

Connecting String Theory



Real World We See Outside Our Window

Historically, string theory was closely connected to particle physics and the ambitious Program of *Unification*,

$$SU(3) \times SU(2) \times U(1)$$

$$SO^*(2, 1) \times N$$

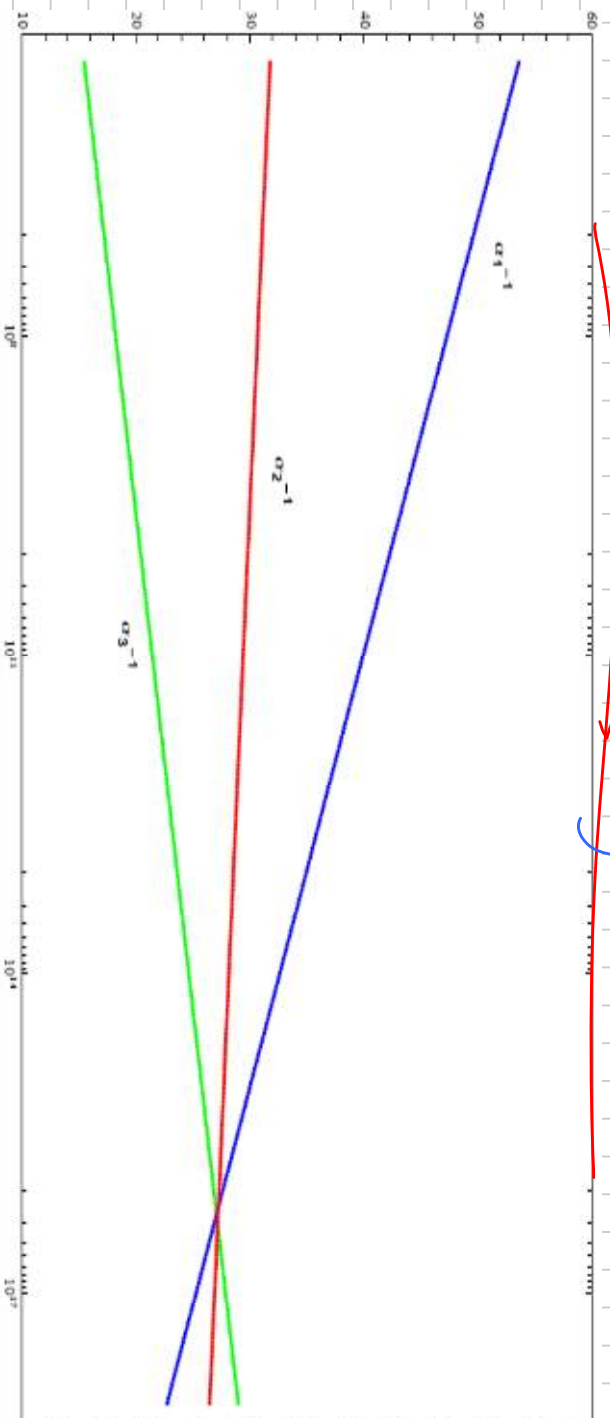
$N$

16 of  $SO(10)$

MMD - BLOWING!

Anom Cancellation +  
Eg Eg Het String  
+ "stringy" mechanisms  
to solve GUT problems

# SUSY Unification



Unified forces close to String Scale!

