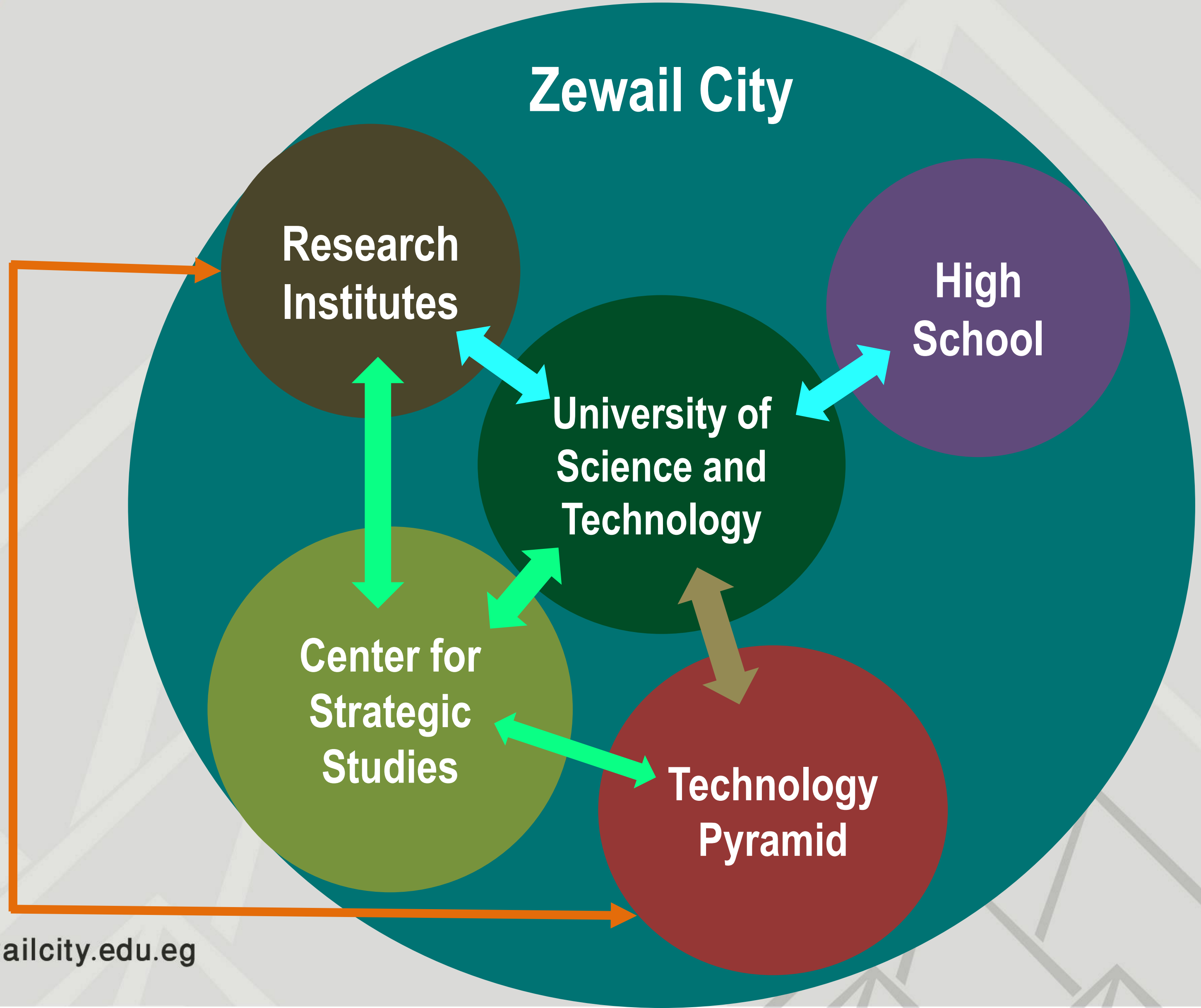
Zewail City Node

Structure of Zewail City



Research at Zewail City

Research interest at Zewail City currently focuses on the following topics:

