A flux-scaling scenario for moduli stabilization and dS vacua

Anamaría Font V.

Universidad Central de Venezuela

in collaboration with:

R. Blumenhagen, D. Herschmann, M. Fuchs, E. Plauschinn, Y. Sekiguchi, F. Wolf. Nucl.Phys. B897 (2015) 500

R. Blumenhagen, C. Damian, D. Herschmann, R. Sun. arXiv 1510.01522

The First Millenium

The origins, 1956-1979

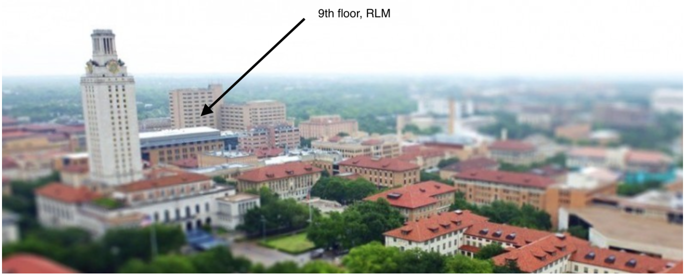
The origins, 1956-1979

TE
UVG Quevedo Rodríguez, Fernando de la Trinidad
FIS Grupos de simetría en física de partículas. -
.Q6 Guatemala : U.V.G, 1979.
1979 173 p. - (UVG-Tesis).
Tesis (licenciatura en física)--Universidad del
Valle de Guatemala, Facultad de Ciencias y
Humanidades.
1. Partículas (Física nuclear) 2. Simetría
(Física)

The origins, 1956-1979

The Austin years, 1981-1986

TEXAS
The University of Texas at Austin



THE PROPAGATOR

A newsletter of the Department of Physics
The University of Texas at Austin
Austin, Texas 78712
Winter, 1982

NOBEL LAUREATE

Steven Weinberg now permanent faculty member

Nobel laureate Steven Weinberg is now a permanent member of the UT Physics faculty. Dr. Weinberg has been designated a Regen-

into 15 languages. His best known scholarly publication is *Gravitation and Cosmology: Principles and Applications of the*

Many good courses

Lectures on Quantum Field Theory

Physics 389M

Fall 1982

University of Texas at Austin

© Steven Weinberg 1982

Many BBQs and happy hours . . .

Many BBQs and happy hours . . .

photo courtesy Elisa Quevedo

Summer schools

TASI, Ann Arbor, 1984

Summer schools

TASI, Ann Arbor, 1984

Summer schools

TASI, Yale, 1985

Summer schools

TASI, Yale, 1985

Fernando's first string phenomenology paper

Nuclear Physics B272 (1986) 661–676
North-Holland, Amsterdam

LOW-ENERGY EFFECTIVE ACTION FOR THE SUPERSTRING

C.P. BURGESS[1]

Institute for Advanced Study, Princeton, NJ 08540, USA

A. FONT[2]

Center for Particle Theory, University of Texas at Austin, Austin, TX 78712, USA

F. QUEVEDO[3]

Theory Group, University of Texas at Austin, Austin, TX 78712, USA

Received 2 December 1985

We construct the low-energy $D = 4$, $N = 1$ supergravity that arises in superstring theories for an arbitrary number of generations. The couplings of all massless modes that carry low-energy gauge quantum numbers are calculated by truncating the heavy Kaluza-Klein modes of the ten-dimensional effective field theory. The resulting action is compared to the most general effective action compatible with the symmetries of the underlying ten-dimensional field (and string) theories. This comparison indicates which features of the truncation correctly approximate the exact low-energy action.

