UV/IR relations from the worldsheet

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Abstract

We derive universal scaling relations for the low-energy effective action of string theory, connecting the vacuum energy and gauge couplings to higher-derivative Wilson coefficients. At one-loop in string perturbation theory, these generic parametric relations follow from modular and conformal invariance of the worldsheet, independently of the specific low-energy phase of the theory, and they become non-trivial in species limits. As a result, we substantially strengthen our previous case for the emergent string conjecture and connect UV/IR mixing to swampland principles. We argue that our results persist to higher loops, hinting at a pathway to study strong couplings using dualities. Further accounting for open-string contributions, if any, our results lead to parametric inequalities which reproduce holographic bounds and support the magnetic weak-gravity conjecture and the dark dimension scenario.

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