

Higgs and *Sparticle* mass predictions from the String Landscape

<http://dx.doi.org/10.1103/PhysRevD.103.035031>

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May 25th, Pheno 2021



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- What does the Landscape & LHC data allude to?

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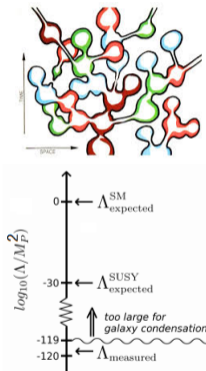
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- The Λ_{CC} problem: Why $\Lambda_{CC} \sim 10^{-120} M_P^2 \sim M_P^2$?
- Resolution in the String Landscape: We live in a Pocket Universe (PU) within an Eternally Inflating Multiverse) a wide range of Λ_{CC} values for each PU.



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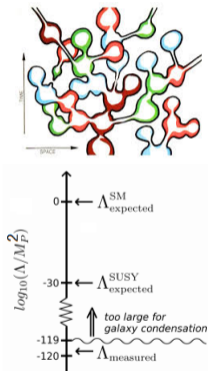
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- Weinberg's solution: Of Λ_{CC}^{PU} in the range $[M_P^2; M_P^2]$, only $\Lambda_{CC}^{PU} \sim 10^{-120} M_P^2$ results in a livable PU.



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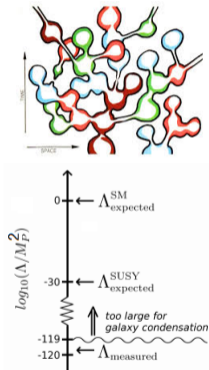
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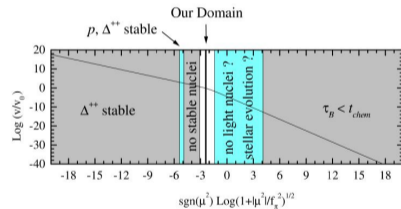
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- Much larger a value of Λ_{CC}) no galaxy formation) non-livable PU.



Anthropics + Landscape

- Similarly m_{weak}^{MP} : Donoghue *et al.*) if m_{weak}^{PU} & $(2-5)m_{weak}^{OU}$ violates **atomic principle**) no observers as we know them.



Higgs and Particle mass predictions from the String Landscape

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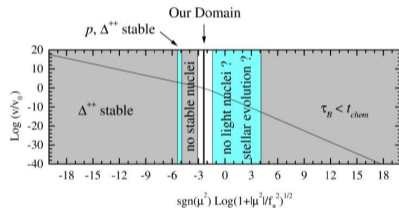
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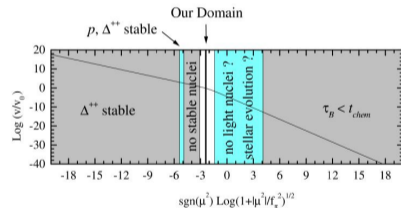
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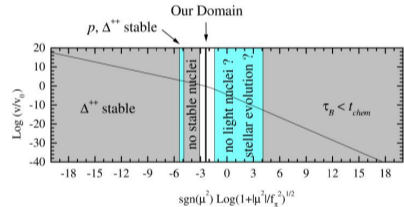
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- Δ_{EW} is a model-independent measure of naturalness calculated from:

$$\frac{m_Z^2}{2}, \quad m_{H_u}^2 = \Sigma_U^U(\tilde{t}_{1,2})$$

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$$\Delta_{EW} = j(\max \text{ RHS contribution}) = \frac{m_Z^2}{2} :$$



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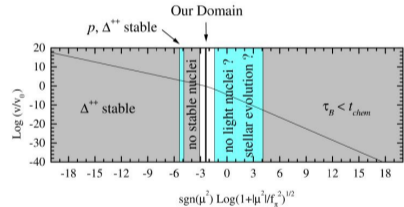
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- For landscape, the condition is $(m_Z^{PU})^2 = 2$ and $m_Z^{PU} \neq m_Z^{OU} = 91.2 \text{ GeV}$.



