

T 56: Flavour physics III

Time: Wednesday 16:00–18:30

Location: Tf

T 56.1 Wed 16:00 Tf

Contribution of the Darwin operator to non-leptonic decays of heavy quarks — ●MARIA LAURA PISCOPO, ALEKSEY RUSOV, and ALEXANDER LENZ — Center for Particle Physics Siegen, Theoretische Physik 1, Universität Siegen

We compute the Darwin operator contribution ($1/m_b^3$ correction) to the width of the inclusive non-leptonic decay of a B meson (B^+ , B_d or B_s), stemming from the quark flavour-changing transition $b \rightarrow q_1 \bar{q}_2 q_3$, where $q_1, q_2 = u, c$ and $q_3 = d, s$. The key ideas of the computation are the local expansion of the quark propagator in the external gluon field including terms with a covariant derivative of the gluon field strength tensor and the standard technique of the Heavy Quark Expansion (HQE). We confirm the previously known expressions of the $1/m_b^3$ contributions to the semi-leptonic decay $b \rightarrow q_1 \bar{\nu}_\ell \ell$, with $\ell = e, \mu, \tau$ and of the $1/m_b^2$ contributions to the non-leptonic modes. We find that this new term can give a sizeable correction of about -4% to the non-leptonic decay width of a B meson. For B_d and B_s mesons this turns out to be the dominant correction to the free b -quark decay, while for the B^+ meson the Darwin term gives the second most important correction - roughly $1/2$ to $1/3$ of the phase space enhanced Pauli interference contribution. Due to the tiny experimental uncertainties in lifetime measurements the incorporation of the Darwin term contribution is crucial for precision tests of the Standard Model.

T 56.2 Wed 16:15 Tf

Investigation of $B \rightarrow \mu\nu$ with inclusive tagging at Belle II — FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, SVENJA GRANDERATH, ●DANIEL JACOBI, and PETER LEWIS for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

$B\bar{B}$ meson pairs are the dominant decay products of the $\Upsilon(4S)$ resonance, which is produced in large amounts in e^+e^- collisions at the SuperKEKB collider in Japan, and their decays are measured by the Belle II experiment. Leptonic B meson decays, such as the investigated $B \rightarrow \mu\nu$ decay, are highly suppressed, both due to Cabibbo-Kobayashi-Maskawa matrix element V_{ub} and helicity arguments. In a two-body decay like $B \rightarrow \mu\nu$, the muon momentum is exactly known in the rest frame of the signal-side B meson. By boosting the signal-side muon into that frame, a better signal resolution and improved sensitivity can thus be achieved compared to the center-of-mass frame. This requires a high-precision boost vector, which can be determined by studying the rest of the event that contains the decay products of the second B meson. This indirectly reconstructs the signal-side B meson kinematics, since in the center-of-mass frame of the e^+e^- collision the B mesons are produced with equal energy and equal but opposite momentum. This talk will discuss the current status of the analysis and possible approaches toward improving the sensitivity of measuring $B \rightarrow \mu\nu$ at Belle II.

T 56.3 Wed 16:30 Tf

QCD factorization of the four-lepton decay $B^- \rightarrow \ell \bar{\nu}_\ell \ell' \bar{\ell}'$ — MARTIN BENEKE¹, PHILIPP BOER¹, ●PANAGIOTIS RIGATOS¹, and KERI VOS² — ¹Technical University of Munich — ²Maastricht University

The radiative decay $B^- \rightarrow \gamma \ell \bar{\nu}_\ell$ has been extensively studied in the context of QCD factorization, when the energy of the photon is large compared to the scale of strong interaction Λ_{QCD} . The branching ratio of this decay depends strongly on the first inverse moment of the B meson light-cone distribution amplitude (LCDA), an important, poorly constrained, non-perturbative parameter for the QCD factorization of other hadronic decays. In this work we consider the same decay with an off-shell photon which further decays into a lepton pair ($\ell, \ell' = e, \mu$), resulting in the exclusive four lepton decay $B^- \rightarrow \ell \bar{\nu}_\ell \gamma^* \rightarrow \ell \bar{\nu}_\ell \ell' \bar{\ell}'$. We investigate whether these decays retain sensitivity on λ_B and provide decay rate estimates for the case of identical and non-identical leptons.