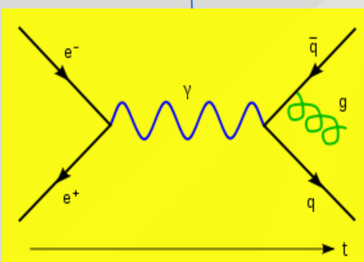
- Nano-science & Technology
- Bio-medical Science
- Energy, Environmental & Space
- Basic Science (Physics)

Center for Fundamental Physics (CFP)- HEP Theory group

- Faculty Members
  - S. Khalil
  - E. Lashin
- Postdoctoral Researchers
  - C. Un
  - A. Nassar
  - M. Abbass
- Graduate Students
  - W. Abdalla
  - A. Hammad
  - M. Amin
  - A. Moursy
  - A. Kassem
  - M. Abdelmoniem

مركز الفيزياء الأساسية
Center for Fundamental Physics
ZEWAIL CITY
ESTABLISHED 2000
INAUGURATED 2011

Research at Center for Fundamental Physics

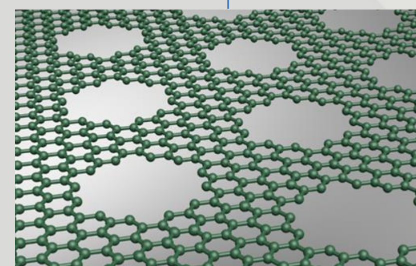


Theoretical High Energy Phys

- Phys of Early Universe
- Phys Sub nuclear
- Unification of Fundamental Forces

Experimental High Energy Phys

- CMS Data Analysis
- HEP app. Material & Bio-Science

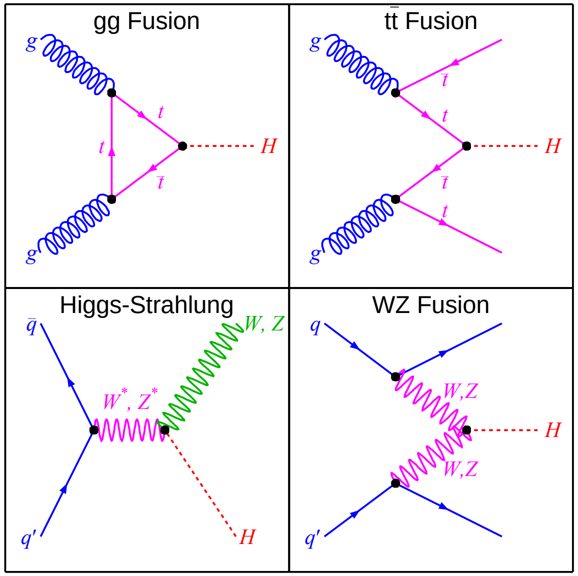


Condensed Matter Physics

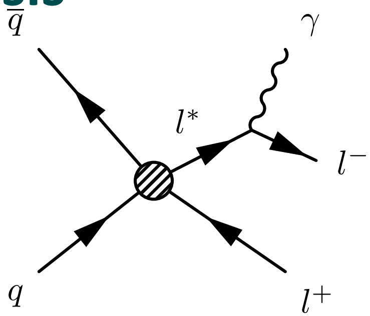
- Graphene electronics & catalysis
- Hydrogen storage

CMS: Physics analysis

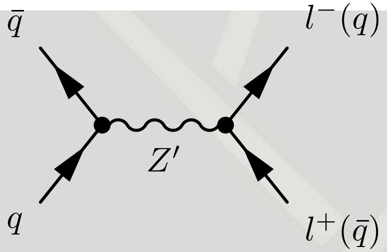
- **Higgs to 4 lepton analysis**



- **Excited Lepton analysis**



- **Heavy Neutral Gauge boson analysis**



CMS group members:

- Dr. Amr Mohamed
- Dr. Ahmed Abdelalim
- Reham Mohamed
- Waleed Esmail
- Ashraf Kassem
- Ahmed Hammad
- Ahmed Mostafa

