T 94: Flavour Physics VI

Time: Friday 9:00–10:30 Location: KH 01.011

T 94.1 Fri 9:00 KH 01.011

Semileptonic Kaon Decays at NA62 — •Atakan Akmete — Mainz University

Semileptonic charged kaon decays $K^+ \to \pi^0\ell^+\nu(\gamma)$ ($K_{\ell 3}$) provide a clean test of e-μ lepton universality and a direct probe of the first row of the CKM matrix unitarity $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$. Current measurements indicate a near three-sigma tension in the determination of V_{ud} and V_{us}, with semileptonic kaon decays alone contributing at the 2.6σ level.

This study aims to update the branching fractions of $K_{\ell 3}$ together with the other dominant K^+ modes using an unbiased low-intensity dataset collected by the NA62 experiment at CERN, providing a clean environment for per-mille-level statistical precision.

From this dataset, events with a single positively charged downstream track are selected, defining a topology that allows all six main decay modes to be measured simultaneously without explicit particle identification. This approach naturally separates decay modes into distinct kinematic regions, effectively acting as a PID substitute and reducing the systematic uncertainties associated with neutral-pion reconstruction and calorimetry.

In this talk, I will present the current status of the analysis, including preliminary results and ongoing systematic studies.

T 94.2 Fri 9:15 KH 01.011

Search for $B \to D^{(*)}\eta\ell\nu$ at Belle II — •David Giesegh, Thomas Kuhr, and Thomas Lück — LMU Munich, Germany

Even though semileptonic B meson decays have been a field of intensive study over the past decades, there are still unresolved questions. One of these is the so-called gap problem, which describes a discrepancy between measurements of the inclusive semileptonic branching fraction and the sum of exclusive semileptonic branching fractions. This difference could be attributed to one or several as of yet unobserved decays, an example for which is $B \to D^{(*)}\eta\ell\nu$, which is allowed within the Standard Model and commonly used in MC simulations of generic B meson decays to fill the gap.

In the analysis presented here we aim to measure this branching fraction for the first time using data collected by the Belle II Experiment. We leverage Belle II's well known initial state kinematics to derive the angle between the decaying B meson and its visible daughters, which is used for signal extraction. Additionally, MVA methods are employed for candidate selection and background suppression, which is especially important in the reconstruction of η candidates. In the talk we will discuss the current status and future outlook of this analysis.

T 94.3 Fri 9:30 KH 01.011

Measurement of the Branching Ratio and q^2-spectrum of $B \to D^{**}\ell\nu$ decays at Belle II — •Eylül Ünlü, Thomas Kuhr, and Thomas Lück — Ludwig-Maximilians-Universität München (LMU), München, Germany

There is currently some tension between the measured value of $R(D^*) = \mathcal{B}(B \to D^*\tau\nu_\tau)/\mathcal{B}(B \to D^*\ell\nu_\ell)$ and the Standard Model prediction, hinting at lepton universality violation. Semileptonic B meson decays to D^{**} mesons are background to the $R(D^*)$ measurement, where D^{**} denotes the orbitally excited P-wave charm mesons: $D_1(2420)$, $D_2^*(2460)$, $D_0^*(2300)$, and $D_1'(2430)$. These decays are not well understood, and discrepancies have been observed between past measurements of their yields made by BaBar and Belle. Hence, improving understanding of these decays reduces an important systematic uncertainty on $R(D^*)$ measurements.

The present study aims to use data from the Belle II experiment to study these decays, particularly to determine the q^2 spectrum, which is a key input for theory predictions.

We reconstruct one of the B mesons from the $\Upsilon(4S) \to BB$ decay in the signal channel, $B \to D^{**}(D^{(*)}\pi)\ell\nu$, and the other B meson in various hadronic modes using the Full Event Interpretation algorithm. The signal yield is determined by a maximum likelihood fit to the mass difference $M(D^{(*)}\pi) - M(D^{(*)})$. The resulting q^2 spectrum is fitted using a differential decay rate model after correcting for detector resolution effects. The status of the analysis will be presented including results on simulation and a first assessment of systematic uncertainties.

