

Patterns of Gauge Mediation in Metastable Supersymmetry Breaking

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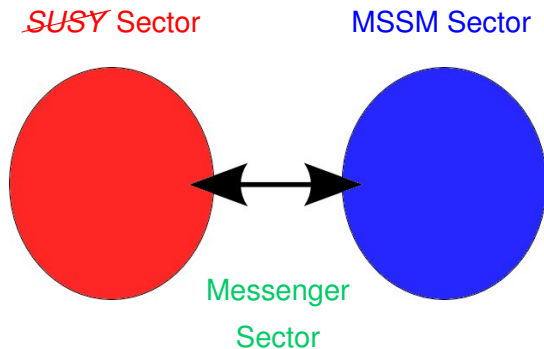
Based on: [arXiv:0707.2958](https://arxiv.org/abs/0707.2958) [hep-ph]

[arXiv:0712.1812](https://arxiv.org/abs/0712.1812) [hep-ph]

with S. A. Abel, J. Jäckel & V. V. Khoze

Supersymmetry Breaking

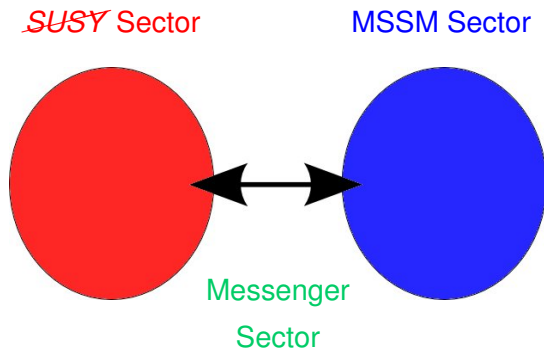
The Usual Story



MSSM phenomenology largely depends on properties of the messenger particles that 'mediate' the SUSY breaking.

Supersymmetry Breaking

The Usual Story

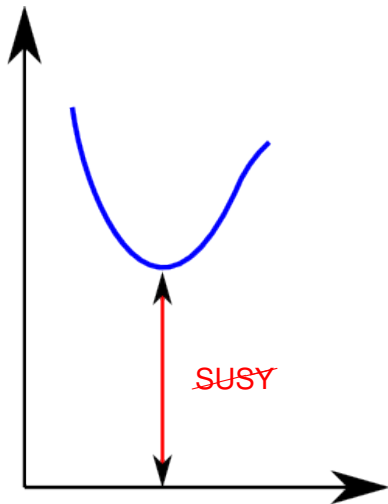


Gauge Mediation: Forget gravity and construct Messenger Sector and *SUSY Sector* with susy gauge and matter fields.

MSSM pheno from such messengers is well understood, but...

SUSY Sector

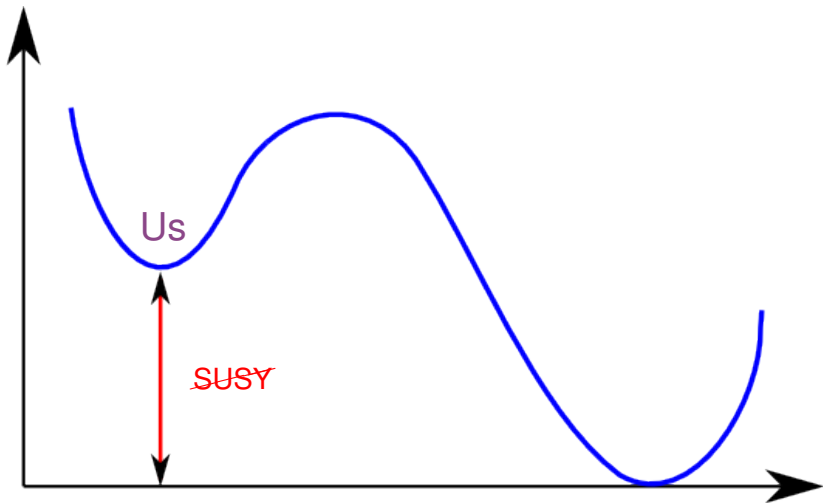
Dynamical SUSY Breaking



- Hard to construct
- Harder to mediate

The Intrilligator-Seiberg-Shih (ISS) Model

A Simple Model of Dynamical SUSY Breaking



Model Building

The Rôle of R -symmetry

To couple a **metastable SUSY breaking** sector to the **MSSM** we also need to think about:

R -symmetry: a global $U(1)$ symmetry often found in supersymmetric models

Don't confuse it with R -parity in the MSSM: R -symmetry is continuous, whereas R -parity is a discrete symmetry.