Recent and Current Activities

SUSY Dark Matter

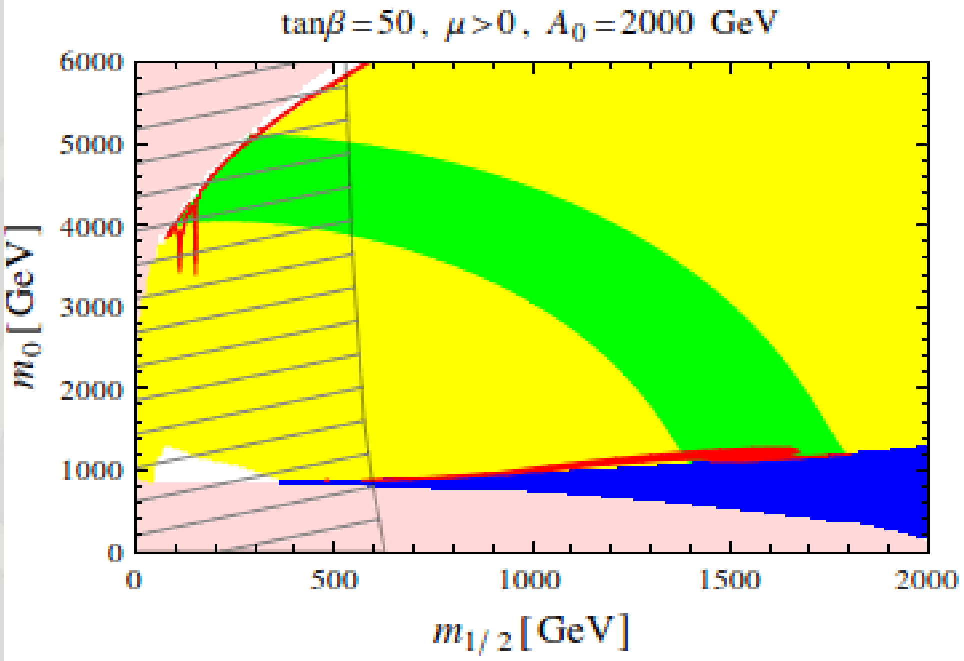
Combining the collider and astrophysics constraints almost rule out the MSSM.

At large tan β, a region with a possible resonance due to MA = 2 mχ is allowed.

Combined LHC and relic abundance constraints rule out most of the MSSM parameter space except a very narrow region with very large tan β (∼ 50).

Non-universality in gaugino and/or scalar masses may remove this tension.

Non-minimal supersymmetric extensions of the SM with a larger particle content or a higher symmetry can evade the problems of the MSSM.



