformation can be violated in case of weak interactions. In the decays of strange and beauty mesons, the CP violation effect is well-established experimentally. In last years, the effect is also confired in charm mesons. Nonetheless, more than the size of CP violation in the Standard Model (SM) is needed to fully explain the baryogenesis process in our universe, implying the necessity of the presence of additional sources of CP violation beyond those known in the SM.

After decades of experimental searches, the CP violation in the charm sector has been observed. The CP asymmetries were measured in $D^0 \to K^+K^-$, and $D^0 \to \pi^+\pi^-$ decays using a large sample of charm mesons collected by the LHCb experiment during the LHC Run 1 and Run 2. By making a full combination of LHCb data, the following value was obtained: $\Delta A_{CP} = (15.4 \pm 2.9) \times 10^{-4}$. Recently, in 2022, physicists from LHCb collaboration measured, for the first time, the CP asymmetry in a single charm meson decay: $a^{dir}_{\pi^-\pi^+} = (23.2 \pm 6.1) \times 10^{-4}$.

Discoveries of CP violation in the decays of charmed mesons open a window to the search for new possible sources of CP asymmetries in charm particles. The particularly interesting decays wherein CP symmetry is suspected to be violated are charm baryons $\Xi_c^+ \to pK^-\pi^+$. The Run 1 data have already been analysed. In one of the regions of the Dalitz plot, agreement with the lack of CP symmetry violation is observed of 2.7 standard deviations. Therefore, further analysis of these decays is crucial with more data statistics collected in Run 2 to confirm the existence of CP violation in such decays. It is hard to determine whether currently used methods are not sensitive enough or CP violation is too small to be measured as, according to the SM, the size of this asymmetry in charm decays is expected to be of the order of $10^4 - 10^3$ or less.

This dissertation presents the details of searches for CP violation effects in the Cabibbo suppressed charm baryon $\Xi_c^+ \to pK^-\pi^+$ decays produced directly in pp collisions at LHC accelerator and collected in the LHCb experiment in Run 2, corresponding to an integrated luminosity of about 6 fb^{-1}. The searches are performed with different techniques in model independent ways. These techniques are: the binned S_{CP} method, the Kernel Density Estimator and the unbinned Energy Test method.

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