Diluting SUSY flavour problem on the Landscape

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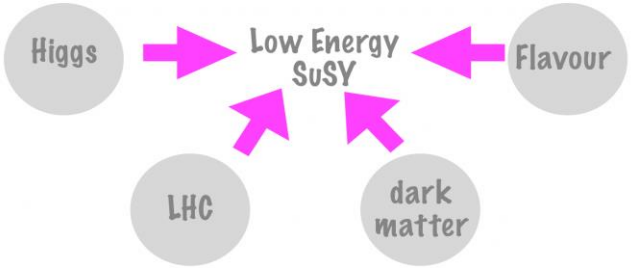
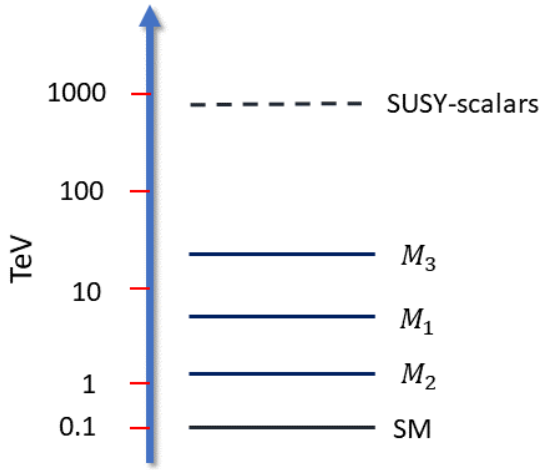
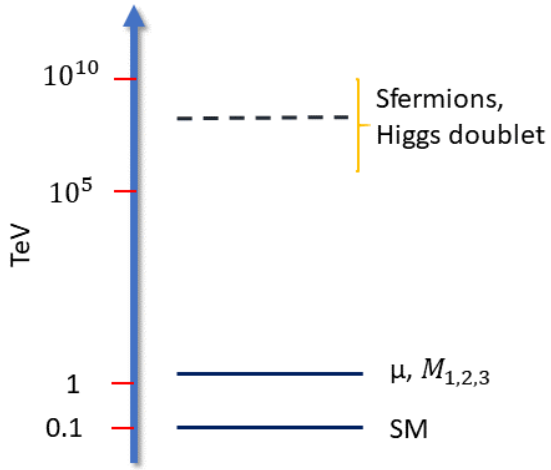
Motivation



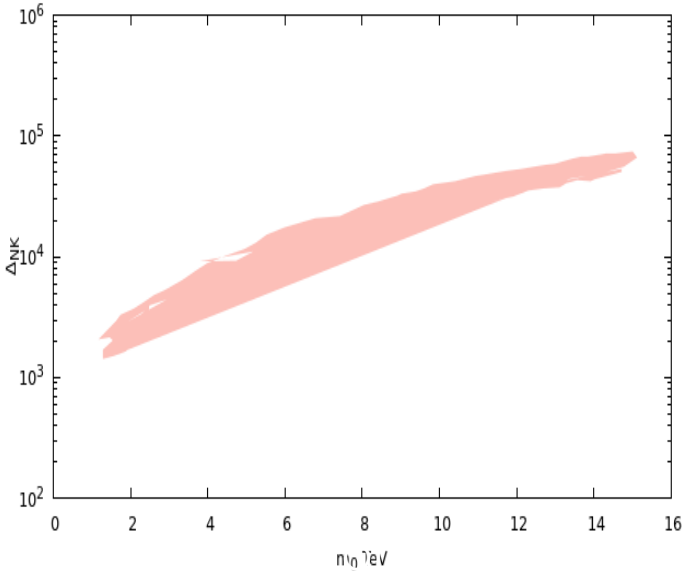
	$\tilde{q}_{1,2}$	$\tilde{l}_{1,2}$	$\tilde{\tau}$	$\tilde{t}$	$\tilde{b}$	$\tilde{g}$	$\tilde{W}$	$\tilde{B}$	$\tilde{H}$
Higgs	✗	✗	✗	> 1	✗	✗	✗	✗	✗
DM	✗	✗	$> .2$	✗	✗	✗	< 2.3	< 0.15	< 1
Flavor	50-60	100	✗	✗	✗	✗	✗	✗	✗
LHC	> 1.8	> 0.4	$> .4$	> 1.2	> 1.2	> 2.2	$> .65$	$> .06$	> 0.3