SUSY Breaking Scale

- For a fertile patch of the landscape with MSSM as low energy EFT, the distribution of PU vacua is given by m_{hidden}^2

$$dN_{vac}(m_{hidden}^2; m_{weak}; \Lambda_{cc}) = f_{SUSY} : f_{EWSB} : f_{cc} : dm_{hidden}^2$$

with $m_{soft} \quad m_{hidden}^2 = M_P$.

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- It was advocated by Douglas, Susskind and Arkani-Hamed *et al.* that SUSY breaking scales should follow a power-law distribution

$$f_{SUSY} \sim m_{hidden}^{2n_F + n_D - 1}$$

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- The EWFT distribution f_{EWSB} is taken as

$$f_{EWSB} = \Theta(30 \quad \Delta_{EW})$$

which ! large A_t ! $m_h \quad 125$ GeV, proper EWSB and $m_{weak}^{PU} \quad 4m_{weak}^{OU}$.

Consequence of Anthropic and Power law Distribution

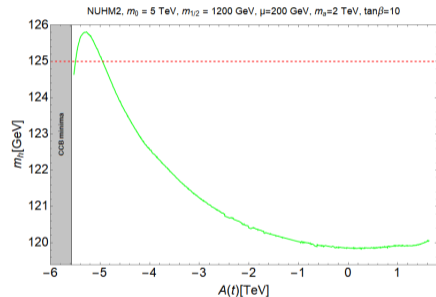
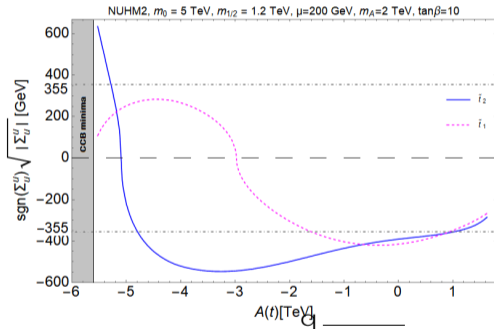
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Anthropics + Landscape SUSY Breaking Scale

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Large negative $A(t)$) smaller $\Sigma_U^U(\tilde{t}_{1,2})$ contributions to the weak scale ! bigger higgs mass.

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- Extra Dimensional theories ! Compactification on some manifold (e.g. Calabi-Yau) ! scalar fields (**moduli**).

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 - KKLТ (non-perturbative effects in flux compactifications) *leads to* a power-law draw on soft terms i.e.

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- 1 KKLТ (non-perturbative effects in flux compactifications) *leads to* a power-law draw on soft terms i.e.

$$f_{SUSY} = m_{soft}^n:$$

- 2 Large Volume Scenario (LVS) (Perturbative & Non-perturbative) *leads to* a logarithmic draw, i.e.

$$f_{SUSY} = \log(m_{soft}):$$

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$$m_0(1;2); m_0(3); m_{1=2}; A_0; \tan \beta; \mu; m_A$$

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- Using these parameters, Higgs and sparticle mass spectrum were calculated using ISAJET code.
- The results are then compared to $f_{SUSY} = m_{Soft}^n$ draw with $n = 0$ (uniform distribution) and $n = 1$ (text book example of a single F-breaking field distributed as a complex number in the landscape).

