Asymptotic Safety in the Higgs Portal to Fermionic Dark Matter

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Abstract:
In spite of its enormous successes, the Standard Model has at least one missing piece, namely dark matter. Observations do not currently preclude fermionic dark matter coupling to the Standard Model via the Higgs portal. This scenario, however, has the theoretical issue that the negative mass dimension of the Higgs portal coupling renders it perturbatively nonrenormalizable. This motivates our renormalization group treatment of a toy model of the Higgs portal to fermionic dark matter searching for evidence of an interacting UV fixed point rendering the system nonperturbatively renormalizable, or asymptotically safe. In the symmetric regime of the scalar potential, we find evidence of interacting fixed points with negative scalar mass squared, indicative of spontaneous symmetry breaking, as in the Higgs sector of the Standard Model at low temperature. Working in the regime of spontaneous symmetry breaking, we find strong indications of an interacting UV fixed point robust under changes in the approximation persisting in successive truncations of the full renormalization group flow. We then construct explicit renormalization group flow trajectories connecting our UV fixed point to potentially phenomenologically allowed IR values of the couplings. Our results suggest the possibility of a UV complete, fermionic dark extension of the Standard Model.