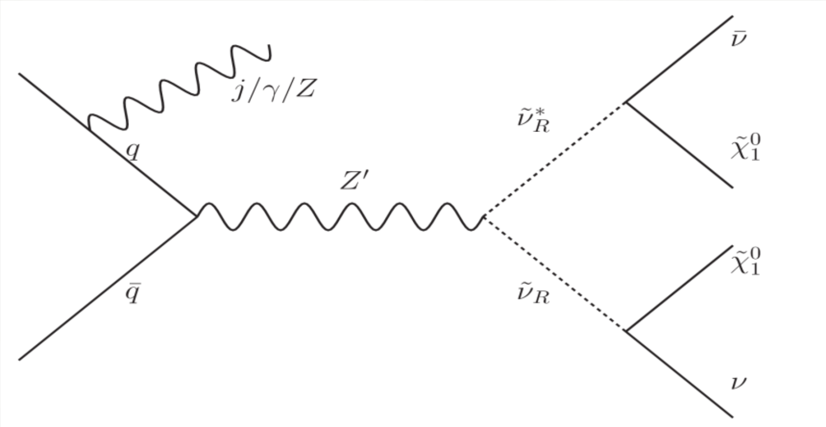
Monojet search in (B-L)SSM at LHC

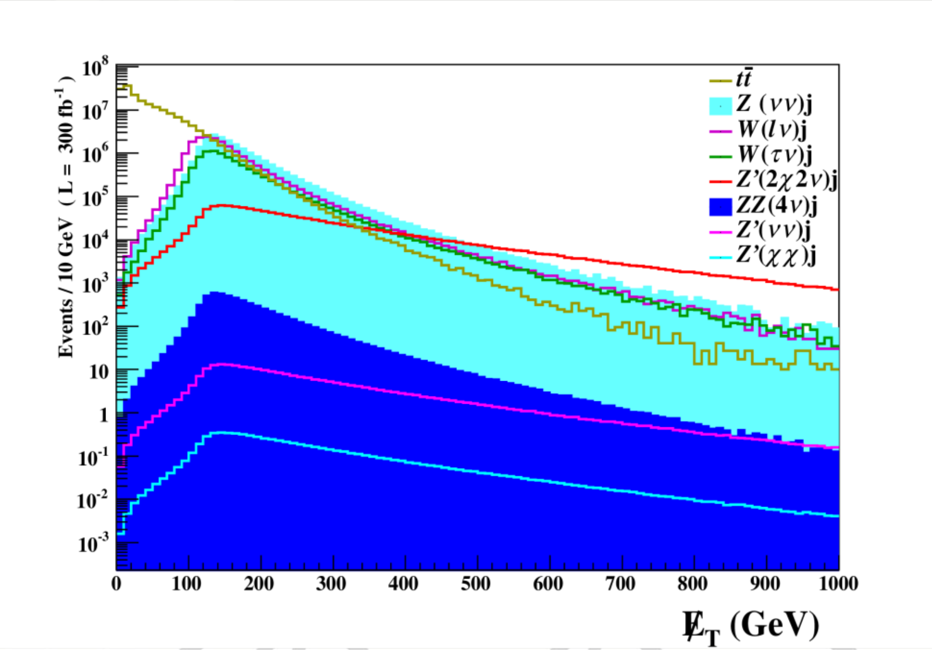
The advantage of the signal is that the final state objects carry a very large (transverse) missing energy, since the Z' is naturally massive and constrained by direct searches to be at least in the TeV scale region.

Under these conditions the efficiency in accessing the invisible final state and rejecting the SM background is very high.

Another special feature of this invisible BLSSM signal is its composition, which is often dominated by RH sneutrino decays.

Sensitivity of the CERN machine can therefore help disentangling the BLSSM from more popular SUSY models.





Heavy Higgs in MSSM and beyond

- The coupling of second CP-even MSSM Higgs with SM particles is highly suppressed.

$BLSSM \Longrightarrow$ extending SM gauge groups by $U(1)_{B-L}$

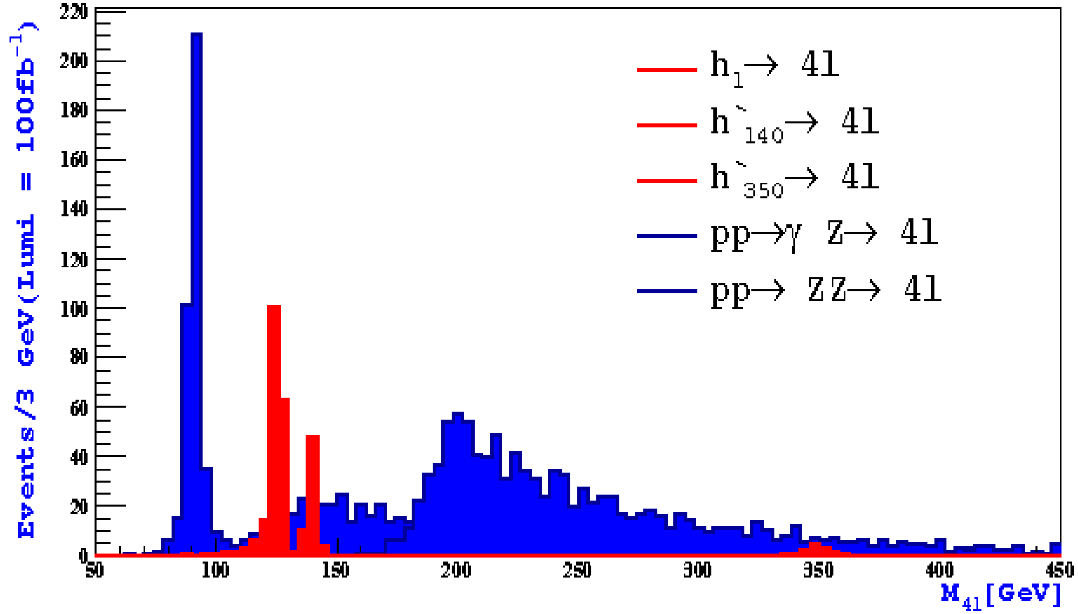
$BLSSM \Longrightarrow$ Three generations of superfields right handed neutrinos $\hat{\nu}$.

