T 74: Flavour Physics V

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

T 74.1 Thu 16:15 VG 1.104

Flavour Tagging for the LHCb Upgrade — •Micol Olocco[1], Quentin Führing[1,2], Sara Celani[3], and Johannes Albrecht[1,2] — [1]University of Dortmund, Dortmund, Germany — [2]Lamarr Institute for Machine Learning and Artificial Intelligence, Dortmund, Germany — [3]Heidelberg University, Heidelberg, Germany

One of the primary objectives of the LHCb experiment is to study charge-parity (CP) violation by analyzing the decays of a wide variety of beauty mesons produced in proton-proton collisions at the LHC. Such studies require the knowledge of the B-signal flavour at production time which cannot be directly inferred from its decay products.

Flavour-tagging algorithms exploit the correlations between the B-meson flavour at production and the charged particles associated with the signal production, allowing for the identification of the candidate as either a B-meson or an $\overline{B}$-meson. Along with the tagging decision, it is crucial to estimate the probability of a misidentification, which is done by applying Machine Learning algorithms.

Since the LHCb detector has been upgraded and operates at an increased instantaneous luminosity, Flavour-Tagging algorithms must be updated accordingly. This contribution will present the revised strategy and ongoing developments of the Flavour-Tagging algorithms for the upgraded LHCb.

T 74.2 Thu 16:30 VG 1.104

Transformer Model for Flavour Tagging at Belle II — Ariane Frey, Lukas Herzberg, Thibaud Humair, Benjamin Schwenker, and •Tilo Wettlaufer — II. Physikalisches Institut, Universität Göttingen

At the Belle II experiment, an entangled state of two B mesons is measured. In order to perform analyses on CP violation, one B meson is fully reconstructed (signal side). Due to entanglement, reconstructing the flavour of the other B meson (tag side) determines the flavour of the signal side. This process of flavour tagging uses the characteristics of flavour specific decay products and correlates them to the tag side flavour, without an exclusive full reconstruction. Currently, both a category based algorithm is used, which reports an effective tagging efficiency of: $Q_{\mathrm{cat.}} = 30.0(13)\,\%$, as well as a graph neural network reporting: $Q_{\mathrm{GNN}} = 37.4(6)\,\%$. An alternative deep neural network uses raw track attributes to construct numerical representations of tracks, giving: $Q_{\mathrm{DNN}} = 29.3(16)\,\%$ for neutral B mesons.
A new flavour tagging algorithm is presented based on the model of tabular transformers. This model uses contextual embeddings which are easier to interpret, as well as provide greater robustness against noisy or missing data compared to only using multi-layer perceptrons (MLP).

T 74.3 Thu 16:45 VG 1.104

Measurement of A^s_{fs} in $B^0_s \to D^-_s\pi^+$ at the LHCb experiment in Run 2 — Johannes Albrecht[1], Jonathan Davies[2], Agnieszka Dziurda[3], Conor Fitzpatrick[2], •James Andrew Gooding[1], Jairus Patoc[4], and Nicole Skidmore[5] — [1]TU Dortmund University, Dortmund, Germany — [2]University of Manchester, Manchester, United Kingdom — [3]Institute of Nuclear Physics PAS, Kraków, Poland — [4]University of Oxford, Oxford, United Kingdom — [5]University of Warwick, Coventry, United Kingdom

$B^0_{(s)} \to D^{(*)-}_{(s)}h^+$ decays are considered a standard candle of the SM and central to measurements of the CKM angle γ. Recently, tensions between the predicted and measured values of $B^0_{(s)} \to D^{(*)-}_{(s)}h^+$ branching fractions have emerged of up to 7σ. These tensions leave a possibility for new physics contributions which may enhance time-integrated CP asymmetries by up to 1%. In the SM, CP violation in flavour-specific $B^0_s \to D^-_s\pi^+$ decays arises only from B^0_s–$\overline{B}^0_s$ mixing, measured previously in semi-leptonic B^0_s decays as a^s_{sl}.

The high quality tracking and particle identification offered by the LHCb detector makes it well-equipped to reconstruct $B^0_s \to D^-_s\pi^+$ decays in the $D^-_s \to K^-K^+\pi^-, \pi^-\pi^+\pi^-$ decay modes, and thus to measure the time-integrated CP asymmetry A^s_{fs}. This measurement is performed for the first time using $5.9\,\mathrm{fb}^{-1}$ of pp-collision data recorded at $\sqrt{s} = 13\,\mathrm{TeV}$ during Run 2 of the LHC.

In this contribution, the approach and current status of the analysis is presented. An overview of the sensitivity of this analysis and considerations of detection and production asymmetries is given.

T 74.4 Thu 17:00 VG 1.104

B-$\overline{\mathrm{B}}$ mixing to NNLO including penguin contributions — •Pascal Reeck[1], Matthias Steinhauser[1], Ulrich Nierste[1], and Vladyslav Shtabovenko[2] — [1]Karlsruher Institute für Technologie — [2]Universität Siegen

In this talk I will discuss recent advances made in the calculation of the NNLO QCD corrections to the width difference between B and $\overline{B}$ mesons. This work focuses on the perturbative high-energy part of the calculation, more specifically the matching coefficients between the $\Delta B = 1$ effective operators of the Weak Interaction and the $\Delta B = 2$ transition operator are calculated as a deep expansion in m_c/m_b.

