SUSY Breaking in String Theory

CERN TH Group Retreat

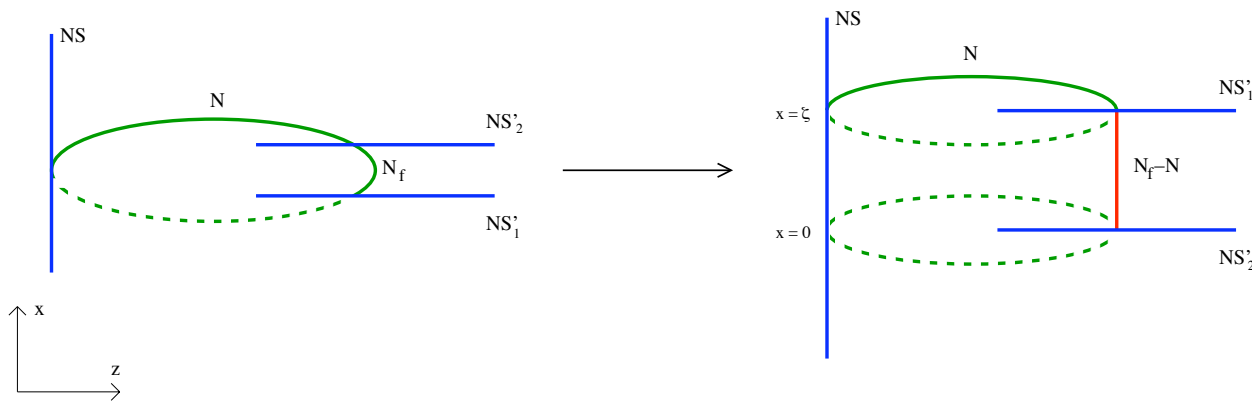Matthew Buican

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Motivation

- SUSY is already well-motivated from the bottom-up.

- String theory provides simultaneously a motivation from the top-down (consistency of the theory) and also provides tools to potentially understand SUSY breaking from the bottom up.

- What are the unique ingredients that string theory has to offer beyond the promise of UV consistency?

- Partial answer: a plethora of objects that can break SUSY and mediate that breaking; calculational tools for strongly-coupled hidden sectors (via AdS/CFT).
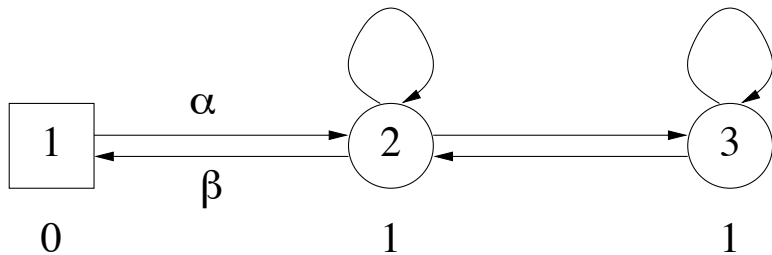
- Specialize to type II.

General Ideas

- SUSY breaking from D-branes and/or from fluxes.

- D-branes (partially) break SUSY. QFT realized on sets of D-branes can have a SUSY breaking state.

MB-MV

- May admit a simple description in terms of open strings (generating, for example, O'R models, etc.) (**AKS**)
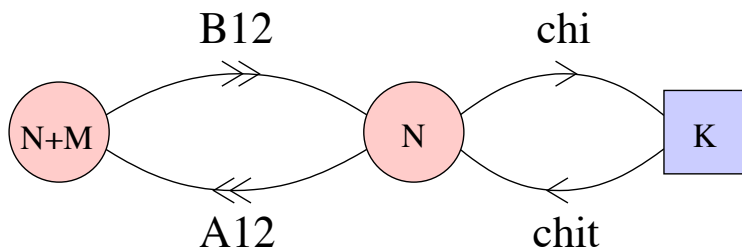

- From fluxes: turn on IASD 3-form flux, $*_6 G = -iG$, or ISD $(0,3)$ flux.

- Also D-brane theories may admit a weakly coupled SUGRA description via gauge/gravity duality. E.g. from adding $p \ll M \ll N$ $\bar{D}3$ branes to **KS** (**KPV**, **DKM**, **MSS**). Can match a particular normalizable perturbation of the geometry with a vev for $\langle T^{\mu\nu} \rangle$ in the dual field theory. At the level of fluxes, this deformation generates an IASD 3-form flux.
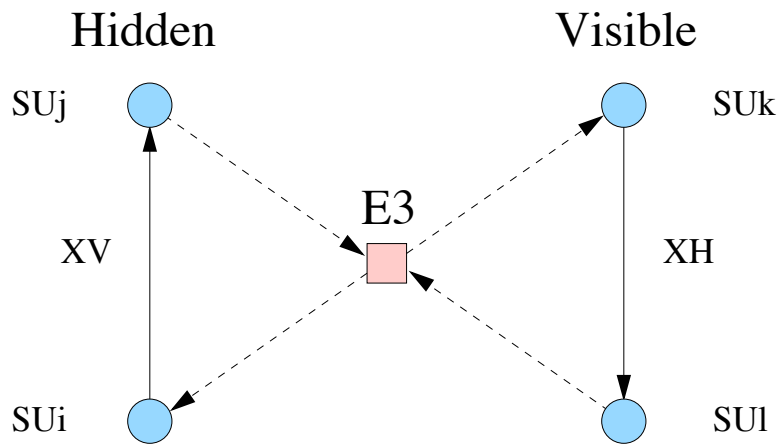
Mediation Mechanisms

- Visible sector realized on some branes (e.g. dP_8 probed by a $D3$ brane, etc.). SUSY breaking occurs in a geometrically separated hidden sector.

- Mediation types in string theory: gravity mediation (perhaps via Kähler and **C**s moduli), gauge mediation via messengers (perhaps strongly coupled), mediation from non-perturbative effects (D-instantons), anomaly mediation, etc.

- IASD G with $D3$ branes induces soft parameters; ISD G with $\bar{D}3$ or $D7$ brane probes induces soft parameters. By considering DBI+CS action in the appropriate fluxed background, can find calculable soft terms in some examples. (**CIU**, ...).

- Upon compactification, these SUSY breaking fluxes can be mapped to non-zero F-terms for Kähler and **Cs** moduli (**CIU**).

- After computing Kähler metrics and gauge kinetic functions of the SSM fields, can in some cases compute the soft terms of the SSM fields. If F-terms are primarily from Kähler moduli may be able to suppress FCNCs.

- Gauge mediation, e.g. adding D7 branes to the modified **KS** setup described above (**BDFVK, MSS**). This provides a holographic realization of GGM. Can compute gaugino masses from loops of D7-D3 messengers.

- Many other constructions of gauge mediation in string theory (**G-ESU**) (and also in F-theory).

- D-brane instantons may also generate contact terms between operators in hidden sector and operators in visible sector (**MB-F)**

Hidden   Visible

SUj   SUk

E3

XV   XH

SUi   SUl

Conclusions

- Lots of interesting possibilities, lots of work to do.