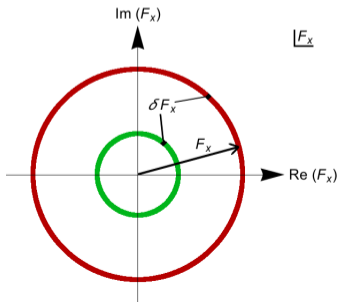


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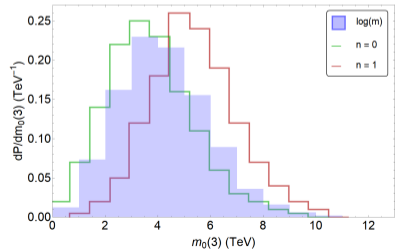
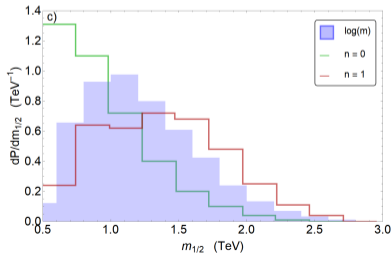
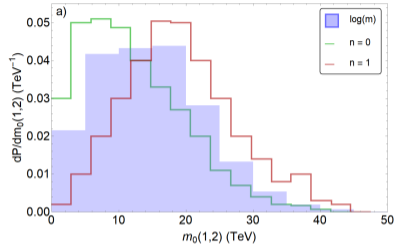
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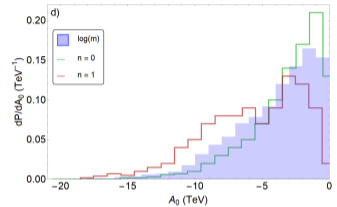
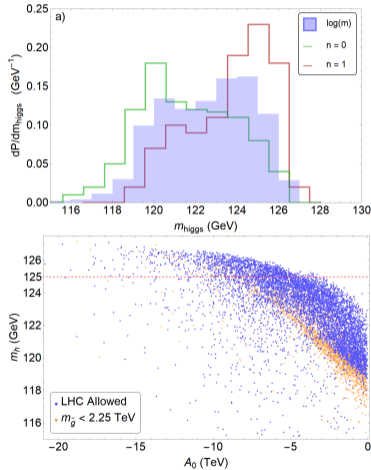
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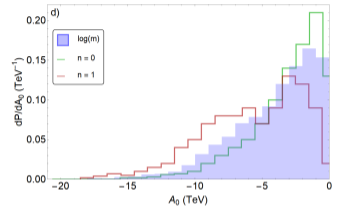
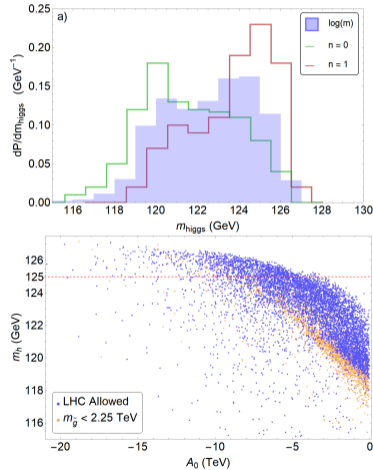
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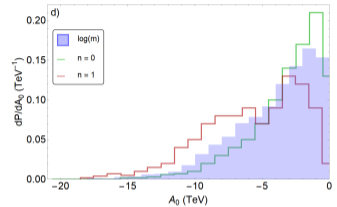
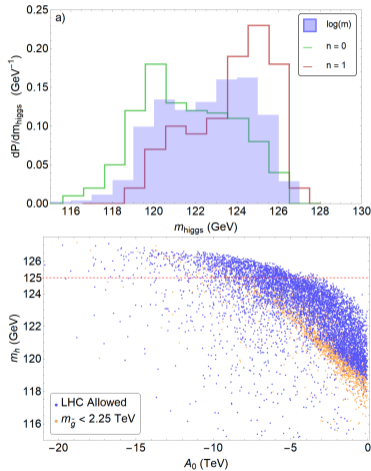
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- Larger A_0) large stop mixing) large radiative corrections to m_h) peak of higgs distribution 125 GeV.
- This is a testable prediction of the string landscape: A SM-like higgs $m_h \approx 125$ GeV is reflective of large mixing in the stop sector.

