A DARK DIMENSION
&
NEW STRING THEORIES

Miguel Montero
Harvard

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This is a talk at

StringPheno

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But rather, it is going to be a

PhenoString

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[2205.12293, w. Cumrun Vafa & Irene Valenzuela]

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Continuation of Irene's talk to its logical conclusion: The **Dark Dimension**

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New string theories in high dimensions

(joint work with H. Parra de Freitas, to appear)

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But Swampland/String Theory also allows us to make a prediction
about the **nature** of the tower.

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Only n=1 is **marginally compatible**, due to the O(1) factors, and only for a **micrometer-sized** extra dimension.

(for more detailed argument that O(1)<1 and estimate, see our paper)

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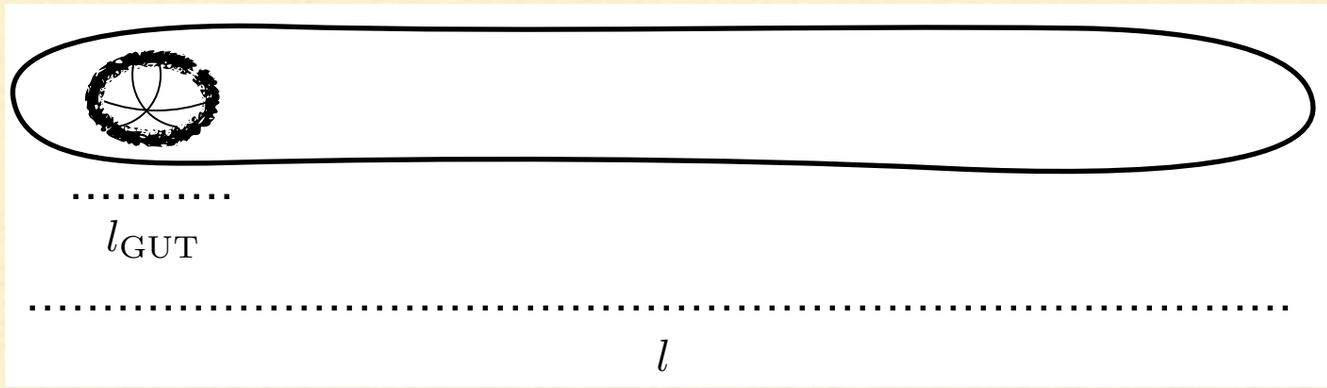
SM potential instability avoided!

SM fields live in a **small**, but finite-sized region of the dark dimension:



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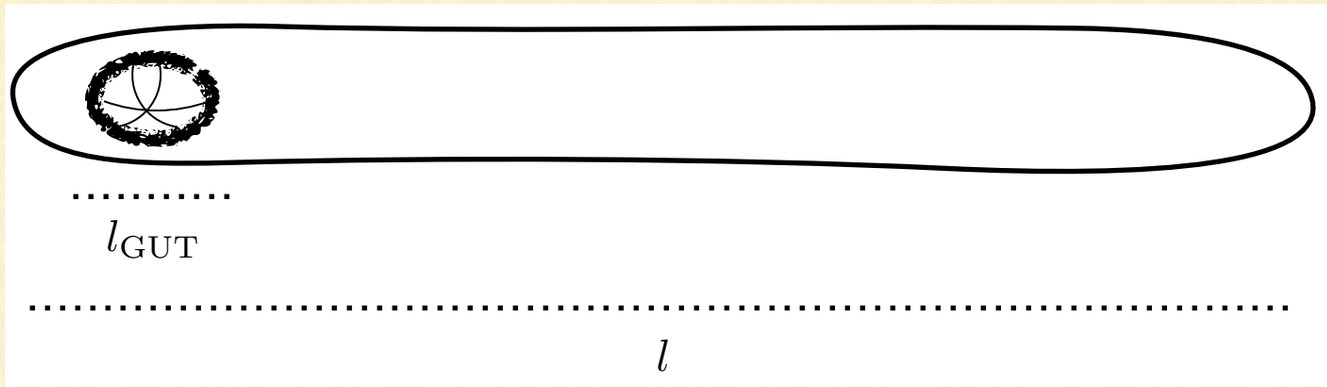