$BLSSM \Longrightarrow$ Two bileptons χ_1 χ_2, needed to break $U(1)_{B-L}$.

$BLSSM \Longrightarrow$ One gauge boson Z'

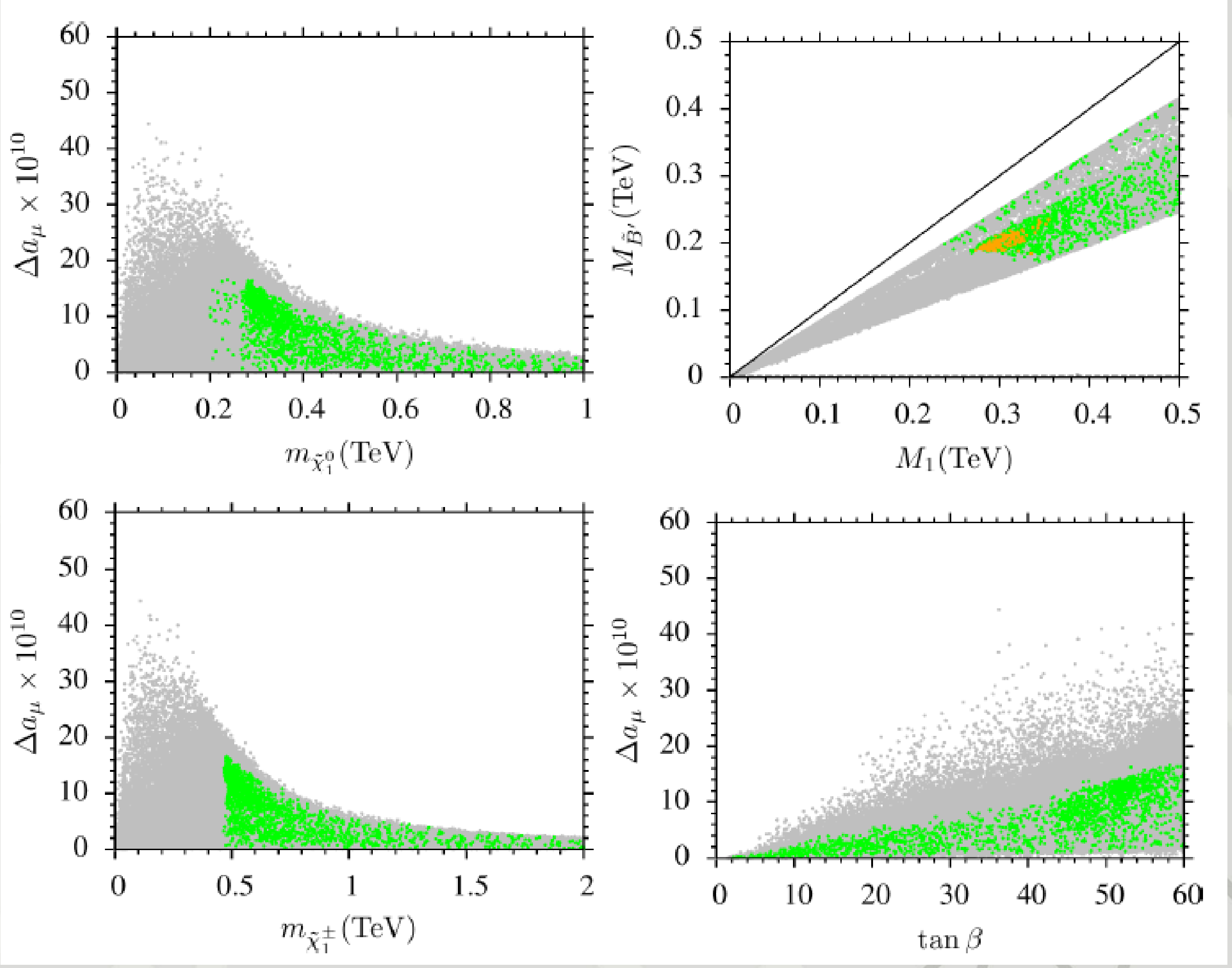
CP-even Higgs mass matrix can be digonalized by unitary 4×4 matrix

