T 113: QCD Theory and Experiment II

Time: Thursday 15:50–17:20 Location: HSZ/0405

T 113.1 Thu 15:50 HSZ/0405

Quark Masses in the Heavy Quark Expansion — •Anastasia Boushmelev[1], Thomas Mannel[1], and K. Keri Voss[2] — [1]Theoretische Physik 1, Center for Particle Physics Siegen Universität Siegen, D-57068 Siegen, Germany — [2]Gravitational Waves and Fundamental Physics (GWFP), Maastricht University, Duboisdomein 30, NL-6229 GT Maastricht, the Netherlands and Nikhef, Science Park 105, NL-1098 XG Amsterdam, the Netherlands

Many observables can be written in terms of an operator product expansion (OPE) which factorizes the expression in perturbative and non-perturbative parts. The examples to be studied in this talk are the Heavy Quark Expansion (HQE) for inclusive semi-leptonic $b \to u$ decays and the inverse moments of the cross section $e^+e^- \to$ hadrons.

In both cases the leading term of the OPE is given by the perturbatively calculated, partonic expression, which depends on the mass of the heavy quark. Calculating this using the pole mass one encounters the problem that this mass scheme suffers from so called renormalon induced ambiguities which spoil the convergence of the perturbative expansion.

However, we propose the following strategy: Since observables should be free of such ambiguities, we use an observable such as an inverse moment of the $e^+e^- \to$ hadrons cross section to eliminate the pole mass from the expression for the semi-leptonic $b \to u$ rate, obtaining a perturbative relation between two observables valid to leading order in the OPE.

T 113.2 Thu 16:05 HSZ/0405

Measurement of D^* meson cross sections in the full phase space for charm in CMS — •Yewon Yang[1], Achim Geiser[1], Nur Zulaiha Jomhari[1], Valentina Mariani[2], Josry Metwally[1], and Max Uetrecht[3] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, D-22607 Hamburg — [2]Università degli Studi di Perugia, Piazza Università, 106123 Perugia — [3]Technische Universität Dortmund, August-Schmidt-Straße 1, 44227 Dortmund

This is a summary talk about total, single- and double-differential cross sections for charm which are measured from the reconstruction of charm hadronic states in the CMS detector. Among all the hadronic states of charm, for this talk especially the reconstruction of D^* which decays into D^0 and a slow pion is introduced at proton-proton center-of-mass energies of 0.9, 5, 7, and 13 TeV. The measured cross sections for this final state show consistency compared to QCD theory and also to other LHC experiments. Then the D^* meson cross sections measured in the full phase space accessible with the CMS detector are extrapolated to extract the total charm cross section. For the first time, this extrapolation applies the p_T-dependent cross-section ratios between meson and baryon of charm, which are recently measured from LHC experiments.

T 113.3 Thu 16:20 HSZ/0405

Study of the X(3915) at Belle — •Yaroslav Kulii[1], Thomas Kuhr[1], and Boris Grube[2] — [1]Ludwig-Maximilians-Universität München — [2]Thomas Jefferson National Accelerator Facility

Many of the charmonium states, which consist of a charm and anti-charm quark, have been found and studied experimentally. Detailed theoretical predictions of the charmonium excitation spectrum agree well with the experimental data.

However, in recent years experiments discovered a growing number of charmonium-like states that do not fit into the predicted charm-anticharm excitation spectrum. One such state is $X(3915)$. It has been discovered by the BaBar and Belle collaborations in the two-photon reaction $e^+e^- \to e^+e^-X(3915) \to e^+e^-J/\psi\omega$, where the final-state electron and positron were not detected. The analysis of projections of angular distributions preferred the $J^{PC} = 0^{++}$ hypothesis, but other quantum numbers, in particular $J^{PC} = 2^{++}$, could not be excluded.

Because of this the $X(3915)$ was initially identified as the $\chi_{c0}(2P)$ charmonium state, although its mass and decay width were not in good agreement with the theory predictions. Following the Belle discovery of the $X^*(3860)$, which agrees much better with the $\chi_{c0}(2P)$ hypothesis, opinions shifted towards interpreting the $X(3915)$ as an exotic state. It could be, for example, a meson molecule or a so-called hybrid meson.

We will present research prospects and the status of the angular analysis to measure the quantum numbers of the $X(3915)$ in its $J/\psi\omega$ decay using Belle data.

T 113.4 Thu 16:35 HSZ/0405

Measuring the Drell-Yan Cross Section using Forward Electrons with the ATLAS Detector — •Craig Wells for the ATLAS-Collaboration — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The full LHC Run-2 dataset offers an unparalleled opportunity to measure the complete decomposition of the Drell-Yan cross section in terms of the lepton decay angles in the rest frame of the incident quarks, rapidity of the dilepton system, and the transverse momentum of the vector boson. For this purpose, forward electrons ($|\mathrm{eta}| > 2.5$) in the ATLAS detector present a unique opportunity to probe Z decays in extreme regions of phase space, which are sensitive to fundamental parameters of the Standard Model.

Forward electrons are, however, experimentally challenging objects to work with, due to large amounts of passive material in this region of ATLAS. This talk will present an overview of the analysis and calibration process for forward electrons, so that they are ready to be used for physics purposes.

T 113.5 Thu 16:50 HSZ/0405

Machine-learning off-shell effects in top quark production at the LHC — •Mathias Kuschick — Institut für Theoretische Physik, Münster

Measuring top quark processes at the LHC is an important test of the Standard Model of particle physics. As the heaviest of all quarks the investigation into its properties allows for tests of QCD and the electroweak interaction as well as tests of the Higgs mechanism, but also provides a window to new physics. Therefore, a precise determination of the top quark's fundamental properties is compulsory. Such determinations heavily rely on precise theoretical calculations. The most sophisticated of such calculations include improvements such as radiative corrections or off-shell effects, which make them extremely computational costly to evaluate. In my talk I will explore the use of modern machine learning techniques such as neural networks to learn how top pair production predictions change when finite width and interference effects are included in an effort to bypass the undesirable computational complexity of such calculations.

T 113.6 Thu 17:05 HSZ/0405

Automated NLO electroweak corrections to processes at hadron and lepton colliders — •Pia Bredt — U. Siegen, Siegen, Germany

The aim of this project was the completion of an automated framework calculating NLO corrections in the full SM for arbitrary processes at hadron and lepton colliders. This framework is an element of the Monte-Carlo program WHIZARD simulating cross sections and differential distributions. Specifically, it builds on the implemented FKS subtraction scheme for NLO QCD calculations, and extends it to automated NLO EW and QCD-EW mixed corrections. To that end, the implemented FKS scheme is generalised to systematically subtract QED and QCD infrared divergences in mixed coupling expansions. The automated computation of NLO contributions is validated for a set of benchmark processes at the LHC, including e. g. $t\bar{t}\ (+H/W/Z)$ production. Cross-checks for e^+e^- processes likewise show that WHIZARD can be used for predictions at lepton colliders including fixed $\mathcal{O}(\alpha)$ corrections. This framework is applied to the study of multi-boson processes at a future multi-TeV muon collider.