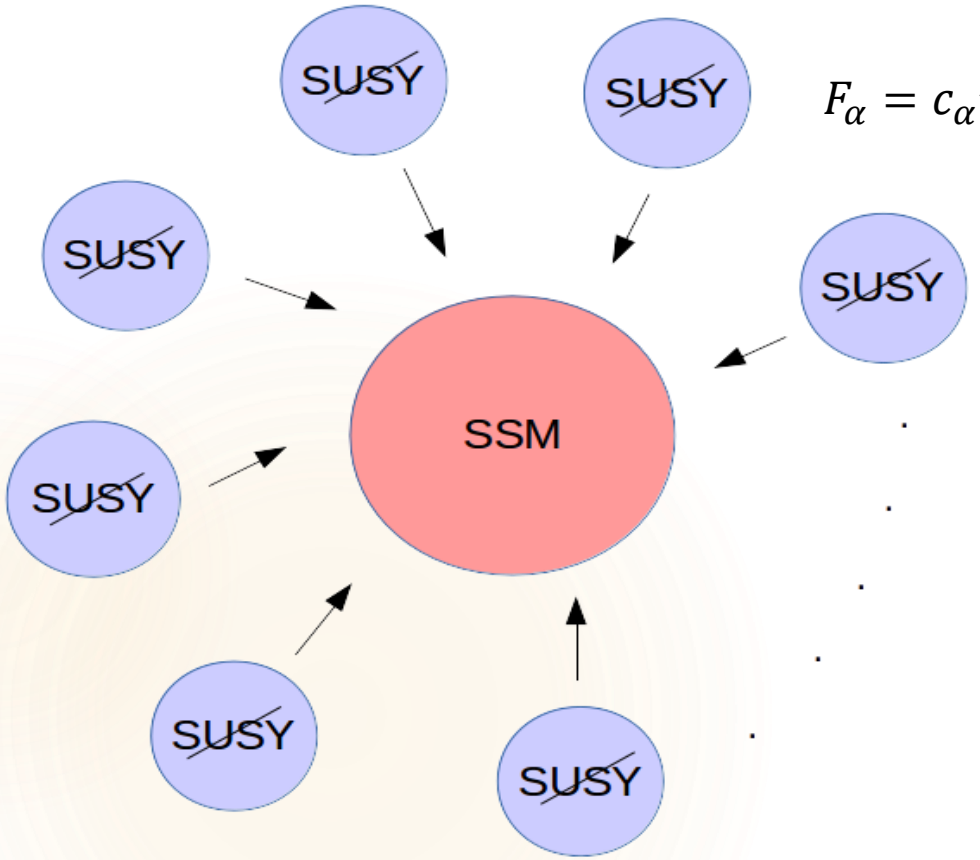
PeV scale SUSY spectrum



Split-SUSY spectrum



Set-up of multi-hidden sectors



$F_\alpha = c_\alpha \tilde{m} M_{Pl}$

Set-up

- Couple supersymmetric standard model to N=1 supergravity.
- The spontaneous breaking of local SUSY in the hidden sector generates explicit soft susy-breaking terms of the required form in the effective low-energy Lagrangian.
- Consider that auxiliary fields of the hidden sector fields contain quantized four-form fluxes, with discrete charges contributing to supersymmetry breaking, as in the Bousso-Polchinski solution to the cosmological constant problem.

  $F_\alpha = c_\alpha \tilde{m} M_{Pl}$

  where c_α is interger charge
- Parametrize coupling between hidden sector fields and MSSM by random continuous parameters taking values inside a compact interval around zero.
- Assume gravity mediation for simplicity.
- Consider a flat probability distribution of flux in each hidden sector. Since each flux is a random variable, the central limit theorem will lead to Normal distributions for all soft terms

