T 31: Beyond the Standard Model (Theory) 1

Time: Tuesday 16:15–18:15 Location: T-H16

T 31.1 Tue 16:15 T-H16

Constructing Effective Field Theories to Higher Mass Dimensions — Robert V. Harlander, Tim Kempkens, Jakob W. Linder, and •Magnus C. Schaaf — Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University

The Standard Model Effective Field Theory (SMEFT) provides a framework to parametrise the effects of yet unseen heavy degrees of freedom in a model independent way. While in recent years the interest in higher-dimensional operators has increased, the construction of a complete and minimal set of operators is remarkably challenging. In this talk, I will report on the implementation of a recently proposed group-theoretical algorithm for the construction of an operator basis. It systematically takes into account the redundancies which arise due to equations of motion and integration-by-parts identities among the operators. The resulting program can be applied to phenomenologically relevant theories like the Standard Model or extensions of it, including new light particles and additional symmetry groups.

T 31.2 Tue 16:30 T-H16

Catching Heavy Vector Triplets with the SMEFT: from one-loop matching to phenomenology — •Emma Geoffray[1], Ilaria Brivio[1], Sebastian Bruggisser[1], Wolfgang Kilian[2], Michael Krämer[3], Michel Luchmann[1], Tilman Plehn[1], and Benjamin Summ[3,4] — [1]Institute for Theoretical Physics, Heidelberg University, Germany — [2]Department of Physics, University of Siegen, Germany — [3]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University, Germany — [4]Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Germany

An important question for both phenomenologists and experimentalists is whether one can put limits on UV model parameters by matching the full theory onto the SMEFT. I will show that this is possible and explore the complementarity between SMEFT and model-specific approaches.

In particular, I will focus on an additional theory uncertainty arising from the matching at one-loop and discuss how this affects the limits set for the Heavy Vector Triplet extension of the Standard Model. I use the SFitter framework to derive limits, taking into account Higgs measurements and electroweak precision data previously implemented, as well as two new resonance searches for VH and VV. I will discuss the impact of those measurements on the fit and the complementarity of our results with direct searches.

T 31.3 Tue 16:45 T-H16

Precision predictions for scalar leptoquark pair production at the LHC — •Christoph Borschensky[1], Benjamin Fuks[2], Adil Jueid[3], Anna Kulesza[4], and Daniel Schwartländer[4] — [1]KIT, Karlsruhe, Germany — [2]LPTHE/Sorbonne Université, Paris, France — [3]KIAS, Seoul, South Korea — [4]WWU Münster, Germany

Leptoquarks are particles that simultaneously carry lepton and baryon number, and appear in many extensions of the Standard Model. The appearance of so-called flavour anomalies has led to increased interest in leptoquark models which are known to mitigate the tensions between theoretical expectations and experimental measurements.

In my talk, I will present precision predictions for the production of scalar leptoquarks at the LHC, evaluated at next-to-leading order in QCD and improved by threshold resummation corrections at next-to-next-to-leading-logarithmic accuracy. Apart from QCD contributions, included are the lepton t-channel exchange diagrams relevant in the light of the recent B-flavour anomalies. The results exhibit an interesting interplay between the different contributions, affected considerably by the choice of parton distribution functions. Additionally, I discuss the impact of NLO-QCD corrections on the so-called off-diagonal production channels, i.e. the production of a pair of different components of a given leptoquark multiplet. These predictions consist of the most precise leptoquark cross section calculations available to date and are necessary for the best exploitation of leptoquark LHC searches.

T 31.4 Tue 17:00 T-H16

Constraining BSM models using high precision observables — •Marten Berger[1], Gudrid Moortgat-Pick[1,2], Georg Weiglein[1,2], and Sven Heinemeyer[3] — [1]II. Institute of Theoretical Physics, University of Hamburg, Germany — [2]DESY, Hamburg, Germany — [3]Instituto de Fisica Teorica UAM-CSIC, Madrid, Spain

The high experimental accuracy of the W boson mass, M_W, measurement provides a powerful tool to test the theory and differentiate between models. One of the best motivated extensions of the Standard Model (SM) is the Minimal Supersymmetric Standard Model (MSSM). The electroweak precision observables such as M_W are highly sensitive to loop contributions determined by the model parameters respectively. Therefore the precise experimental accuracy can be used to narrow down possible scenarios. In this talk a stand-alone mathematica code for predicting M_W in the MSSM is presented. It includes full one-loop as well as leading higher-order corrections of SUSY-type, which are combined with state-of-the-art SM-type contributions. The prediction for M_W is discussed in comparison with the current experimental result.

