T 52: Flavour Physics III

Time: Wednesday 16:15–18:15 Location: VG 1.104

T 52.1 Wed 16:15 VG 1.104

Measurement of the $\pi^0 \to e^+e^-\gamma$ decay at NA62 — •Célia Polivka — Johannes Gutenberg-Universität Mainz

The current value for the $\pi^0_D \to e^+e^-\gamma$ Dalitz decay is $\mathcal{B}r(\pi^0_D) = (1.174 \pm 0.035) \cdot 10^{-2}$ and has a large uncertainty. This is a limiting factor for other measurements that use the Dalitz decay as normalisation channel. This analysis aims to improve the precision on this measurement using data from the NA62 experiment at CERN. The π^0 mesons are tagged by $K^+ \to \pi^+\pi^0$ decays. The π^0_D is then identified by reconstruction of the three track vertex of e^+, e^- and π^+. Presented are the status of the analysis and an outlook on the precision of the measurement.

T 52.2 Wed 16:30 VG 1.104

Semileptonic Kaon decays in NA62 — •Atakan Akmete — Mainz University

The semileptonic charged kaon decays $K^+ \to \pi^0\ell^+\nu(\gamma)$ ($K_{\ell 3}$) provide a clean way to test the e-μ lepton universality and probe the first row unitarity $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$ of the CKM matrix. Current results indicate a tension, known as the Cabibbo angle anomaly.

This work aims to update the branching fractions of $K_{\ell 3}$ decays, along with the other main K^+ decay channels using a minimum bias low-intensity dataset collected by the NA62 experiment (CERN) in 2024. This dataset offers high statistics in a clean environment. The measurement is performed by analyzing single positively charged tracks, allowing all six main decay modes to be measured simultaneously.

In this talk, I will present the current status of the analysis, including the expected precision on the branching fractions.

T 52.3 Wed 16:45 VG 1.104

The Anatomy of $K^+ \to \pi^+\nu\nu$ distributions — •Kai Henryk Sieja[1], Emmanuel Stamou[1], Mustafa Tabet[1], Martin Gorbahn[1,2], and Ulserik Moldanazarova[2,3] — [1]TU Dortmund University, Germany — [2]University of Liverpool, United Kingdom — [3]Karaganda Buketov University, Kazakhstan

The rare decays $K^+ \to \pi^+\nu\nu$ and $K_L \to \pi^0\nu\nu$ are among the strongest probes of Beyond-the-Standard-Model dynamics with new sources of quark-flavour violation. These decays are thus the main target for the dedicated experiments NA62 and KOTO, with new data published in 2024 by NA62. Different New Physics scenarios can have an distinctive effect on the NA62 distributions. We analyze the impact of lepton-number violating or conserving dimension-six operators on the experimentally accessible distributions within the LEFT framework. Concrete New Physics models can induce operators with different chirality, i.e., vector-, scalar, tensor-type operators, and different neutrino flavour structure. Using all published data from NA62, we assess the impact of a combined binned likelihood analysis in constraining the New Physics parameter space and how this varies for different operator types, as well as the competitiveness of correlated constraints within SMEFT.

T 52.4 Wed 17:00 VG 1.104

Charm-Quark Mass in the Heavy Quark Expansion — •Anastasia Boushmelev[1], Thomas Mannel[1], and K. Keri Vos[2] — [1]Theoretische Physik 1, Center for Particle Physics Siegen Universität Siegen, D-57068 Siegen, Germany — [2]Gravitational Waves and Fundamental Physics (GWFP), Maastricht University, Duboisdomein 30, NL-6229 GT Maastricht, the Netherlands and Nikhef, Science Park 105, NL-1098 XG Amsterdam, the Netherlands

The Heavy Quark Expansion is a powerful framework for making predictions for inclusive heavy hadron decays. It provides a method to calculate decay rates and spectra as a double expansion in powers of $\Lambda_{\rm QCD}/m_Q$ and $\alpha_s(m_Q)$ and is well established for b-decays enabling precise predictions for various observables. In this context, the quark mass in an appropriate scheme is determined with sub-percent precision, and $\alpha_s(m_Q)$ is as low as 0.1.

Though, considering the charm sector, the treatment of the quark mass has to be further investigated as these mass schemes are not suitable in this case. Here we suggest to replace the charm mass, as well as further non-perturbative quantities, directly by q^2 moments based on a similar strategy applied on b-decays using e^+e^- inverse moments studied in [1]. Following this strategy we study the impact on the perturbative series of q^2 moments, as well as the total rate.