Graduation, 1986

Topics In Supergravity And Superstring Phenomenology

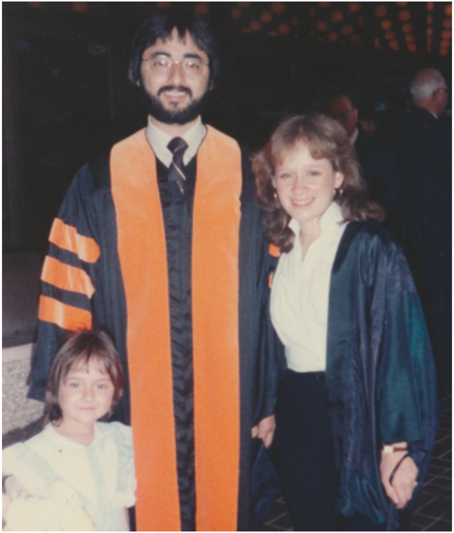
Fernando Quevedo Rodriguez (Texas U.)

May 1986 - 84 pages

UMI-86-18568

Note: Ph.D. Thesis
Keyword(s): INSPIRE: THESIS

Graduation, 1986



Austin, May 1986

Orbifolds, 1987-1989

Volume 217, number 3 PHYSICS LETTERS B 26 January 1989

$Z_N \times Z_M$ ORBIFOLDS AND DISCRETE TORSION

A. FONT
LAPP, B.P. 909, F-74019 Annecy-le-Vieux, France

L.E. IBÁÑEZ
CERN, CH-1211 Geneva 23, Switzerland

and

F. QUEVEDO
Department of Physics, McGill University, Montreal, PQH3A 2T8, Canada

Received 1 November 1988

We extend previous work on Z_N-orbifolds to the general $Z_N \times Z_M$ abelian case for both (2, 2) and (0, 2) models. We classify the corresponding (2, 2) compactifications and show that a number of models obtained by tensoring minimal $N=2$ superconformal theories can be constructed as $Z_N \times Z_M$-orbifolds. Futhermore, $Z_N \times Z_M$-orbifolds allow the addition of discrete torsion which leads to new (2, 2) compactifications not considered previously. Some of the latter have negative Euler characteristic and Betti numbers equal to those of some complete intersection Calabi–Yau (CICY) manifolds. This suggests the existence of a previously overlooked connection between CICY models and orbifolds.

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Table 1
$Z_N \times Z_M$-orbifolds. Here $\alpha = \pm 2\pi/3$ and $\beta = \pm 2\pi/6$. $N=2$ superconformal models with similar massless spectrum are shown in the last column.

Model #	Orbifold	a	b	ε	$\chi/2$	$N_{\overline{27}}$	N_{27}	$N=2$ cand.
0	$Z'_6 \equiv Z_2 \times Z_3$	$(\frac{1}{2}, 0, -\frac{1}{2})$	$(0, \frac{1}{3}, -\frac{1}{3})$	1	24	11	35	$1^4\, 2^2\, 4$ $1^3\, 2\, 4(-10)$
1	$Z_2 \times Z_2$	$(\frac{1}{2}, 0, -\frac{1}{2})$	$(0, \frac{1}{2}, -\frac{1}{2})$	1	48	3	51	$1^2\, 2^2\, 4^2$ $1\, 2\, 4^2(-10)$
2				-1	-48	51	3	$4^2(-10)^2$

mirror pair

Dualities, 1990's

Volume 249, number 1 PHYSICS LETTERS B 11 October 1990

Strong–weak coupling duality and non-perturbative effects in string theory

A. Font [a], L.E. Ibáñez [b], D. Lüst [b] and F. Quevedo [c]

[a] Departamento de Fisica, Universita Central de Venezuela, Aptdo 20513, Caracas 1020-A, Venezuela
[b] CERN, CH-1211 Geneva 23, Switzerland
[c] Theoretical Division LANL, Los Alamos, NM 87545, USA

Received 13 July 1990

We conjecture the existence of a new discrete symmetry of the modular type relating weak and strong coupling in string theory. The existence of this symmetry would strongly constrain the non-perturbative behaviour in string partition functions and introduces the notion of a maximal (minimal) coupling constant. An effective lagrangian analysis suggests that the dilaton vacuum expectation value is dynamically fixed to be of order one In supersymmetric heterotic strings, supersymmetry (as well as this modular symmetry itself) is generically spontaneously broken

