T 9: Flavor physics: Lepton universality tests I

Time: Monday 16:30–18:00 Location: H-HS X

T 9.1 Mon 16:30 H-HS X

Rare baryonic decays and lepton universality tests at LHCb — •Vitalii Lisovskyi and Johannes Albrecht — Experimentelle Physik 5, TU Dortmund

Flavour-changing neutral-current $b \to s\ell^+\ell^-$ transitions are forbidden at tree level in the Standard Model (SM), and can only occur at loop level. Therefore, they are sensitive to potential New Physics (NP) effects. In the SM, the transitions $b \to se^+e^-$ and $b \to s\mu^+\mu^-$ have the same probability to happen, this property is called lepton universality (LU). Probing LU in b-hadron decays is considered as a promising area for NP searches. In particular, tensions at the level of about 2.5 standard deviations with respect to the SM predictions have been observed in rare $B \to K^{(*)}\ell^+\ell^-$ decays.

This talk presents a first test of the LU in rare decays of b baryons, namely $\Lambda_b^0 \to pK\ell^+\ell^-$, using the data collected by the LHCb experiment. The decay $\Lambda_b^0 \to pKe^+e^-$ is observed for the first time, which allows to test LU with about 15% precision. The analysis approach, its main challenges and potential future improvements are discussed.

Furthermore, prospects for studies of rare decays of the Λ_b^0 and heavier b baryons at the LHCb experiment are discussed.

T 9.2 Mon 16:45 H-HS X

Measurement of the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ at Belle using the Belle II software — Florian Bernlochner[2], Michael Feindt[1], Pablo Goldenzweig[1], •Felix Metzner[1], and Maximilian Welsch[2] — [1]Karlsruher Institut für Technologie — [2]Rheinische Friedrich-Wilhelms-Universität Bonn

The discrepancy observed for the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ of the decays $\mathrm{B} \to \mathrm{D}^{(*)}\tau\nu$ relative to the normalisation modes $\mathrm{B} \to \mathrm{D}^{(*)}\ell\nu$ ($\ell = \mathrm{e}, \mu$) between the experimental results and the Standard Model (SM) prediction is one of a few longstanding tensions of the SM. The new Belle II software framework and the therein included conversion tool B2BII allows to reevaluate the Belle data set of 772 million $\mathrm{B\bar{B}}$ pairs recorded from 1999 until 2010 using the improved algorithms of the modern framework. With this approach a new measurement of the ratios $\mathcal{R}(\mathrm{D}^{(*)})$ with an improved hadronic tagging algorithm — the Full Event Interpretation (FEI) — is carried out. Profiting from a higher reconstruction efficiency, due to the new tagging algorithm, this analysis aims to provide new insights into these semileptonic B decays. In this talk, the procedure and the current status of the analysis will be presented.

T 9.3 Mon 17:00 H-HS X

Semitauonic B-decays at Belle II with a hadronic tagging — Florian Bernlochner[1], Jochen Dingfelder[1], •Michael Eliachevitch[1], Felix Metzner[2], and Maximillian Welsch[1] for the Belle II-Collaboration — [1]Rheinische Friedrich-Wilhelms-Universität Bonn — [2]Karlsruher Institut für Technologie

One of the prominent candidates in the search for new physics at the precision frontier is the ratio $\mathcal{R}(\mathrm{D}^{(*)})$ of $\bar{\mathrm{B}} \to \mathrm{D}^{(*)}\tau\nu_\tau$ to $\bar{\mathrm{B}} \to \mathrm{D}^{(*)}\ell\nu_\ell$ decays, where $\ell = \mathrm{e}, \mu$. Combined measurements from the B factories and LHCb reveal an excess of the semitauonic decays with respect to Standard Model predictions. The Belle II experiment in Tsukuba, Japan, will enable new insights into this anomaly.

This talk presents the procedure, status, and plans for an analysis using the hadronic tag side reconstructed with the Full Event Interpretation, a tagging algorithm developed for the Belle II experiment.

T 9.4 Mon 17:15 H-HS X

Signal extraction of $B^0 \to \pi^-\tau^+\nu_\tau$ at Belle and Belle II — Jochen Dingfelder, Peter Lewis, and •Lu Xu for the Belle II-Collaboration — Physikalisches Institut, Universität Bonn, Bonn, Germany

The decay $B^0 \to \pi^-\tau^+\nu_\tau$ is sensitive to new physics beyond the Standard Model, such as contributions from charged Higgs bosons or leptoquarks. The world's best limit was established by the Belle experiment using its full dataset, measuring $\mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau) < 2.5 \times 10^{-4}$ at 90% confidence level. We present the current status of an ongoing measurement of $\mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau)$ with improved hadronic tagging in leptonic and hadronic τ decay modes. The study aims to extract the ratio $R(\pi) = \mathcal{B}(B^0 \to \pi^-\tau^+\nu_\tau)/\mathcal{B}(B^0 \to \pi^-\ell^+\nu_\ell)$ with ℓ denoting either an electron or muon. A MVA based on a boosted decision tree is employed to separate light lepton and τ contributions from each other.

T 9.5 Mon 17:30 H-HS X

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 2.5 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 9.6 Mon 17:45 H-HS X

Measurement of the ratio $R_{K^{*0}}$ using Run 1 + 2 data of the LHCb experiment — •Stephan Escher, Christoph Langenbruch, Simon Nieswand, Stefan Schael, and Eluned Smith — RWTH Aachen, Germany

In the Standard Model (SM) of particle physics flavour-changing neutral-current processes are forbidden at tree-level and can only occur in electroweak loop diagrams. Therefore, $b \to s$ transitions are rare and sensitive to heavy particles beyond the SM. In the SM the coupling of gauge bosons to leptons are independent of their flavour, which is known as lepton flavour universality (LFU). Thus, the $R_{K^{*0}}$ ratio, defined as $R_{K^{*0}} = \mathcal{B}(B^0 \to K^{*0}\mu^+\mu^-)/\mathcal{B}(B^0 \to K^{*0}e^+e^-)$, is predicted to be unity in the SM (neglecting lepton mass effects). The existence of new particles, that couple differently to electrons and muons, could influence the $R_{K^{*0}}$ ratio significantly and lead to deviations from unity.

To this date, the most precise measurement of $R_{K^{*0}}$ is performed by the LHCb collaboration using Run 1 data showing a deviation of $2.4 - 2.5$ standard deviations (σ) from the SM expectations.

This talk will present the strategy of the analysis using the combined Run 1 and 2 LHCb data sample, which will allow for a more precise determination of $R_{K^{*0}}$. Particular emphasis will be on the study of backgrounds as well as on the validation of fit yields and efficiencies of the control channel.