CONFORMAL
SEQUESTERING
SIMPLIFIED

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WHY?

SUSY
Little Hierarchy Problem

⇒ Broden search of ideas/signals
≤ experimental data

HOW? DIRECTION?

SUSY FLAVOR PROBLEM

EFT Mechanisms for Sfermion flavor-blindness:

\[
\begin{align*}
\text{GMSB} \\
\text{AMSB} \\
\text{GMSB} \\
\text{(Gravity-loop mediation Hybrids)}
\end{align*}
\]

Prerequisite — "Sequestering" — i.e., suppression of flavor "Planck slop". 
Extra-dimensional Sequestering
in EFT

Visible Sector

5D SUGRA
(+ radius stabilizer)

Hidden Sector SUSY

Extra dimension filters out “Planck slope”.

Randall, Sundrum '98
Luty, Sundrum '99

String Theory UV completion
might spoil sequestering
by overpopulating the Bulk??

Anisimov, Dine, Graesser, Thomas '02
Kachru, McGreevy, Svrcek '06

Is there a renormalizable path to
Sequestering? What are the rules?
Conformal Sequestering

For GMSB: Nelson, Strassler 00b

\[ \text{WARPED} \]

\[ 5 \text{D SUGRA} \]

Extra dimension

\[ \text{AdS/CFT} \]

\[ 4 \text{D RGE} \]

Extended HS

For AMSB:

Luty, Sundrum '01, '02, '03

Advantage:

Extra-dimensional non-renormalizable

\[ N=2 \text{ SUGRA + \ldots EFT} \]

\[ \rightarrow \]

Broader classes of

4D renormalizable

\[ N=1 \text{ flat space QFT.} \]

(but strongly non-perturbative)
LITTLE SUGRA

General Coord. Invariance \( \Rightarrow \) Conformal Invariance

requires \( g_{\mu\nu}(x) \)

requires only \( g_{\mu\nu}(x) = \phi_0^2 \gamma_{\mu\nu} \)

+ SUSY

\( \Phi \equiv \text{chiral s'Field.} \)

"compensator"

Only part of SUGRA that can get Lorentz invariant REV

\( \Rightarrow \) AMSB

Randall, Sundrum '98

Giudice, Luty, Murayama, Rattazzi '98

\[
L_{YS} = \int d^4 \Theta \left( \mu |\Phi| |Q|^2 + \int d^4 \Theta \frac{z(\mu \Phi)}{|F_\phi|^2} + \Delta Q^2 \right)
\]

scale invariant

\( \Rightarrow \)

\[
m_{1/2} \sim \frac{\beta(g)}{g^2} F_\phi
\]

\[
m_0^2 \sim \frac{\Delta g}{\mu g} |F_\phi|^2 \]

\( A \sim \gamma F_\phi \)

\( \approx \text{Flavor-blind} \).
FLAVOR PLANCK SLOP

Flat spacetime $\Rightarrow F_\Phi \sim F_{HS} / M_{Pl}$

$\Rightarrow \Delta L = \frac{c_{ij}}{M_{Pl}^2} \int d^4 \Theta \frac{x^i x^j Q_i Q_j}{HS} \text{ dominates AMSB }$ naively.

CONFORMAL SEQUESTERING

$\mathcal{L}_{HS \text{ CFT}} + \sum \Theta_{HS} \hat{\Theta} \text{ VS RGE}$

$\mathcal{L}_{HS \text{ CFT}} + \sum \left( \frac{\mu}{M_{Pl}} \right)^6 \Theta_{HS} \hat{\Theta} \text{ VS}$

- The $\hat{\Theta}$ hard to compute, but $\sim O(1)$ & +ve.
- AMSB requires $\left( \frac{\mu}{M_{Pl}} \right)^6 \sim 10^{-6}$ so we are at the edge.
- Strongly motivates program of Flavor & CP tests.
SYMMETRY: FRIEND AND FOE

Discovering + understanding strongly-coupled CFTs (as basis for HS) greatly aided by (HS) symmetries.

