T 78: Flavor VII

Time: Wednesday 17:30–19:00 Location: HSZ/0304

T 78.1 Wed 17:30 HSZ/0304

Completing the Heavy Quark Expansion — •Ilija Sibin Milutin[1], Thomas Mannel[1], and Keri Vos[2] — [1]Siegen University, Siegen, Germany — [2]Maastricht University, Maastricht, The Netherlands

The Heavy Quark Expansion (HQE) has become the major tool to perform precision calculations for inclusive rates and spectra of heavy hadron decays. The HQE is an expansion in powers of the inverse mass of the heavy quark $1/m_b$ and introduces HQE matrix elements which need to be extracted from data. Recently, moments of the dilepton spectrum of inclusive semileptonic $B \to X_c \ell \bar{\nu}$ have been used to extract the CKM matrix element V_{cb} with incredible percent-level precision and in agreement with the world's best determination of V_{cb}.

The HQE for the inclusive semileptonic $B \to X_c \ell \bar{\nu}$ decay is usually set up in such a way that one assumes that the charm quark is also a heavy quark. Therefore, one will also have contributions of order $\Lambda_{\rm QCD}^n/m_c^n$.

At dimension six, i.e. at $1/m_b^3$, a coefficient function behaving as $\ln m_c^2$ appears and at dimension eight, terms with $1/m_c^2$ appear. A consistent power counting therefore needs to be set up. Numerically, we find that $m_c^2 \sim m_b \Lambda_{\rm QCD}$ and therefore two powers of m_c should be counted as one power of m_b. Consequently, in order to complete the existing calculation at order $1/m_b^4$, we need to include contributions of order $1/m_b^3 \cdot 1/m_c^2$ that may be numerically relevant.

In this talk, we present how we determine these contributions and the results for the moments of the leptonic invariant mass spectrum.

T 78.2 Wed 17:45 HSZ/0304

Studies of hadronic tag reconstruction and muon identification efficiency for $B \to X_u \ell \nu$ decays at the Belle II experiment — •Merle Graf-Schreiber[1], Florian Bernlochner[2], Lu Cao[1], Marcel Hohmann[3], Munira Khan[2], Tommy Martinov[1], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]Universität Bonn — [3]University of Melbourne

The Belle II experiment is located at the SuperKEKB e^+e^- collider where it collects collision data around the $\Upsilon(4S)$ resonance, which primarily decays into $B\bar{B}$ pairs. The clean experimental environment of e^+e^- collisions enables us to study the inclusive $B \to X_u \ell \nu$ decay with good resolution, where X_u can be any charmless hadronic final state. The measurement of the partial branching fractions of this decay can be used to extract the Cabibbo-Kobayashi-Maskawa matrix element $|V_{ub}|$, which is important for constraining the unitary triangle. In addition insights about the discrepancy between the $|V_{ub}|$ value measured in inclusive versus exclusive decays can be gained.

The lepton of the signal B decay and the second (tag) B meson of the $\Upsilon(4S)$ decay are crucial ingredients for reconstructing the kinematics of the X_u system and the undetected neutrino. The muon identification efficiency and its calibration to account for possible differences between data and simulation using the $ee \to \mu\mu\gamma$ process are going to be discussed in this talk. The tag B meson is reconstructed using a multivariate based tagging algorithm, the full event interpretation. The second part of this talk is going to focus on studying the tagging performance using variables related to the $B_{\rm tag}$ meson.

T 78.3 Wed 18:00 HSZ/0304

Fitting procedure for the inclusive measurement of $\mathrm{B} \to \mathrm{X_u} \ell \nu$ at Belle II — Martin Angelsmark[1], Florian Bernlochner[1], Lu Cao[2], Jochen Dingfelder[1], Merle Graf-Schreiber[2], Marcel Hohmann[3], •Munira Khan[1], Tommy Martinov[2], and Kerstin Tackmann[2] — [1]Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn — [2]DESY, Hamburg — [3]University of Melbourne

The discrepancy between the results of exclusive and inclusive measurements of the Cabibbo-Kobayashi-Maskawa matrix element $|\mathrm{V_{ub}}|$ remains an open question in flavor physics. The precise determination of $|\mathrm{V_{ub}}|$ proves to be difficult since it is CKM suppressed and therefore suffers from a high physics backgrounds originating from the CKM favored $\mathrm{b} \to \mathrm{c}$ transition. Phase space regions that allow clear separation of these two processes are heavily dominated by modeling uncertainties. We are preparing a new determination using data from the Belle II experiment. Belle II is a next-generation flavor factory with an anticipated data set of 50 ab^{-1} of collision events. In this talk we present the current status of the analysis and focus on a new fitting procedure for the signal extraction.