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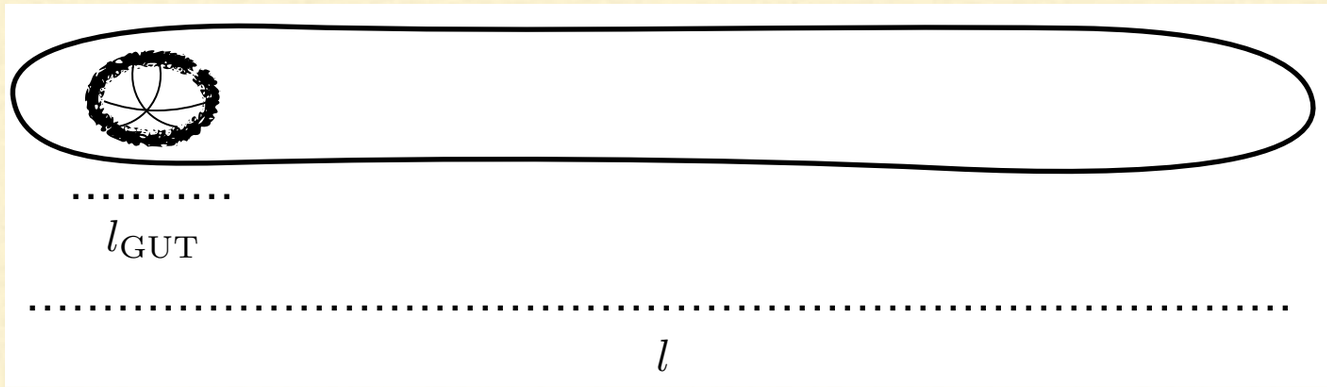

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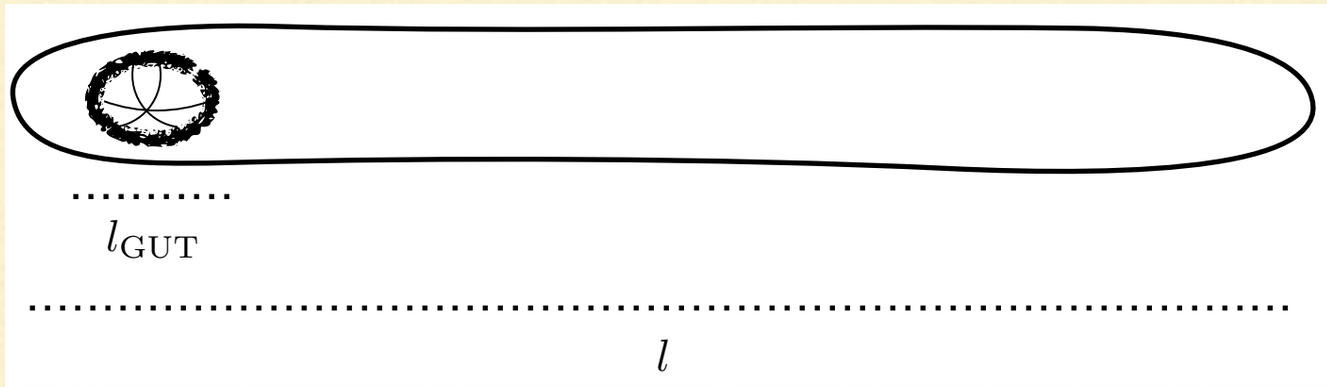

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Setting $M_\nu \sim m_\nu$ ties EW and cosmo problems,

$$\langle H \rangle \sim \frac{\Lambda^{1/6} M_{pl}^{1/3}}{y\, \lambda^{2/3}} \sim 10 - 10^3\, GeV$$

There are **many** angles to explore in this scenario:

- Nature of DM. Black holes? Tower? (See **Dieter's talk**)
- Neutrino tower predictions (see **Eduardo Gonzalo's parallel talk**)
- Signatures in **Ultra-High-Energy Cosmic rays** [Anchordoqui '22]
- Connection to the **H0 tension?**

On top of the most obvious, verifiable experimental prediction: A large dark **extra dimension of micrometer size**, and a fundamental quantum gravity scale of 10^10 GeV.

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Hector is a PhD student w. Mariana Graña & **applying for postdocs** this fall!

