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The Asymptotically Safe Standard Model: From quantum gravity to dynamical chiral symmetry breaking

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We present a comprehensive non-perturbative study of the phase structure of the asymptotically safe Standard Model. The physics scales included range from the asymptotically safe trans-Planckian regime in the ultraviolet, the intermediate high energy regime with electroweak symmetry breaking to strongly correlated QCD in the infrared. All flows are computed with a self-consistent functional renormalisation group approach, using a vertex expansion in the fluctuation fields. In particular, this approach takes care of all physical threshold effects and the respective decoupling of ultraviolet degrees of freedom. Standard Model and gravity couplings and masses are fixed by their experimental low energy values. Importantly, we also accommodate for the difference between the top pole mass and its Euclidean analogue. Both, the correct mass determination and the threshold effects have a significant impact on the qualitative properties, i.e. the number of relevant directions, of the ultraviolet fixed point as well as the stability properties of the specific ultraviolet-infrared trajectory with experimental Standard Model physics in the infrared. We show, that in the present rather advanced approximation the matter part of the asymptotically safe Standard Model has the same number of relevant parameters as the Standard Model, and is asymptotically free. Interestingly, the fixed-point Higgs potential is flat but has two relevant directions. These results and their analysis are based and accompanied on a thorough discussion of the systematic error of the present truncation, also important for systematic improvements.

Author: Mr PASTOR GUTIERREZ, Alvaro (Max Planck Institute for Nuclear Physics)

Presenter: Mr PASTOR GUTIERREZ, Alvaro (Max Planck Institute for Nuclear Physics)

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