Phenomenology of Large Volume Compactifications in Type IIB String Theory

Kerim Suruliz (DAMTP, Cambridge)

SUSY 07, Karlsruhe, July 31, 2007

based on:

hep-th/0704xxx, J. Conlon, C. Kom, KS, B. Allanach, F. Quevedo
hep-th/0701154, D. Cremades, M.-P. Garcia del Moral, F. Quevedo, KS
hep-th/0610129, J. Conlon, S. Abdussalam, F. Quevedo, KS

...

Plan of Talk

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- Motivation.

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- Moduli stabilisation and Large Volume models.

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- Summary and Conclusions.

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- What does string theory predict for the supersymmetry breaking pattern?
- Moduli stabilisation and supersymmetry breaking closely related.
- Take the top down approach: study classes of string theory models with stabilised moduli and try to find firm predictions.

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- Closed string moduli are divided into complex structure (shape) and Kähler (size) moduli.

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- The Kähler moduli fixed by non-perturbative contributions to superpotential (KKLT scenario).

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- T_b overall volume, T_s small 'blow-up' cycle.

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- A minimum is found at

$$\tau_s = \mathcal{O}(1)$$
$$\mathcal{V} \sim e^{a_s\tau_s}$$

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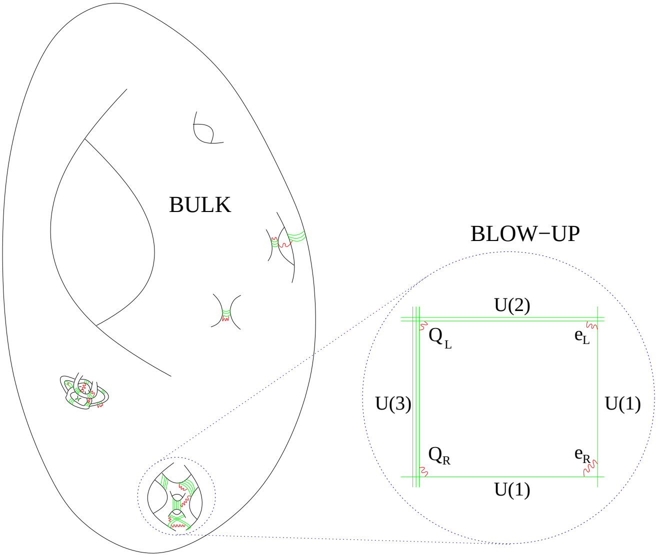
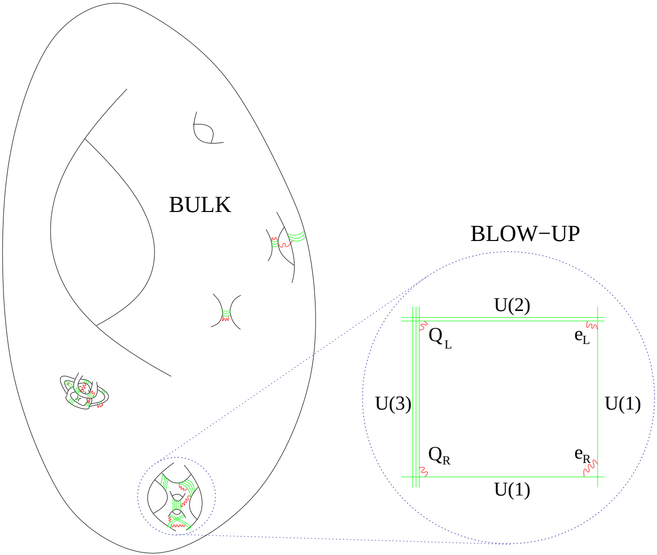
- With $\mathcal{V} \sim 10^{15}$ (in l_s^6) get $m_s \sim 10^{11}$GeV. Intermediate scale scenario $\Longrightarrow$ no gauge coupling unification.


BULK
BLOW−UP
U(2)
Q_L
e_L
U(3)
U(1)
Q_R
e_R
U(1)



- Assume local brane model giving the matter content of the MSSM: magnetised D7 branes.

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- From there one computes

$$\begin{aligned} M_a &= \frac{1}{2}\frac{F^m \partial_m f_a}{\mathrm{Re} f_a}. \\ m_i^2 &= (m_{3/2}^2 + V_0) - F^m \bar{F}^{\bar{n}} \partial_m \partial_{\bar{n}} \tilde{K}_i, \end{aligned}$$

etc.

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- Magnetic fluxes F responsible for chirality. Their presence gives unknown corrections to the gauge kinetic functions and Kähler potentials.