$$\Gamma M^2 \Gamma = \left\{ m^2_h, m^2_{h'}, m^2_H, m^2_{H'} \right\}$$



h′ → ZZ → 4l at Run-II

Muon g-2 in BLSSM



Single field inflation In SUGRA

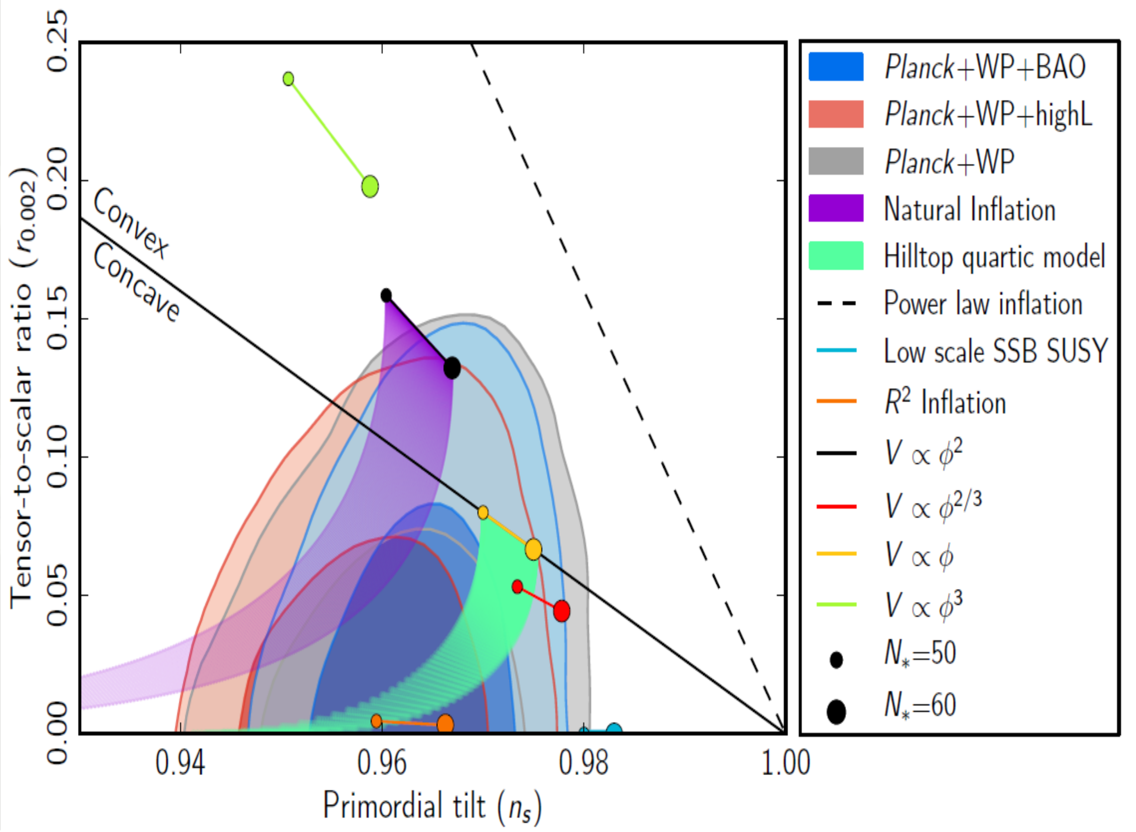
- The slow-roll parameters are defined as