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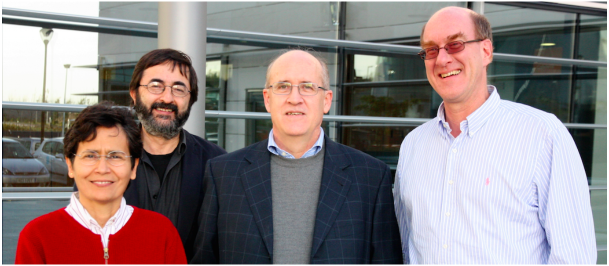

S-duality Quartet, Madrid, December 2011

On the family front, three lovely daughters

Geneva, September 1990

ICTP Prize Winners 1998

Anamaria Font, Miguel Virasoro and Fernando Quevedo

Anamaria Font
Fernando Quevedo

The ICTP Prize in the field of High Energy Physics (in honour of Professor Chen Ning Yang) has been awarded jointly to Anamaria Font from Universidad Central de Venezuela, Caracas, Venezuela, and Fernando Quevedo from Universidad Nacional Autonoma de Mexico (UNAM), Mexico D.F., Mexico,

for their contribution to the phenomenological studies in superstring theory based on orbifold compactifications and many works on Calabi-Yau compactifications, mirror symmetry and duality symmetries. These works have contributed to a greater understanding of the low energy string physics, as well as various stringy symmetries. In particular, the important concept of S-duality has been introduced by them and their collaborators.

The Second Millenium

Bottom-up, LVS, string inflation, dS, . . .

In Cambridge, Elisa Quevedo

Bottom-up, LVS, string inflation, dS, . . .

In Trieste

CSRs

Fortschr. Phys. **62**, No. 11 – 12, 975 – 980 (2014) / **DOI** 10.1002/prop.201400067

A comment on continuous spin representations of the Poincaré group and perturbative string theory

Anamaría Font[1,*], **Fernando Quevedo**[2,3,**], and **Stefan Theisen**[4,***]

[1] Departamento de Física, Centro de Física Teórica y Computacional, Facultad de Ciencias, Universidad Central de Venezuela, A.P. 20513, Caracas 1020-A, Venezuela
[2] Abdus Salam ICTP, Strada Costiera 11, Trieste 34014, Italy
[3] DAMTP/CMS, University of Cambridge, Wilberforce Road, Cambridge CB3 0WA, UK
[4] Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, 14476 Golm, Germany

Received 17 September 2014, accepted 17 September 2014
Published online 16 October 2014

Key words Poincaré group, perturbative string theory.

We make a simple observation that the massless continuous spin representations of the Poincaré group are not present in perturbative string theory constructions. This represents one of the very few model-independent low-energy consequences of these models.

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No continuous spin representations in perturbative string theory

Generic prediction !

A flux-scaling scenario for moduli stabilization and dS vacua

based on Nucl.Phys. B897 (2015) 500, arXiv 1510.01522

in with R. Blumenhagen, C. Damian, D. Herschmann, M. Fuchs, E. Plauschinn, R. Sun, Y. Sekiguchi, F. Wolf

Outline

- Introduction
- Flux-scaling scenario
  - Generalized superpotential
  - Criteria for moduli stabilization
  - Example
  - Results
- Minkowski and de Sitter vacua
- Summary and final comments

F. Quevedo, COSMO 2015

This talk Mostly

- **Getting de Sitter**
- **Getting inflation**

Crucial issue: Moduli stabilisation

(concentrate on IIB strings: KKLT, LVS)

A. Font, Quevedo Fest 2016

This talk Mostly

Crucial issue: Moduli stabilisation

(concentrate on IIB strings: ~~KKLT, LVS~~)

with geometric and non-geometric fluxes

- **Getting de Sitter**
- **Getting inflation** (only comments)

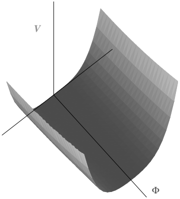
Introduction

fluxes: non-trivial backgrounds for field strengths

e.g. NS-NS: $\int_{\Pi_3} \langle H \rangle = h \neq 0$; R-R: $\int_{\Pi_3} \langle \mathfrak{F} \rangle = \mathfrak{f} \neq 0$ $\quad \Pi_3$: internal 3-cycle

can be used to

- ▷ fix moduli, i.e. $\langle \Phi \rangle$, in the $4d$ effective theory



Φ : massless scalar with flat potential

$\exists$ in generic standard compactifications

- ▷ trigger supersymmetry breaking
- ▷ induce axion monodromy inflation
- ▷ ...