Results-Soft Dilepton Signal

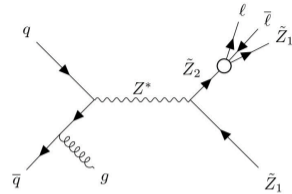
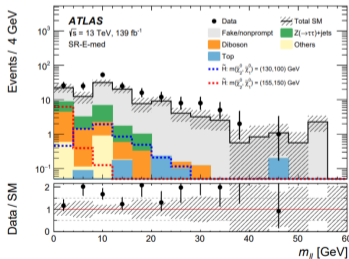
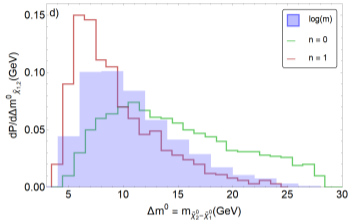
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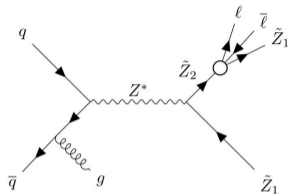
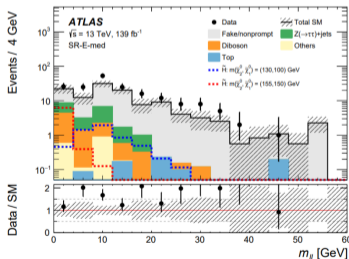
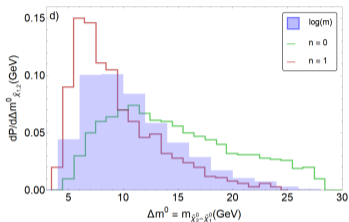
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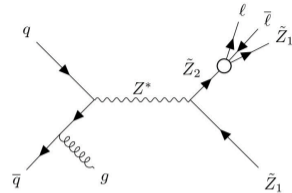
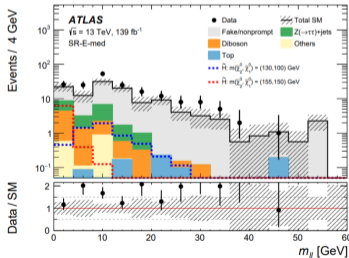
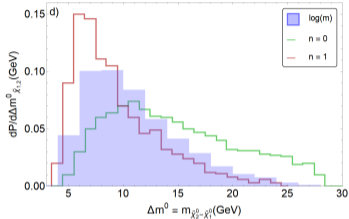
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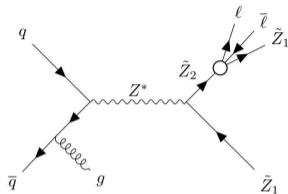
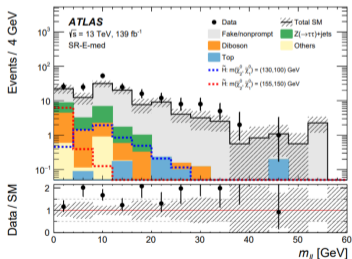
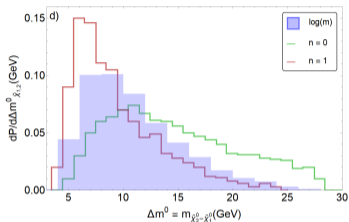


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■ The log-draw gives a broad peak structure 8 12 GeV.

Statistics of SUSY breaking in the Landscape

Anthropics + Landscape SUSY Breaking Scale

Alternative Soft-term Distribution

Results-Soft Dilepton Signal

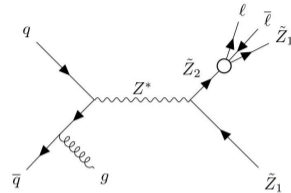
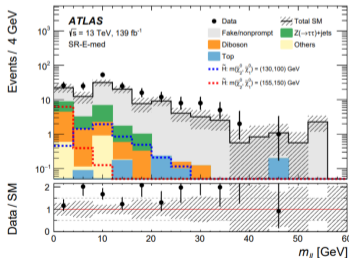
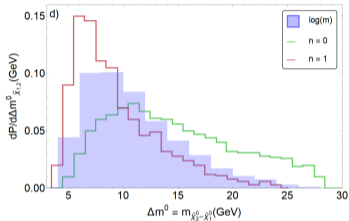
Higgs and Sparticle mass predictions from the String Landscape