[1] A. Boushmelev, T. Mannel and K. K. Vos, JHEP 07 (2023), 175 doi:10.1007/JHEP07(2023)175 [arXiv:2301.05607 [hep-ph]].

T 52.5 Wed 17:15 VG 1.104

Measurements of mixing parameters and search for CP violation in mixing using multibody charm hadron decays at LHCb — •Florian Reiss and Marco Gersabeck — Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

The large samples of charm hadrons collected by the LHCb experiment facilitates the measurement of the charm mixing parameters and the search for charge and parity symmetry violating (CPV) effects with high precision. Multi-body charm hadron decays are of particular interest, as the interference of intermediate resonances can enhance CPV effects in certain regions of the phase space of the decay.

We present studies performed with model-dependent approaches to describe the contribution of the intermediate resonances to the overall decay amplitude as a function of phase space and decay time to extract the parameters of interest. The acceleration of these analyses using Graphics Processing Units is demonstrated and the expected sensitivity of ongoing measurements is shown.

T 52.6 Wed 17:30 VG 1.104

Early measurement of charm mesons production asymmetries at LHCb in Run 3 — •Luca Balzani[1], Laurent Dufour[2], Paula Herrero Gascon[3], Serena Maccolini[1], Dominik Stefan Mitzel[1], Sascha Stahl[2], Giulia Tuci[3], and Francesco Zenesini[4] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland — [3]Heidelberg University, Heidelberg, Germany — [4]University of Bologna, Bologna, Italy

Ahead of Run 3 of the LHC, the LHCb detector was profoundly upgraded to leverage the programmed increase in luminosity. Studying the features of the upgraded detector is of paramount importance in order to reliably perform measurements.

Production asymmetries are observables which depend on the colliding system characteristics but shall not be influenced by experimental effects. Having these latter contributions under control is essential to perform a consistent measurement. This makes production asymmetries ideal candidates to investigate the characteristics of the new LHCb detector. Being one of the first measurements done with the new data, it will also provide useful insights for their validation. Precise measurements of production asymmetries also allow for a better understanding of QCD models used in Monte Carlo generators, especially in the high-rapidity region. Finally, this analysis will lead to the first measurement of neutral charm meson production asymmetry for proton-proton collisions at the LHC energies. This contribution will discuss the general strategy and the techniques used for the measurement.

T 52.7 Wed 17:45 VG 1.104

Studies of CP violation in $D^0 \to \pi^+\pi^-\pi^0$ decays with the energy test method using LHCb Run 3 data — •Todor Todorov, Marco Gersabeck, Evelina Gersabeck, Florian Reiss, and Jan Karch — Albert-Ludwigs-Universität Freiburg, Freiburg im Breisgau, Germany

The standard model prediction for CP violation in the charm sector is relatively small and has a magnitude of the order of $\mathcal{O}(10^{-3} - 10^{-4})$. An observation of such violation has been made by the LHCb collaboration in $D^0 \to hh$ decays, but this remains the only significant experimental evidence. $D^0 \to \pi^+\pi^-\pi^0$ decays offer a promising candidate for studies of CP asymmetries, because they proceed via the same electroweak decay mode as the observation channel. Multibody decays also provide a 2 dimensional phase-space where different local contributions to CP violation can be observed even in the case of global CP symmetry. The energy test statistical method is chosen to search for local CP asymmetries due to its independence of model and choice of binning. An early study of the application of this statistical test to LHCb Run 3 data is presented, which is projected to benefit from a four-fold increase in data sample size in comparison to previous LHCb analyses.

T 52.8 Wed 18:00 VG 1.104

Studies of angular and CP asymmetries in $D^+_{(s)} \to h^+\mu^+\mu^-$ decays at LHCb — •Luca Toscano, Dominik Mitzel, and Serena Maccolini — TU Dortmund

The LHCb experiment has recorded the world's largest sample of charm hadron decays and takes a leading role in measurements of rare decays and searches for CP violation.

Rare semi-leptonic charm decays such as $D^+ \to \pi^+\mu^+\mu^-$ and $D_s^+ \to K^+\mu^+\mu^-$ are sensitive to beyond-standard-model effects in flavour-changing neutral current $c \to u\mu^+\mu^-$ transitions. Observables such as angular and CP asymmetries, can be defined to test the Standard Model. Null tests on these observables are performed in the vicinity of intermediate hadronic resonances, where new physics signals can be enhanced.

In this talk, the first study of angular distributions and CP asymmetries in $D^+_{(s)} \to h^+\mu^+\mu^-$ decays is presented. The analysis uses data collected by the LHCb detector from 2015 to 2018 at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 6fb^{-1}. The preliminary results are showed.