Search for AMSB with the DELPHI data

T. Alderweireld
Faculté des Sciences, Université de Mons Hainaut, Mons, Belgium
email: thomas.alderweireld@cern.ch

The data collected by the DELPHI experiment up to the highest LEP2 energies were used to put constraints on the Anomaly Mediated SUSY Breaking model with a flavour independent $m_0$ parameter. The experimental searches covered several possible signatures experimentally accessible at LEP, with either the lightest neutralino, the sneutrino or the stau being the LSP. They included the search for nearly mass degenerate chargino and neutralino (always present in AMSB), the search for Standard Model like or invisible Higgs boson, the search for stable staus, and the search for cascade decays resulting in the LSP (neutralino or sneutrino) and a low multiplicity final state containing neutrinos.

1 Introduction

Anomaly Mediated Supersymmetry Breaking (AMSB) is an interesting solution to the flavour problem of mSUGRA. Rescaling anomalies in the supergravity Lagrangian always gives rise to soft mass parameters in the observable sector. It follows that anomalies contribute to the SUSY breaking in any case, whatever is the symmetry breaking mechanism. We’ll refer to AMSB as the model in which all other components that mediate the SUSY breaking are suppressed, and the anomaly mediation is the dominant mechanism.

AMSB is very predictive: all the low energy phenomenology can be derived by adding to the Standard Model (SM) just two extra parameters and one sign. Unfortunately, the minimal AMSB model results in tachyonic masses for sleptons at the electroweak scale. One way of getting rid of tachyons is to suppose additional, non anomaly, contributions to the SUSY breaking which can generate a positive contribution ($m_0^2$) to the soft masses squared. It has to be emphasized that AMSB scenarios favor light Higgs ($h^0$), i.e. $m_{h^0} < 120$ GeV/$c^2$, hence if the Higgs is not be found in the runs at the Tevatron or, further on, at the LHC, the AMSB model itself will be completely ruled out.

2 Phenomenology of AMSB

If there is only one common squared mass term for all scalars, all masses and couplings can be derived in terms of just three parameters and one sign, namely, the mass of the gravitino, $m_{3/2}$, the ratio of Higgs vacuum expectation values, $\tan \beta$, the common scalar mass parameter $m_0$ and the sign of the Higgs term, $\text{sign}(\mu)$. In the model considered here, only the slepton mass spectrum and, to some extent, the Higgs depend on the assumptions of a common scalar term $m_0$. All other features are characteristics of any AMSB scenario, whatever is the procedure used to cope with the tachyonic masses of the sleptons. Since $m_0$ is a free parameter, according to its value there are three possible candidates for the LSP: either the nearly mass degenerate $\chi_1^0/\chi_1^\pm$, the $\tilde{\nu}$ or the $\tilde{\tau}$. Scenarios with any of the above as LSP were explored using the data collected.
by the DELPHI experiment during the period at high (LEP2) and low (LEP1) energy of the LEP operations.

3 Results

The searches results used in the present work, include the search for nearly mass degenerate chargino and neutralino (always present in AMSB), the search for Standard Model like or invisible Higgs boson, the search for stable staus, and the search for cascade decays resulting in the LSP (neutralino or sneutrino) and a low multiplicity final state containing neutrinos. They are fully described in the DELPHI AMSB paper and references therein. In any of the searches, no excess of candidates was observed with respect to the standard model predictions and limits on masses and AMSB theoretical parameters were set at 95 % confidence level using ISAJET 7.58 to compute the AMSB mass and cross-section spectra. Fig. show, the remaining allowed points in the planes $(m_0,m_{3/2})$(Up) and $(M_{\tilde{\chi}^0_1},M_{\tilde{\nu}})$(Down) after having applied all the results of the searches described in.

One sees from Fig. that a gravitino lighter than 24 TeV/c^2, a lightest neutralino lighter than approximately 69 GeV/c^2 and sneutrinos lighter than 105 GeV/c^2 should not be allowed in AMSB. Moreover, a limit on the theoretical parameter, $m_0$ arising from the non-anomalous contribution is set to be above 168 GeV/c^2 at the electroweak scale independently of the breaking mechanism.

![Figure 1](image_url)

Figure 1: (Up) Physically allowed $m_0$ and $m_{3/2}$ parameters in AMSB after having considered all the results of the searches. (Down)Physically allowed $M_{\tilde{\chi}^0_1}$ and $M_{\tilde{\nu}}$ masses in AMSB after having considered all the results of the searches.

References

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