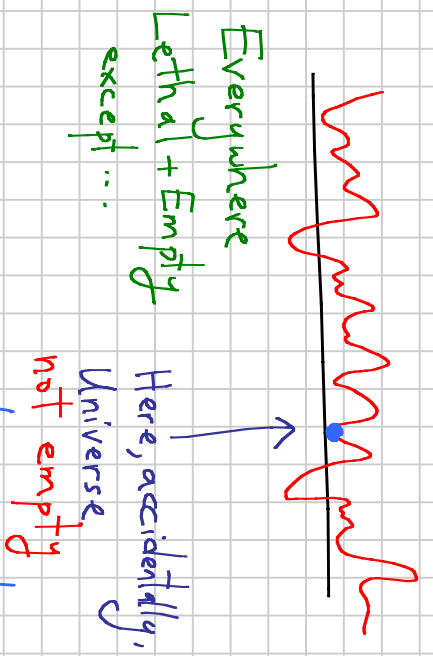
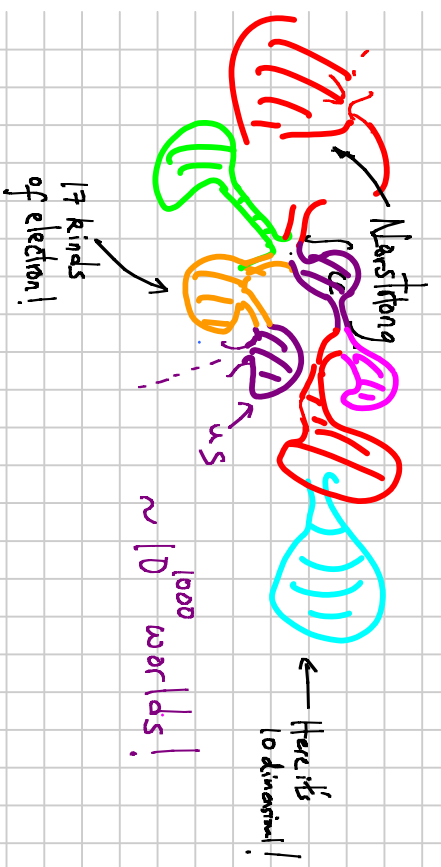
Stabilizes Weak Scale, WIMP DM

Pre-LHC: Many (not all!) leading string theorists.

“(1) LHC will discover SUSY, (2) String Theory loves SUSY + Unification”

\* Now: ... CIFTAS ...

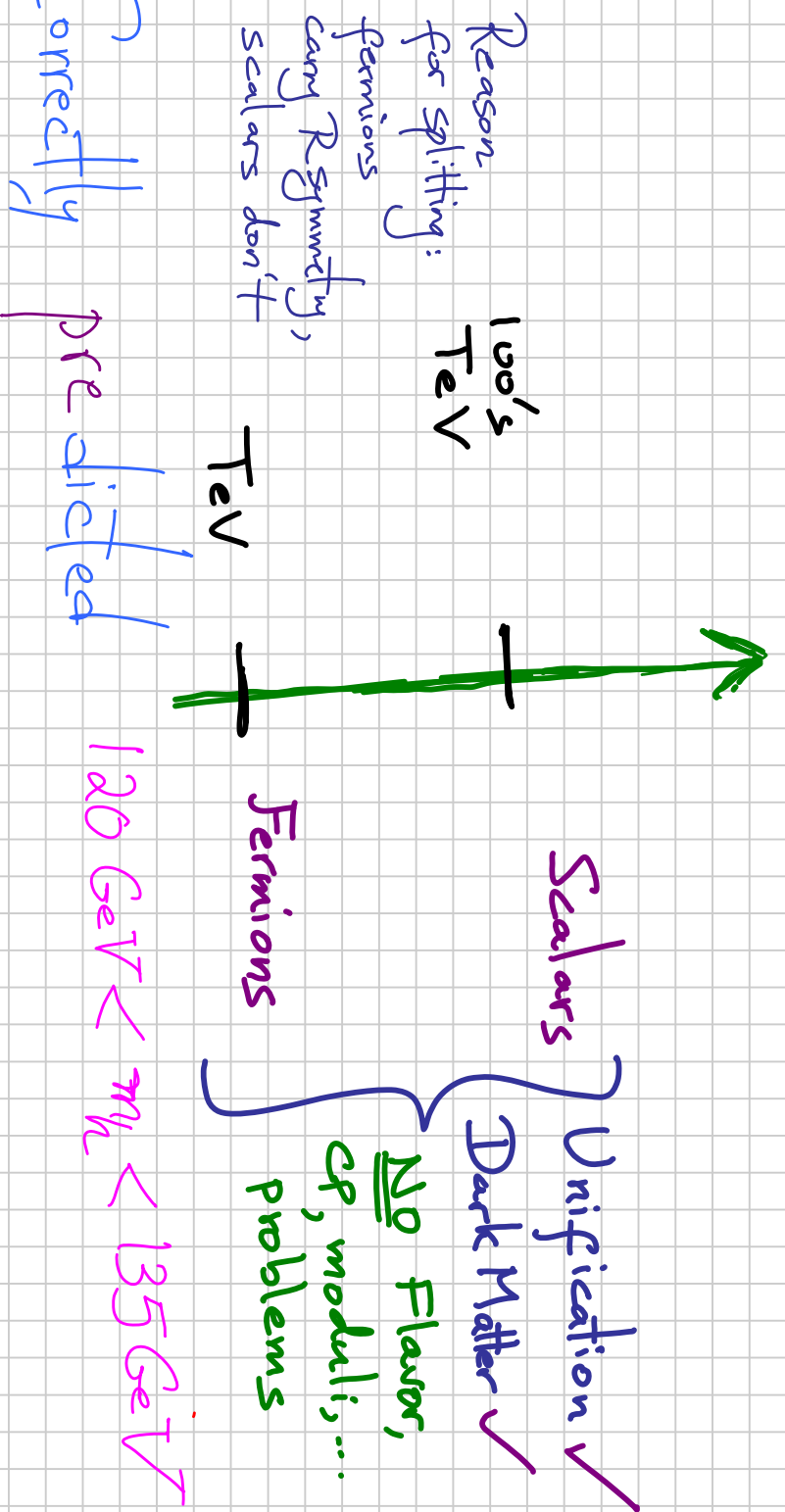
(Anyway, String Theory is mainly about Quantum Gravity)



