Mass Hierarchies in Strongly Warped KKLT Scenarios

Based on: R. Blumenhagen, A. Gligovic, S. Kaddachi
arXiv: 2206.08400

KKLT: models proposed to give *de Sitter* vacua in 4D

Parametric control? Consistent with quantum gravity constraints?

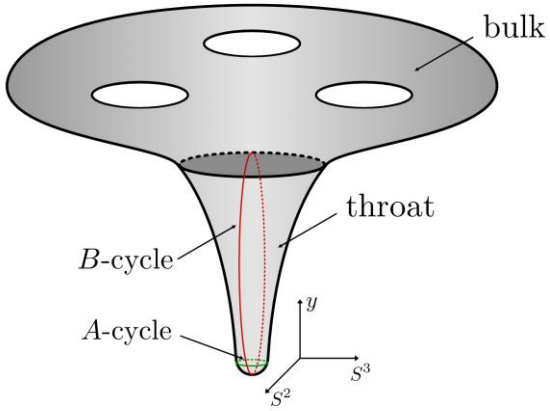
Flux compactifications

Starting point: Type IIB string theory, compactified on Calabi-Yau three-fold

Spacetime: $M_{10} \rightarrow M_4 \times Y_3$ SUSY: $N = 2\ (D = 10) \rightarrow N = 1\ (D = 4)$

Standard feature: massless fields (*moduli*) → generate potential via fluxes in compact space

Internal geometry: Long, redshifted throat glued to compact bulk (UV region)



Tadpole cancellation: $N_{flux} + N_{D3} - \frac{1}{2} N_{O3} = 0$

EFT specified by: 1) Superpotential W 2) Kähler potential K

KKLT in three steps

Step 1: Stabilization of complex structure moduli (U^a, Z) & axio-dilaton S through fluxes

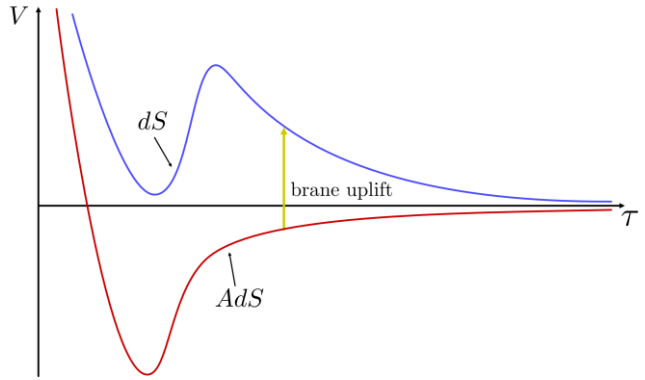
Refinement: *Racetrack* for axio-dilaton $\boxed{W = W_Z + a_1 e^{-c_1 S} + a_2 e^{-c_2 S}}$ $\rightarrow \quad |W_0| \ll 1$

Scenario 1: W_Z competes with other terms Scenario 2: W_Z sub-leading

Step 2: Stabilization of Kähler modulus T through non-perturbative corrections $W = W_0 + A\, e^{-a\, T}$

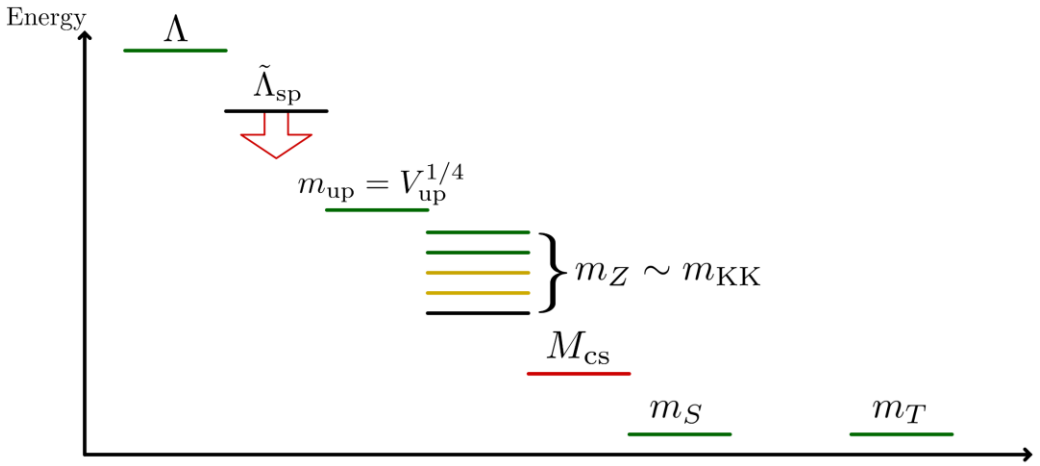
Step 3: Uplift A$dS \rightarrow dS$ via $\overline{D3}$ - brane placed at tip of throat

Objective: Collect all physical energy scales & compare!



Mass hierarchies and flux tadpole N

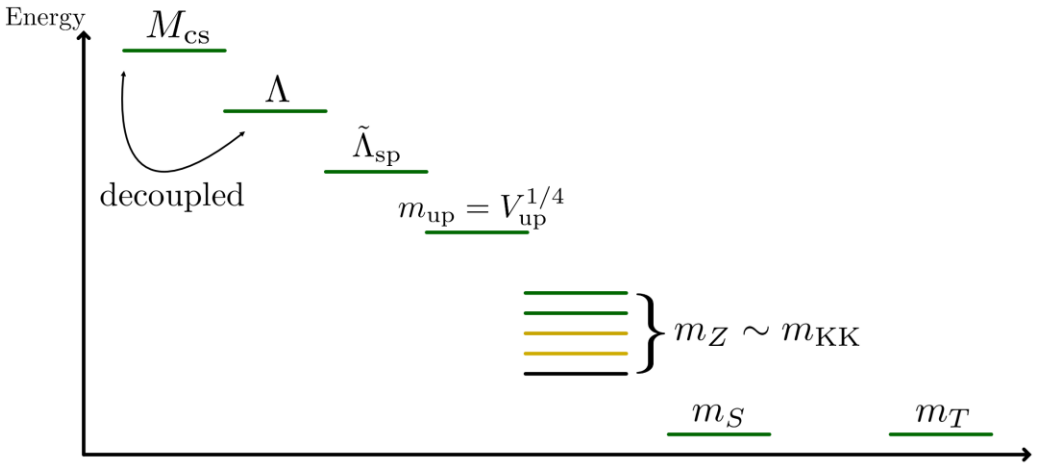
Scenario 1



Tadpole: $N \gtrsim (\log|Z|)^4 |Z|^{-2/3}$

Theory: $N \gtrsim 10^{7-8}$ Num. example: $N \sim O(10^{19})$

Scenario 2



Tadpole: $N \gtrsim 10^{\#}\, c_1/g_s^2$

Theory: $N \gtrsim 10^{3-4}$ Num. example: $N \sim O(10^5)$