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Systematics of the α′ Expansion in F-theory

The main open technical problem to extract reliable low-energy information from string compactifications is understanding the corresponding effective field theories (EFT) beyond tree-level. Perturbative corrections have a direct impact on moduli stabili- sation because the scalar potential vanishes at tree level due to a no-scale property. Even though some corrections have been computed, a systematic approach has not yet emerged. To this end we study the moduli dependence of perturbative corrections to the 4D scalar potential using two techniques: approximate symmetries of 10D type IIB string theory and dimensional analysis within the framework of F/M-theory duality. In the first case, the presence of two rescaling symmetries allows to derive the dependence of any α′ and string loop correction on the dilaton and the volume of the Calabi-Yau threefold. In the second case, we find that conventional zero mode Kaluza-Klein reductions on elliptically fibred Calabi-Yau fourfolds of the M-theory action with arbitrary higher derivative terms can generate only (α′)^(even) corrections to the 4D scalar potential. In particular, for the case of trivial fibrations we find that all higher derivative contributions vanish in the F-theory limit. We therefore argue that (α′)^(odd) effects should arise from a proper process of integrating out Kaluza- Klein and winding states on the elliptic fibration. We provide evidence for this claim by showing that our dimensional analysis allows us to recover the known (α′)^3 corrections in the low-energy F-term expansion from 11D loops in trivially-fibred fourfolds. We further argue that (α′)^1 corrections are not present at tree-level in the string coupling expansion.

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