Cosmological Implications of the LARGE Volume String Scenario

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Collaborations with:

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String Scenarios: Some cosmology challenges

- Big-bang singularity χ
- Cosmological inflation or alternatives
- After inflation
- Current acceleration
- Consistency with low energy phenomenology

MODULI STABILISATION

4-cycle size: *τ* **4-cycle size:** *τ* **(Kahler moduli) (Kahler moduli)**

3-cycle size: U 3-cycle size: U (Complex structure (Complex structure moduli) + String Dilaton: S moduli) + Dilaton S

String Scenarios

• **IIB (+F-theory) KKLT LVS**

Moduli Stabilisation

• **IIA**

• **Heterotic**

• **G2 manifolds**

GKP Overview *W* = *W*⁰ + *W*matter + *Wnp* + ⇢*X* (1.2) electromagnetic, weak and strong interactions. The strong interactions in the second line has the kinetic energy for the kinetic e matter fields: quarks and leptons = 1*/*2 as well as their (Yukawa) couplings to the Higgs field

1. Fluxes: GVW Fix CS moduli: z and dilaton: S $W_0 =$ Z $\texttt{PSS: GVW} \qquad W_{\texttt{0}} = \int G \wedge \Omega$ 1.58×10^{-6} and 1.5×10^{-6} dilaton: S $=$ $\sqrt{2}$ $W_0 = \int_{\pi M} G \wedge \Omega$
 $C = 2\pi M \int_{\Delta}^{1} H_0 = 2\pi K$ Fix CS moduli: z and dilaton: S \overline{A} (= 0). The third line is the kinetic and potential energy for the Higgs field. $G_3 = F_3 - iSH_3,$ $\int F_3 = 2\pi M, \int H_3 = -2\pi K$ 0

gravity (\overline{C}) and the kinetic and topological terms for the gauge fields (\overline{C}

2. Warped throats *S S T I S T S S T I S* $\ddot{}$ *d*⁴*x* $2\pi F$ *h* ^p¹ *hg^µ*⌫@*µr*@⌫*^r ^q V*²↵*/*³ $z^{1/3} = e^{A} = e^{-\frac{2\pi K}{3g_sM}} \equiv e^{-\alpha}$ $2[′]$ $=$ $e[′]$ $=$ $e[′]$ s^{g_s} m $=$ $e[′]$

KKLT Overview Please check the next set of arguments:

Z

G ^ ⌦ (1.6)

• Nonperturbative effects: $W_{np} = \sum A_i e^{-a_i T_i}$ Itive eff $\overline{\mathbf{a}}$ $\mathbf e$ $\overline{}$ @*W* @*X* $\ddot{}$ $\ddot{\bullet}$ $\ddot{}$ $\,V\,$ $\imath p$ $=$ $\sum A_i e^{-a_i I_i}$

1. Recall that a probe brane in a probe brane in a probe brand is described by the combine by the combine by the combination of the combine by the **SUSY AdS Vacua: DW=0**

1 Effective Field Theory of Kingdom and Theory of Theory of Kingdom and Theory of Theory of Theory of Kingdom

• Anti D3 brane (SUSY breaking+uplift) $\left(\frac{1}{2} \right)$ $r \cdot \frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$

t**U3 brane (SUSY breaking+uplitt)**
\n
$$
V_{\text{uplift}} = \frac{D^2}{(T + T^*)^{\alpha}} = \frac{D^2}{\mathcal{V}^{2\alpha/3}} \begin{cases} \alpha = 3 & \text{KKLT} \\ \alpha = 2 & \text{KKLMMT} \end{cases}
$$

LARGE Volume Scenario $\overline{}$ $\overline{}$ in $\overline{}$ and $\overline{}$ and $\overline{}$

Perturbative corrections to K:

$$
K = -2\ln\left(\mathcal{V} + \frac{\hat{\xi}}{2}\right)
$$

describes the regime for the visible sector near the singularity

$$
V_F \propto \left(\frac{K^{S\bar{S}}|D_S W|^2 + K^{a\bar{b}} D_a W \bar{D}_{\bar{b}} \bar{W}}{\mathcal{V}^2}\right) + \left(\frac{Ae^{-2a\tau}}{\mathcal{V}} - \frac{Be^{-a\tau}W_0}{\mathcal{V}^2} + \frac{C|W_0|^2}{\mathcal{V}^3}\right)
$$

$$
\boxed{\mathcal{V} \sim e^{a\tau}}
$$
 with $\tau \sim \text{Re } S \sim 1/g_s > 1.$