$$\varepsilon = \frac{m_{Pl}^2}{2}\left(\frac{V_\varphi}{V}\right)^2, \qquad \eta = m_{Pl}^2\left(\frac{V_{\varphi\varphi}}{V}\right), \qquad |\eta|, \varepsilon \ll 1$$

We define the inflation observables: The spectral index n_s and the tensor to scalar ratio r as following

$$n_s = 1 - 6\varepsilon + 2\eta,$$
$$r = 16\varepsilon,$$

- Planck Satalite constraints on inflation observables



Moduli Stabilization in String Theory

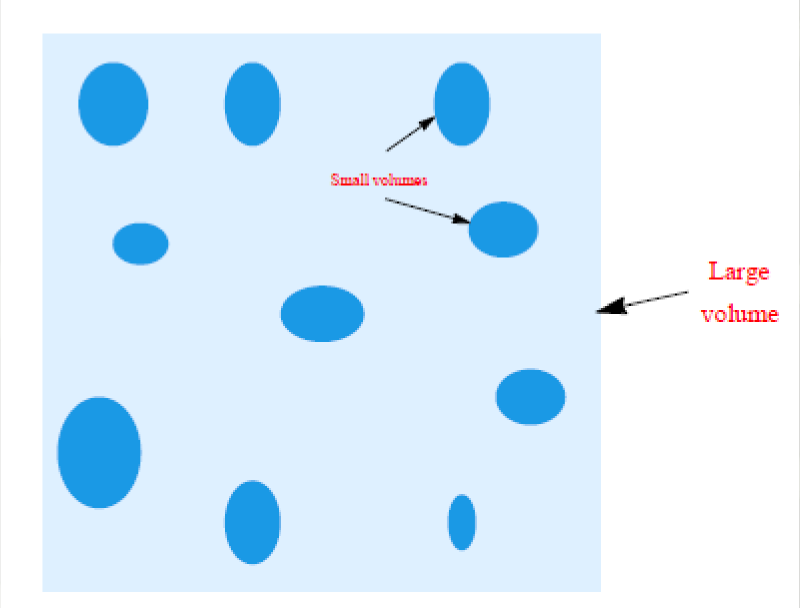
- Kachru, Kallosh, Linde and Trivedi (KKLT) could stabilize the volume modulus T using a non-perturbative superpotential and Kahler potential

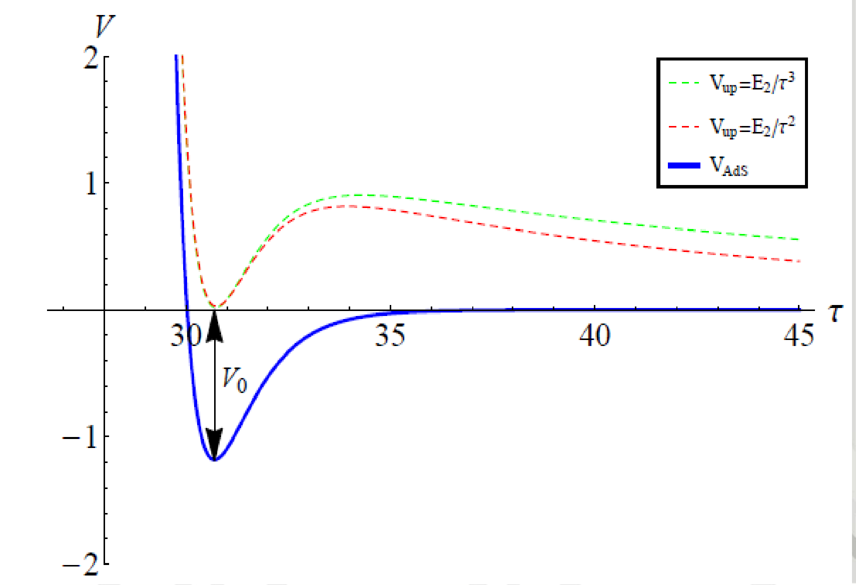
$$W = W_0 + A e^{-aT} \qquad K = -3\ln[T + \overline{T}]$$

