T 84: Theory EW

Time: Wednesday 17:30–19:00 Location: HSZ/0204

T 84.1 Wed 17:30 HSZ/0204

Polarized cross sections for vector boson production with Sherpa — •Mareen Hoppe[1], Frank Siegert[1], and Marek Schönherr[2] — [1]Institute of Nuclear and Particle Physics, Technische Universität Dresden — [2]Institute for Particle Physics Phenomenology, Durham University

Polarization of vector bosons started to become an extensively investigated topic in recent years due to its sensitivity to the concrete mechanism of electroweak symmetry breaking and to beyond standard model physics. The general-purpose Monte-Carlo event generator Sherpa is used for event simulation of various processes in the analysis of LHC data. In this talk, an implementation is presented which will enable the simulation of polarized cross sections for vector bosons in future releases of Sherpa. Special features like the simulation of all polarized contributions in a single run - including the bulk of their NLO QCD behavior - and the direct calculation of the interference between them are discussed. Validation data comparing the new implementation with literature studies and results from its first applications in phenomenological analyses will be shown for several processes.

T 84.2 Wed 17:45 HSZ/0204

Soft photon emission at the LHC and the LBK theorem — •Roger Balsach[1], Domenico Bonocore[2], and Anna Kulesza[1] — [1]Institute of Theoretical Physics, WWU Münster, D-48149 Münster, Germany — [2]Physik Department T31, Technische Universität München, D-85748, Garching, Germany

The emission of low energetic (soft) photons plays a fundamental role in the understanding of Quantum Field Theories. However, there appears to be a discrepancy between the experimental measurements and the calculations for one-photon emission observables. Furthermore, future improvements to the ALICE detector will result in better measurement of soft photon emission, necessitating increasing precision of theoretical predictions.

For those reasons, we compute the cross-section for processes with a single photon emission including NLP and one-loop QCD corrections.

T 84.3 Wed 18:00 HSZ/0204

Detection schemes for light-by-light scattering — Naser Ahmadiniaz, Thomas Cowan, •Sebastian Franchino-Viñas, Jörg Grenzer, Alejandro Laso-Garcia, Michal Smid, Toma Toncian, María Anabel Trejo, and Ralf Schützhold — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

In the theory of Quantum Electrodynamics loop corrections induce nonlinear interactions for the electromagnetic fields, allowing for effects such as light-by-light scattering. One of the most promising scenarios for its experimental detection regards the quantum vacuum diffraction and birefringence of x-rays at the combined field of two optical lasers. In this talk, we will theoretically compare various scenarios; as a way to deal with experimental constraints, we analyze cases in which the initial and final x-ray photons differ not just in polarization, but also in propagation direction or energy.

T 84.4 Wed 18:15 HSZ/0204

NLO QCD predictions for polarised WZ production — •Christoph Haitz — Institut für Theoretische Physik 2, Julius-Maximilians Univerität Würzburg

The double-pole approximation allows the calculation of observables with polarised virtual particles in a gauge-independent way. One class of processes where this is particularly useful are gauge-boson pair-production processes. This method has been very successful for the study of vector bosons decaying into leptons. The natural step forward from this is the investigation of hadronically decaying bosons. In my talk I will discuss the NLO QCD predictions to the production of a polarised WZ pair where the W boson decays hadronically and the Z boson leptonically. In particular it will be explained what physical observables are best suited to discriminate between the different polarisation states of the resonant bosons. Furthermore the effects of the NLO QCD corrections on the differential cross-sections will be elaborated, as the corrections can become very large and fundamentally change the features of the distributions.

T 84.5 Wed 18:30 HSZ/0204

Two-loop Symmetry Restoration in a Chiral Abelian Gauge Theory in DReg with Non-Anticommuting γ_5 — •Paul Kühler — Institut für Kern- und Teilchenphysik, TU Dresden

Dimensional Regularization is a popular and powerful method for renormalizing gauge theories at the multiloop level. This is due not least of all to the fact that DReg preserves BRST symmetry for vector-like theories such as QCD and QED, which not only guarantees that the renormalized theories make sense as a quantum theory, but it also tremendously simplifies calculations.

This feature is unavoidably lost in the case of chiral theories like the electroweak sector of the SM. Technically, this manifests in inconsistencies arising from insisting on retaining certain relations valid for γ_5 in 4-dimensions in the formal D-dimensional space of DReg. One way out is the BMHV scheme which gives up anti-commutativity and recommends itself by its consistent treatment generalizable to the multiloop setting. BRST symmetry is intermediately broken but may be restored by adding finite, non-invariant counterterms.

In this talk we exemplify our approach to renormalizing chiral gauge theories in the BMHV scheme with the aim of applying it to the SM. Here we present a concrete two-loop calculation of a simple, chiral Abelian model (based on Belusca-Maito et al., JHEP, Vol. 11, 2021; 2109.11042) with its necessary counterterm structure, and we discuss the explicit restoration of well-known Ward identities like transversality of the photon self-energy. In this setting, they are an immediate test of the restoration (or lack thereof) of the classical symmetry.

T 84.6 Wed 18:45 HSZ/0204

Algebraic Renormalization of abelian chiral Gauge Theories with non-anticommuting γ_5 at the Multi-Loop Level — •Matthias Weisswange — Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Deutschland

Divergences emerging in quantum corrections need to be handled via regularization and renormalization. However, treating manifestly 4-dimensional quantities such as γ_5 and $\varepsilon^{\mu\nu\rho\sigma}$ naively within dimensional regularization (DReg) may lead to inconsistencies. This constitutes a problem in chiral gauge theories, such as the electroweak Standard Model. In order to avoid such inconsistencies, γ_5 needs to be treated rigorously as a non-anticommuting object using the Breitenlohner-Maison/'t Hooft-Veltman (BMHV) scheme within DReg. Employing the BMHV scheme, however, violates gauge invariance, which subsequently needs to be restored using symmetry-restoring counterterms guaranteed to exist by the methods of algebraic renormalization. These counterterms may be calculated via special Feynman diagrams with an insertion of the $\widehat{\Delta}$-operator, which reflects the breaking of chiral gauge invariance, using the regularized quantum action principle of DReg. In the case of an abelian chiral gauge theory this is consistently done at the multi-loop level, showing that the counterterm structure in the BMHV scheme may be written in a very compact form, suitable for computer implementations. Ultimately, this renormalization procedure will be needed for high-precision calculations of e.g. electroweak observables.