Area 5: Benchmark scenarios from UV models

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1 Matching BSM to SMEFT at one loop accuracy

The standard model effective field theory (SMEFT) describes physics at energies below the new mass scale beyond the electroweak scale. The imprints of ultraviolet (UV) physics are encoded in the Wilson coefficients (WC) of the SMEFT. Measuring these coefficients and their correlations allows for discriminating between different UV models. The important technical step in this procedure is the *matching*, where the heavy degrees of freedom are integrated out and their effects are represented by local operators. The resulting WC are expressed in terms of the parameters of the UV theory such as couplings and masses. This facilitates the interpretation of the SMEFT analyses in explicit UV models.

Matching beyond tree-level is important since many interesting observables are generated only at the one-loop level. This task is not only technically challenging, but given the number of possible UV models, repetitive and time-consuming. To address the issue, several dedicated tools have been developed recently. For example, the `SuperTracer` [1] and `STrEAM` [2] packages aim at facilitating the one-loop EFT matching of generic UV models using the path integral methods. `Matchmaker` [3], instead, will automate the diagrammatic EFT matching of generic UV models (not yet released).

One of the goals of the Area 5 meetings is to come up with proposals for *benchmark models* which *i*) serve as a playground for validation of different tools for the automated matching and *ii*) are phenomenologically relevant. We envisage a set of standard benchmarks to be agreed among experts that will represent a challenge for these tools. Very few fully worked out benchmark examples exist in the literature, although, see for instance [4].

2 MSSM to SMEFT decoupling limit

It is interesting to match the SMEFT to the MSSM to compare with the vast number of MSSM studies. The use of the SMEFT requires that the MSSM particles are much heavier than the weak scale. The one-loop WIlson coefficients found from integrating out MSSM stops can be found in [6] and global fits have been used to place restrictions on relatively light stops [7]. Alternatively, neutralinos and charginos can be taken heavy, integrated out and matched to the SMEFT [8]. Since the Higgs sector of the MSSM is the same as the type-II 2HDM, benchmarks from the 2HDM can be used to study the MSSM [5, 9].

Fitting to the whole set of coefficients generated by the MSSM requires choosing some initial benchmark points. One goal of the EFT-WG Area-5 is to develop a small set of benchmark

points for comparison between MSSM studies and SMEFT studies and suggestions for such benchmarks are encouraged.

References

[1] J. Fuentes-Martin, M. König, J. Pagès, A. E. Thomsen and F. Wilsch, [arXiv:2012.08506 [hep-ph]].

[2] T. Cohen, X. Lu and Z. Zhang, [arXiv:2012.07851 [hep-ph]].

[3] C. Anastasiou, A. Carmona, A. Lazopoulos, and J. Santiago, `MatchMaker`.

[4] V. Gherardi, D. Marzocca and E. Venturini, JHEP **07**, 225 (2020) [erratum: JHEP **01**, 006 (2021)] doi:10.1007/JHEP07(2020)225 [arXiv:2003.12525 [hep-ph]].

[5] H. E. Haber and O. Stål, Eur. Phys. J. C **75**, no.10, 491 (2015) [erratum: Eur. Phys. J. C **76**, no.6, 312 (2016)] doi:10.1140/epjc/s10052-015-3697-x [arXiv:1507.04281 [hep-ph]].

[6] B. Henning, X. Lu and H. Murayama, JHEP **01**, 023 (2016) doi:10.1007/JHEP01(2016)023 [arXiv:1412.1837 [hep-ph]].

[7] A. Drozd, J. Ellis, J. Quevillon and T. You, JHEP **06**, 028 (2015) doi:10.1007/JHEP06(2015)028 [arXiv:1504.02409 [hep-ph]].

[8] H. Han, R. Huo, M. Jiang and J. Shu, Phys. Rev. D **97**, no.9, 095003 (2018) doi:10.1103/PhysRevD.97.095003 [arXiv:1712.07825 [hep-ph]].

[9] M. Gorbahn, J. M. No and V. Sanz, JHEP **10**, 036 (2015) doi:10.1007/JHEP10(2015)036 [arXiv:1502.07352 [hep-ph]].