- In Large Volume Scenario (LVS), potential possesses an AdS minimum at exponentially large volume

$$K = K_{cs} - 2\log\left(\mathcal{V} + \frac{\xi}{2}\right),$$

$$W = W_0 + A_4 e^{-\frac{a_4}{g_s}T_4} + A_5 e^{-\frac{a_5}{g_s}T_5}$$





String Phenomenology

- SUSY is broken by the uplift mechanism

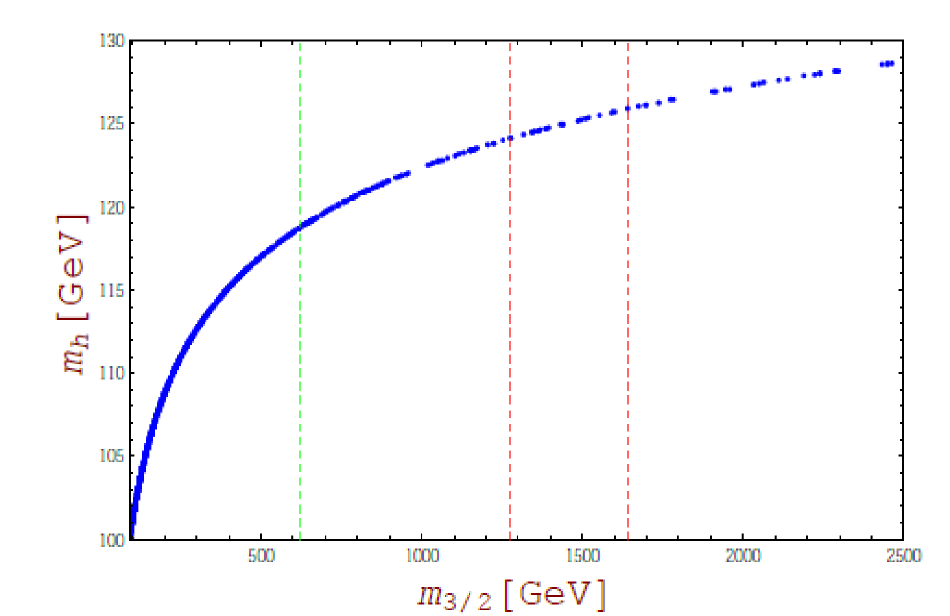
- In KKLT, the soft terms are given by

$$m_0^2 = \frac{|W|^2}{(2\tau)^3}\Big|_{dS} = m_{3/2}^2,$$
$$m_{1/2} = \frac{\sqrt{2\tau}}{6} D_T W(T) \frac{\partial}{\partial T} \ln(\mathrm{Re} f^*)\Big|_{dS} \simeq \frac{m_{3/2}}{a\tau},$$
$$A_0 = -\frac{1}{\sqrt{2\tau}} \bar{D}_{\bar{T}} \overline{W_h}\Big|_{dS} = -\frac{3m_{3/2}}{a\tau},$$

- Unacceptable phenomenologically

- In LVS, the soft terms are given by

$$m_0 \simeq m_{1/2} = m_{3/2}$$
$$A_0 \simeq -m_{3/2}.$$



Thank You