Baer, Barger, Salam, Sen-Gupta

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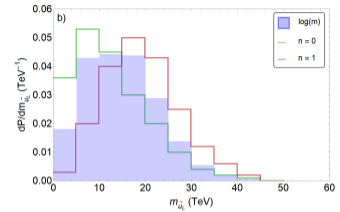
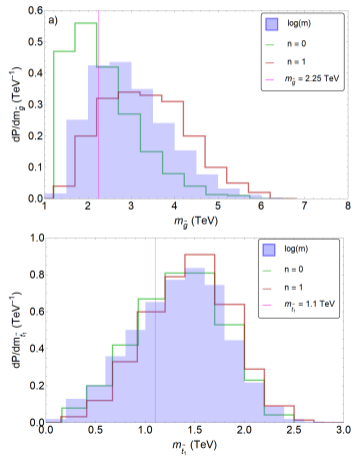
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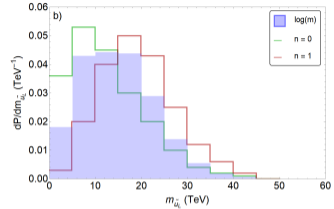
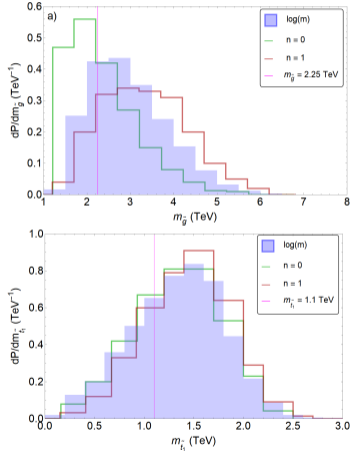
- $m_Z^2=2$ ' $m_{H_u}^2$ $\Sigma_U^y(\tilde{t}_{1,2})$! is SUSY conserving) too big a value of ! too big m_{weak} unless one finetunes.
- String landscape favors $(100 \text{ } 350\text{GeV})$ m_{soft}) small ! **light higgsinos.**
- Small has a signature in the higgsino pair-production channel.
- The log-draw gives a broad peak structure $8 \text{ } 12$ GeV.
- Current search results from ATLAS with 139fb^{-1} data ! slight excess in bins with $m_{ll} \text{ } 5 \text{ } 10$ GeV.[3]

Results



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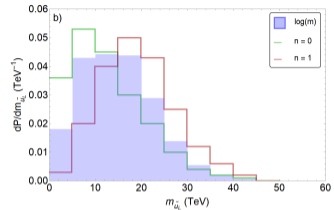
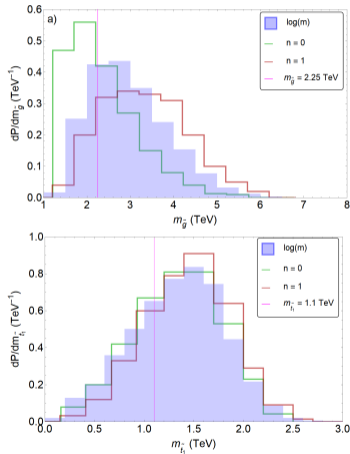
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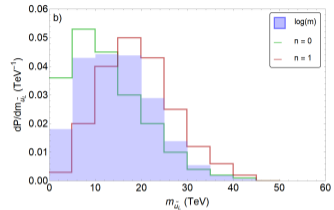
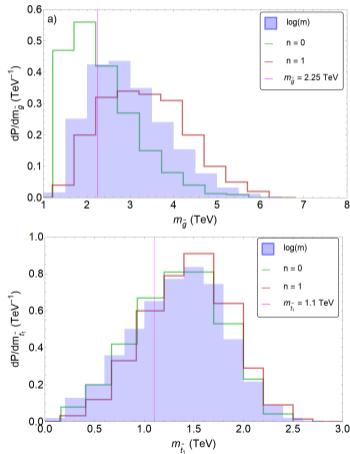
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- First and Second generation squarks yield peaks in the 10 – 40 TeV range ! decoupling solution to the SUSY flavor and CP problem.

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■ Why String Landscape?

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■ Dark matter content: higgsino-like WIMP and *axion*.

References

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