Expression of soft terms in Supergravity

$$M_a = \frac{1}{2} {g_a}^2 F^\alpha \partial_\alpha f_a$$

$${m_{i\bar{j}}}^2 = {m_{3/2}}^2 K_{i\bar{j}} - F^\alpha F^{\bar{\beta}} (\partial_\alpha \partial_{\bar{\beta}} K_{i\bar{j}} - K^{m\bar{n}} \partial_\alpha K_{i\bar{n}} \partial_{\bar{\beta}} K_{m\bar{j}})$$

$$A_{ijk} = (m_{3/2} - F^\alpha \partial_\alpha log m_{3/2}) Y_{ijk} + F^\alpha \partial_\alpha Y_{ijk} - 3F^\alpha {\Gamma_\alpha}^l {}_{(i} Y_{ljk)}$$

where, Kahler connexion

$${\Gamma_{\alpha i}}^l = K^{l\bar{\rho}} \partial_\alpha K_{i\bar{\rho}}$$

- From the cancellation of the cosmological constant

$${m_{3/2}}^2 = \frac{1}{3} \sum_{\alpha=1}^{N} \frac{F_\alpha^2}{M_{Pl}^2} = \frac{1}{3} \tilde{m}^2 \sum_\alpha c_\alpha^2$$

- The formula for scanning soft terms are

$$(m_0^2)_{i\bar{j}} = m_{3/2}^2 \delta_{i\bar{j}} + \tilde{m}^2 \sum_\alpha d_{\alpha, i\bar{j}} c_\alpha^2$$

$$M_{1/2}^a = \tilde{m} \sum_\alpha s_\alpha^a c_\alpha ;$$

$$A_{ijk} = m_{3/2} y_{ijk} + \tilde{m} \sum_\alpha a_{\alpha, ijk} c_\alpha$$

where $g_0^2 = \sum_\alpha \overline{\left(\frac{1}{3} - g_\alpha^2\right) c_\alpha^2} \approx \frac{N}{9} (1 - d_0^2) M^2$, $-d_0 \leq a_\alpha, d_\alpha, s_\alpha, g_\alpha \leq d_0$ are continuous parameter of O(1).

