Heterotic Strings and Holomorphic Factorization

Hector Parra De Freitas (IPhT Saclay)

Based on [HPF, to appear]

and following recent work with B. Fraiman, M. Graña and S. Sethi.

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[de Boer+ '01]

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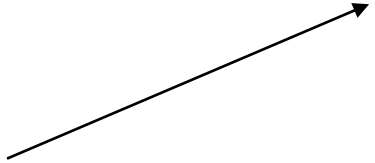
(e.g. CHL strings, Holonomy triples,…)

done in [Fraiman, HPF '22]



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= purpose of this work

Motivation: Explore the interplay of rank reduction and SUSY breaking.

- non-ADE gauge symmetries
- higher level current algebras

- Cosmological constant profiles
- Appearance of tachyons

[cf. Graña's and Fraiman's talks]

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Strategy: Relate theories to 2D chiral CFTs with c = 24.

Supersymmetric case:

1. Vanilla heterotic string: Compactify on T8 and polarize Narain lattice Λ.

Negative definite

$$\Lambda = \Gamma_{8,24} \simeq N_I \oplus E_8(-1) \quad \Rightarrow \quad Z(\tau,\bar{\tau}) = Z_L(\tau) \times Z_R(\bar{\tau})$$

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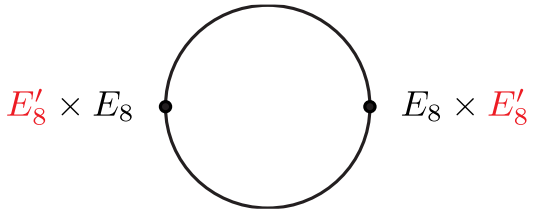
2. <u>CHL string:</u> (def: orbifold by exchange of E8's with half-shift on a circle)

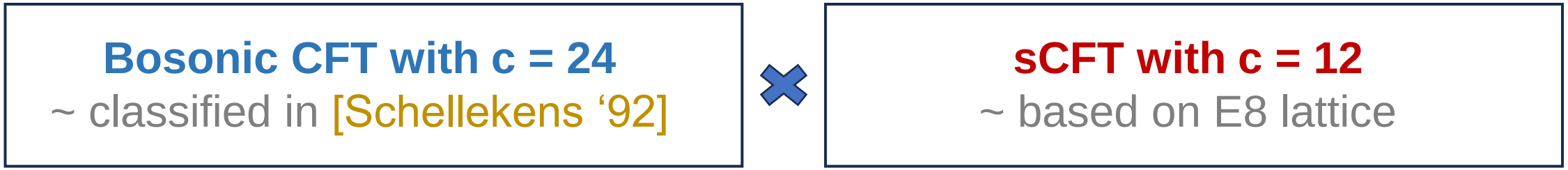


Story repeats. Compactify on T7 and polarize Λ.

Worldsheet factorizes at 17 points in moduli space of 2D theory.

General situation:

Holomorphically factorized heterotic worldsheets in 2D (with 16 supercharges) take the form



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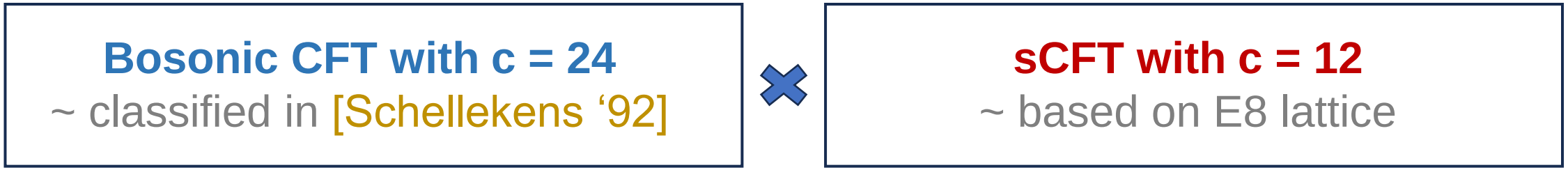

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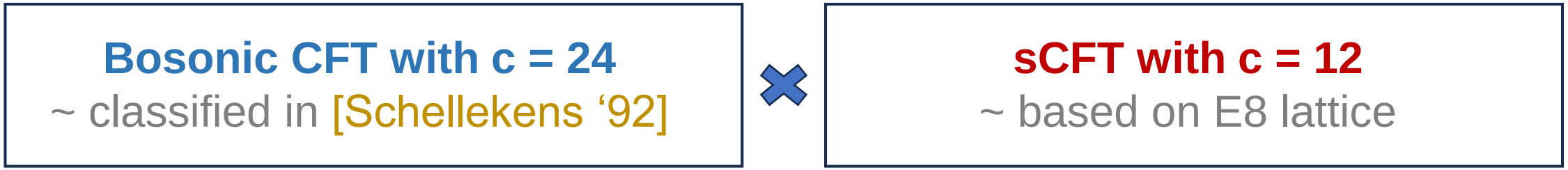

There are 71 possible left-moving CFTs, arranged into **12 genera** according to underlying lattice [Hohn '17].

