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Laplacians in Various Dimensions and the Swampland

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The species cutoff is a moduli-dependent quantity signaling the onset of quantum gravitational phenomena, whose form can be oftentimes determined from higher-derivative and higher-curvature corrections within low-energy gravitational EFTs. In this work, we point out that these Wilson coefficients are eigenfunctions of an appropriate second-order elliptic operator defined over moduli space in theories with more than four supercharges. This was already known to be the case for the leading \mathcal{R}^4-correction to the two-derivative (bosonic) action of maximal supergravity in d\leq 10. Here, we reconsider this fact from the Swampland point of view and show how, in d=10,9,8, solving a Laplace equation imposes non-trivial restrictions on the species hull vectors. We further argue that this property is also satisfied in settings with less supersymmetry. In particular, we focus on the \mathcal{R}^4-operator in minimal supergravity theories in d=10,9, and on the leading \mathcal{R}^2-term in setups with 8 supercharges in d=6,5,4. Finally, we provide a symmetry-based criterion for determining when the relevant elliptic operator should be the Laplacian. A bottom-up rationale for this constraint remains to be fully understood, and we conclude by outlining some compelling possibilities.

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