High Scale Soft Terms

- In the diluted flux limit $F = 0$ (i.e. $\tau_s \gg \epsilon$),

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\begin{aligned}
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B &= -\frac{4M}{3}.
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- Here $M = F^s/(2\tau_s)$.
- Introduce now perturbations due to corrections ϵ_α to $\tilde{K}$.

$$\begin{aligned} M_i &= M(1+\epsilon_i) \\ m_a &= \frac{M}{\sqrt{3}}(1+\epsilon_a) \\ A_{abc} &= -\frac{1}{\sqrt{3}}(m_a + m_b + m_c) \end{aligned}$$

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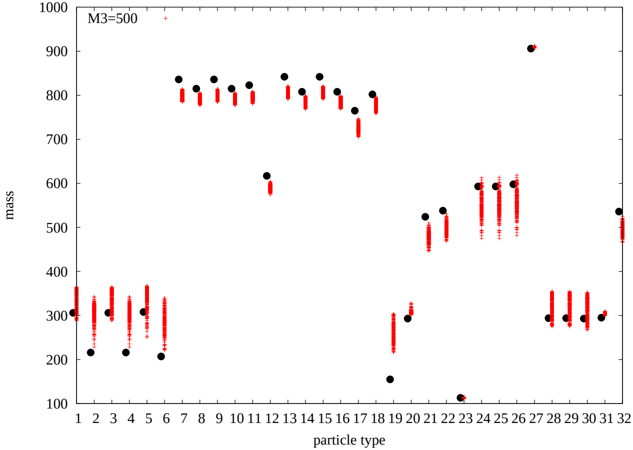
- Use micrOMEGAs to compute all of these.

Spectra II

- The spectra with $m_{\tilde{g}} \approx 900\text{GeV}$ fixed in order to set overall scale, with 20% fluctuations at high scale.



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- Discrimination of models - two approaches. Counting observables and kinematic observables.

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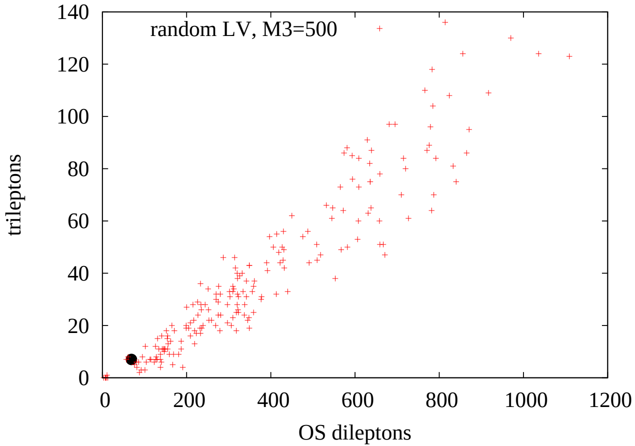
- OS dilepton and trilepton events.



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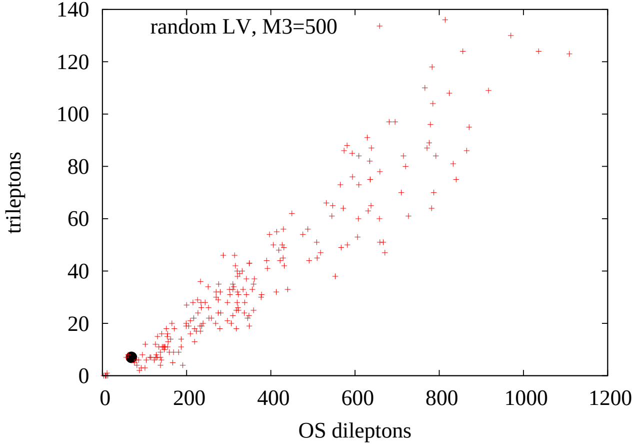

- The number of dilepton (and thus trilepton) events varies a lot even when the overall spectrum mass scale is fixed - $m_{\tilde{g}} \approx 900$GeV.

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- If there are not many dileptons, the spectrum will be hard to reconstruct as lepton observables are cleanest ($\sim 90\%$ tagging efficiency for e, μ).

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- The slepton and neutralino masses are

$$m_{\tilde{e}_R, \tilde{\mu}_R} = 270, ...$$

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- The chargino masses are $m_{\tilde{\chi}_1^+} = 303, m_{\tilde{\chi}_2^+} = 480.$

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- Generate 100fb^{-1} of data with backgrounds (except W+jets and Z+jets).
- Cuts are as in ATLAS TDR:
  1. Four hard jets with $P_T > 100, 50, 50, 50$GeV.
  2. Isolated lepton $P_T > 10$GeV.
  3. $E_T^{miss} > 0.2 M_{eff}$, with

$$M_{eff} = P_{T_1} + P_{T_2} + P_{T_3} + P_{T_4} + E_T^{miss}.$$

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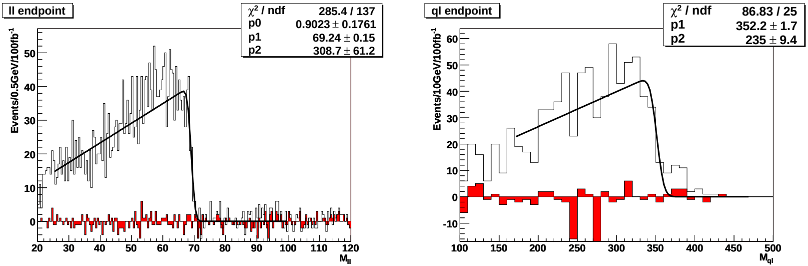