Each genus, except for the monster, gives a moduli space with non-trivial decompactification limit to D ≥ 6 [Fraiman, HPF '22]

Non-supersymmetric case:

Observation: 10D heterotic strings are given by chiral CFTs with c = 16.

2 Bosonic CFTs	**7 Fermionic CFTs**
Supersymmetric Heterotic	Non-supersymmetric Heterotic

See [Boyle Smith+ ‘23] for recent work.

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Done recently in [Hohn, Möller ‘23] !

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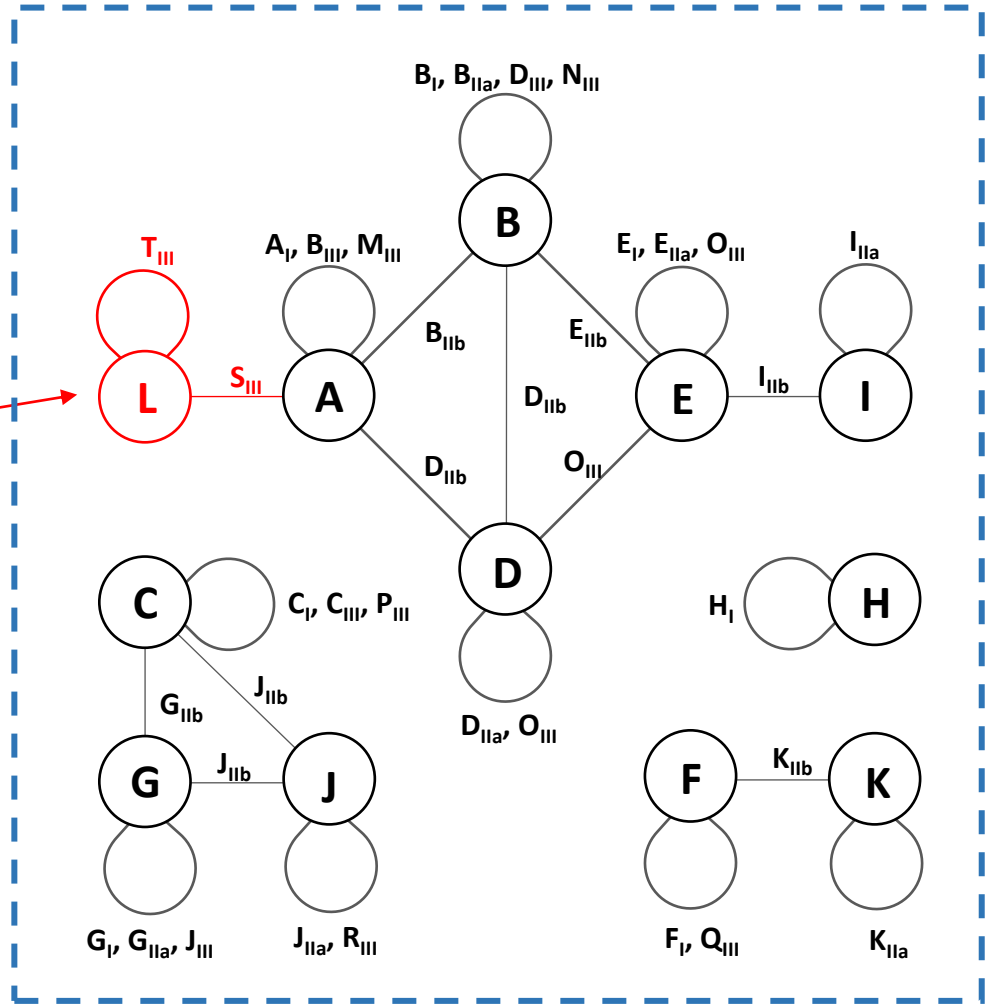

Neighborhood Graph

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Labels indicate type of orbifold:

I, IIa and IIb = inner automorphism + $(-1)^F$

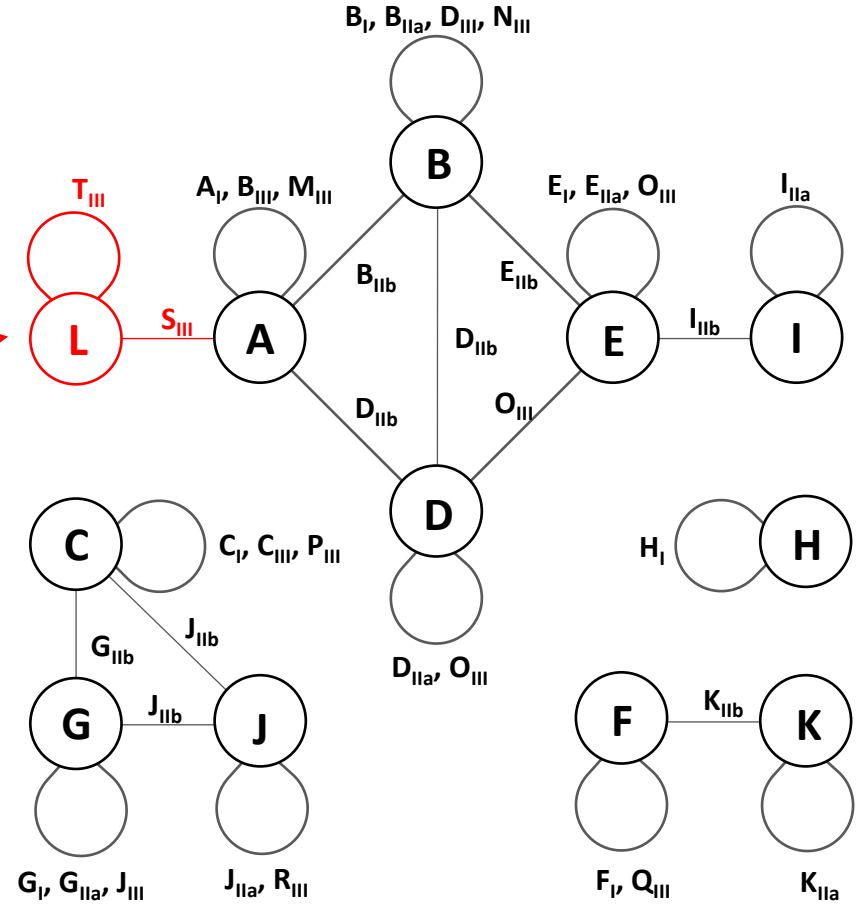
different kinds of shift vectors

e.g. I means usual SS reduction

IIa,b possible for rank reduced theories

III = outer automorphism + $(-1)^F$

e.g. E_8 string.