T 56.4 Wed 16:45 Tf

Measurement of the photon energy spectrum in the fully-inclusive hadronic-tagged $B \rightarrow X_s \gamma$ decays at the Belle II experiment — ●HENRIKAS SVIDRAS — DESY, Notkestraße 85, 22607 Hamburg, Germany

Belle II is an experiment at the next-generation B factory SuperKEKB

located at KEK in Tsukuba, Japan. It aims to probe heavy flavour physics at a higher precision than its predecessors, namely BaBar and Belle. The goal is to collect 50 ab^{-1} of data during its run: more than 50 times that of Belle. One of the particularly promising decay channels to study is the inclusive radiative $B \rightarrow X_s \gamma$ decay, where X_s denotes any possible decay products containing an s quark and γ is a high-energetic photon. This decay can provide constraints for beyond-SM theories, for example by measuring CP asymmetries, and be used to extract important parameters such as the b quark mass. The analysis presented in this talk focuses on the hadronic-tagged fully-inclusive approach, where one of the daughter B mesons of the $\Upsilon(4S) \rightarrow B\bar{B}$ decays into hadrons. The extraction of the photon energy spectrum of the $B \rightarrow X_s \gamma$ is one of the goals of the analysis. The talk presents an overview of the aspects and challenges of this measurement at Belle II.

T 56.5 Wed 17:00 Tf

Towards completion of the four-body contributions to $\bar{B} \rightarrow X_s \gamma$ — ●LARS-THORBEN MOOS and TOBIAS HUBER — Center for Particle Physics Siegen, Theoretische Physik 1, Universität Siegen

The inclusive radiative $\bar{B} \rightarrow X_s \gamma$ decay constitutes an important pillar in the indirect search for new physics and allows to constrain the parameter space of many models.

In this talk we present the ongoing efforts in the computation of four-body contributions to the process $\bar{B} \rightarrow X_s \gamma$, namely those of $b \rightarrow s \bar{q} q \gamma$ at NLO in the strong coupling and the necessary complementing 5-particle cuts of the gluon-bremsstrahlung $b \rightarrow s \bar{q} q \gamma + g$.

Although these corrections are expected to be small, this computation formally completes the NLO contributions to $\bar{B} \rightarrow X_s \gamma$.

Since the anomalous dimensions are already computed to a sufficient order, the main tasks are the systematic generation of the 1-loop amplitude, the automation of the phase space integration, the infrared-regularization and finally the renormalization of the diagrams including the operator mixing.

The results obtained so far are shown and the further structure of the calculation is outlined.

T 56.6 Wed 17:15 Tf

Measurement of inclusive $B \rightarrow X_u \ell \nu$ decay with hadronic tagging at Belle — FLORIAN BERNLOCHNER, ●LU CAO, WILLIAM SUTCLIFFE, and RAYNETTE VAN TONDER for the Belle-Collaboration — Physikalisches Institut, Universität Bonn, Germany

Precise measurement of the CKM matrix element $|V_{ub}|$ permits a stringent test of the Standard Model (SM) of particle physics through its role of constraining the apex of the unitarity triangle. The sizeable tension between the exclusive and inclusive determinations of $|V_{ub}|$ is limiting the precision of this test, which evoked many investigations in the past decades. With the full data set of the Belle experiment comprising 772 million $B\bar{B}$ pairs, we measure partial branching fractions in three phase-space regions covering about 31% to 86% of the accessible $B \rightarrow X_u \ell \nu$ phase-space. The $|V_{ub}|$ value is extracted based on a two-dimensional fit of the hadronic mass spectrum and the four-momentum transfer squared distribution in the phase-space of $E_\ell^B > 1 \text{ GeV}$. In addition, the unfolded differential distributions of the key kinematic variables will be provided for the first time, which are crucial for future model-independent determinations of $|V_{ub}|$.