Results

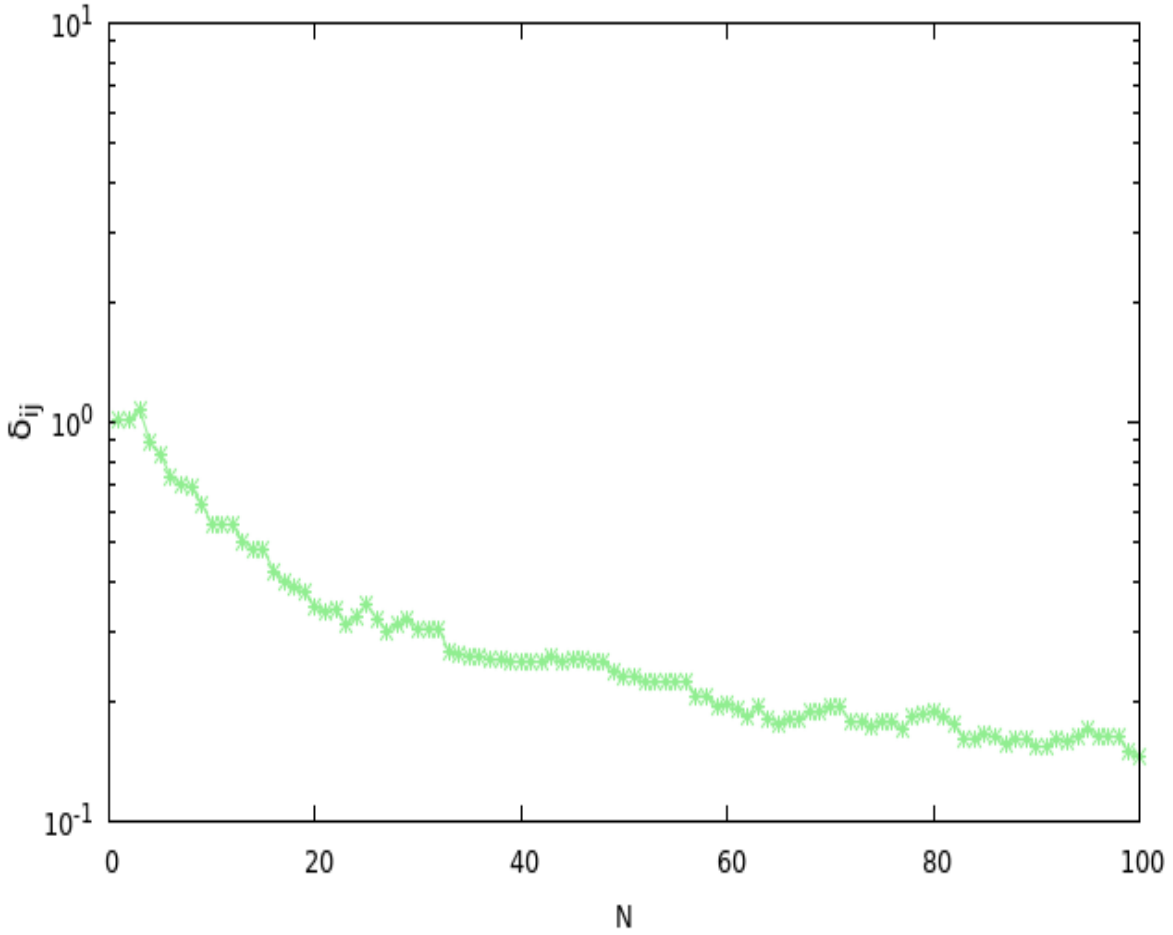
Analytical expression of deltas

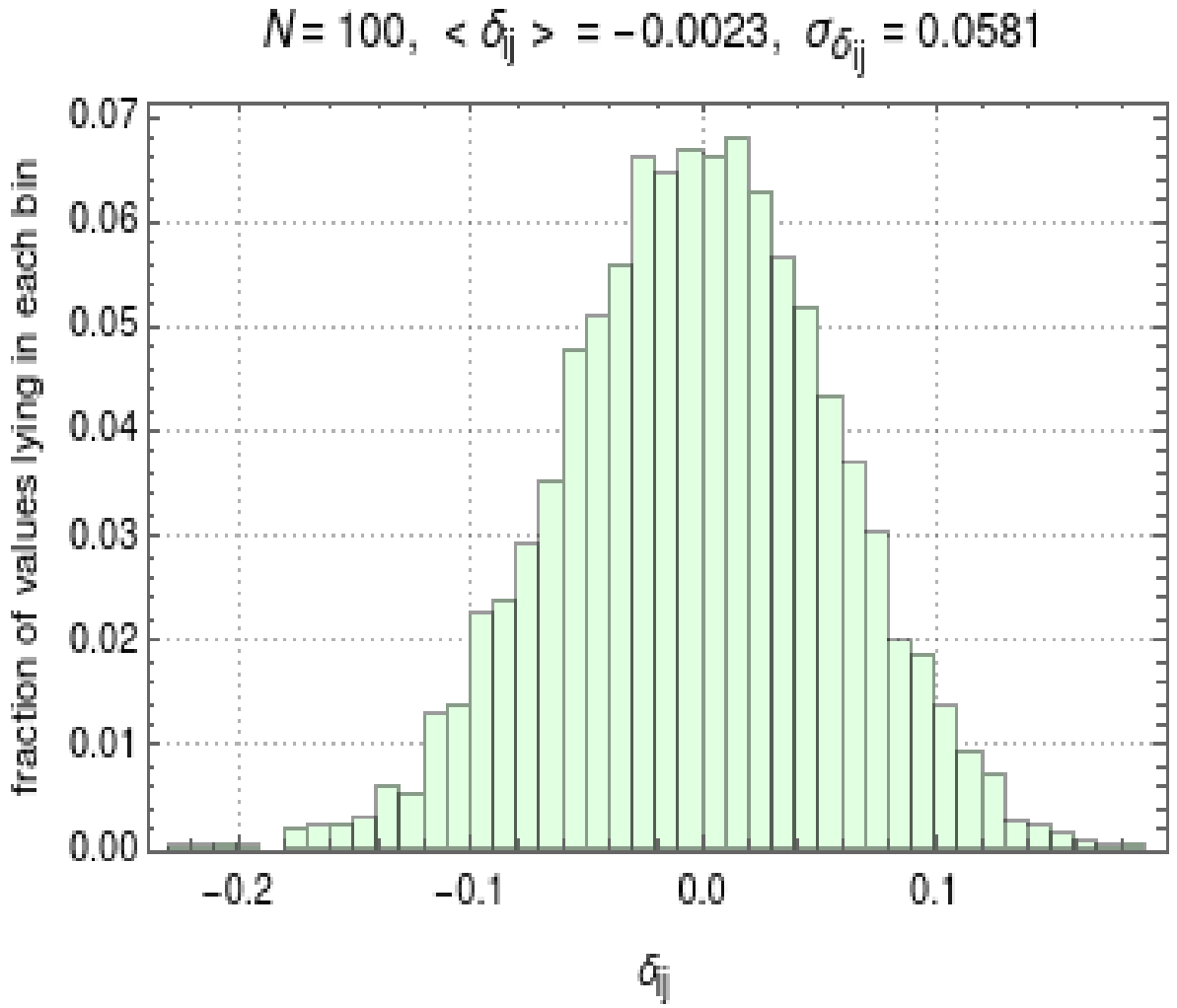
$$(\delta_{ij})_{LL/RR} = \frac{\delta {m_0}^2}{\overline{{m_0}^2}} \cong \frac{1}{\sqrt{N}} \sqrt{\frac{1}{5}\left(4 + 27{d_0}^2\right)} \ ,$$