Exponentially large volume for weak coupling (SUSY broken by Fluxes, AdS) $A dS$ is the visible sector which we will parameter ϵ

- From F/D terms, hidden matter Burgess et al, Dudas et al, Villadoro-Zwirner, Cicoli et al, T-branes (Cicoli, FQ, Valandro arXiv:1512.04558)
- From non-perturbative effects on hidden brane at singularities

dS Moduli Stabilisation dS Moduli Stabil oilisatior
_↑ 0

Relevant Scales	
String Scale	$M_s = \frac{g_s^{1/4} M_P}{\sqrt{4\pi \nu}},$
Kaluza Klein Scale	$M_{KK} \simeq \frac{M_P}{\sqrt{4\pi \nu^{2/3}}},$

Gravitino mass

$$
m_{3/2} \simeq \left(\frac{g_s^2}{2\sqrt{2\pi}}\right) \frac{W_0 M_P}{\mathcal{V}}.
$$

Volume modulus mass

Volume modulus mass
$$
m_V \simeq m_{3/2}/\sqrt{V}
$$
.

. The probability to decay to decay to decay to an \mathcal{A}

Vacuum decay rates $\qquad \Gamma \sim e^{-\mathcal{V}^3}$

$$
\Gamma \sim e^{-\mathcal{V}^3}
$$

Constraints on the volume

- Validity of EFT $(m_{3/2}<: V>>10³$
- CMP $(m_{volume} > 30 \text{ TeV})$: $V < 10^9$

Ranges of relevant scales (GeV)

$$
\begin{cases}\n10^{17} > M_s > 10^{14} \\
10^{15} > m_{3/2} > 10^{10} \\
10^{12} > M_{1/2} > 10^2 \\
10^7 > T_{RH} > 1\n\end{cases}
$$

LVS vs KKLT

- $W_0 \sim 0.1 100$
- AdS non SUSY
- Minimum: perturbative in big cycle vs non-perturb. in small cycle
- Uplift:anti D3 branes, Dterms...
- Small parameter = $1/V$
- SUSY broken by fluxes
- Many moduli: need $h_{21} > h_{11} > 1$ + one blow up, the rest by loop effects/D-terms
- $W_0 < 1$
- AdS SUSY
- Minimum: tree-level vs nonperturbative
- Uplift: anti D3 branes...(no Dterms)
- Small parameter W0
- SUSY broken by uplifting mechanism
- Many moduli: nonperturbative effects for each of them or ...

Revisiting Anti D3 Brane Uplift

Nilpotent Superfields EFT terms of a chiral superfield *X* that is further constrained to be nilpotent *X*² = 0 with the aim at description the breaking the breaking of an antipresent in *K* and *W* due to the nilpotency condition. Furthermore this condition implies that for a nilpotent superfield *X* with components *X*0*, , F*: $\overline{\mathbf{I}}$ $\overline{\mathbf{I}}$ **ilnotent** Superfields FFT and baryogenesis for instance. Moreover the many parameters of the many parameters of the many parameters of th is not understood. In particular the mass of the Higgs is not protected under quantum

by itself allow for an explanation of dark matter, the dark matter, the density perturbations of the CMBB cont
Itself allows of the CMBB control the CMBB control to the CMBB control to the CMBB control to the CMBB control

$$
X = X_0(y) + \sqrt{2}\psi(y)\theta + F(y)\theta\overline{\theta}
$$

\n
$$
= \frac{\psi\psi}{2F}
$$

\n
$$
K = K_0 X X^*
$$

\n
$$
W = \rho X + W_0
$$

\n
$$
V = K_0^{-1} \left\| \frac{\partial W}{\partial X} \right\|^2 = \frac{|\rho|^2}{K_0} \ge 0
$$

\n
$$
\mathcal{L} = -\rho^2 + i \partial_a \bar{\psi} \overline{\sigma}^a \psi + \frac{1}{4\rho^2} \bar{\psi}^2 \partial^2 \psi^2 - \frac{1}{16\rho^6} \psi^2 \bar{\psi}^2 \partial^2 \psi^2 \partial^2 \bar{\psi}^2
$$