moduli Φ

typical: axiodilaton S, Kähler (size) T, complex structure (shape) U

in $\mathcal{N}=1$, $S, T, U \in$ chiral multiplets, $\mathrm{Re}\ \Phi$: saxion, $\mathrm{Im}\ \Phi$: axion

it is necessary to fix $\langle \Phi \rangle$

to avoid fifth forces

gauge couplings determined by vevs, $\frac{1}{g_{\mathrm{YM}}^2} \sim \mathrm{Re}\langle aS + bT + cU \rangle$

first attempt to fix S (heterotic): $W = h + ce^{-\gamma S}$ Dine, Rohm, Seiberg, Witten

more modern (IIB): $W = W_{\mathrm{flux}}(S, U) + W_{\mathrm{np}}(T) = W_{\mathrm{flux}} + ce^{-\gamma T}$

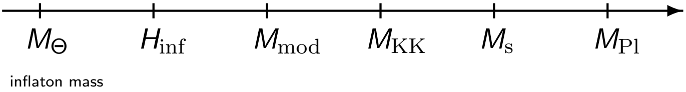
KKLT, Kachru, Kallosh,Linde,Trivedi ; Large Volume Scenario, Balasubramanian,Berglund,Conlon,Quevedo

in KKLT, LVS $M_T \ll M_{S,U}$

Idea

combine moduli stabilization and axion monodromy inflation

in string scenario with



to obtain $M_{\rm mod} > M_\Theta$, fix all S, U, T, moduli at tree level

it can be done using non-geometric fluxes !

Flux-scaling scenario

flux induced moduli potentials in 4*d*

$$\mathcal{S} = \frac{1}{\ell_s^8} \int d^{10}x \, \sqrt{-G} \, \Big\{ e^{-2\varphi} \big[\mathcal{R} - H^2 \big] - \textstyle\sum_n \mathfrak{F}_n^2 + \cdots \Big\}$$

$$\int_{\Pi_3} \langle H \rangle = h \qquad \Rightarrow \qquad V = \frac{h^2 e^{2\varphi}}{R^{12}} \qquad \Rightarrow \qquad W = \begin{cases} h & \text{heterotic} \\ hS & \text{orientifolds} \end{cases}$$

superpotentials in $\mathcal{N}=1$ type II orientifolds with NS-NS and R-R fluxes

$$\text{IIB} \quad \begin{matrix} \int_{\Pi_3} \langle H \rangle \\ \int_{\Pi_3} \langle \mathfrak{F} \rangle \end{matrix} \quad \Rightarrow \quad W(S,U) \qquad ; \qquad \text{IIA} \quad \begin{matrix} \int_{\Pi_3} \langle H \rangle \\ \int_{\Pi_{2m}} \langle \mathfrak{F}_{2m} \rangle \end{matrix} \quad \Rightarrow \quad W(S,U,T)$$

to recover T-duality introduce non-geometric fluxes   Shelton, Taylor, Wecht

$$H \xleftrightarrow{T} F \xleftrightarrow{T} Q \xleftrightarrow{T} R$$

$*$ $\mathcal{N}=1$ V_{F} from W and Kähler potential K: $V_{\mathrm{F}} = e^K \Big\{ K^{I\bar{J}} D_I W D_{\bar{J}} \overline{W} - 3 \big| W \big|^2 \Big\}$

Generalized superpotential I

Aldazabal, Cámara, A.F., Ibáñez;
Graña, Louis, Waldram; Benmachiche, Grimm

IIB orientifolds on Calabi-Yau 3-fold $\mathcal{M}$ characterized by $(J, \Omega, h^{2,1}_{\pm}, h^{1,1}_{\pm})$