Even more extreme unification!

But makes connection to Particle Physics appear hopeless / "paradoxical" / unimportant

# My own best bet since '04 - '06: Minimal Split SUSY



LOOKS CRAZY WITHOUT LANDSCAPE  
MUCH MORE PLAUSIBLE WITH LANDSCAPE

\* String theorists are for the most part no longer actively pursuing connecting to particle physics of the real world.

\* Understandable as a short-term strategy

\* But in my view a real mistake in the long run...

String Theory remains the most  
magical / structure we have encountered  
in theoretical physics — and the  
magic seems directly connected  
to the particle physics of the  
real world. } Though we are frustrated  
in "zeroth draft" → "first draft" }



Think of connecting to the real  
world **NOT FOR "POSITIVE"**  
**REASONS** (Ruling out ideas...) **BUT**  
**FOR CREATIVE REASONS**

(The real world knows exponentially more  
about physics + math than physicists + mathematicians)

Questions Posed by Nature are Vastly  
Deeper + more fruitful than ones  
we humans would tend to pose for ourselves

# Funny Clues?

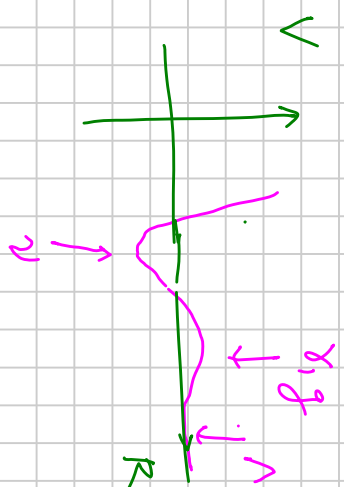
\* (1 Generation SM almost simplest chiral gauge theory...)

\* (What is  $\theta_{\text{QCD}} \lesssim 10^{-10}$ ?)

