T 31: Theory Higgs, BMS

Time: Tuesday 17:00–18:15 Location: HSZ/0201

T 31.1 Tue 17:00 HSZ/0201

Higgs pair production in SMEFT at full NLO QCD: an investigation of truncation effects — •Jannis Lang — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

We present results for Higgs boson pair production in gluon fusion at NLO (2-loop) QCD including operators in the Standard Model Effective Field Theory (SMEFT) framework. Contributions from subsets of higher order terms in $\frac{1}{\Lambda^2}$, such as squared dimension-6 operators at cross section level and double operator insertions at amplitude level, are used as a proxy for the study of truncation effects of the SMEFT expansion. The different truncation options are contrasted to the non-linear Higgs Effective Field Theory (HEFT) framework for selected phenomenological examples.

T 31.2 Tue 17:15 HSZ/0201

Precision test of the muon-Higgs coupling at a high-energy muon collider — •Nils Kreher[1], Tao Han[2], Wolfgang Kilian[1], Yang Ma[2], Jürgen Reuter[3], Tobias Striegl[1], and Keping Xi[2] — [1]Department of Physics, University of Siegen, Walter-Flex-Straße 3, 57068 Siegen, Germany — [2]Pittsburgh Particle Physics, Astrophysics, and Cosmology Center, Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, PA 15206, U.S.A. — [3]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany

I will present a sensitivity test of the muon-Yukawa sector at a high-energy muon collider. While in the Standard Model this sector is described by a single parameter, effects of new physics that is not aligned with the Standard Model Yukawa interactions may introduce a more sophisticated parameter dependence, which can be understood either in SMEFT or a HEFT frameworks. With the accidentally small value of the muon Yukawa coupling and its subtle role in the high-energy production of multiple (vector and Higgs) bosons, I will show that it is possible to measure the muon-Higgs coupling to an accuracy of ten percent for a 10 TeV muon collider and a few percent for a 30 TeV machine by utilizing the three boson production, potentially sensitive to a new physics scale about $\lambda = 10 \sim 30$ TeV. In addition I will discuss effects of an extended Higgs sector to the same processes in both frameworks.

T 31.3 Tue 17:30 HSZ/0201

Projecting composite operators onto a unique basis — Robert V. Harlander, •Jakob W. Linder, and Magnus C. Schaaf — 1Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen, Aachen

The Standard Model effective field theory (SMEFT) describes the low-energy effects of possible high-energy theories in terms of Standard Model fields. In a top-down approach, the effective Lagrangian can be obtained by constructing the effective action using a functional matching procedure, for example. However, this yields a non-unique action in general.

To restore the desired uniqueness, an algorithm is developed to decompose any operator with arbitrary mass dimension into operators free of redundancies due to equations of motion, integration-by-part identities or internal symmetries. For this purpose, the operators are converted into a redundancy-free basis, which can be constructed automatically for arbitrary mass dimensions. In this talk, I will report on such a basis and ProSMEFTion, our implementation of the algorithm.

T 31.4 Tue 17:45 HSZ/0201

Debye mass effects in the Dark Sector in the Early Universe — Simone Biondini[1], Nora Brambilla[2], •Andrii Dashko[3], Gramos Qerimi[2], and Antonio Vairo[2] — [1]Department of Physics, University of Basel, Klingelbergstr. 82, CH-4056 Basel, Switzerland — [2]Physik-Department, Technical University Munich, James-Franck-Str. 1, 85748 Garching, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg, Germany

We address the impact of the thermal Debye mass m_D scale on the bound-state formation and ionization (dissociation) in the dark sector in the Early Universe. We focus on heavy dark fermions (with mass m) charged under a $U(1)_d$ group coupling dark matter to dark photons and dark light fermions with the coupling constant $\alpha = g^2/4\pi$. We determine the effect of the HTL resummation on the bound state formation and dissociation rates of heavy dark fermions in presence of a hot (with temperature T), weakly coupled ($T \gg gT$) dark plasma, under the assumption that $m \gg m\alpha \gg T$. Our analysis is based on Non-Relativistic Effective Field Theory (NREFT) to address the dark matter threshold dynamics and on Thermal Field Theory to address the thermal scales. We obtain and solve coupled Boltzmann equations and show how our results affect the evolution of the dark matter density in the Early Universe. Working with this simplified model of the dark sector, we show that the effect of HTL resummation on the bound-state formation and thermal relic abundance is non-negligible (and of the same order as the NLO fixed order correction), which indicates the importance of further studies in more realistic scenarios.

T 31.5 Tue 18:00 HSZ/0201

Trilinear Higgs Self-Couplings at $\mathcal{O}(\alpha_t^2)$ in the CP-Violating NMSSM — •Christoph Borschensky[1], Thi Nhung Dao[2], Martin Gabelmann[3], Margarete Mühlleitner[1], and Heidi Rzehak[4] — [1]Karlsruhe Institute of Technology, Germany — [2]PHENIKAA University, Hanoi, Vietnam — [3]DESY, Hamburg, Germany — [4]Eberhard Karls Universität Tübingen, Germany

In supersymmetric theories the Higgs boson masses are derived quantities where higher-order corrections have to be included in order to match the measured Higgs mass value at the precision of current experiments. Closely related through the Higgs potential are the Higgs self-interactions. In addition, the measurement of the trilinear Higgs self-coupling provides the first step towards the reconstruction of the Higgs potential and the experimental verification of the Higgs mechanism sui generis.

In this talk, I will present the $\mathcal{O}(\alpha_t^2)$ corrections to the trilinear Higgs self-couplings in the CP-violating Next-to-Minimal Supersymmetric extension of the SM (NMSSM), calculated in the gaugeless limit at vanishing external momenta. The higher-order corrections turn out to be larger than the corresponding mass corrections, but show the expected perturbative convergence. The inclusion of the loop-corrected effective trilinear Higgs self-coupling in gluon fusion into Higgs pairs and the estimate of the theoretical uncertainty due to missing higher-order corrections indicate that the missing electroweak higher-order corrections may be significant.