15min+5min for questions

Emerging from the Swamp

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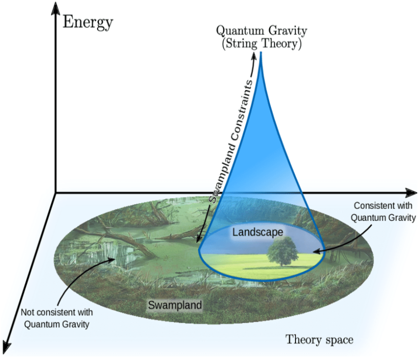
The Swampland Programme

Consistent set of conjectures motivated mainly (but not exclusively) by string theory (see e.g. Palti '19).



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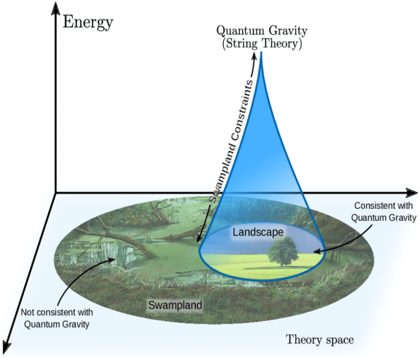

- No Global Symmetries Conjecture
- Distance Conjecture [Ooguri, Vafa '06]
- Weak Gravity Conjecture
- (A)dS Distance Conjecture
- Gravitino Conjecture

  ⋮

- The Emergence Proposal [Palti '19]
- The Emergent String Conjecture [Lee, Lerche, Weigand '18]

What do swampland conjectures look like?

- **Swampland Distance Conjecture:**[Ooguri, Vafa '06] At an infinite distance in moduli space, a tower of exponentially light states appears in our EFT, with masses given by

$$M(p) \sim M(p_0) e^{-\alpha d(p_0, p)}, \tag{1}$$

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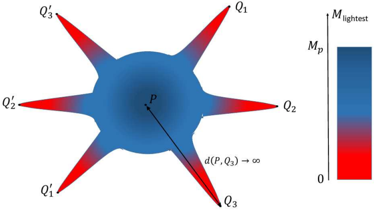

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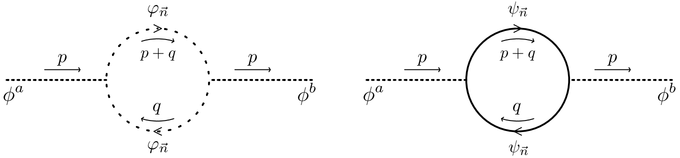
Comparison with usual renormalization procedure in QFT:



Integrating out light states with $m_{\vec{n}}(\phi^a) = m_{\vec{n}}(\phi_0^a + \delta\phi^a)$, where ϕ^a are scalars will produce a correction to the propagator matrix

$$D_{ab}(p^2) = \frac{1}{p^2 - \Pi_{ab}(p^2)}\,, \quad \Pi_{ab}(p^2) = \sum_{\vec{n}} \Pi_{ab,\vec{n}}(p^2)\,. \tag{2}$$

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All sums are restricted!

The cut-off of our theory is the **species scale**. For a $4D$ theory, that is [Dvali et al. '07]

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where $N_{\rm sp} = \begin{cases} \#\text{particles with } m < \tilde{\Lambda} & \text{(QFT picture)} \\ \text{S of minimum black holes} & \text{(BH picture)} \end{cases}$

- QFT picture: Graviton propagator [Donoghue '93]

$$\pi^{-1}(p^2) = p^2 \left(1 - \frac{N_{\rm sp}\, p^2}{120\pi M_{\rm Pl}^2} \log\left(-\frac{p^2}{\mu^2}\right) + \gamma \sum_{n=1}^{N_{\rm sp}} \frac{p^2}{M_{\rm Pl}^2} \frac{m_n}{\sqrt{-p^2}} \right)\,, \tag{7}$$

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Possibly more reliable method: BH picture!

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Exact Emergence [Blumenhagen, Cribiori, Gligovic, AP '23]

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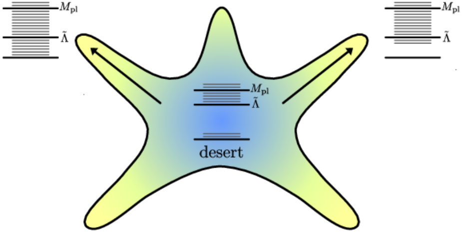
- Method: Integrate out the **full, infinite** towers of states with mass scales below the species scale using zeta function regularization.
- At decompactification limit: Full prepotential for the resolved conifold obtained for the first time this way, including perturbative terms $\rightarrow$ exact emergence.



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- Emergence Proposal: strong, weak, exact...
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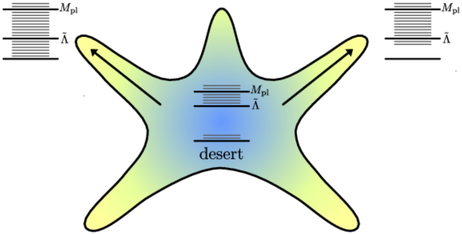
- Integrating out extended objects?

Summary



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Thank you for your attention!