2 (*y*)✓ + *F*(*y*)✓¯✓ (2.2) $s_{\text{1}} \sim \text{V}$ olkov-Akulov ! \blacksquare In flux compactifications the presence of an anti- \sim Volkov-Akulov! **~ Volkov-Akulov !** m_e all possible all possible the energy, increasing the energy, intensity and reach to the highest possible limits, in the highest possible limits, in the highest possible limits, m_e

Nilpotent Superfields and KKLT The construction is constructed and an election construction and and analyze and analyze features. Namely, new supergravity models were constructed depending on two chiral superfields [16], $\left[\text{N}\right]$ is a set only C , is a singled a chiral superfield $\left[\text{N}\right]$ representative matter field, which we assume to be stabilized at *C* = 0 but we keep it in the action to rically by the fluxes, and consider as simple model of the remaining dynamics. We consider the (for **The INTE of Nilpotent Superfields and KKLT**

**Goldstino: Nilpotent
chiral superfield**
$$
X^2(x,\theta) = 0.
$$

KKLT $K = -3\log(T + T^*) + c(T + T^*)^n XX^* + ZCC^* + \cdots$ $\mathcal{L} = (\mathcal{I} + \mathcal{I}) + \mathcal{O}(\mathcal{I} + \mathcal{I})$ $\mathbf{v} \mathbf{v} = \mathbf{v} \mathbf{v} \mathbf{u} + \mathbf{v} \mathbf{v} \text{ matter} + \mathbf{v} \mathbf{v} \text{ } np + \mathbf{v} \text{ } \math$ $Z = (T + T^*)^m + b(T + T^*)^k XX^*$ $V = V_0 + V_{\text{matter}} + V_{np} + \rho X$ also the 'modular weights' *n, m, k* which are expected to be non-positive rational numbers. Particular $V_0 + V_1$ matter $V_1 + V_2$ μ ^{*X*} \blacksquare \overline{r} $\overline{}$ $\begin{array}{c} \textbf{1} \textbf$ α ^x $)$ + \mathbb{R}^2 \overline{c} ($+$ *|*⇢*| K*⁰ $g(T+T^*) + c(T+T^*)^n XX^* + ZCC^* + \cdots$ $W = W_0 + W_{\text{matter}} + W_{np} + \rho X$ $Z =$ $\frac{1}{2}$ $\binom{7}{ }$ \overline{a} @*X* $\binom{1}{k}$ $^{*})^{m}+l$ $\frac{1}{\sqrt{2}}$ *|*⇢*|* μ + $\left(\mathbb{C}^{\ast}\right) ^{k}XX^{\ast}$ *W* = *W*⁰ + *W*matter + *Wnp* + ⇢*X* (1.2)

Plug into SUGRA expression for V, $V = V_{KKLT} + V_{uplift}$: The coecients *c, b* are arbitrary (after absorbing other coecients as field redefinitions of *C*) and 2

$$
V_{\text{uplift}} = \frac{|\rho|^2}{c(T + T^*)^{n+3}}
$$
 (like KKLT, KKLMMT)
Kallosh at al. 2013-15

(like KKLT, KKLMMT)

We are the MX + *MX* + see also Polchinski @ SUSY 2015

Antibrane uplift from manifestly SUSY EFT! @ SUSY 2015 *n* = 8 xee also Polchinski
A pribrane uplift from manifestly SIISV EET! after separation multivary son E¹. Antibrane uplift from manifestly SUSY EFT! see also Polchinski
Antibrane unlift from manifestly SHSY EET! a susy 2015

Anti D3 Brane/O3⁻ Spectrum

Metastability of dS LVS minima

• Brown-Teitelboim (+CdL) D5/NS5 brane nucleation

• AdS: Brane tension>upper bound, so stable in EFT

• dS: Decay rate \sim exp(-V³)

 P_{dS}/P_{AdS} ~ e^{-V} (The larger the volume, more stable!) $P_{\text{ds}}/P_{\text{dec}}$ ~ e^{V^2}

(Also: no evidence for bubble of nothing decay)

S. de Alwis, R. Gupta, E. Hatefi, FQ arXiv:1308.1222

Inflation (moduli as inflatons)

e.g. 1: Swiss Cheese Calabi-Yau's

e.g.