T 56.7 Wed 17:30 Tf

The differential B-meson semi-leptonic width at NLO — THOMAS MANNEL, ●DANIEL MORENO, and ALEXEI A. PIVOVAROV — NN, Center for Particle Physics Siegen, Theoretische Physik 1, Universität Siegen

In this talk we present a new approach based on Heavy Quark Effective Theory (HQET) to compute the B-meson semi-leptonic decay width differential in the lepton pair energy. The key feature is the use of the spectral representation of the leptonic loop. The new setup allows for a systematic computation of corrections and the possibility to compute moments of the distribution with lepton energy cuts. We develop our method for the computation of α_s corrections, which requires the computation of the imaginary part of two loop integrals with two masses.

T 56.8 Wed 17:45 Tf

Measurement of the q^2 moments in semi-leptonic B meson decays at Belle II — JOCHEN DINGFELDER, FLORIAN BERNLOCHNER, and ●MAXIMILIAN WELSCH — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The determination of inclusive $|V_{cb}|$ from $b \rightarrow c\ell\nu$ decays relies on the Heavy Quark Expansion (HQE) involving coefficients and associated non-perturbative matrix elements, which can be expressed in terms of a number of expansion parameters. The moments of the kinematic distribution of the decay can be computed in a similar manner and are dependent on the same HQE parameters. Consequently, measurements of such moments can be used to better constrain the expansion parameters and, thereby, more precisely determine $|V_{cb}|$. In this talk, we present the first measurement of the q^2 moments of $B \rightarrow X_c\ell\nu$ decays with 74fb^{-1} of Belle II data. The q^2 moments of the $b \rightarrow c\ell\nu$ transition are particularly powerful for constraining the HQE expansion as they can be expressed in terms of a reduced set of non-perturbative parameters due to reparametrization invariance.

T 56.9 Wed 18:00 Tf

Tagged analysis of $B \rightarrow \pi\ell\nu$ at Belle — FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, ●JONATHAN GRUMKE, and PETER LEWIS for the Belle-Collaboration — Physikalisches Institut, Bonn, Germany

We study the exclusive semileptonic decay $B \rightarrow \pi\ell\nu$, where ℓ is an electron or muon, with the Belle experiment at KEK in Tsukuba, Japan. From 1999 to 2010 Belle collected events from electron-positron collisions at a center-of-mass energy corresponding to the mass of the $\Upsilon(4S)$ resonance which almost always decays into a pair of B mesons.

Events are tagged by fully reconstructing one B meson in a hadronic decay mode using the Full Event Interpretation algorithm. The remaining unassigned tracks are used to reconstruct the signal side B meson from a pion and lepton candidate. The hadronic B tagging allows for a precise reconstruction of the kinematics of the signal B meson and therefore a good signal-to-background ratio, but requires a large data set due to its small efficiency. In this talk, the general analysis strategy and status of the tagged $B \rightarrow \pi\ell\nu$ analysis is presented.

T 56.10 Wed 18:15 Tf

Untagged Analysis of $B \rightarrow \pi\ell\bar{\nu}_\ell$ using Early Belle II Data — FLORIAN BERNLOCHNER, JOCHEN DINGFELDER, ●SVENJA GRANDERATH, and PETER LEWIS for the Belle II-Collaboration — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

A discrepancy between the results of exclusive and inclusive measurements of the CKM matrix element $|V_{ub}|$ persists. The charmless semileptonic decay $B \rightarrow \pi\ell\bar{\nu}_\ell$ is one of the most accessible and powerful channels for determining $|V_{ub}|$ in exclusive modes. Using data from the Belle II experiment, a new precision measurement of $|V_{ub}|$ will become possible. In preparation for this, an untagged measurement method for extracting $B \rightarrow \pi\ell\bar{\nu}_\ell$ events is developed using early Belle II data. Lepton and pion candidates are combined to form $B \rightarrow \pi\ell\bar{\nu}_\ell$ candidates. In order to increase the signal purity, a boosted decision tree is employed to suppress continuum and other backgrounds. This talk will discuss the current status of the analysis and present an outlook on the precision of future Belle II $|V_{ub}|$ measurements.