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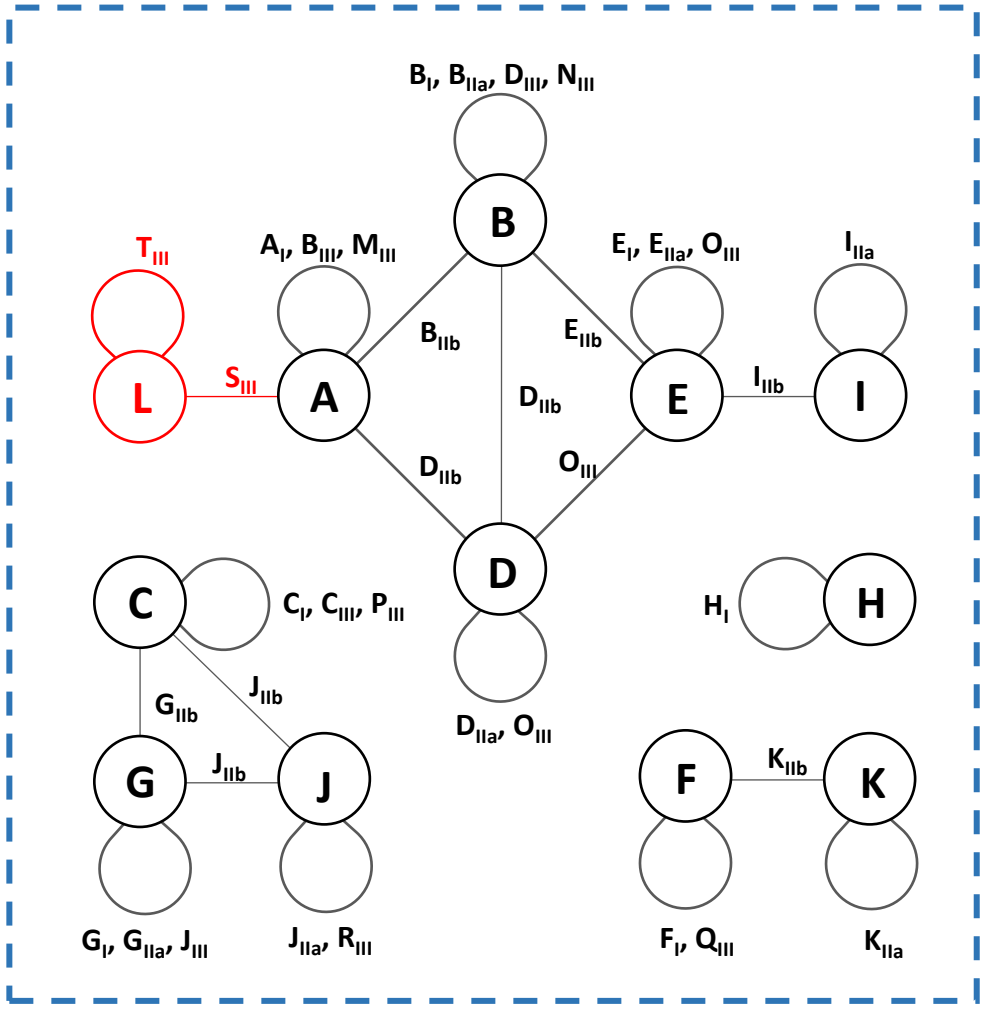
- $\mathbf{B_{IIa}}$: SS reduction of E_8 string (A bit exotic, generic tachyon?)

Other theories: obtained along the same lines?
Those of type I and IIb should be easy to get.



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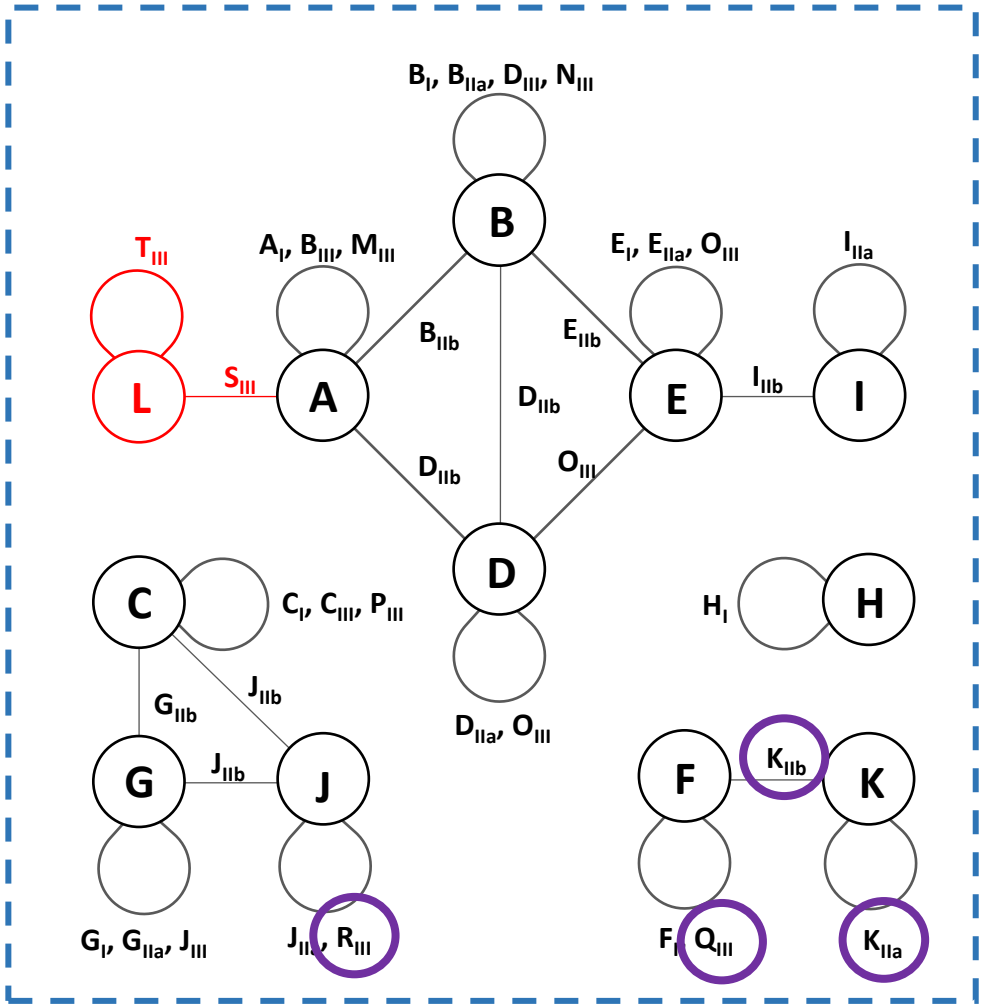

