

Supersymmetry breaking scenarios and possible searches at ATLAS:

SUSY can be broken in several possible ways, each method having its advantages and disadvantages. They also have some common features and some unique features. A look at these features collectively can give us a good idea as to which theories are more viable and which can be ruled out completely. ATLAS can be the instrument in determining which of these theories can survive the test of experimentation. It is my idea that a broad approach can be taken to look at various phenomenological claims of each of these theories and try to test them through MC simulations at this time, which in turn may shed more light in understanding the intricacies of the theories concerned, and then testing them through the data as they start arriving. Many of the phenomenological predictions of these theories are also based on very restricted parameter space and several have some “smoking gun” signatures for a year’s worth of data luminosity at ATLAS. So a study of these signatures can in general facilitate the study of SUSY at ATLAS more efficiently in the later years of the experiment. These searches can be made in parallel to the ongoing SUSY notes and can be possibly added to SUSY notes 8. Many of the studies performed can be also useful for other SUSY searches and notes.

The many possible scenarios:

- SUGRA or mSUGRA
- GMSB
- AMSB and mAMSB
- Moduli Mediation
- Mixed-Modulus Anomaly Mediation or “Mirage Mediation” (more about this)
- Gaugino assisted AMSB and “Gaugomaly” mediation

Note that all the approaches mentioned here towards a successful theory of SUSY breaking requires that SUSY is broken in some sort of a hidden sector and is transmitted to the visible sector through some messenger fields. The nature of the messenger fields and their relative contribution to the visible mass spectra determines which one of the above is nature's way of breaking SUSY. Also, from a theory point of view, all the above mechanisms are part of the String/M Theoretic scenarios in higher dimensions. It is now a general consensus among theoreticians that mSUGRA although being an excellently simple model for SSB cannot possibly be the candidate for SSB (due to other phenomenological and theoretical issues). It was also pointed out in the introductory paper for AMSB that “anomalous” contributions are always present independent of the scenario.

A survey of the scenarios:

- **mAMSB**

this is the case when one considers the gaugino mass obtained through the anomalous super-Weyl transform of the super-Yang Mills sector is the largest contribution to the gaugino mass. *> this would be great, since we have to assume no messenger fields couple the hidden and the visible sectors.*

However, these anomalies cannot be the only contributions or we get negative slepton masses.

It is an easy to deal with scenarios and can be simulated first for ATLAS. It has a “smoking gun” signal and a lack of which in data can easily rule out a purely sequestered sector mediated SUSY breaking. (ref. 1)

I have already talked about this scenario and the possible analysis we can do. Hopefully by next week, I should have some analysis plots with the suggested work by Frank.

I have installed and have a running version of Isajet769 in LXPLUS. I need to install and run ISAWIG to make ISAJET output Herwig readable files. (?) I can analyze the AMSB scenarios with Herwig and root. Is there to do this within Pythia?

Similar studies for DELPHI and D0 has been done and can serve as guidelines. (ref. 2,3)

Ref :

1. hep-th/9810155 v2 2 Apr 1999
2. Delphi 2003-047 CONF 667
3. Eur Phys J C 33, s01, s749-s751 (2004)
4. FSU-HEP-000708 Baer, Mizukoshi, Tata.
5. hep-ph/0001249 v2 26 Jan 2000
6. hep-ph/0208214 v2 27 Aug 2002

Reference 4-6 can be the guides to conduct our search for AMSB at ATLAS.

- **Mixed Modulus Anomaly Mediated SUSY breaking**

From string theoretic viewpoint SUSY breaking terms can arise from

1. models based on KKLT construction in Type IIB superstring theory.

Kachru, Kallosh, Linde and Trivedi. PRD68:046005, 2003

2. Kahler stabilization models of Heterotic strings. (NPB571:3-25,2000, PRD67 045008,2003)

The above can be implemented to find that SUSY breaking terms automatically arise from the modulus (gravity) mediated contributions as well as the AMSB terms. The most striking fact is that the Moduli and the Anomaly contributions are comparable. Also the negative slepton mass problem does not arise. This can be viewed as gravity+anomaly mediation at an equal footing.

Parameters:

$m_{3/2}$, α , $\tan \beta$, n_i , $\text{sign}(\mu)$

I am interested in this scenario because of theoretical underpinnings and the interest the papers show in validation at the LHC.

Ref. 1 can be a starting point of this search and ref. 2-5 can be guides. I have spoken to F Paige about this and he is going to talk with H Baer of ref 1 to implement a “patch” in Isajet to investigate this scenario.

References:

1. hep-ph/0604253 1 Aug 2006 (Baer et. al.)
2. J HEP 0509 2005 039
3. J HEP 0511 2005 034
4. Phys Rev D 72 2005 015004

- Gaugino Assisted SUSY breaking (hep-ph/0009195)
- Gaugomaly scenarios (hep-th 0406012)

Will be interesting to look into (not much available phenomenologically!) as other scenarios of AMSB.

An simple algorithm to modify mAMSB in ISAJET, I think, will take care of Gaugino assisted scenarios as the theory and the parameter space is very similar.

Will need more theory guideline to look into “Gaugomaly”

Any theories with all three? Are they possible?