Cluster of Excellence Precision Physics, Fundamental Interactions and Structure of Matter
PRISMA

Mainz Institute for Theoretical Physics

Probing Physics Beyond the Standard Model with Precision

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The LHC and other particle-physics experiments continue to confirm the Standard Model in an impressive manner. No conclusive evidence for New Physics in the TeV range has been found so far. In this situation, precision measurements are an adequate measure to search for physics beyond the Standard Model. To fully support the experimental program of the LHC and in particular its high-luminosity extension, precise theoretical predictions are crucial. The rapid progress in techniques for the evaluation of perturbative corrections and the accompanying automation open the possibility to routinely calculate higher-order corrections also in extended models. The goal of the scientific program was to bring together experts in the field of higher-order calculations with researchers in the phenomenology of theories Beyond the Standard Model (BSM) and effective field theories (EFTs) to discuss the need and the preparation of appropriate automated tools for precise predictions in extended models.

In the first week of the scientific program, the focus of the meeting was on EFTs for the description of deviations from the Standard Model. In the second week, the discussion dealt with specific extensions of the Standard Model. Each week started with talks by experimentalists to update the participants concerning the latest experimental findings of the LHC collaborations. In the following days there was a theoretical overview talk of about one hour each day in the late morning, followed by discussions. Several of these talks were presented by junior participants without a permanent position. For the presentations we asked the audience not to bring their laptops. This worked out very well and had a positive effect on fostering discussions during and after the talks. The topics of the talks were: Electroweak precision observables and EFTs (Matthias Schott, ATLAS), Multi-boson interactions (Matthias Mozer, CMS), Introduction to EFT (Ian Lewis), The Standard Model EFT-tools and strategies (Ilaria Brivio), EFT and perturbation theory (Michael Trott), EFT summary (Christoph Englert), Experimental results and open theory-related aspects (Luca Perozzi, CMS), Introduction and overview of BSM theories (Werner Porod), Renormalization of BSM theories (Heidi Rzehak), Automation of NLO calculations for BSM theories (Jean-Nicolas Lang), BSM summary (Michael Krämer).

The discussions during the workshop focused on important questions for the development of the field. Some examples are: Can the EFT of the Standard Model become a standard to describe deviations? How should large effects from squares or products of dimension-6 operators be interpreted? When and how should dimension-8 operators be incorporated in prediction? Are precision calculations within the Standard Model EFT a

worthwhile exercise? Are precision calculations within BSM theories needed? Are gauge-dependent renormalization schemes useful?

While the discussion of some of these questions was quite controversial, there was a clear request from the experimentalists to continue precision calculations for the Standard Model and to come up with recommendations for analyses in BSM theories. Moreover, there was a consensus that automation of precision calculations for BSM theories should be continued. The workshop was used by many participants to start new and to reinforce existing collaborations. We here list some examples of such projects: renormalization of mixing angles, precise predictions for vector-boson pair production within EFTs, supersymmetric Higgs mass calculations in the EFT framework, theory preparation for upcoming high-precision measurements at the LHC (W-boson mass, effective weak mixing angle), interpretation of electroweak precision data as part of LHC analyses, interplay of anomalous fermion-gauge couplings on EFT analyses in the Higgs sector, impact of parton distributions on current limits on four-fermion Wilson coefficients. The scientific program will certainly influence the further development of the field.