W generalizes $\int_{\mathcal{M}} (\mathfrak{F} - iSH) \wedge \Omega$ Gukov, Vafa, Witten

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$$W = \int_{\mathcal{M}} (\mathfrak{F} + \mathcal{D}\Phi_c) \wedge \Omega\,, \quad \Phi_c = iS - iT_\alpha \sigma^\alpha - iG^a \omega_a\ ; \quad \alpha = 1, \cdots, h^{1,1}_{+}$$

$$a = 1, \cdots, h^{1,1}_{-}$$

$$\Omega = X^\lambda \alpha_\lambda - \mathcal{F}_\lambda \beta^\lambda\,,\ \mathcal{F}_\lambda = \partial_\lambda \mathcal{F}\,, \quad \mathcal{F} : \text{prepotential}\ ; \quad \lambda = 0, \cdots, h^{2,1}_{-}$$

$$U^i = -i\frac{X^i}{X^0}\,; \quad i = 1, \cdots, h^{2,1}_{-}$$

Generalized superpotential I

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$$U^i = -i\frac{X^i}{X^0}\ ; \qquad i = 1, \cdots, h^{2,1}_-$$

$$\mathcal{D} = d - H\wedge\ - F\circ\ - Q\bullet\ - R\llcorner \qquad \begin{cases} F\circ & : & p\text{-form} & \to & (p+1)\text{-form} \\ Q\bullet & : & p\text{-form} & \to & (p-1)\text{-form} \\ R\llcorner & : & p\text{-form} & \to & (p-3)\text{-form} \end{cases}$$

e.g. on 4-form: $\mathcal{D}\sigma^\alpha = -\tilde{q}^{\lambda\,\alpha}\alpha_\lambda + q_\lambda{}^\alpha \beta^\lambda$ $\qquad \tilde{q}, q$: non-geometric fluxes

$\mathcal{D}^2 = 0 \Rightarrow$ Bianchi identities, e.g. $\quad \tilde{q}^{\lambda\,\alpha} q_\lambda{}^\beta - q_\lambda{}^\alpha \tilde{q}^{\lambda\,\beta} = 0$

Generalized superpotential II

$$W = \int_{\mathcal{M}} \Big[\mathfrak{F} - i\,S\,H + i\,T_\alpha \left(Q \bullet \sigma^\alpha\right) + i\,G^a \left(F \circ \omega_a\right) \Big] \wedge \Omega = W(S, U, T, G)$$

$$= -\left(\mathfrak{f}_\lambda X^\lambda - \tilde{\mathfrak{f}}^\lambda \mathcal{F}_\lambda\right) \;+\; iS\left(h_\lambda X^\lambda - \tilde{h}^\lambda \mathcal{F}_\lambda\right)$$

$$+\, iT_\alpha\left({q_\lambda}^\alpha X^\lambda - \tilde{q}^{\lambda\,\alpha}\mathcal{F}_\lambda\right) \;+\; iG^a\left(f_{\lambda\,a} X^\lambda - \tilde{f}^{\lambda}_{\;a}\mathcal{F}_\lambda\right)$$

Kähler potential Grimm, Louis

$$K = -\log\left(-i\int_{\mathcal{M}} \Omega \wedge \overline{\Omega}\right) - \log\left(S + \overline{S}\right) - 2\log\mathcal{V}$$

$$\mathcal{V} = \frac{1}{6} e^{-3\phi/2} \int_{\mathcal{M}} J \wedge J \wedge J$$

Flux induced R-R tadpoles

$$N^{\rm flux}_{\rm D3} = \int_{\mathcal{M}} H \wedge \mathfrak{F} \quad ; \quad \left[N^{\rm flux}_{\rm D7}\right]^\alpha = -\int_{\mathcal{M}} \left(Q \bullet \sigma^\alpha\right) \wedge \mathfrak{F} \quad ; \quad \text{also } \left[N^{\rm flux}_{\rm D5}\right]_a$$