T 78.4 Wed 18:15 HSZ/0304

Measurement of the ratio of partial branching fractions of hadronicly tagged inclusive $B \to X_u \ell \nu$ to $B \to X_c \ell \nu$ decays at the Belle experiment. — •Marcel Hohmann[1], Phillip Urquijo[1], and Kerstin Tackmann[2] — [1]The University of Melbourne, Melbourne — [2]DESY, Hamburg

We present a measurement of the ratio of partial branching fractions of the semi-leptonic inclusive decays, $B \to X_u \ell \nu$ to $B \to X_c \ell \nu$, where $\ell = e, \mu$. The measurement is performed on the world leading sample of 772×10^6 $B\overline{B}$ pairs collected at the $\Upsilon(4S)$ resonance by the Belle experiment using the state-of-the-art Full Event Interpretation algorithm developed for the Belle II experiment to fully reconstruct the companion B-meson. Identifying inclusive $B \to X_u \ell \nu$ decays is difficult due to the abundance of Cabibbo–Kobayashi–Maskawa (CKM) favored $B \to X_c \ell \nu$ events which share a similar single lepton signature and whose composition are not fully understood. To minimize dependence on modeling of these channels a data-driven $B \to X_c \ell \nu$ description is employed. The ratio is measured via a two-dimensional fit to the lepton momentum, $p_\ell^{B_{sig}}$, and four-momentum transfer squared, q^2, in the regime $p_\ell^{B_{sig}} > 1.0\,\mathrm{GeV}$, covering approximately 86% and 79% of the $B \to X_u \ell \nu$ and $B \to X_c \ell \nu$ phase-space respectively. The determination of this ratio allows for direct extraction of $|V_{ub}|/|V_{cb}|$, corresponding to the length of one of the sides of the Unitarity Triangle. Precise knowledge of this side-length allows for powerful tests of the flavor sector of the standard model and to constrain beyond standard model physics.

T 78.5 Wed 18:30 HSZ/0304

Machine learning applications to the measurement of $|V_{ub}|$ at Belle II — •Tommy Martinov[1], Florian Bernlochner[2], Lu Cao[1], Merle Graf-Schreiber[1], Marcel Hohmann[1,3], Munira Khan[2], and Kerstin Tackmann[1] — [1]DESY, Hamburg — [2]University of Bonn — [3]University of Melbourne

The Belle II detector is located at the SuperKEKB collider in Japan and performs high-precision flavour physics studies through e^+e^- collisions at a center-of-mass energy of approximately 10.58 GeV. Using data collected by the Belle II experiment, new precision measurements of $|V_{ub}|$ will be performed using inclusive semi-leptonic decays to a hadronic system, a lepton and a neutrino ($B \to X_u \ell \nu$). This is particularly important for constraining the unitarity triangle, including potential insights in the long-standing discrepancy between $|V_{ub}|$ measurements from inclusive and exclusive semi-leptonic decays. However, this process is overwhelmed by the much more likely decay to a hadronic system containing a charm quark ($B \to X_c \ell \nu$). A multivariate classifier can be used to improve the signal-to-background separation compared to simple kinematic selections. However, the signal acceptance of such a classifier is usually not uniform as a function of the main parameters of interest (leptonic system invariant mass q^2, hadronic mass M_X...). Different methods exist to constrain the classifier and obtain more uniform signal efficiency. Two examples are the uBoost method for Boosted Decision Trees and the DisCo method for Neural Networks. In this presentation the applications of these methods on simulated $B \to X_{u/c} \ell \nu$ data will be discussed.

T 78.6 Wed 18:45 HSZ/0304

Semileptonic Charged Kaon Decays in NA62 — •Atakan Tugberk Akmete — Johannes Gutenberg University Mainz

The NA62 experiment at the CERN SPS was proposed and designed to measure the branching ratio of the ultra-rare $K^+ \to \pi^+ \nu\bar{\nu}$ using a decay-in-flight technique. NA62 took data of $K_{\pi\nu\nu}$ in 2016, 2017, 2018, 2021 and 2022.

In such Kaon experiments, it is also possible to measure the branching ratios of the semileptonic decays $K \to \pi^0 \ell \nu(\gamma)$ ($K_{\ell 3}$) with high precision. $K_{\ell 3}$ provides a very clean way to test the lepton universality and probe the first row of the unitary of the CKM quark mixing matrix $|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = 1$. The measurement is done by analyzing the charged single tracks to measure the six main decay modes at once without any specific PID. This strategy reduces the systematics and allows to measure of the branching fractions by using binned maximum-likelihood fit of each MC component to the data. In this talk, I will present my preliminary results using this method.