T 57: Flavour Physics 5

Time: Wednesday 16:15–18:15 Location: T-H16

T 57.1 Wed 16:15 T-H16

Search for $B^0_{(s)} \to p\bar{p}\mu^+\mu^-$ decays with the LHCb experiment — Johannes Albrecht, •Maik Becker, Lukas Calefice, and Vitalii Lisovskyi — Experimentelle Physik 5, TU Dortmund

In 2019 the LHCb collaboration reported the first observation of the decays $B^0_{(s)} \to J/\psi p\bar{p}$. The branching fraction of the B^0_s mode was measured to be $(3.6 \pm 0.4) \times 10^{-6}$, which was much larger than the theoretically expected value of $\mathcal{O}(10^{-9})$ at that time. For the B^0 mode, however, the branching fraction was in agreement with theoretical predictions.

The question arises whether the corresponding non-resonant decays are also observable with the full data set of 9 fb^{-1} collected by the LHCb experiment. For the B^0_s mode the leading-order Feynman diagram is similar to the one for the $B^0_s \to \mu^+\mu^-$ decay, but includes an additional $p\bar{p}$ pair from gluon radiation, lifting the helicity suppression. For the B^0 mode Cabibbo-suppressed $b \to d\mu^+\mu^-$ transitions dominate.

In this talk an ongoing analysis of $B^0_{(s)} \to p\bar{p}\mu^+\mu^-$ decays using data from the LHCb experiment will be presented. In particular, the selection and studies on the resonant control channels are shown. The search aims at intensifying the efforts of the LHCb collaboration to study rare decays with leptons and baryons in the final state.

T 57.2 Wed 16:30 T-H16

Test of lepton universality with $\Lambda_b \to pKl^+l^-$ decays at LHCb — Johannes Albrecht, Vitalii Lisovskyi, and •Jannis Speer — Experimentelle Physik 5, TU Dortmund

In recent measurements of b-hadron decays a pattern of consistent tensions with the SM predictions is observed. This includes decays with $b \to sl^+l^-$ transitions, which play an important role in lepton flavor universality tests such as R_K and $R_{K^{*0}}$. Complementary to b-meson decays, lepton flavor universality can also be tested in b-baryon decays which come with partly orthogonal experimental uncertainties. The first measurement of the ratio of branching fractions of the decays $\Lambda_b \to pKe^+e^-$ and $\Lambda_b \to pK\mu^+\mu^-$, R^{-1}_{pK}, was published by the LHCb Collaboration using proton-proton collision data corresponding to 4.7 fb^{-1}. In the dilepton mass-squared range $0.1 < q^2 < 6.0\,\mathrm{GeV}^2/\mathrm{c}^4$ and the pK mass range $m(pK) < 2600\,\mathrm{MeV}/\mathrm{c}^2$ the ratio of branching fractions was measured to be $R^{-1}_{pK} = 1.17^{+0.18}_{-0.16} \pm 0.077$. The legacy measurement of R^{-1}_{pK} tries to reduce the uncertainties by analysing the full 9 fb^{-1} dataset of LHCb experiment and improving the selection.

In this talk the first study of the data recorded in the years 2017 and 2018 is presented. Furthermore the ongoing improvements in the signal selection requirements are discussed.

T 57.3 Wed 16:45 T-H16

Isospin asymmetries in rare B decays — Johannes Albrecht, •Fabio De Vellis, and Vitalii Lisovskyi — Experimentelle Physik 5, TU Dortmund

Isospin symmetry is a fundamental property of the Standard Model. It predicts a branching fraction that is almost the same for decays which differ only by one spectator quark, like $B^0 \to K^0\mu^+\mu^-$ and $B^+ \to K^+\mu^+\mu^-$. The same is true for the decays $B^0 \to K^{*0}\mu^+\mu^-$ and $B^+ \to K^{*+}\mu^+\mu^-$. For these decays a quantity which describes differences in branching fraction, namely the asymmetry, can be defined. This is particularly convenient since it is theoretically clean and it allows to cancel some experimental systematics. Previous measurements on these decays from LHCb and Belle, despite being compatible with expectations, suggested coherent deviations that could be interpreted as statistical fluctuations, or unaccounted theoretical uncertainties, or as a sign of New Physics. In this talk an update of the asymmetry measurement with the full LHCb dataset is presented. This means that data corresponding to an integrated luminosity of 6 fb^{-1} are added to the dataset used in previous Run 1 analysis. This analysis also aims to give an update to the differential branching fraction measurement of the above-mentioned decays.

T 57.4 Wed 17:00 T-H16

Measurement of the ratio $R_{K\pi\pi}$ with the LHCb experiment — Christoph Langenbruch, •Johannes Heuel, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen University

In the Standard Model (SM) of particle physics, the coupling of electroweak gauge bosons to all leptons is universal. Stringent tests of this Lepton Flavour Universality (LFU) are possible by measuring ratios of rare $b \to s\ell\ell$ decays with different leptons in the final state. These decays are loop-suppressed in the SM and therefore sensitive to new heavy particles beyond the SM.