Criteria for moduli stabilization

- supersymmetric minima with unconstrained axions have tachyons Conlon
  thus, search for non-supersymmetric minima with saxions stabilized in perturbative regime (weak string coupling, large radius)
- only axions can remain massless
- values of $\langle \Phi \rangle$ and M_{mod} are parametrically controlled by adjusting fluxes
- mass of lightest massive axion (inflaton candidate) is parametrically or numerically controlled
- require $M_{\mathrm{mod}} < M_{\mathrm{KK}}, M_s$

STU **Example**, $h^{2,1}_{-} = 1,\ h^{1,1}_{+} = 1$

$$K = -\log\left(S + \overline{S}\right) - 3\log\left(T + \overline{T}\right) - 3\log\left(U + \overline{U}\right)$$

$$W = -\mathfrak{f} - 3\tilde{\mathfrak{f}}U^2 - h\,U\,S - q\,U\,T$$

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stable AdS non-supersymmetric minimum with flux scaling

axions: $\mathrm{Im}\,U = 0, \quad h\mathrm{Im}\,S + q\mathrm{Im}\,T = 0$

saxions: $\mathrm{Re}\,T = -15\,\dfrac{\tilde{\mathfrak{f}}}{q}\,v\,, \quad \mathrm{Re}\,S = -12\,\dfrac{\tilde{\mathfrak{f}}}{h}\,v\,, \quad (\mathrm{Re}\,U)^2 = v^2 = \dfrac{1}{3\sqrt{10}}\,\dfrac{\mathfrak{f}}{\tilde{\mathfrak{f}}}$

$q < 0\,,\ h < 0\,,\ \mathfrak{f} > 0\,,\ \tilde{\mathfrak{f}} > 0\,, \qquad \mathfrak{f} \gg \tilde{\mathfrak{f}}\ \Rightarrow\ \mathrm{Re}\,T, \mathrm{Re}\,S > 1$

STU **Example**, $h^{2,1}_- = 1,\ h^{1,1}_+ = 1$

$$K = -\log\left(S+\overline{S}\right) - 3\log\left(T+\overline{T}\right) - 3\log\left(U+\overline{U}\right)$$

$$W = -\mathfrak{f} - 3\tilde{\mathfrak{f}}U^2 - h\,U\,S - q\,U\,T$$

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mass scales

$$M^2_{\rm mod} = \mu\,\frac{M^2_{\rm Pl}}{4\pi\cdot 2^7}\,\frac{h|q|^3}{\mathfrak{f}^{\frac{3}{2}}\,\tilde{\mathfrak{f}}^{\frac{1}{2}}}\,, \quad \mu \approx \left(2.1,\ 0.37,\ 0.25\,;1.3,\ 0.013,\ 0\right)\,, \quad M_{3/2} \sim M_{\rm mod}$$

$$\frac{M^2_{\rm s}}{M^2_{\rm KK}} = 62.5\left(\frac{h}{q}\right)^{\frac{1}{2}}\,, \quad \frac{M^2_{\rm mod}}{M^2_{\rm KK}} \sim h\,q\left(\frac{\tilde{\mathfrak{f}}}{\mathfrak{f}}\right)^{\frac{1}{2}}\,, \quad M_{\rm Pl} \underset{p}{\gtrsim} M_{\rm s} \underset{p}{\gtrsim} M_{\rm KK} \underset{p}{\gtrsim} M_{\rm mod}$$

Some general results

- analyzed several models with non-supersymmetric flux-scaling extrema, also including more T's and odd Kähler G's
- not always possible to have $M_{\mathrm{mod}} < M_{\mathrm{KK}}$

Some general results

- analyzed several models with non-supersymmetric flux-scaling extrema, also including more T's and odd Kähler G's
- not always possible to have $M_{\rm mod} < M_{\rm KK}$
- when $h^{1,1} > 1$ new tachyons appear but can be lifted by a D-term potential due to magnetized D7-branes wrapping Σ_4

$$V_{\rm D} = \frac{M_{\rm Pl}^4}{2{\rm Re}(f)}\xi^2\,, \qquad \xi = \frac{1}{\mathcal{V}}\int_{\Sigma_4} J \wedge c_1(L) \qquad \text{FI depends on } T_\alpha$$

