New families of scale separated vacua

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String Phenomenology, Padova, June 27, 2024

Based on 2309.00043 [R. Carrasco, TC, F. Marchesano and D. Prieto] and review 2311.12105 [TC]

10d spacetime $=$  $\times$ 

4d world — Compact X^6

- Cosmological constant Λ

$\implies R_{\text{(A)dS}} M_{\text{p}} \sim |\Lambda|^{-1/2}$

- Kaluza-Klein scale $M_{\text{KK}} \sim \frac{M_{\text{s}}}{\text{Vol}_{X_6}^{1/6}}$ (and winding scale)

Scale separation: $R_{\text{(A)dS}} M_{\text{KK}} \gg 1$

Hiding the extra dimensions

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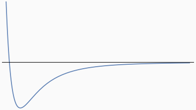

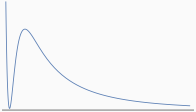

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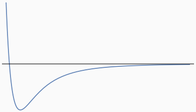

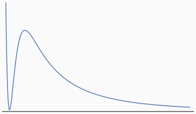

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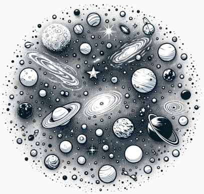
10d spacetime $=$  $\times$ 

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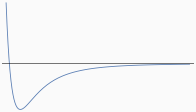

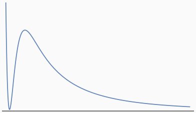

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DGKT in type IIA [DeWolfe, Giryavet, Kachru, Taylor, '05]

- $X_6 = T^6/(\mathbb{Z}_3 \times \mathbb{Z}_3) \Longrightarrow h^{2,1} = 0$ & let us forget twisted moduli

$$t^a \propto \frac{\sqrt{|\hat{e}_1 \hat{e}_2 \hat{e}_3|}}{|\hat{e}_a| \sqrt{m}} \quad \text{with} \quad \hat{e}_a \equiv e_a - \frac{1}{2} \frac{\mathcal{K}_{abc} m^b m^c}{m}$$

Tadpole: $\mathrm{d}G_2 = G_0 H + Q_{\mathrm{O6}} \delta_{\mathrm{O6}}$

$\Longrightarrow$ Flux quanta e_a, m^a unconstrained

$$\boxed{\hat{e}_a \sim n}$$

$$t^a \sim n^{\frac{1}{2}}, \quad \mathrm{Vol}_{X_6} \sim n^{\frac{3}{2}}, \quad e^{\phi} \propto (\mathcal{K}_{abc} t^a t^b t^c)^{-\frac{1}{2}} \sim n^{-\frac{3}{4}}, \quad e^{\phi_4} \sim n^{-\frac{3}{2}}$$

Good control: $n \to \infty \Longrightarrow$ large volume/weak coupling

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$$\Lambda \propto -3e^{K}|W|^2 \sim n^{-\frac{9}{2}}$$

$$R_{\mathrm{AdS}}M_{\mathrm{KK}} \sim n^{\frac{1}{2}}\,, \quad \text{and} \quad R_{\mathrm{AdS}}M_{\mathrm{W}} \sim n$$

Susy AdS:

- Moduli stabilised
- Controlled regime
- Scale separation
- Pert. stable

Generalisable:

- Metric fluxes [Camara, Font, Ibáñez '05] [Derendinger, Kounnas, Petropoulos, Zwirner '05] [Villadoro, Zwirner '05]
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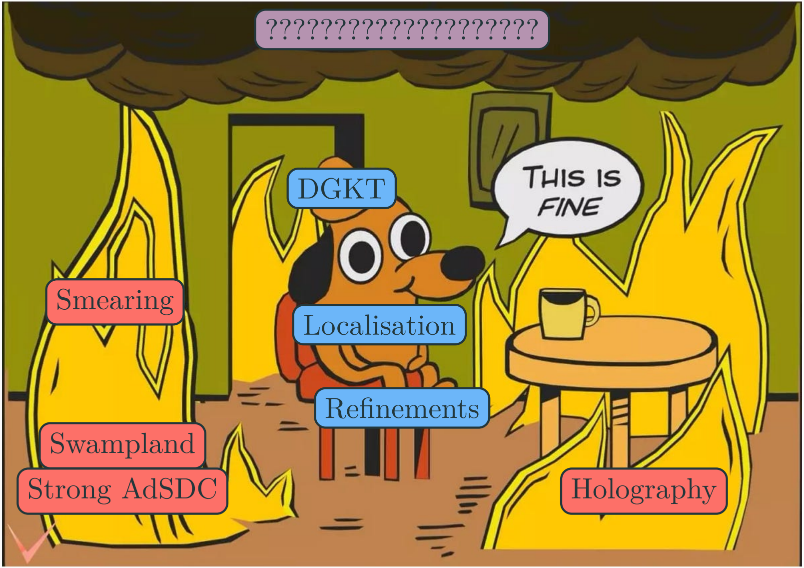