T 94.4 Fri 9:45 KH 01.011

Angular analysis of $B^0 \to D^*\tau\nu$ in Run 2 at the LHCb experiment — Tobias Knospe[1], Johannes Albrecht[1], Greg Ciezarek[2], Marco Gersabeck[3], Lucia Grillo[4], •Biljana Mitreska[5], Chris Parkes[5], Manuel Schiller[4], Derek Yeung[5], and Havva Hasret Nur[4] — [1]TU Dortmund University, Dortmund, Germany — [2]CERN, Geneva, Switzerland — [3]Albert-Ludwigs-Universität Freiburg, Freiburg, Germany — [4]University of Glasgow, Glasgow, UK — [5]The University of Manchester, Manchester, UK

The global average of the ratio $R(D^*)$ between the $B^0 \to D^*\tau\nu$ and $B^0 \to D^*\mu\nu$ branching fractions is at tension with the SM prediction. The angular structure of the $b \to c\ell\nu$ transition using effective field theory allows to probe potential New Physics (NP) effects with greater sensitivity than a measurement of the branching fraction. An angular analysis of the $B^0 \to D^*\tau\nu$ decay is presented, based on proton-proton collision data collected by the LHCb experiment, corresponding to an integrated luminosity of $1.6\,\text{fb}^{-1}$. The signal distribution is extracted through a multidimensional fit to the data, using templated distributions derived from both simulation and data control samples. The $R(D^*)$ ratio and several NP Wilson coefficients are measured in different combinations. Additionally, the $R(D^*)$ ratio as well as the hadronic form factors are measured in a Standard Model scenario using BGL and BLPR parameterizations.

T 94.5 Fri 10:00 KH 01.011

***R*(*D**) measurements with ATLAS Run 2 data** — •Laily Sultanaliyeva[1], Leonid Gladilin[2], and Vladimir Tikhomirov[2] — [1]University of Bonn, Bonn, Germany — [2]Moscow, Russia

Semileptonic decays of hadrons can be used for testing the equality of the couplings of the three charged leptons to the gauge bosons, i.e. Lepton Flavour Universality (LFU). Sensitive to LFU violation ratios of branching fractions for various hadrons decays have been previously studied by BaBar, Belle and LHCb experiments. The aim of this analysis is to measure $R(D^*) \equiv \mathcal{B}(B^0 \to D^{*-}\tau^+\nu_\tau)/\mathcal{B}(B^0 \to D^{*-}\mu^+\nu_\mu)$ with proton-proton (pp) collisions data collected by the ATLAS experiment during LHC Run 2 and compare with the current world-average result, which now exceeds the Standard Model predictions by $\sim 2.7\sigma$.

The ratio of branching fractions $R(D^*)$ is measured with data recorded during pp collisions with $\sqrt{s} = 13\,\text{TeV}$ corresponding to the integrated luminosity of $140\,\text{fb}^{-1}$. The $\tau^\pm$ leptons are reconstructed through the semileptonic decay $\tau^\pm \to \mu^\pm\bar{\nu_\mu}\nu_\tau$, while for D^* mesons the following decay chain is used: $D^{*\pm} \to D^0\pi^\pm \to (K^\mp\pi^\pm)\pi^\pm$. Both $\tau-$ and $\mu-$ decay modes of B^0 mesons have the same number of detectable particles in the final state, and thus can be selected and analysed together. A multi-dimesional fit then can be used to separate two signal processes from each other as well as from background processes. In this talk the current state of the analysis will be presented.

T 94.6 Fri 10:15 KH 01.011

R(D) and R(D*) Measurement using an Inclusive Tagging Method — •Fabio Novissimo[1], Tia Crane[2], Thomas Lück[1], and Thomas Kuhr[1] — [1]Ludwig-Maximilians-Universität München (LMU), München, Germany — [2]DESY - Universität Hamburg

Lepton flavour universality (LFU) is a fundamental symmetry of the Standard Model (SM). This symmetry states that the three generations of leptons (electrons, muons and tauons), couple with equal strength to the W boson. Any deviation from this symmetry is a clear sign of new physics. In this regard, the semileptonic decays of B mesons are an invaluable portal for LFU tests. More specifically, the measurement of the ratios R(D) and R(D*) defined as

$$R(D^{(*)}) = \frac{\mathcal{B}\left(B \to D^{(*)}\tau\nu_\tau\right)}{\mathcal{B}\left(B \to D^{(*)}\ell\nu_\ell\right)}$$

are two great ways to probe this symmetry, since the ratios allow many uncertainties to cancel and are predicted with a very high precision in the SM. Latest averaged results show that there is a 3.8σ tension with the SM prediction, making this measurements very relevant. The analysis presented in this talk aims to obtain an even more precise measurement of the ratios R(D) and R(D*) using Belle II data, and adopts an inclusive tagging approach, which allows increased statistics at the expenses of higher background levels. This talk will provide an overview of the analysis, as well as the current status and future outlook.