But symmetry $\Rightarrow$ symmetry currents.

\[ t_{\alpha' \rho} \overline{\Psi}_x^a \gamma_\mu \Psi_x^b \quad \epsilon \quad t_{\alpha' \rho} X^+_\alpha X_\rho \]

$\uparrow$

HS symmetry generator

$\Rightarrow$ vanishing anomalous dimension!

\[ \Delta \lambda = \int d^4 \theta \; t_{\alpha' \rho} X^+_\alpha X_\rho Q_i Q_j \]

DANGEROUS! Luty, Sundrum '01

Categorization of specific dangers/loopholes:

Schmaltz, Sundrum '06
DESIGNER CFTs FOR HS MODEL-BUILDING

How generic & plausible is conformal sequestering in this CFT LANDSCAPE?

Dine, Fox, Gorbatov, Shadmi, Shirman, Thomas '04
Ibe, Izawa, Nakayama, Shinbara, Yanagida '06
Schmaltz, Sundrum '06
\[ L_{HS} = \int d^4 \theta (\bar{X}_x^+ X_x^+ + X_x^+ X_x + A^+ A) + \int d^2 \theta W_x^2 \]

\[ + \int d^2 \theta (\lambda_A A^3 + m_A A^2 + m_x \bar{X}_x X_x) + h.c. \]

- \( m_x \ll m_A \ll M_{\text{Pl}} \)

\( \text{SU}(N) \) gauge theory + adjoint \( A \)

- \( F \) "flavors" \( X_x + \bar{X}_x \), \( N < F < \frac{3N}{2} \)

\( m_x = 0 : \) Kutakos '95; Kutakos, Schwimmer '95

\( \Rightarrow \) flows to IR CFT, \( g_* , \lambda_* \) strong

until \( m_A \), below which \( \rightarrow \text{SQCD}_{N,F} \)

\( m_x \neq 0 \) \( \text{SQCD}_{N,F} : \) Intriligator, Seiberg, Shih '06

\( \Rightarrow \) \( \text{SUSY} \)

by metastable vacuum

\[ F \sim m_x \Lambda_{\text{sqcd}} \]

\[ \text{here} \sim m_x \Lambda_m \]

\[ \text{life time } \propto \exp((-\Lambda^* / m_x)^*) \]
SYMMETRIES OF CONFORMAL REGIME

\[ (m_x, m_A = 0) \]

V. Naively

\[ U(F)_x \otimes U(F)_{\bar{x}} \otimes U(1)_A \otimes U(1)_R \]

\[ = SU(F)_x \otimes SU(F)_{\bar{x}} \otimes U(1)_{\text{"Baryon"}} \otimes U(1)_R \]

\[ \otimes U(1)_{\text{"axial"}} \otimes U(1)_A \]

\[ \text{strong anomaly \& strong } \lambda_+ \]

\[ \text{ie. symmetries of SQCD.} \]

Imposing \( SU(F)_{x+\bar{x}} \) symmetry on theory (or weakly gauging it) eliminates

\[ \Delta L_{\text{HS}} = \int d^4x \sum_{\alpha, \beta} x_\alpha^+ t_{\alpha \beta} x_\beta^+ Q_i^+ Q_j^+ \]

\( SU(F)_x \otimes SU(F)_{\bar{x}} \) generator

\[ U(1)_{\text{Baryon}} \] accidental symmetry of entire HS model \( \Rightarrow \) on general grounds \( \langle X^+ X - X^+ X \rangle_D = 0 \)

\[ \text{Emergent symmetries can be sought in dual description. Absent for } F > N \checkmark \]

\[ \text{HS FULLY SEQUESTERS.} \]
FUTURE

GMSB + AMSB Hybrids in conformal sequestrim
of Poppitz-Trivedi (97) type: Sundrum '04
Can SU(F) gauge theory ∃ SU(5) vs GUT?

Model-building/phenomenology targeting
Weak scale little hierarchy problem.

SIMPLICITÉ — GENERICITÉ — PLAUSIBILITÉ

✓

-related: Ooguri, Ookouchi '06
CFT landscape

AdS/CFT "dual" cartoon:

Planck Brane

VS:

Warped Bulk
SUGRA
+ U(1)"gauge theory

Metastable
SUSY down ~ AdS throat

IR Brane ~ 10^{13} GeV

What is connection of these ideas to
post-KKLT String theory/World view?