A moduli stabilisation scheme

motivated by large field inflation

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1605.06299 with **R. Blumenhagen** and **F. Wolf**

1510.01522 with R. Blumenhagen, C. Damian, A. Font and **R. Sun**
1503.07634 with R. Blumenhagen, A. Font, M. Fuchs, E. Plauschinn,Y. Sekiguchi and F. Wolf

Outline

Axion monodromy inflation

★ at the large complex structure point

★ with non-geometric fluxes

R. Sun's talk

Aligned inflation

★ near the conifold point

R. Blumenhagen's talk

F. Wolf's talk

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here: basic construction

Flux-scaling vacua

the simplest class of flux vacua you can imagine

Flux-scaling vacua

take a Kähler potential which preserves axionic shift symmetry

large complex structure

$$K = -\log(S+S) - \log f(\Re[X])$$

conifold e.g. $\mathbb{P}^{11226}[12]$

$$K_{c.s.} = -\log\left(\frac{1}{2\pi}|Z|^2 \log|Z|^2 + C|Z|^2 + A + \Re Y + B\,\Re Y^2\right)$$

[Garcia-Extebarria, Grimm, Valenzuela]

Flux-scaling vacua

take a superpotential which does not depend on all axions

$$W = f + h\,S + g\,U + q\,T + ..$$

$$W = f + F\,U^2 + (h\,S + q\,T)\,U + ..$$

and only has the minimal number of fluxes to stabilise saxions

Flux-scaling vacua

$$W = f + h\,S + g\,U + q\,T + ..$$

★ vacua with **massless axion(s)**

★ easy to find

★ control over corrections

★ original motivation: perfect starting point for

realising **axion inflation**

$$W = f + h\,S + q\,T + \Delta W_{ax}$$

Flux-scaling vacua and axion inflation

$$W = f + h\,S + q\,T + \Delta W_{ax}$$

★ axion monodromy inflation

[McAllister, Silverstein, Westphal]
[Marchesano, Shiu, Uranga;
Hebecker, Kraus, Witkowski;
Blumenhagen, Plauschinn]

ΔW_{ax} polynomial

hierarchies polynomial

★ aligned inflation

[Kim, Nilles, Peloso]

ΔW_{ax} exponential

hierarchies exponential

Flux-scaling vacua and axion inflation

$$W = f + h\,S + q\,T + \Delta W_{ax}$$

★ axion monodromy inflation

ΔW_{ax} polynomial

example:

non-geometric flux vacua
at large complex structure

★ aligned inflation

ΔW_{ax} exponential

example:

flux vacua at the conifold
(Kähler moduli stabilised via LVS)

Examples of flux-scaling vacua

I.) non-geometric vacua at large c.s.

II.) vacua near the conifold

Flux-scaling vacua with non-geometric fluxes

$$W = f + h\,S + q\,T + ..$$

★ non-geometric fluxes generate linear term in T

★ *alternative* to KKLT and LVS

★ Kähler moduli same mass as dilaton and c.s.

★ stringy origin not yet clear

Axion monodromy inflation

$$W = f + h\,S + q\,T + \Delta W_{ax}$$

$$\Delta W_{ax} = i\,(H\,S + Q\,T)$$

axion monodromy inflation

★ fluxes couple to massless axion polynomially

★ generates a potential for a light axion

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axion monodromy inflation

★ fluxes couple to massless axion polynomially

★ generates a potential for a light axion

★ minima AdS ➡ uplift to de Sitter e.g. D-term or AntiD3..

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more details, particularly on the uplift to de Sitter

in Rui Sun's talk

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quite nice - at least if the effective sugra is stringy -

but hierarchy of scales with non-integer fluxes

Flux-scaling vacua near the conifold

$$W = W_0 + A_s\, Z^N\, e^{-a_s T_s}$$

★ stabilises axio-dilaton and complex structure

★ Kähler moduli stabilised via LVS

★ fits perfectly with consistency conditions at the conifold

$$\mathcal{V}|Z|^2 \gg 1 \qquad \text{with} \qquad Z \sim e^{-sth}$$

$$\Rightarrow \mathcal{V} \gg e^{2\,sth}$$

★ one quite light Kähler modulus (dangerous for inflation)

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Flux-scaling vacua near the conifold

what's cool about the conifold?

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take a flux-scaling minimum

exponential term from conifold modulus

exponential mass hierarchy

Flux-scaling vacua near the conifold

what's cool about the conifold?

take a flux-scaling minimum

exponential term from conifold modulus

aligned inflation **?**

irgendwas mit periods

$$W = f + F\,U + h\,S + f\,(\alpha\,Z + \beta\,Z\log Z + \gamma + ..)$$

★ stabilise the conifold modulus

$$M_Z \sim \frac{1}{|Z|\mathcal{V}}$$

★ integrate it out

$$W = f + h\,S + g\,U + f\,\alpha\,e^{-(H\,S+G\,U)} + ...$$

$$M_{mod} \sim \frac{1}{\mathcal{V}} \qquad M_{ax} \sim \frac{|Z|}{\mathcal{V}}$$

ΔW_{ax}

exponentially light axion

What's *not* so cool about the conifold

$$W = f + F\,U + h\,S + f\,(\alpha\,Z + \beta Z \log Z + \gamma + ..)$$

★ stabilise the conifold modulus

★ integrate it out

$$W = f + h\,S + g\,U + f\,\alpha\,e^{-(H\,S + G\,U)} + ...$$

but actually

$$W = f + h\,S + g\,U + \alpha_1\,U^2 + \alpha_2\,U^3 + ...$$

Flux-scaling vacua

actually perfect for realising axion inflation

Flux-scaling vacua

actually perfect for realising axion inflation

but it does not yet fully work

....

★ scales for axion monodromy inflation

★ CY periods for aligned inflation

★ Kähler moduli for both

What could save large field inflation here?

★ find Calabi Yau with appropriate periods

★ consider different starting point e.g. KK modes

★ multifield inflation

★ other points in moduli space

★ ...

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simple vacua with control

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★ ...

THANK YOU!

simple vacua with control