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This is called the **Sethi string** [Sethi '13], and the above is an example of a **discrete theta angle.**

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(Called the Asymmetric IIB Orbifold, or AOB background)

[Komargodski et al '09]

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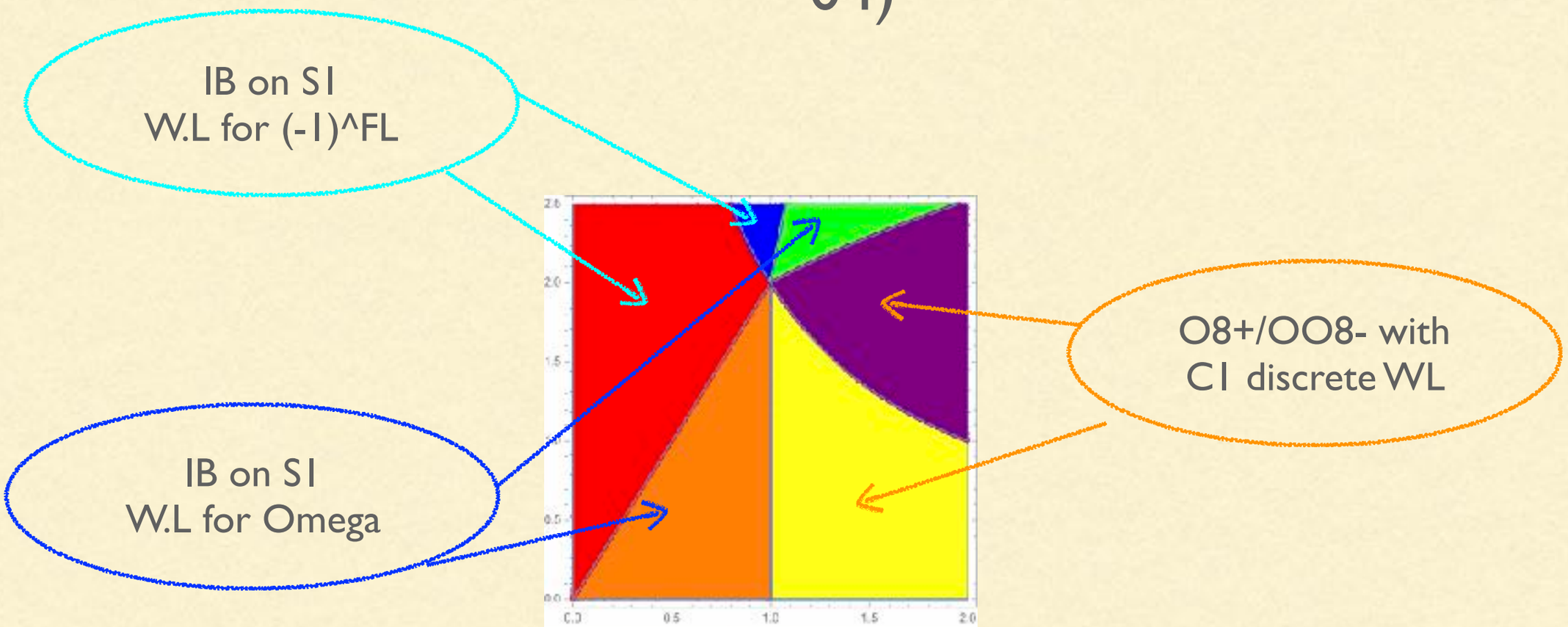