$$(\delta_{ij})_{LR/RL} = \frac{\Delta A^u v_u}{\overline{{m_0}^2}} \cong \frac{3 d_0 v_u}{\sqrt{N \tilde{m} M}}$$

Result: Dilution of Flavor Violation

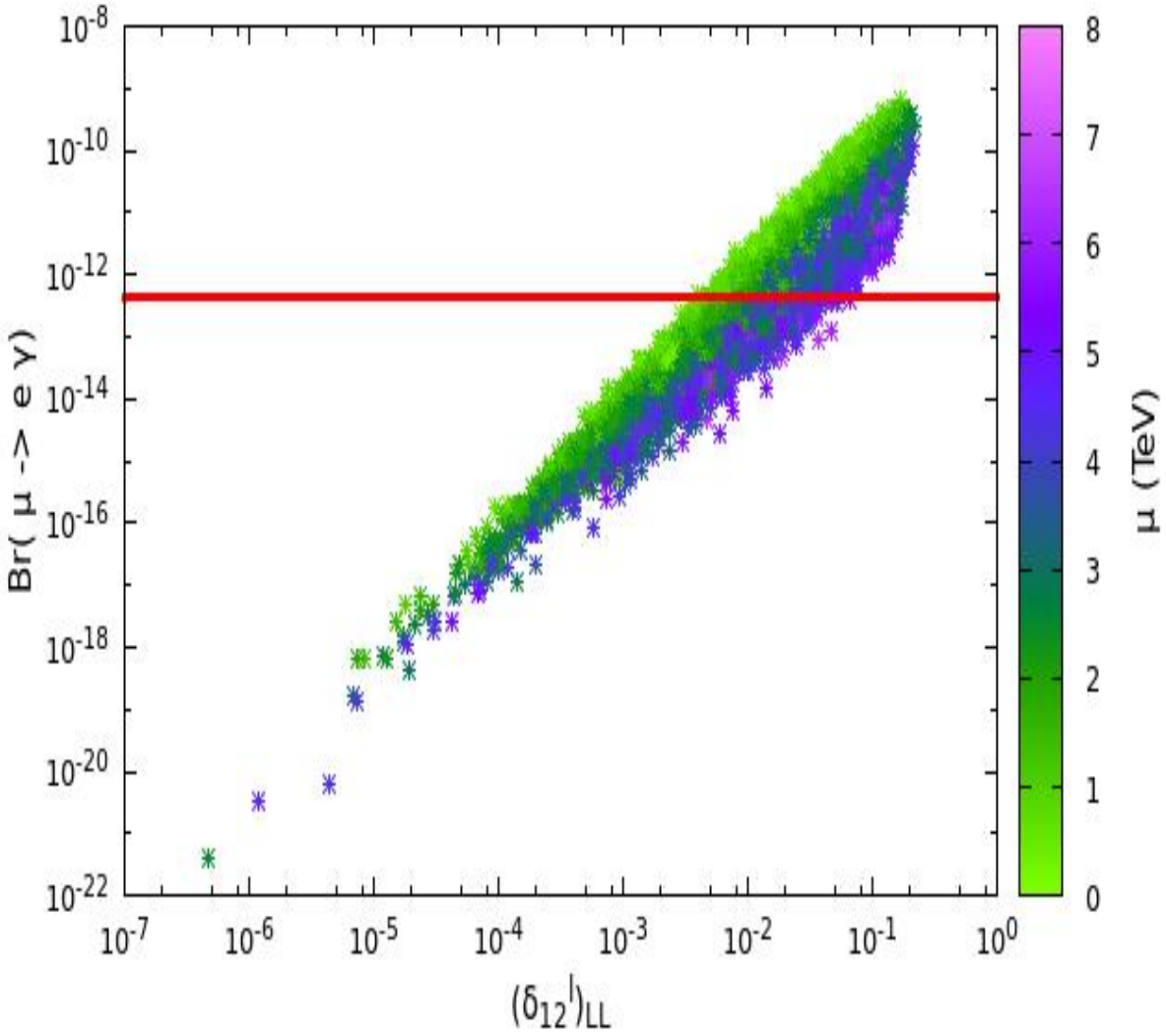
In this setup, there is a $1/\sqrt{N}$ suppression in off-diagonal entries that comes from the large number of hidden-sector fields.

