Non-geometric Flux Compactifications and the Swampland

Muthusamy Rajaguru

Lehigh University

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Based on 0611001, 0706.0514, 2203.15818, 2210.03706 and WiP with Katrin Becker, Eduardo Gonzalo, Anindya Sengupta, Johannes Walcher, Timm Wrase….

Outline

- Motivation
- Review of LG construction
- Moduli Stabilization and the Swampland
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- Identifying patterns in less explored corners of the landscape.
- Helps in testing conjectures.
- Powerful non-renormalization theorems allow for control.

[Becker et al '06, 07]

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- Begin with a type IIA compactification on a rigid CY_3 $(h^{2,1} = 0)$ and consider its mirror dual.

- No geometric description as $h^{1,1} = 0$, but we have a LG description.

  [Witten ‘93]

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$1^9/Z_3$	$2^6/Z_4$
$W = \sum_{i=1}^{9} (x^i)^3$	$W = \sum_{i=1}^{6} (x^i)^4$
$x^i \to \omega\, x^i \,, \omega = e^{\frac{2\pi i}{3}}$	$x^i \to \omega\, x^i \,, \omega = e^{\frac{2\pi i}{4}}$
$\sigma : (x_1, x_2 \dots x_9) \to -(x_2, x_1 \dots x_9)$	$\sigma : (x_1, x_2 \dots x_6) \to e^{\frac{\pi i}{4}} (x_1, x_2 \dots x_6)$

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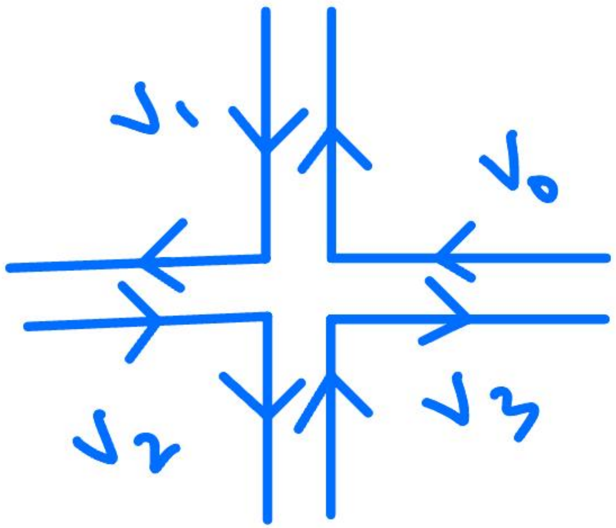
- For example, for a single variable superpotential $W = x^4$ these are given by,



where $V_0 + V_1 + V_2 + V_3 = 0$

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- The cohomology basis is spanned by the RR ground states $|l\rangle$ where $l = 1,2,3$. These can also be represented by the chiral ring,

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- The RR charges of the cycles are then computed as below,

$$\langle V_n|l\rangle = \int_{V_n} e^{-x^4} x^{l-1} dx = \frac{1}{4}\, \omega^{nl}\left(1 - \omega^l\right)\Gamma(\frac{1}{4})$$

where $\omega = e^{\frac{\pi i}{2}}$.

[Hori et al '00]

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- The LG tools let us compute the derivatives of the superpotential at the Fermat point. [Becker et al '22]

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- Building on the single variable case, the cycles and the RR ground states (cohomology basis) are given by,

$$\Gamma_{n_1 n_2 n_3 n_4 n_5 n_6} \rightarrow cycles$$

$$\boldsymbol{\Omega}_{\mathbf{l}} \leftrightarrow \mathbf{l} = |l_1, l_2, l_3, l_4, l_5, l_6\rangle \rightarrow cohomology\ basis$$

where $l_i = 1,2,3$ and $\sum_i l_i = 2\ (mod\ 4)$ because of the orbifold.

Moduli Stabilization and the Swampland

- For supersymmetric Minkowski vacua we have,

$$G = \sum_{\boldsymbol{l}_{10}} A^{\boldsymbol{l}_{10}} \Omega_{\boldsymbol{l}_{10}} \quad \text{where } \sum_i l_i = 10 \text{ for } \mathbf{l}_{10}$$

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- The massless Minkowski conjecture suggests that there are no 4d Minkowski vacua without massless scalars.

  [Gautason et al '18, Andriot et al '22]

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Even if we are to find counter-examples we are at a special point in moduli space (Fermat point). [cf. Lüst’s talk]

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- LG orbifolds with no Kähler moduli are a promising avenue for moduli stabilization!
- Are massless directions truly flat.
- Understand Kähler potential better to study non-supersymmetric vacua.
- Other Gepner models with interesting properties.