Model Building

The Rôle of R -symmetry

To couple a **metastable SUSY breaking** sector to the **MSSM** we also need to think about:

R -symmetry: a global $U(1)$ symmetry often found in supersymmetric models

Problem: Exact R -symmetry prevents gauginos from having a mass.

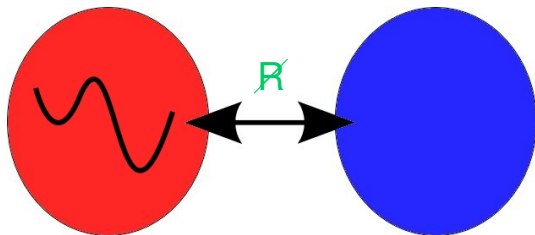
► In realistic models **gauginos** must be massive. ◀

⇒ Have to break R -symmetry as well as **SUSY**.

Metastable Gauge Mediation

Just the Usual Story?

Could carefully introduce messenger fields charged under both the **metastable SUSY** and **MSSM** gauge groups.

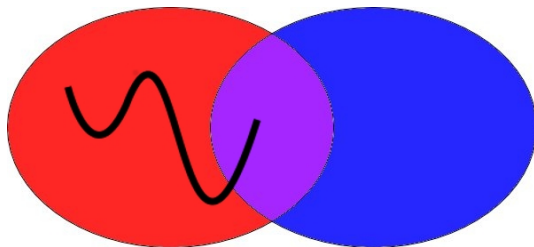


Does the **MSSM** care about the details of the hidden sector?

Metastable Direct Gauge Mediation

More Ambitious

We constructed a model where some fields of the **metastable SUSY-breaking** sector are charged under the gauge groups of the **MSSM**.



R -symmetry is broken radiatively in the SUSY-breaking sector.

Generally find: **R -symmetry Breaking** \ll **SUSY Breaking**

Phenomenology

Not the Usual Picture

Fundamentally different:

Gaugino Masses

M & $SUSY$

sFermion Masses

$SUSY$

Phenomenology

Not the Usual Picture

In our model the scale of *R*-symmetry breaking can be significantly less than the scale of SUSY breaking.

Physically, this means:

$$\begin{array}{ccc} \text{Gaugino Masses} & \ll & \text{sFermion Masses} \\ \mathcal{R} \text{ \& \ } \text{SUSY} & & \text{SUSY} \end{array}$$

Phenomenology

Not the Usual Picture

In our model the scale of *R*-symmetry breaking can be significantly less than the scale of SUSY breaking.

Physically, this means:

$$\begin{array}{ccc} \text{Gaugino Masses} & \ll & \text{sFermion Masses} \\ \mathcal{R} & \& & \text{SUSY} & \text{SUSY} \end{array}$$

Compare to usual gauge mediation scenarios:

R-symmetry is broken at a higher scale than supersymmetry.

$$\Rightarrow \text{Gaugino Masses} \sim \text{sFermion Masses}$$

The Spectrum

Checking Correct EWSB

From 2 parameters in our *SUSY* sector we can calculate all soft susy breaking terms.

Using *SoftSusy* we have RG evolved them down to M_W and derived a full spectrum consistent with radiative electroweak symmetry breaking.

This requires $\tan(\beta) \approx 58$.

For gaugino/neutralino/chargino masses around 100 GeV we find:

$$\text{sQuarks} \sim 11 \text{ TeV}$$

$$\text{sLeptons} \sim 2 \text{ TeV}$$

► Explicit realisation of a Split SUSY spectrum ◀

Summary

Patterns of Gauge Mediation in Metastable Supersymmetry Breaking

- **Metastability** allows one to construct simple, calculable, models of low scale supersymmetry breaking.
- In such models, **R -symmetry** breaking is important.
- Can construct models which exhibit **significant deviation** from the commonly accepted spectrum of gauge mediation scenarios.

Our model: Large $\tan \beta$, and Split SUSY Spectrum