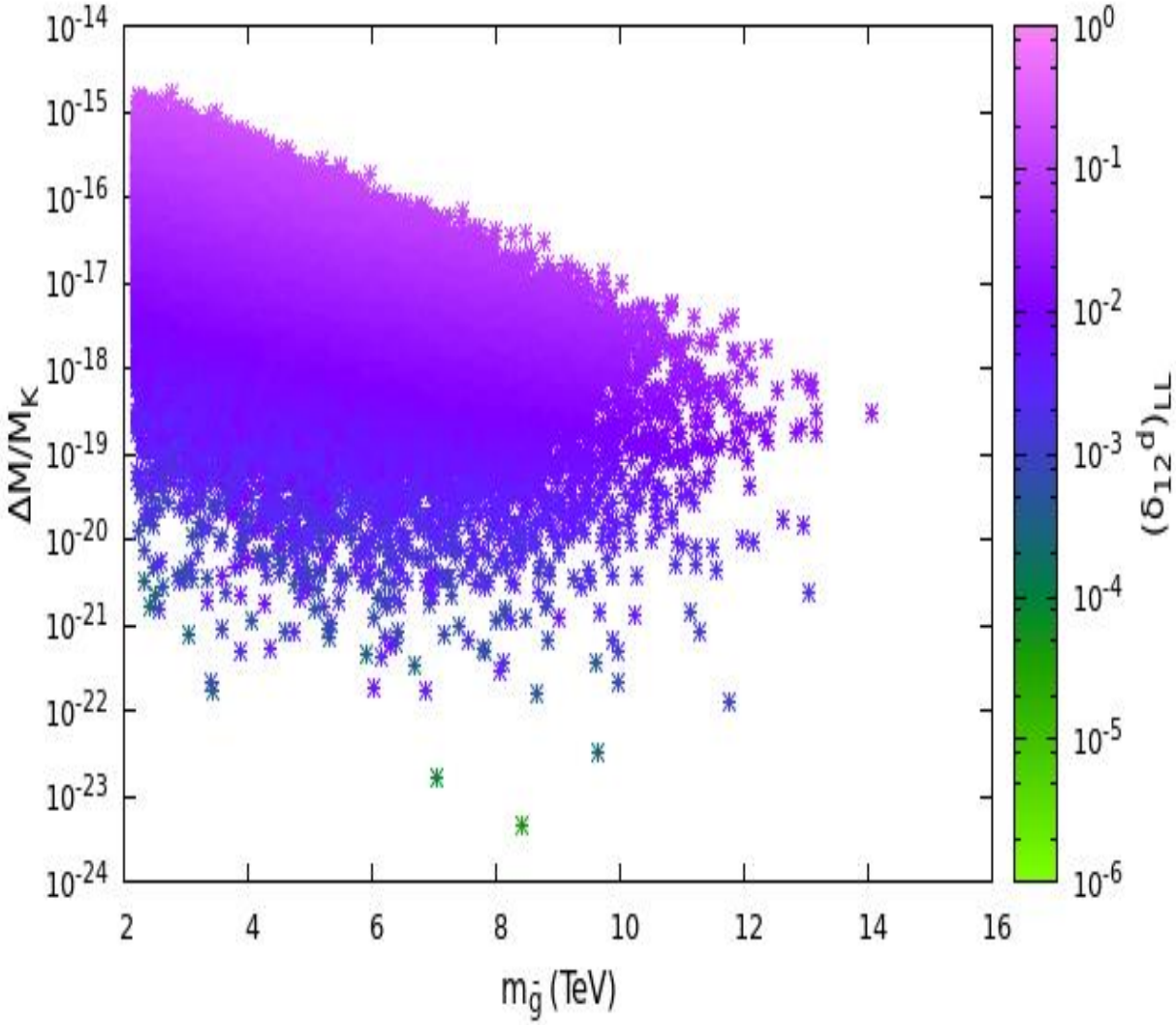




Flavor and Dark matter phenomenology

- We consider the two of the strongest constraints, i.e. the mass difference between the