This calculation yields novel results for the NNLO contributions with penguin operators which had not been considered previously at this order. Moreover, the NNLO contributions with two current-current operators, which were previously only known up to $\mathcal{O}(m_c^2/m_b^2)$ are calculated to a higher precision.

T 74.5 Thu 17:15 VG 1.104

Mixing Phases and Penguin Effects in B Meson Decays — Kristof De Bruyn[1,2], Robert Fleischer[1,3], and •Eleftheria Malami[4] — [1]Nikhef, Science Park 105, 1098 XG Amsterdam, Netherlands — [2]Van Swinderen Institute for Particle Physics and Gravity, University of Groningen, 9747 Groningen, Netherlands — [3]Faculty of Science, Vrije Universiteit Amsterdam, 1081 HV Amsterdam, Netherlands — [4]Center for Particle Physics Siegen (CPPS), Theoretische Physik 1, Universität Siegen, D-57068 Siegen, Germany

The phenomenon of B^0_q–$\bar{B}^0_q$ mixing ($q = d, s$) provides a sensitive probe for exploring physics beyond the Standard Model. Associated with this mixing are the phases ϕ_d and ϕ_s, which are crucial for studies of CP violation. The decays $B^0_d \to J/\psi K^0$, $B^0_s \to J/\psi\phi$, and $B^0_s \to D^+_s D^-_s$ play significant roles in determining these mixing phases. However, these decays are affected by contributions from penguin topologies, which limit the theoretical precision in the extraction of these quantities. To properly account for these penguin effects, we introduce a formalism that utilises the CP asymmetries of these decays. By applying this strategy to the most recent experimental data, we provide updated insights. Moving towards the high-precision era, with experimental data becoming more precise, this approach can provide a much sharper picture of the underlying dynamics.

T 74.6 Thu 17:30 VG 1.104

Λ_b baryon LCDAs in the short-distance expansion — Thorsten Feldmann and •Daniel Vladimirov — Theoretische Physik 1, Center for Particle Physics Siegen, Universität Siegen, 57068 Siegen, Germany

Light-cone distribution amplitudes (LCDAs) for the Λ_b baryon enter as universal hadronic matrix elements in QCD factorization approaches for energetic decays. Observables (e.g. form factors) can then be expressed as a convolution of the LCDA and a hard scattering kernel to the desired order in the strong coupling. The LCDAs are genuinely non-perturbative quantities that describe the low-energy dynamics of the hadronic bound state, which cannot directly be derived from first principles. In this work, we discuss the "radiative tail" of the 3-particle Λ_b LCDAs which can be computed in HQET perturbation theory by expanding in the light-cone separations between the light and heavy quarks in the baryonic bound state. Our results provide useful constraints on the modelling of Λ_b LCDAs in terms of a handful of HQET parameters.

T 74.7 Thu 17:45 VG 1.104

Search for radiative leptonic $B^+ \to \mu^+\nu_\mu\gamma$ decays at LHCb — Martino Borsato[1], •Fabian Glaser[2,3], and Marie-Hélène Schune[3] — [1]Milano-Bicocca University and INFN, Milano, Italy — [2]Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany — [3]IJCLab, Orsay, France

The radiative leptonic decay $B^+ \to \mu^+\nu_\mu\gamma$ has never been observed but is of great interest as it is considered the golden mode to probe the B^+ meson substructure. In particular, a measurement of its branching fraction allows to probe the parameter λ_B, the first inverse moment of the B^+ meson light cone distribution amplitude (LCDA), which is a vital input for the calculation of non-leptonic B meson decays.

The reconstruction of this decay in proton-proton collisions at the

LHCb experiment is extremely challenging. Selecting events in which the photon converts to an e^+e^- pair in the detector material allows to determine the displaced B decay vertex. With this approach, the background from photons produced in the proton collision is drastically reduced and the B flight direction can be used to correct for the missing neutrino momentum. This talk gives an overview of the current status of the ongoing analysis using data recorded in proton-proton collisions in Run 2.

T 74.8 Thu 18:00 VG 1.104

Search for the decays $\Xi_b^0 \to \Xi^0 J/\psi$ and $\Xi_b^0 \to \Xi^0\psi(2S)$ at the LHCb experiment — Johannes Albrecht[1], Vitalii Lisovskyi[2], •Leandra Moeser[1], and Janina Nicolini[3] — [1]TU Dortmund University, Dortmund, Germany — [2]Aix-Marseille Université, CNRS/IN2P3, CPPM, Marseille, France — [3]CERN

Weak decays of heavy-quark baryons provide an opportunity to probe for effects beyond the Standard Model, complementary to searches in meson decays. Given the high masses of b-baryons, they are primarily studied at hadron colliders. The LHCb experiment is ideally suited to investigate such weakly decaying b-baryons.

The current status of the search for the tree-level decays $\Xi_b^0 \to \Xi^0 J/\psi$ and $\Xi_b^0 \to \Xi^0\psi(2S)$ is presented. The used data was collected at the LHCb experiment from 2016 to 2018, corresponding to an integrated luminosity of $5.4\,\mathrm{fb}^{-1}$. The challenges posed by the reconstruction of neutral decay chains are discussed and the calibration of the simulation is presented.