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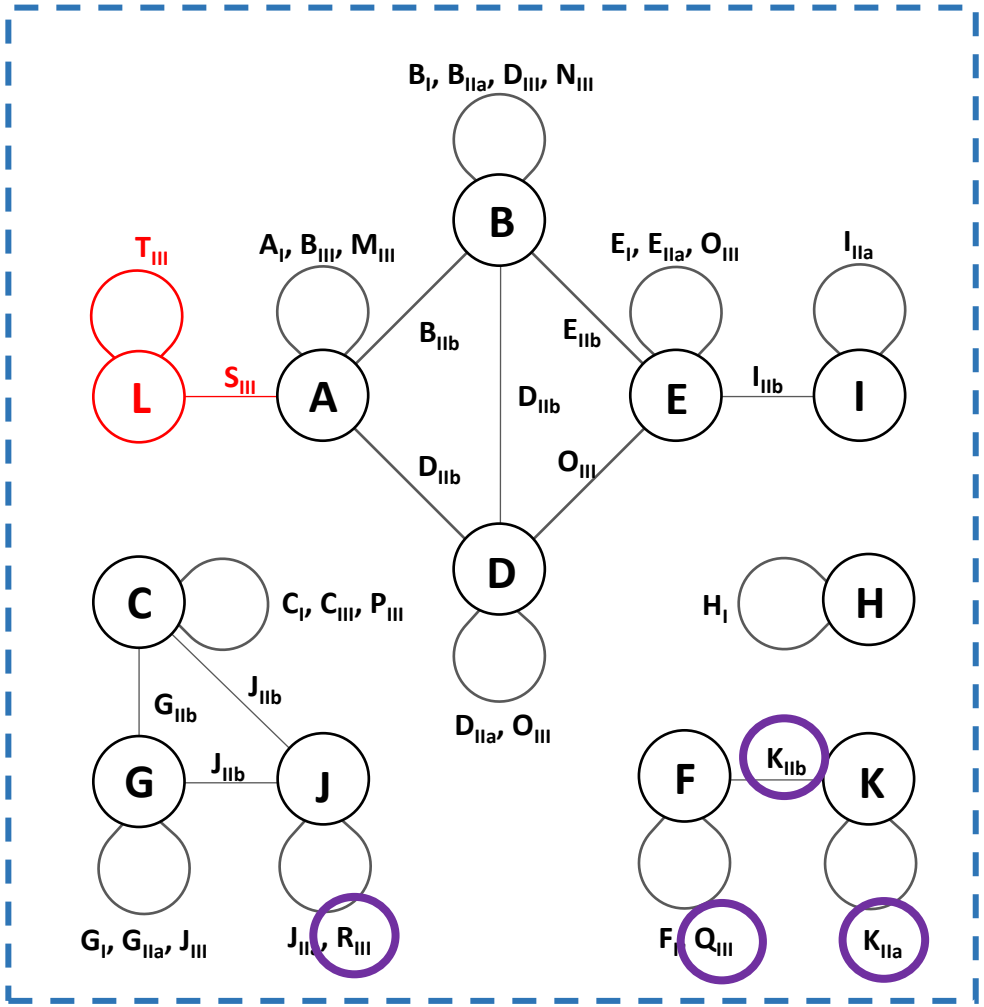
Might be useful in constructing non-supersymmetric AdS3 vacua [Baykara+ ‘22] since the problem of minimizing the CC is bypassed.



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Future work:

1. In supersymmetric case the 2D CFTs encode gauge symmetries of 6D counterparts. Does this occur here also?

2. Can we extend this picture to include Type II theories? In supersymmetric case this comes out naturally.

3. Are there relations among the spectra of the different theories? Is there a frozen singularity picture?

Thanks for you attention!