neutral K-mesons, ΔM_K and the leptonic rare decay $\mu \to e + \gamma$.





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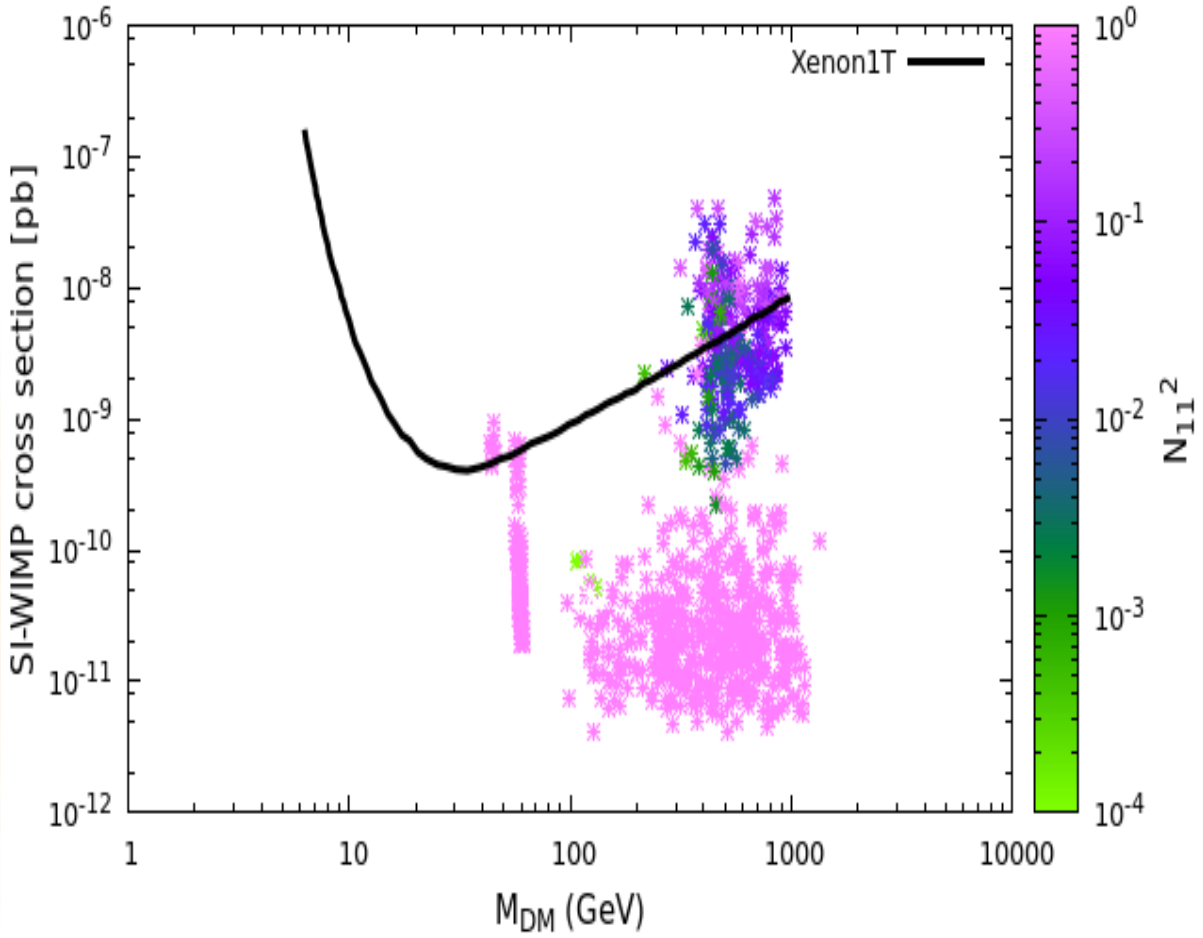

