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Light Fermions and the Swampland

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Quantum gravity can have important implications for Particle Physics and Cosmology. In this talk, I will describe the state-of-the-art and phenomenological implications of the AdS Distance conjecture and the Non-susy AdS Instability conjecture. In particular, we consider constraints on D-dimensional theories in Minkowski, dS and AdS backgrounds in the light of these swampland conjectures as applied to their compactification in a circle. For Minkowski and dS vacua the results may be summarized by a light fermion conjecture which states that in theories with a positive first non-vanishing supertrace $(-1)^{k+1} \text{Str}(M^{2k}) > 0$, a surplus of light fermions with mass $m_f < \Lambda_D^{1/D}$ must be present, where Λ_D is the cosmological constant. The case of AdS can be made consistent with the mild but not the strong version of the AdS Distance conjecture. I will also apply the above constraints to the Standard Model of particle physics, obtaining that it would be inconsistent in Minkowski space but consistent in dS if the lightest neutrino is Dirac and lighter than the cosmological constant scale, unless there is light fermionic dark matter. This can be translated to an upper bound on the EW scale which may shed some light into the naturalness issues observed in our universe.

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