 $M_n^{(dPs)^n}$ $\mathbb{P}_{[1,3,3,3,5]}[15]$ $\mathbb{P}^4_{1,2,2,10,15}(30)$ $\mathbb{P}^4_{1,1,2,2,6}(12)/\mathbb{Z}_2$

Blumenhagen, et al., Grimm et al., Kreuzer et al. 08

Kähler Moduli Inflation (Blow-up)

$$
V \cong V_0 - \frac{4W_0 a_n A_n}{\mathcal{V}^2} \left(\frac{3\mathcal{V}}{4\lambda}\right)^{2/3} \left(\tau_n^c\right)^{4/3} \exp\left[-a_n \left(\frac{3\mathcal{V}}{4\lambda}\right)^{2/3} \left(\tau_n^c\right)^{4/3}\right].
$$

Calabi-Yau: h_{21} > h_{11} >2

Small field inflation (r<<<1) 0.960<n<0.967 Loop corrections??

e.g. 2: Fibre Calabi-Yau

e.g.

 $\mathcal{V} = \lambda_1 t_1 t_2^2 + \lambda_2 t_3^3,$ $\tau_i = \partial \mathcal{V}/\partial t_i,$

 \bullet international depicted, \bullet inflations of the predictions of the first bona-**Overall, string inflation** $\frac{3}{2}$ **models in good shape** $\frac{1}{2}$ **and the light graph** $\frac{1}{2}$ **and the light graph** $\frac{1}{2}$ **and the light graph** $\frac{1}{2}$ **and** $\frac{1}{2}$ **an after Planck 2013-2015** $\begin{bmatrix} \mathbb{R}^d & \mathbb{R}^d \end{bmatrix}$ which di∟er somewhat in the internal find $\frac{1}{8}$ but all find $\frac{1}{8}$ but all find $\frac{1}{8}$

C. Burgess, M. Cicoli, FQ arXiv:1306.3512 two of the string models, 'Axion models, 'Axion monodromy inflation' $\mathcal{S}^{\mathcal{S}}$

Fibre vs Starobinsky Inflation \overline{a} vs Starob insky Infla \overline{a} ³*U*(*e* Let us take the expansion scale for *f*(*R*) to be *M* ⌧ *M^P* . This might be justified if the **Fibre vs Starobinsky Inflation**

- Starobinsky $\alpha = 1$, Fibre $\alpha = 2$. • Starobinsky $\alpha = 1$ Fibre $\alpha = 2$
	- Starobinsky from strings? scale \sim 1.1 \sim 3.1 \sim 3.1 **•** Starobinsky from strings *^M*⁶ *^R*⁴ ⁺ *....* (2.5)

$$
f(R) = R + \frac{a_2}{M^2} R^2 + \frac{a_3}{M^4} R^3 + \frac{a_4}{M^6} R^4 + \dots
$$

$$
V(\phi) = \frac{M^2}{2\kappa^2} e^{-2\sqrt{\frac{2}{3}}\phi} (U_0 + U_1 e^{\sqrt{\frac{2}{3}}\phi} + U_2 e^{2\sqrt{\frac{2}{3}}\phi} + U_3 e^{3\sqrt{\frac{2}{3}}\phi} + \dots
$$

• Fibre very generic: Most known CY are fibrations (Anderson, Gray, et al 2015) Fib $\overline{\mathbf{v}}$ $\frac{1}{2}$ ery general gene ri \sim **1** <mark>(*L*ou de la know</mark> • Fibre very generic: Most known CY are

Summary of Fibre Inflation

- String model of inflation with moduli stabilisation incorporated.
- Similar physics but much better rooted than Starobinsky duals (UV completion, tuning, etc.)

- Multi field generalisations (but only small nongaussianities, Burgess et al 2010, 2012)
- Low l effects, α' inflation, global realisation (Cicoli et al. 2016)

Kahler+Fibre Inflation \mathbf{S} \mathcal{F}_{1} 1300.8 29840.

Stringy realisation of α-attractors

• $\alpha=2$ (fibre inflation) Burgess, Cicoli, FQ (2007)

- α=(VInV)⁻¹ (Kahler blow-up inflation)
• Conlon, FQ (2006) t idu σ i j σ
-

• ...α=(InV)⁻¹ (polyinstanton inflation) Cicoli, Pedro, Tasinato (2011) 10/3 ! COII, Pt ϵ dro,

Inflation: Fibre+Kahler

After Inflation

General prediction

Axion partner of the volume: mass $<$ exp(-volume) $< 10^{-22}$ eV Dark energy or matter and dark radiation