T 31.5 Tue 17:15 T-H16

Bachelor thesis: Vacuum stability constraints in the NMSSM — •Fabio Campello[1], Georg Weiglein[2], and Thomas Biekötter[2] — [1]Universität Hamburg, Hamburg, Deutschland — [2]DESY, Hamburg, Germany

In supersymmetric extensions of the Standard Model the electroweak (EW) vacuum is not generally the global minimum of the scalar potential, and tunneling to deeper minima is possible. Since the lifetime of the EW vacuum must be at least of the order of the age of the universe, constraints on the parameter space can be obtained from an analysis of vacuum stability. In this talk the vacuum structure of the next-to-minimal supersymmetric extension of the SM (NMSSM) is investigated, where the scalar potential receives contributions from an extended Higgs sector and from superpartners of the SM fermions. The results are discussed in comparison to the case of the minimal supersymmetric extension (MSSM).

T 31.6 Tue 17:30 T-H16

SU(6) Gauge Higgs Unification — •Andreas Bally[1], Andrei Angelescu[1], Florian Goertz[1], and Simone Blasi[2] — [1]Max Planck Institute for Nuclear Physics, Heidelberg — [2]Vrije Universiteit, Brussel, Belgium

We present a minimal viable Gauge-Higgs Grand Unification scenario in warped space based on a SU(6) bulk symmetry - unifying the gauge symmetries of the SM and their breaking sector. We show how the issue of light exotic new states is eliminated by appropriately breaking the gauge symmetry on the UV and IR boundaries by either brane scalars or gauge boundary conditions. The SM fermion spectrum is naturally reproduced including Dirac neutrinos and we compute the Higgs potential at one-loop, finding easily solutions with a realistic Higgs mass. The problem of proton decay is addressed by showing that baryon number is a hidden symmetry of the model. Among the phenomenological consequences, we highlight the presence of a scalar leptoquark and a scalar singlet. The usual X,Y gauge bosons from SU(5) GUTs are found at collider accessible masses.

T 31.7 Tue 17:45 T-H16

Baryogenesis and Dark Matter in Extended Inert Doublet Model — •Sven Fabian, Florian Goertz, and María Isabel Dias Astros — Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

Despite the great success of the Standard Model (SM) of Particle Physics in explaining many experimental observations to an astonishing degree of accuracy, it cannot account for the long-standing conundrums of the nature of dark matter (DM) and of the obvious dominant abundance of matter compared to antimatter in our Universe. In this talk, we will discuss the Inert Doublet Model, augmented with a higher-dimensional operator tied to the SM gauge sector and – vital for baryogenesis – inducing CP violation. In addition to identifying the parameter space for the observed DM relic abundance, we investigate the potential of this operator for giving rise to the measured baryon asymmetry during the electroweak phase transition. We will find that the discussed extension of the IDM can, in principle, serve as an effective theory in which both DM and baryogenesis are accounted for.

T 31.8 Tue 18:00 T-H16

Higher-Dimensional Operators in the Inert Doublet Model: Dark Matter and CP Violation — •María Isabel Dias Astros, Florian Goertz, and Sven Fabian — Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

Facing the puzzles of dark matter (DM) with its properties yet to be deciphered, the Inert Doublet Model (IDM) has been widely studied as a possible theory explaining DM and in the context of the Electroweak Phase Transition, as a first step towards accommodating the three Sakharov conditions allowing for baryogenesis. Following this motivation, we will discuss in this talk the IDM as an effective field theory (EFT) with a higher-dimensional CP-violating operator added to the scalar potential. Working with the EFT approach, a comprehensive discussion of DM phenomenology with promising parameter space is given, while taking theoretical and the latest experimental constraints into account. In particular, for particles heavier than 500 GeV higher-dimensional derivative operators lead to an extended viable parameter space even for non-(quasi)degenerate scalar masses. We conclude that the discussed sources of CP violation do not spoil the predicted DM relic abundance.