mSUGRA fits at SPS1a

by

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Based on work performed with S Kraml and W Porod

Talk outline

- Precision on fundamental SUSY breaking from LHC
- Additional precision from LC
- Role of theoretical uncertainties

Codes

We use ISAJET 7.64, SOFTSUSY 1.71, SPHENO 2.0 as a representative selection of up-to-date codes[1].

- RGE 2-loops
- Higgs VEVs run, except for ISAJET 7.64
- Assorted Higgs mass calculations, up to 2-loop order
- Various approximations/full 1-loop corrections to sparticle masses
- Yukawa couplings have full (ISAJET 7.64, SPHENO 2.0) or approximate 1-loop SUSY corrections (SOFTSUSY 1.71)

[1] http://kraml.home.cern.ch/kraml/comparison/compare.html for autmatic comparison

LHC SPS1a Observables

- Spectrum assumed to be given by ISAJET 7.64
- Experimental errors from Polesello *et al*'s work: edge variables and shape fits: 100 fb^{-1}.
- $\tilde{q}_L \to \chi_2^0 q$, $\chi_2^0 \to \tilde{l} l$, $\tilde{l} \to \chi_1^0 l$ chain used.

	m_{ll}^{max}	m_{llq}^{max}	m_{llq}^{min}	m_{lq}^{high}	m_{lq}^{low}
	76.70	426.1	200.9	375.0	299.4
Δ_{exp}	0.04	1.4	2.1	1.7	0.8
Δ_{th}	3.50	16.6	9.2	15.4	15.6
	m_{llb}^{min}	m_{h^0}	$m_{\tilde{g}}$	$m_{\tilde{b}_1}$	$m_{\tilde{q}_R} - m_{\tilde{\chi}_1^0}$
	182.9	113.6	606.6	492.3	423.2
Δ_{exp}	7.5	1.0	3.5	3.9	10.0
Δ_{th}	7.6	1.6	11.3	30.7	15.6

Table 1: LHC observables assumed for SPS1a (in GeV).

LC SPS1a Observables

Experimental errors for $\mathcal{L} = 1$ ab^{-1} at 500 GeV machine obtained from G Blair, W Porod, P Zerwas, hep-ph/0210058 (scaled).

	$m_{\tilde{\chi}_1^0}$	$m_{\tilde{\chi}_2^0}$	$m_{\tilde{\chi}_1^+}$	$m_{\tilde{\nu}_e}$	$m_{\tilde{\nu}_\tau}$	$m_{\tilde{\chi}_3^0}$
	96.6	176.8	176.4	185.8	184.8	360.6
Δ_{exp}	0.2	0.3	0.1	0.9	1.1	5.8
Δ_{th}	0.5	2.2	1.8	1.7	1.7	6.2
	$m_{\tilde{e}_R}$	$m_{\tilde{e}_L}$	$m_{\tilde{\tau}_1}$	$m_{\tilde{\tau}_2}$	$m_{\tilde{\chi}_4^0}$	m_h
	142.9	201.9	133.2	205.9	379.4	113.6
Δ_{exp}	0.1	0.3	1.0	0.9	18	0.05
Δ_{th}	0.7	1.7	1.1	1.5	5.3	1.59

Table 2: LC observables assumed for SPS1a (in GeV).

SOFTSUSY LHC Fits

(Fits to ISAJET 7.64or SPHENO 2.0 similar and included in report). For LHC experimental errors only, $\chi^2_{min}/n =$238/6:

$$m_0 = 96.1 \pm 1.1, \qquad m_{1/2} = 234.6 \pm 0.4,$$
$$A_0 = -391 \pm 22, \qquad \tan\beta = 14.3 \pm 1.8$$

Including experimental$\oplus$theory errors $\chi^2_{min}/n =$5.15/6:

$$m_0 = 92.7 \pm 14.2, \qquad m_{1/2} = 239.3 \pm 7.5,$$
$$A_0 = -224 \pm 676, \qquad \tan\beta = **$$

Fit now looks *reasonable*. However, precision obtained with experimental errors only is a useful guide in case theory uncertainties are reduced.

SOFTSUSY LC Fits

For LC experimental errors only, $\chi^2_{min}/n =$2022/13:

$$m_0 = 96.8 \pm 0.2, \qquad m_{1/2} = 250.1 \pm 0.2,$$
$$A_0 = 52 \pm 10, \qquad \tan\beta = 14.5 \pm 0.6$$

Precision is a factor of 2-5 better than LHC fits on each parameter. Including experimental$\oplus$theory errors $\chi^2_{min}/n =$18.3/23:

$$m_0 = 97.9 \pm 1.8, \qquad m_{1/2} = 247.9 \pm 2.1,$$
$$A_0 = -156 \pm 88, \qquad \tan\beta = 9.9 \pm 1.9$$

$\tan\beta$ now *constrained*. Rest of parameters are a factor of 3-7 more precise.

Summary

- Defined uncertainty to be variance in codes' output
- Not including theoretical uncertainty could be fatal
- Only presented SOFTSUSY 1.71's results here, but SPHENO 2.0's and ISAJET 7.64's are similar.
- LC adds factor of 2-3 to precision of each variables with current theory uncertainties
- If theory uncertainties are reduced to negligible levels, they improve by a further factor of about 3