Freed-Witten condition $\Rightarrow$ $\xi = 0$ at the AdS supersymmetric minimum

$\xi = 0$ also at AdS non-supersymmetric extremum with same ratios of vevs

extremum is not shifted but negative mass of Kähler tachyon is uplifted

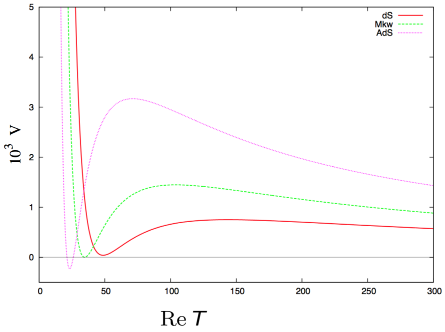
Minkowski and de Sitter vacua I

via Q-fluxes only — de Carlos, Guarino, Moreno; Blabäck, Danielsson, Dibitetto

in STU models need at least 2 non-geometric fluxes

$$W = -qT(U - U^3) + iS(\epsilon_2 + 3i\epsilon_1 U + 3\epsilon_2 U^2 + i\epsilon_1 U^3) \qquad \mathfrak{so}(3,1)^{\oplus 2}$$
$$-\xi_3(\epsilon_1 - 3i\epsilon_2 U + 3\epsilon_1 U^2 - i\epsilon_2 U^3) - q\xi_7(1 - U^2)$$

de Carlos, Guarino, Moreno



$q = -3, \epsilon_1 = 1, \xi_3 = 1, \xi_7 = 16$

$\epsilon_2 = 45$ AdS

$\epsilon_2 = 44$ dS

no flux-scaling

lightest mode is saxion

Minkowski and de Sitter vacua II

via anti D3-branes KKLT, KKLMMT

$$V_{\rm up} = \frac{A}{\mathcal{V}^{\frac{4}{3}}}\,, \quad \text{for } \overline{\rm D3} \text{ on warped throat}$$

STU example: $W = -ifU + ih_0 S - 3ihSU^2 - iqT$

without $V_{\rm up}$, non-tachyonic susy AdS with flux scaling

$${\rm Re}\, T = -\frac{5^{\frac{1}{2}} f}{2q}\left(\frac{h_0}{h}\right)^{\frac{1}{2}}, \ldots$$

with $V_{\rm up}$, **new** stable non-susy Minkowski with flux scaling

$${\rm Re}\, T = \frac{f}{3^{\frac{1}{4}} q}\left(\frac{h_0}{h}\right)^{\frac{1}{2}}, \ldots \qquad ; \qquad A = A_{\rm Mink} = \frac{3^{\frac{1}{4}}}{2} qh \left(\frac{h}{h_0}\right)^{\frac{1}{2}}$$

taking $A > A_{\rm Mink}$ leads to dS, lightest mode is saxionic

Minkowski and de Sitter vacua III

via D-terms from $U(1)_{\hat{\lambda}}$ multiplets, $\hat{\lambda} = 1, \cdots, h_+^{2,1}$ Robbins, Wrase

$$V_{\mathrm{D}} = \left[(\mathrm{Re}\, f)^{-1}\right]^{\hat{\lambda}\hat{\sigma}} D_{\hat{\lambda}} D_{\hat{\sigma}}\,, \qquad D_{\hat{\lambda}} = i\partial_I K\, \delta_{\hat{\lambda}} \Phi^I$$

flux dependence from $\delta\Phi^I = \xi^{\hat{\lambda}} \delta_{\hat{\lambda}} \Phi^I$, e.g. for $h_-^{1,1} = 0$

$$D_{\hat{\lambda}} = \frac{1}{\mathcal{V}} \left(f_{\hat{\lambda}\alpha}\, t^{\alpha} - r_{\hat{\lambda}}\, e^{\varphi} \mathcal{V} \right)\,, \qquad \mathcal{V} = \tfrac{1}{6} \kappa_{\alpha\beta\gamma} t^{\alpha} t^{\beta} t^{\gamma}\,, \quad T_{\alpha} = \tfrac{1}{2} \kappa_{\alpha\beta\gamma} t^{\beta} t^{\gamma} + \cdots$$