Cosmological Moduli Problem

• Usually moduli masses $= m_{3/2}$

(de Carlos et al 1993, Scrucca-Gomez-Reino 2008)

- And assume soft terms $= m_{3/2}$
- Identify $m_{3/2}=1$ TeV
- But LVS is nongeneric scenario
- Volume modulus mass $\langle m_{3/2} \rangle$
- So CMP more acute than expected!
- Unless $m_{3/2}$ >> 1TeV

2. Moduli can cause cosmological problems: **Cosmological Moduli 'Problem'**

 8π

 $M_{\rm Pl}^2$

Coughlan et al 1983, Banks et al, de Carlos et al 1993

e.g. After Kahler Inflation towards the local minimum and not to the decompactification minimum after inflation. We at the end of inflation. Making generic assumptions regarding the reheating epoch, change in the energy density of the universe during inflation and the scale of inflation, ref. [7] used (1 3*w*re)*N*re ⇡ 57 + ln *r* + er na *,* (2.4) with the volume modulus organizations of the volume of in (3.22). To determine the Hubble constant at *t*eq, first note that (4.21) can be used to

Explicit computation of Vacuum misalignement Explicit computation of Vacuum misalianement (2.2) to find the following preferred range for *N^e* in the standard cosmological timeline: **Explicit computation of vacuum misaligne** *H*(*t*2) = *H*(*t*1) auon or vacuum misang

$$
Y = \frac{\delta \varphi}{M_{\rm pl}} = \sqrt{\frac{2}{3}} \delta \phi \simeq 2\sqrt{\frac{2}{3}} R \phi_* \simeq 0.1 - 1
$$
 Maharana
arXiv:16

 ϵ (reflux)

 $R\phi_* \simeq 0.1 - 1$ *Maharana*, FQ ¹⁰1*/*2*V*1*/*² *.* (4.23) M.Cicoli, K. Dutta, A. arXiv:1604.08512

Number of efoldings and use (3.9) to obtain the shift in this consistency condition to the modulus of the shift in thi section, finding the relationships of the relationship **Sumber of efoldings:**

$$
N_e + \frac{1}{4}N_{\text{mod}} + \frac{1}{4}(1 - 3w_{\text{re}})N_{\text{re}} \approx 57 + \frac{1}{4}\ln r + \frac{1}{4}\ln\left(\frac{\rho_*}{\rho_{\text{end}}}\right)_{\text{tag,4}}
$$

$$
\left(55 - \frac{1}{4}N_{\text{mod}}\right) \pm 5
$$

$$
N_{\text{mod}2} \approx \frac{2}{3}\ln\left(\frac{16\pi \mathcal{V}^{5/2}(\ln \mathcal{V})^{5/2}Y^4}{10\beta^2}\right)
$$

$$
N_e \simeq 44.65 + \frac{1}{4}\ln\left(\frac{\rho_*}{\rho_{\text{end}}}\right) \simeq 45 \qquad n_s \simeq 0.955.
$$

Thermal History

Alternative History

From S. Watson, SUSY 2013

Volume Reheating*

***Sequestered scenarios**

M.Cicoli, J.P. Conlon, FQ arXiv:1208.3562 T. Higaki, F.Takahashi arXiv:1208.3563

$$
\Gamma_{\Phi \to a_b a_b} = \frac{1}{48\pi} \frac{m_{\Phi}^3}{M_P^2}.
$$
\n
$$
\Gamma_{\Phi \to H_u H_d} = \frac{2Z^2}{48\pi} \frac{m_{\Phi}^3}{M_P^2}
$$
\n
$$
\Gamma_{\Phi \to BB} = \left(\frac{\lambda}{3/2}\right)^2 \frac{9}{16} \frac{1}{48\pi} \frac{m_{\Phi}^3}{M_P^2}
$$
\n
$$
\Gamma_{\Phi \to C\bar{C}} \sim \frac{m_0^2 m_{\Phi}}{M_P^2} \ll \frac{m_{\Phi}^3}{M_P^2}
$$
\nMatter scalars C

\n
$$
\Gamma_{\Phi \to C\bar{C}} \sim \frac{m_{\Phi}^3}{M_P^2} \sim 0.6 \text{ GeV} \left(\frac{m_{\Phi}}{10^6 \text{GeV}}\right)^{3/2}.
$$

Dark Radiation mechanism responsible for achieving a decay channels which channels whic