\*  $\sin \theta_c = \sqrt{\frac{m_d}{m_s}}$   $\chi = \begin{pmatrix} 0 & A \\ A & B \end{pmatrix}$  features

\*  $N^{1/4} \sim \frac{m_W^2}{M_{\text{Pl}}}$   $\sim m_2$  [WIMP DM is Partially explained by Weinberg CC]

\* SM just barely has  $\text{AdS}_3 \times S^1$  vacuum



# MV/IR + Naturalness

\* We know MV/IR in gravity violates

Wilsonian paradigm — why haven't we seen this help with  $\Lambda / \text{m}^2$  problems?  $\mathbb{P}$

\* '87 Greg Moore,  $\Lambda^{2D-\text{non SUSY}} = \langle 4, 14 \rangle$

= 0 because of "Atkin-Lehner symmetry", later seen as  $N = \int df = 0$  "total deriv phenom"

Fund  
Down

\* Recently same "total deriv phenom." seen to violate Wilsonian naturalness in simple models for  $(g, 2)_{\mu \dots}$

Swamp and

Talks about things we care about, difficult to make precise statements

Strongly Connected (vis UGCity + suDetermination)

Bards on EFFTs

Precise Statements about things we mostly don't care about

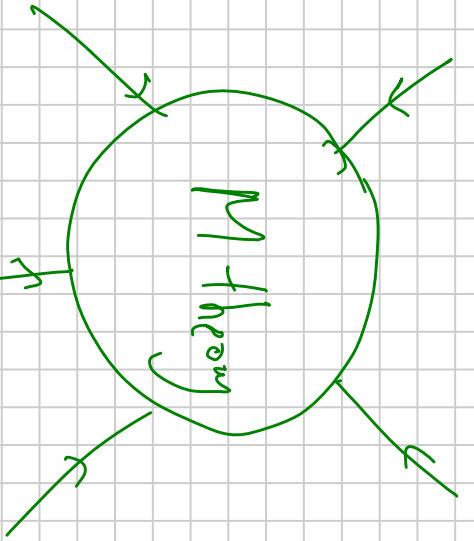
Can we get precise statements we care about?

\* Can we have  $SU(2021)$  YMG in  $D = \mathcal{P}$ ?

\* Is there an ADS<sub>3</sub> string background dual to DISing?

\* Can we predict  $A(99 \rightarrow 99)$ , say for E $\gg$ Mp?

Upper Limit on  $\tau_{\text{proton}}$ ?



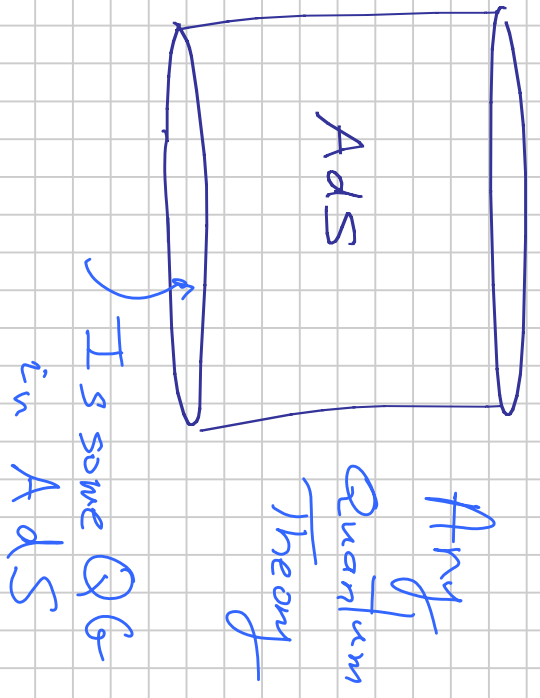
One Unified Theory!  
 (Unif seen in Flat Space)

# Huge Extra Magic in Flat Space Limit

[ Already magic in Particle physics = hidden,  
 but **deeply connected to real world** — and

Shows signs of connecting + extending to  
 String Theory... ]

vs-



Is some QG  
 in AdS

Approximate Statements About Real World

Driven more by "external/directive magic"

Exact Statements About Imaginary Worlds

Driven more by human ingenuity

[That you might even engineer in a [somewhere...]

Biggest <sup>“</sup>Challenge of Particle Physics” <sup>”</sup> Getting New Experiments!

Theorists can play a big role!

Hang out with Experimentalists —

FUN, STIMULATING + great

feminist THEORETICAL PHYSICS

WORLD OUT THERE!