The LHCb experiment is ideally suited for the study of rare b hadron decays due to its large acceptance, the high trigger efficiencies and the excellent tracking and particle identification. Recent measurements of $b \to s\ell\ell$ ratios published by the LHCb Collaboration show tensions with the SM predictions of up to 3.1 standard deviations. Therefore, further studies of LFU tests using other rare B decay channels are crucial.

The current status of the ongoing measurement of the ratio $R_{K\pi\pi}$ of the branching fractions of the decays $B^+ \to K^+\pi^+\pi^-\mu^+\mu^-$ and $B^+ \to K^+\pi^+\pi^-e^+e^-$ is presented. The measurement is experimentally challenging as the hadronic system is measured inclusively.

T 57.5 Wed 17:15 T-H16

Probing multilepton decays with the LHCb experiment — Johannes Albrecht and •Vitalii Lisovskyi — Experimentelle Physik 5, TU Dortmund

In the recent years, a number of tensions has been observed in rare decays of B hadrons to a lighter hadron and two leptons. With the large dataset collected by the LHCb experiment, it becomes possible to study even higher-order processes. For instance, in the Standard Model, radiation of a virtual photon from the initial state or the final state can create an additional dilepton pair, leading to a final state with four leptons. In theories beyond the Standard Model, there are alternative mechanisms to reach such final state, which makes such decays excellent probes in searches for New Physics. In this talk, decays of beauty hadrons and quarkonia to final states with four leptons will be discussed. In particular, a search for the decay $B^+ \to K^+\mu^+\mu^-\mu^+\mu^-$ with the dataset collected by the LHCb experiment will be presented. I will discuss the experimental challenges and sources of background, as well as estimate the expected sensitivity.

T 57.6 Wed 17:30 T-H16

Search for the $B^0 \to D^0\bar{D}^0$ decay with the LHCb experiment. — •Jonah Blank and Sophie Hollit — TU Dortmund

With precise measurements of B meson decays the LHCb experiment can test the integrity of the Standard Model of particle physics. Especially $B \to D\,D$ decays are interesting to examine $C\,P$ violation and further constrain the unitarity triangle. While decays to charged $D^\pm$ mesons have already been well measured, the $B^0 \to D^0\bar{D}^0$ decay channel has not yet been observed by any experiment.
In this analysis, data collected by the LHCb experiment at $\sqrt{s} = 7,8\,\mathrm{TeV}$ and 13 TeV corresponding to an integrated luminosity of 9 fb^{-1} is used to search for the $B^0 \to D^0\bar{D}^0$ decay channel. The $B^0 \to \bar{D}^0\pi^+\pi^-$ decay channel is utilized as a normalisation mode to cancel most uncertainties. An update of the current status of the analysis will be presented.

T 57.7 Wed 17:45 T-H16

Measurements of strangeness production with the upgraded LHCb detector — •Lukas Calefice[1,2], Vitalii Lisovskyi[1], Johannes Albrecht[1], and Vladimir Gligorov[2] — [1]Experimentelle Physik 5, TU Dortmund — [2]CNRS/LPNHE, Sorbonne Université, Paris

The LHCb experiment is currently undergoing a major upgrade of its detector to enable running at a five times higher instantaneous luminosity with respect to the previous data taking. Among other things the upgrade comprises the removal of the hardware trigger stage, a complete re-design of the software trigger, replacing the front-end readout electronics of all sub-detectors and an entire new set of tracking detectors. Validating the performance and data quality of the newly configured detector is a crucial task for the beginning of the next data taking period.

Due to their very large production cross-sections at the LHC strange hadrons such as Λ^0 and K^0_S can be studied with only few days of data taking. Therefore, these are used to investigate the alignment of tracking detectors, to check the PID performace and validate the simulation

of the upgraded detector. Finally, a measurement of the strangeness production cross-sections at 13 and 13.5 TeV will be performed with the early data after restarting the LHC.

This talk focuses on the preparations of the detector validation with data from the previous data takings.

T 57.8 Wed 18:00 T-H16

Search for ^{3}He ions at LHCb — •Hendrik Jage, Gediminas Sarpis, Valery Zhukov, and Stefan Schael — I. Physikalisches Institut B, RWTH Aachen University

In recent presentations, AMS-02 has reported the observation of several anti-helium candidates in cosmic rays. In 2020, it has been suggested by M. Winkler and T. Linden that dark matter annihilation into b-quarks could produce a detectable $^3\overline{\text{He}}$ flux in cosmic rays via $\overline{\Lambda}_b^0$ decays.

The LHCb detector at CERN is an experiment dedicated to the study of b-hadrons, which are abundantly produced in the proton-proton collisions at the Large Hadron Collider (LHC). Therefore, the large sample of Λ_b^0 decays, collected by LHCb until 2018, provides a unique opportunity to study the potential displaced production of ^{3}He via Λ_b^0 decays.

While prompt ^{3}He from proton-proton collisions has already been observed at the LHC by the ALICE Collaboration in the central region ($|y| < 0.5$), prompt and displaced ^{3}He has not yet been searched for at LHCb ($2 < \eta < 5$). In this talk, the possibility of identifying ^{3}He at LHCb is discussed and the status of the on-going analysis is presented.