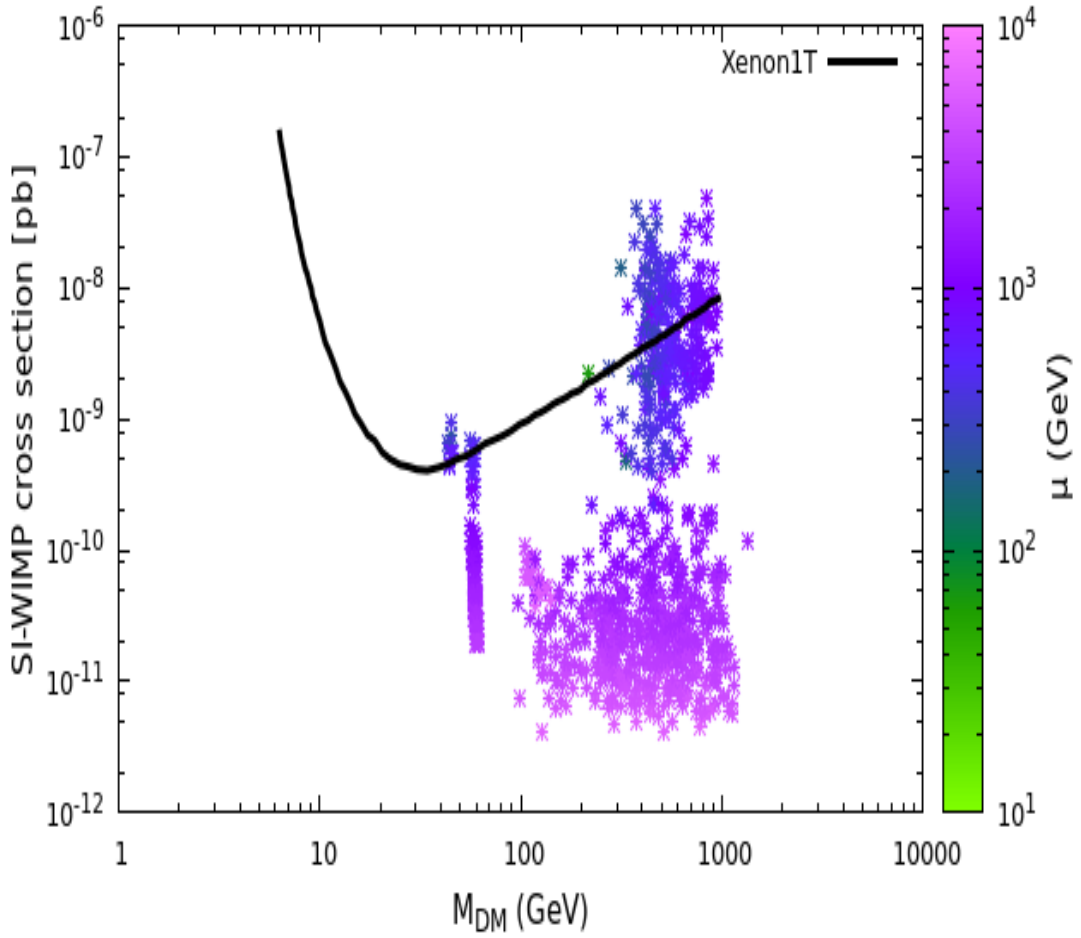

Summary

- String landscape naturally dilutes supersymmetric flavor problem in the presence of large number of hidden sector (spurion) fields.

- The result does not depend on the explicit details of the string construction, but crucially on the form of the soft terms in the supergravity potential, in the presence of a large number of hidden sector fields.

- Suppression of the flavour violating entries goes as $1/\sqrt{N}$.

- Significant bino-higgsino mixing leads well-tempered dark matter because of low μ value.
- Small μ value will also lead small finetuning.

Thank You