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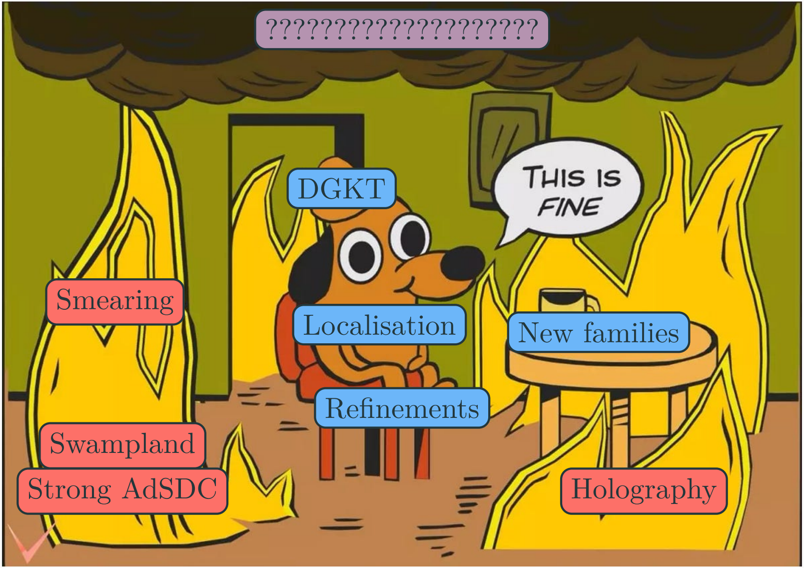

New families: Double T-duality [Banks, Van Den Broek '06]

- We consider $(T^2)^3/\Gamma$

$\hat{e}_1 \sim n^{2r}\,, \qquad \hat{e}_2, \hat{e}_3 \sim n^{r+s}$ (DGKT was $r = s = \frac{1}{2}$)

$\Longrightarrow t^1 \sim n^s \quad t^2, t^3 \sim n^r$

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- Scale separation: $r > 0, \quad r + s > 0$
- Weak coupling: $r + \frac{s}{2} > 0$

Can be satisfied even when $s < 0 \longleftrightarrow$ shrinking torus factor

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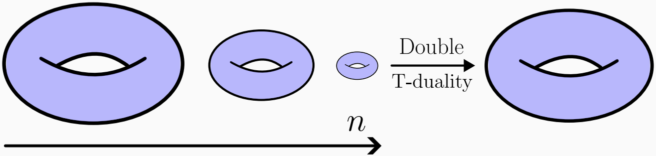

Where T-duality brings us

- $K_K = -\log\Big(i\kappa(T^1-\bar{T}^1)(T^2-\bar{T}^2)(T^3-\bar{T}^3)\Big), \qquad \kappa = \mathcal{K}_{123}$
- $K_Q(\cancel{T^a})$

<u>Double T-duality for $a=1$:</u> $T^1 \mapsto -\frac{1}{T^1}$

$K_K \mapsto K_K + \log|T^1|^2$

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$$W_{\mathrm{RR}} = e_0 + e_a T^a + \tfrac{1}{2}\mathcal{K}_{abc} m^a T^b T^c + \tfrac{m}{6}\mathcal{K}_{abc} T^a T^b T^c$$

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$$W_{\text{NS}} = h_\mu U^\mu$$

$$\downarrow$$

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- Quadratic term mixing U^μ and T^1

H-flux $\mapsto$ Metric fluxes (rank-one)

Lost Romans mass but price to pay: Depart from CY

Back to 4d setup

$W_{\rm RR}, W_{\rm NS} = h_\mu U^\mu + f_{a\mu} T^a U^\mu$

$f_{a\mu} \in \mathbb{Z} \longleftrightarrow$ metric fluxes:

$$d\omega_a = -f_{a\mu}\beta^\mu, \qquad d\alpha_\mu = -f_{a\mu}\tilde{\omega}^a$$

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$\Longrightarrow$ e fluxes (G_4 and G_6) are not constrained

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- Status uncertain in string theory

⟶ Progress on source localisation and past worries

⟶ Bottom-up constructions clashes with Swampland and holography

- We proposed new families of sol. in massless type IIA

⟶ More details right now!

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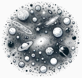
- Scale separation needed to justify 4d EFT  $\times$ 

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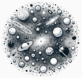
- Scale separation needed to justify 4d EFT  $\times$ 

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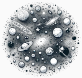
- Scale separation needed to justify 4d EFT  × 

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