Contribution ID: **13** Type: **not specified**

The role of neutral kaons in the high-precision measurements of CP violation in the charm sector

Wednesday, 13 November 2024 17:30 (13 minutes)

High-precision measurements of CP violation in charm decays are of paramount importance, since physical CP-violating asymmetries are highly suppressed in the Standard Model, at the level of (10^{-3}–10^{-4}) and even lower for the time-dependent observables.

The first observation of CP violation in the charm sector, with the famous ΔA_{CP} mechanism, $\Delta A_{CP} = a_d(KK) - a_d(\pi\pi) = (-15.4 \pm 2.9) \times 10^{-4}$, is still highly debated, as it is not yet clear whether it has a standard or non-standard nature. Any new observation of CP violation therefore would provide valuable theoretical insights to solve the current puzzle.

These high-precision measurements require extreme care as very small experimental biases, such as charge asymmetric effects in particle production and detection, must be accounted for with very high accuracy. This experimental challenge, which is already extremely difficult and complex today, will become even more so with the data sample that the LHCb Upgrade I experiment is collecting during LHC Run 3 and 4. It will be particularly challenging during its second upgrade phase, at very high instantaneous luminosity in LHC Run 5 and beyond, where an unprecedented data sample of heavy-flavour decays, amounting to approximately 300 fb^{-1} of integrated luminosity, will be collected.

The most common approaches to precisely bound or measure such biases rely on fully data-driven methods, typically using one or more calibration channels where the CP violation is expected to be much smaller than the experimental uncertainties involved. Some of the more promising decay modes to be used as references in the high-precision regime are the $D^0 \to K^0_S\pi^+\pi^-$ and the $D^+ \to K^0_S\pi^+$ decays.

The particle-antiparticle asymmetry in these channels is highly influenced by the time evolution of neutral kaons, which can travel several metres in the detector before decaying. The $K^0 - \overline{K}^0$ mixing and interactions of neutral kaons with the detector create an asymmetry in the detection of the K^0_S produced by D or $\overline{D}$ mesons, which must be modelled and precisely determined using the abundant samples available of neutral and charged D mesons. This talk presents the extension of the current methods employed to determine the neutral kaon asymmetry in a very high-precision regime, and its application to the ongoing and future searches for CP violation in the charm sector at the LHCb experiment.

Primary authors: CELESTINO, Irene (Istituto Nazionale di Fisica Nucleare); MORELLO, Michael Joseph (SNS and INFN-Pisa (IT)); KLEIJNE, Nico (Istituto Nazionale di Fisica Nucleare)

Presenter: CELESTINO, Irene (Istituto Nazionale di Fisica Nucleare)

Session Classification: Young Scientist Forum