T 31: Flavour physics II

Time: Tuesday 16:15–18:15 Location: VG 1.104

T 31.1 Tue 16:15 VG 1.104

Search for Quantum Disentanglement in the $B^0\overline{B}^0$ system at Belle II — •Max Kei Hattenbach, Hans-Günther Moser, and Sagar Hazra — Max-Planck-Institute for Physics, Munich, Germany

$B^0\overline{B}^0$ pairs produced at the $\Upsilon(4S)$ resonance are expected to be maximally entangled - an assumption crucial for measurements of time-dependent CP violation in experiments such as Belle, BaBar, and Belle II. If a fraction of these $B^0\overline{B}^0$ pairs becomes disentangled, regardless of the underlying mechanism, it could introduce systematic uncertainties into analyses, which are currently not accounted for. In this study, we search for possible disentanglement effects by analysing the hadronic decay mode $B^0 \to D^{(*)-}\pi^+$ using Belle II data. A signature of disentanglement would be observed as a damping and/or phase shift in the measured time-dependent asymmetry, compared to the behaviour under maximally entanglement. By examining decay time difference (Δt) of the two B mesons, we aim to test the sensitivity for time-dependent CP violation measurements using Monte Carlo studies.

T 31.2 Tue 16:30 VG 1.104

Study of Entanglement and Coherence at Belle II — •Simeon Hamurcu, Hans-Günther Moser, Sagar Hazra, and Maximilian Kei Hattenbach — MPI for Physics, Munich

Belle II is a next generation B-factory that aims to precisely measure Standard Model (SM) parameters and conduct searches for New Physics (NP) beyond the Standard Model. Electrons and positrons are asymmetrically collided at center of mass energies around the $\Upsilon(4S)$-resonance. This resonance mainly decays into a pair of B^0-mesons. In time dependent measurements it is assumed that these pairs are produced in a coherent and entangled state. This assumption however has not yet been tested at Belle II and tests at the predecessor experiment Belle still do not exclude a partial disentanglement. It is therefore necessary to conduct further studies to exclude or quantify disentanglement.

We implement models of disentanglement by adapting software from the B^0-lifetime and mixing frequency analysis. For that we compute and implement a new convolution to a resolution function of the Belle II detector and add additional disentanglement parameters to the software.

A validation is finally performed on signal Monte Carlo.

T 31.3 Tue 16:45 VG 1.104

$B_c \to \eta_c$ form factors at large recoil: Interplay of soft-quark and soft-gluon double logarithms — Guido Bell[1], Philipp Böer[2], Thorsten Feldmann[1], •Dennis Horstmann[1], and Vladyslav Shtabovenko[1] — [1]Theoretische Physik 1, Center for Particle Physics Siegen, Universität Siegen — [2]CERN, Theoretical Physics Department

Soft-Collinear Effective Theory is an important tool used for setting up factorisation theorems and achieving resummations to all orders in perturbation theory. While most conceptual problems appearing in calculations at leading power have been understood, at subleading power endpoint divergent convolution integrals appear in the factorisation theorems preventing the use of renormalization group equations for resummations. While this problem has been solved in a few collider processes, it persists in exclusive B-decays. We therefore resort to diagrammatic resummation techniques to derive the double-logarithmic series of the soft-overlap contribution to $B_c \to \eta_c$ transition form factors, assuming the scale hierarchy $m_b \gg m_c \gg \Lambda_{\rm QCD}$. We find that the leading double logarithms arise from a peculiar interplay of soft-quark endpoint logarithms from ladder diagrams with energy-ordered spectator-quark propagators, as well as standard Sudakov-type soft-gluon corrections. We elucidate the all-order systematics, and show that their resummation proceeds via a novel type of integral equations.

T 31.4 Tue 17:00 VG 1.104

Heavy-to-light form factors to three loops — Matteo Fael[1], Tobias Huber[2], Fabian Lange[3,4], •Jakob Müller[2], Kay Schönwald[3], and Matthias Steinhauser[5] — [1]Theoretical Physics Department, CERN — [2]Theoretische Physik 1, CPPS, Universität Siegen — [3]Physik-Institut, Universität Zürich — [4]Paul Scherrer Institut, Villingen — [5]Institut für Theoretische Teilchenphysik, Karlsruhe Institute of Technology

In this talk, we discuss the computation of form factors for decays of heavy into light quarks at third order in QCD for various currents. We describe the different steps of the calculation and use the results to compute the hard matching coefficients in Soft-Collinear Effective Theory for all currents. Further, we extract the hard function in $\bar{B} \to X_s\gamma$ to three loops using the tensor coefficients at light-like momentum transfer and study the impact of three-loop QCD corrections on partial decay rates in charged-current semi-leptonic $\bar{B} \to X_u l\bar{\nu}$ decays, where the newly computed corrections to the vector and axialvector coefficients constitute an essential ingredient to carry out this analysis.