Energy density:

$$
\rho_{total} = \rho_\gamma \left(1 + \frac{7}{8} \left(\frac{4}{11} \right)^{4/3} N_{eff} \right).
$$

Standard Model N_{eff} =3.04 α split Sustainable cases superiories since the decay channel to α

At CMB: WMAP, ACT, SPT $h \in G$ is the inclusion of \mathcal{L}^{max} corrections to the K¨ahler potential gives rise rise rise rise rise. the cond. While, decay channel to SUSY scalars opens up to SUSY scalars opens up to SUSY scalars opens up, leading to SUSY scalars opens up to SUSY scalars opens up, the subsequent of the subsequent opens up to SUSY scalar

3.12
$$
\kappa \le \Delta N_{eff} \le 3.48 \kappa
$$

\n $\kappa = (1 + 9n_a/16)/n_H Z^2$ \n6.14 $\lesssim \Delta N_{eff} \lesssim 1.6$

Simplest Z=1: a significant reduction of data radiation of data radiation. In this case, the simplest $Z=1$:

General: Strong constraints on $3.12 \kappa \leq \Delta N_{eff} \leq 3.48 \kappa$ matter and couplings! $1.56 \leq \Delta N_{eff} \leq 1.74$

$$
0.14\,\lesssim\,\Delta N_{\rm eff}\,\lesssim\,1.6
$$

lowed. Interestingly dark radiation over production over the absence of also in the absence of absenc Cicoli+Muia 2016

MSSM: Non-thermal Higgsino DM

Model independent indirect search 300-600 GeV Higgsinos all others multi TeV

CONCLUSIONS

- Several stringy (EFT) de Sitter scenarios
- Several inflationary scenarios with concrete predictions (blow-up: r<<1, low-energyy SUSY, loops? Fibre: r<0.01, too large SUSY scale)
- CMP: after inflation signature of strings (e.g. dark) radiation, non-thermal MSSM,...)
- Most known ingredients used (stringy vs simplicity): geometry, fluxes, branes, perturbative, non-perturbative effects

De Sitter 3:

DILATON DEPENDENT NON-PERTURBATIVE EFFECTS (ON LVS)

Hidden Sector on Hidden **Branes@Singularities** p_{1} to the scalar potential of order $\frac{1}{2}$ 1/4, and therefore can be safely neglected. The safely neglected. The safely neglected $\frac{1}{2}$ **Similarly four finally fixed at Algebra** $\mathcal{S}\in \mathcal{C}$ and $\mathcal{S}\in \mathcal{C}$ Hidden **Branes@Singularities**

Hidden

$$
W_{\rm np} = A e^{-aT} + B e^{-b(S+hQ)}
$$

 $V = V_{LVS} + V_{up}$ $V = V \longrightarrow V$

$$
V_{\rm up} \propto h^2 \, \frac{e^{-2b\langle s \rangle}}{\mathcal{V}} \, ,
$$

Not explicit CY realisation yet

CONCRETE COMPACT CY

Enhancing the value of r?

$$
V \simeq \frac{\mathcal{C}_2}{\langle \mathcal{V} \rangle^{10/3}} \left[(3 - R) - 4 \left(1 + \frac{1}{6} R \right) e^{-\kappa \hat{\varphi}/2} + \left(1 + \frac{2}{3} R \right) e^{-2\kappa \hat{\varphi}} + R e^{\kappa \hat{\varphi}} \right]
$$

Re << 1

• $n_s = 0.98$ and r=0.01 for $N_e \simeq 50$

• $n_s = 0.99$ and r=0.01 for $N_e \simeq 60$

May need Neff>3.04?

Comments on α-attractors *<u>D</u> α-attering* $\frac{1}{2}$ r *actors* There is a set of the set of the Kallosh and Linde Comments on d-attractors Ω simple case of Ω ^{thractor</sub>} inflaton field inflaton field the following values of the following values of the cosmological observables in \mathbb{R}

Kallosh and Linde

e.g. Non-Thermal Dark-Matter (MSSM)

- KKLT: gravitino decay
- KKLT: D7 Higgsino overproduction
- KKLT:D3 small region allowed Higgsino DM
- LVS: Volume decay
- LVS:D7 Higgsino overproduction
- LVS: D3: allowed region to be constrained by 1Ton (Xenon, CTA) and 100TeV (not LHC).

L. Aparicio, M. Cicoli, B Dutta, F. Muia + FQ arXiv:1607.00004