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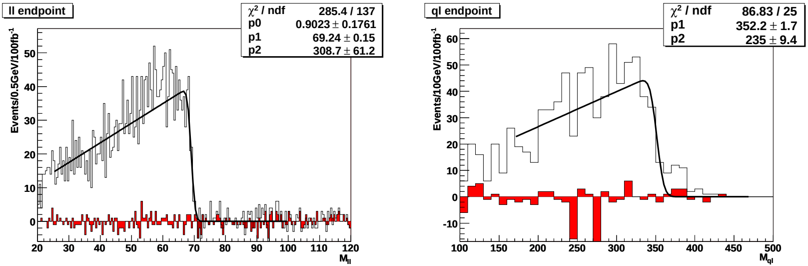
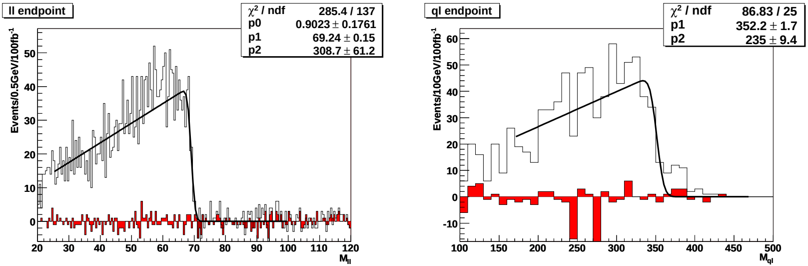


- Dilepton endpoint at

$$M_{ll}^{max} = \sqrt{\frac{(m_{\tilde{\chi}_2^0}^2 - m_{\tilde{l}_R}^2)(m_{\tilde{l}_R}^3 - m_{\tilde{\chi}_1^0}^2)}{m_{\tilde{l}_R}^2}}$$

- 

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- Can be reconstructed with very good accuracy, ± 0.15GeV.

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- Smeared due to jet finding algorithm, combinatorics etc.

Spectrum Reconstruction III

- qll, ql endpoints use the decay chain $\tilde{q}_L \to q\tilde{\chi}_2^0 \to q\tilde{l}^{\pm}l^{\mp} \to ql^{\pm}l^{\mp}\tilde{\chi}_1^0$.
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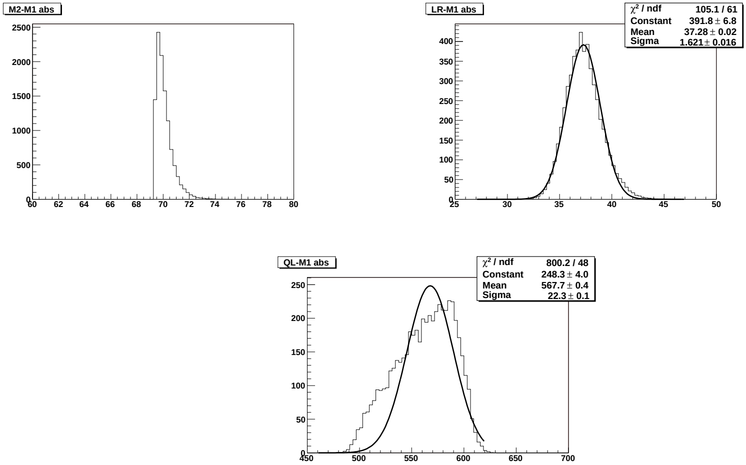
- Now fit mass differences: this is done by random generation of masses for $\tilde{\chi}_1^0, \tilde{\chi}_2^0, \tilde{l}_R, \tilde{q}_L$, calculating $M_{ll}^{max}, M_{qll}^{max}, M_{ql}^{max}, M_{qll}^{min}$ and using an $e^{-\chi^2/2}$ probability distribution.

Spectrum Reconstruction V

- Can reconstruct mass differences well:



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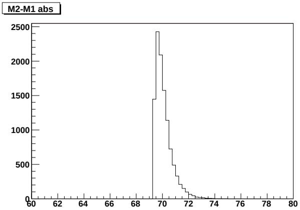

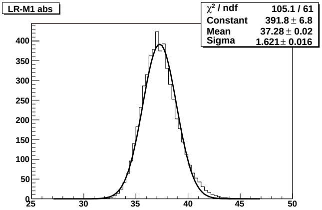

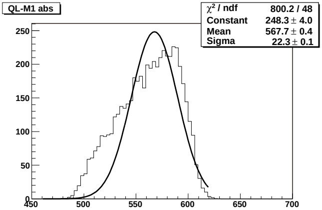

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- Answer: yes - use the ratio $M_1 : M_2 : M_3 = 1 : 2 : 6$.

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Thank you for your attention