geometric F-flux R-flux

$D_{\hat{\lambda}}$ depends on S and T, gauge kinetic function f depends on U

Minkowski and de Sitter vacua III

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flux dependence from $\delta\Phi^I = \xi^{\hat\lambda}\delta_{\hat\lambda}\Phi^I$, e.g. for $h_-^{1,1} = 0$

$$D_{\hat\lambda} = \frac{1}{\mathcal{V}}\Big(\underbrace{f_{\hat\lambda\alpha}}_{\text{geometric F-flux}}\, t^\alpha - \underbrace{r_{\hat\lambda}}_{\text{R-flux}}\, e^\varphi \mathcal{V}\Big)\,, \qquad \mathcal{V} = \tfrac{1}{6}\kappa_{\alpha\beta\gamma}t^\alpha t^\beta t^\gamma\,, \quad T_\alpha = \tfrac{1}{2}\kappa_{\alpha\beta\gamma}t^\beta t^\gamma + \cdots$$

$D_{\hat\lambda}$ depends on S and T, gauge kinetic function f depends on U

toy ex. $h_+^{2,1} = 1$: $f = cU,\ W = i\mathfrak{f}U + i\tilde{\mathfrak{f}}U^3 - ihS + iqT,\ V_{\rm D} = \frac{f_{\hat 11}^2}{c\, U_{\rm R}\, T_{\rm R}^2}\left(3 + \frac{q}{h}\frac{T_{\rm R}}{S_{\rm R}}\right)^2$

$V = V_{\rm F} + V_{\rm D}$ admits Mink. vacuum with massless axion $\to$ inflaton candidate Θ

Θ becomes massive at 2nd stage, $W' = \lambda W + \Delta W$ $\qquad \lambda \gg 1$

$M_{\rm KK} > M_{\rm mod} > M_\Theta$ requires fractional fluxes

$\downarrow$

can arise from polynomial corrections to prepotential

Summary and Final Comments

- Using non-geometric fluxes, constructed non-susy non-tachyonic models with all moduli, except some axions, stabilized in AdS. Moduli vevs and masses can be controlled by flux scaling but there is tension with $M_{\rm mod} < M_{\rm KK}$.

- Minkowski and dS flux-scaling vacua can be achieved via $\overline{\rm D3}$ or D-term uplift.

- Natural set-up for F-term axion monodromy inflation.

- $10d$ origin of $\mathcal{N}=1$, $4d$ scalar potential with non-geometric fluxes
Blumenhagen, A.F., Plauschinn

  ⋆ Dimensional reduction of double field theory on a Calabi-Yau 3-fold with small fluxes gives scalar potential of $\mathcal{N}=2$, $4d$ gauged supergravity of D'Auria, Ferrara, Trigiante.

  ⋆ Upon orientifold projection, $\mathcal{N}=2 \to \mathcal{N}=1$, $V = V_{\rm F} + V_{\rm D} + V_{\rm tad}$

Happy 60th Birthday !

Best wishes for the future.

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Best wishes for the future.

Especially, . . .

wish you success with the crusades

wish you success with the crusades

String Phenomenologists:

Strategic (long term) Plan:

String theory scenario that satisfies all particle physics and cosmological observations and hopefully lead to measurable predictions

F. Quevedo, PASCOS 2011

wish you success with the crusades

The Abdus Salam
International Centre
for Theoretical Physics

IAEA

In line with the dramatic geo-economic changes taking place, we are now entering a new phase in which ICTP should take a leading role in promoting better working conditions for scientists in the developing world. We aspire to assist science policy makers and scientists of these countries in the creation of local centres of excellence and active scientific networks. In order to confront these new challenges, ICTP will collaborate with scientists in emerging countries, assisting in this way the poorest regions in Africa, Latin America and Asia whilst, simultaneously, strengthening and broadening the research activities of our Centre.

Greetings from ICTP Director Fernando Quevedo

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Thanks !