T 31.5 Tue 17:15 VG 1.104

Modelling Quark-Hadron Duality Violation in Inclusive $B \to X_c\ell\bar{\nu}$ — •Ilija S. Milutin[1], Thomas Mannel[1], Rens Verkade[2,3], and K. Keri Vos[2,3] — [1]TP1, CPPS, University of Siegen, Germany — [2]GWFP, Maastricht University, The Netherlands — [3]NIKHEF, Amsterdam, The Netherlands

The Heavy Quark Expansion (HQE) is the main tool for calculating decay rates and kinematic moments of inclusive semi-leptonic B meson decays. The HQE manifests as an Operator Product Expansion (OPE) in terms of powers of the inverse heavy bottom quark mass ($1/m_b$). Using the HQE, the CKM matrix element V_{cb} has been extracted at percent-level precision from moments of inclusive $B \to X_c\ell\bar{\nu}$ decays. The calculations upon which the theoretical estimates rely are done in terms of quarks and gluons, which are not accessible for experiments. Quark Hadron Duality (QHD) allows for a translation of theoretical predictions at the quark-level to experimental observables at the hadron-level. Since the increased accuracy in HQE predictions up to $O(1/m_b^5)$, violation of the QHD may start to become a relevant limit to the achievable precision. When QHD is violated, the OPE stops being a valid expansion. In my talk, I will show how we can derive a model for the Quark Hadron Duality Violation and how it can enter different kinematic moments of the $B \to X_c\ell\bar{\nu}$ decays.

T 31.6 Tue 17:30 VG 1.104

Measurement of kinematic moments of semileptonic B-meson decays with the Run 1 data set of Belle II — Florian Bernlochner, •Munira Khan, Markus Prim, and Slavomira Stefkova — Physikalisches Institut der Rheinischen Friedrich-Wilhelms-Universität Bonn

The determination of the Cabibbo-Kobayashi-Maskawa matrix element $|V_{cb}|$ relies on $b \to c\ell^-nu_\ell$ transitions. The inclusive semileptonic process can be described with the Heavy Quark Expansion (HQE). Using the operator product expansion the total decay rate can be parameterized with a small number of non-perturbative parameters. These parameters cannot be determined from first principles, but their values are encoded into kinematic moments of the decay rate. We present the current status of measuring the full set of kinematic moments (q^2, M_X, E_ℓ) within a single analysis, which characterize the semileptonic $b \to c\ell^-nu_\ell$ and $b \to q\ell^-nu_\ell$ transitions using the Run 1 data of the Belle II experiment. This allows for the first time to properly correlate experimental uncertainties between the different moments. In addition, we present preliminary fits for $|V_{cb}|$ to simulated samples to illustrate the increase in sensitivity of this approach.

T 31.7 Tue 17:45 VG 1.104

Search for New Physics with $B^0 \to D^*\mu\nu$ angular analysis and LHCb — •Tobias Knospe[1], Johannes Albrecht[1], Biljana Mitreska[1], Hasret Nur[3], Lucia Grillo[3], Greg Ciezarek[4], Marco Gersabeck[5], Derek Yeung[2], and Manuel Schiller[3] — [1]TU Dortmund University, Dortmund, Germany — [2]The University of Manchester, Manchester, UK — [3]University of Glasgow, Glasgow, UK — [4]CERN, Geneva, Switzerland — [5]Albert-Ludwigs-Universitaet-Freiburg, Freiburg, Germany

Studying the angular structure of $b \to c\ell\nu$ using effective field theory allows to probe potential New Physics (NP) effects. An angular analysis of the $B^0 \to D^*\mu\nu$ decay is presented, based on proton-proton collision data collected by the LHCb experiment, corresponding to an integrated luminosity of $3\,\text{fb}^{-1}$. The signal decays are extracted through a multidimensional fit to the data, using templated distributions derived from both simulation and control samples in the proton-proton collision data. The real and imaginary parts of NP Wilson co-

efficients are measured in single-coefficient scenarios and a combined multi-parameter fit. Additionally, hadronic form factors are measured in a Standard Model scenario using CLN, BGL and BLPR parameterizations.

T 31.8 Tue 18:00 VG 1.104

Joint measurement of the $b \to c\tau\nu$ Wilson Coefficients with LHCb and Belle II. — Johannes Albrecht[1], Florian Bernlochner[2], Biljana Mitreska[1], and •Marco Colonna[1] — [1]TU Dortmund University, Dortmund, Germany — [2]University of Bonn, Germany

Semileptonic $b \to c\ell\nu$ decays are excellent probe for testing Lepton Flavour Universality and New Physics (NP) effects. A combined measurement of NP Wilson coefficients is performed using of $B \to D^*\tau\nu$ decays in proton-proton collision data collected by LHCb and electron-positron collision data from Belle II. The signal is extracted using a multidimensional fit to data using templated distributions derived from simulation and from control samples. New Physics contributions are measured via their corresponding Wilson coefficients and in several fit configurations that allow for different New Physics operators.