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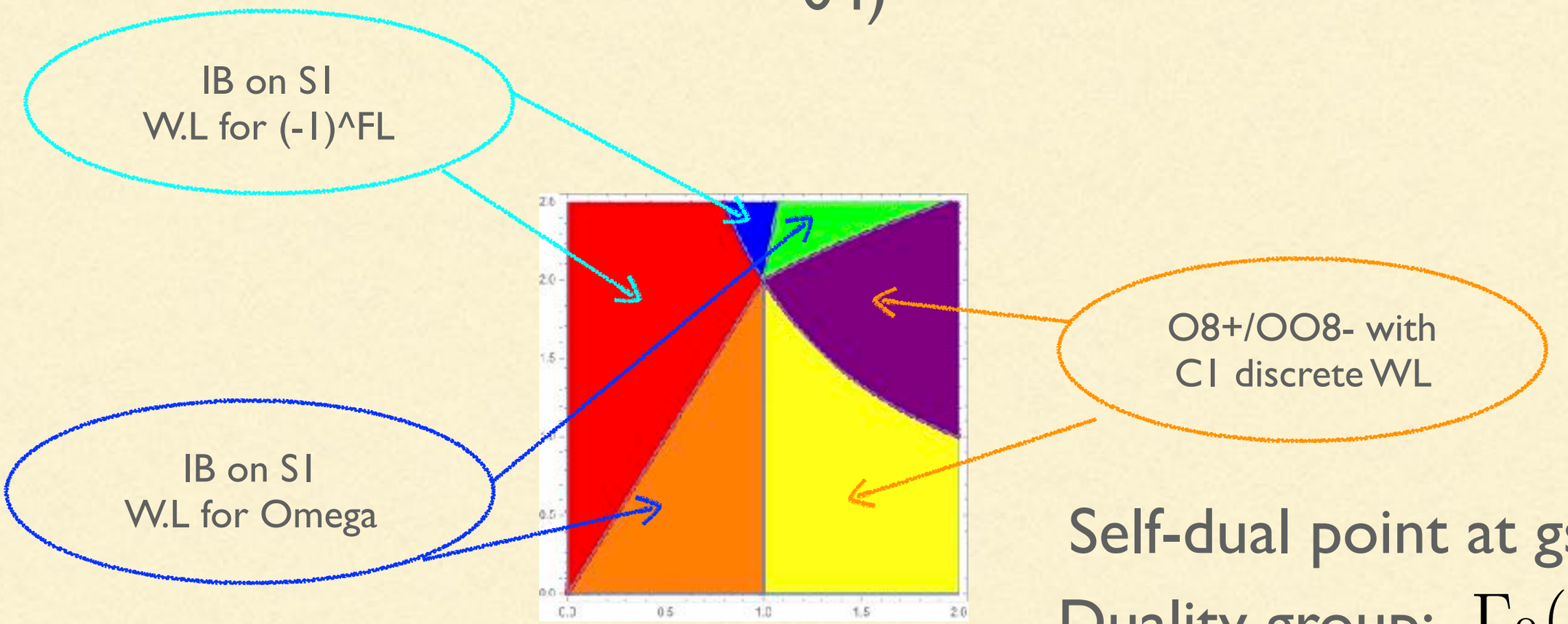

Self-dual point at gs=2

Duality group: $\Gamma_0(2)$

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These are called Bieberbach manifolds and classified in math. lit; only the two classes above exist. So **we are not missing anything else** this obvious.

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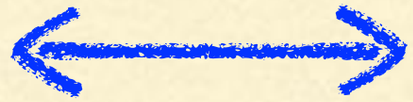

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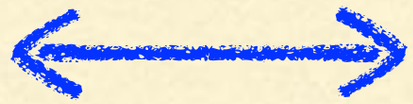

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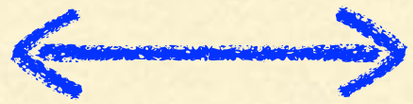

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First example of a violation with 16 supercharges.
(for particles, see [Heidenreich-Reece-Rudelius '16])

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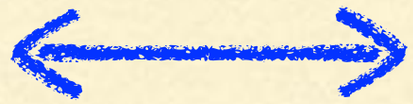

Strings charged under B

$$\int_\Sigma B$$

The string of charge 1 is not BPS. Even charges are.

First example of a violation with 16 supercharges.
(for particles, see [Heidenreich-Reece-Rudelius '16])

Many Swampland papers using anomaly inflow on strings assume this; these need to be revisited.

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there are probably a lot more examples in lower dimensions and with less SUSY.

A lot to discover!

A **Dark Dimension**

&

New String Theories

- A single large, extra dimension of size
- Gravity becomes strongly coupled at
- Tower of dark KK modes; connections to DM, neutrinos, and cosmic rays

- Three new SUSY string theories in 9d,8d and 7d
- Some of the new models do not have a full lattice of BPS strings
- Exploring all ramifications? Lower-dimensional analogues? How large can the sublattice be?

Thank you!