Axion Monodromy Inflation on Warped Throats

Ander Retolaza

Instituto de Física Teórica IFT UAM/CSIC


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Axion Monodromy Inflation

- Measurements by BICEP2 $\Rightarrow$ Primordial Grav. Waves
  Inflation

$\Delta \phi > M_p$ so we need:
- Control over corrections to inflaton potential
- UV completion of inflation

Our best inflaton candidate: A
- String Theory Axion

Many talks...
Axion Monodromy Inflation

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- Large field Inflation: $\Delta \phi > M_p$ so we need:
  - Control over corrections to inflaton potential
  - UV completion of inflation

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*Many talks...*
Axion Monodromy Inflation

As String Theory axions have sub-Plankian decay constant...
- Many-axion models
  
  Kim, Nilles, Peloso
  Dimopoulos, Kachru, McGreevy & Wacker
Axion Monodromy Inflation

As String Theory axions have sub-Plankian decay constant...

- Many-axion models [Kim, Nilles, Peloso, Dimopoulos, Kachru, McGreevy, & Wacker]
- Axion Monodromy models [Silverstein, McAllister, Westphal]
  - Non-perturbative effects break continuous shift symm.

\[ V(\phi) \]

\[ \phi \]
Axion Monodromy Inflation

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- "New" framework: F-term Axion Monodromy
  Marchesano, Shiu, Uranga

  Shiu’s & Uranga’s talks
Consider a Type II compactification with fluxes such that

\[ \int_{\Pi_p} F_p = M \; ; \; \int_{\Sigma_2} B_2 = \phi \; ; \; \int_{\Pi'_{4-p}} F_{8-p} = F_4 \]

There is a CS coupling...

\[ \int_{10d} B_2 \wedge F_p \wedge F_{8-p} \]

So that the physical RR\((p + 2)\) flux is

\[ \tilde{F}_{p+2} = dC_{p+1} + F_p \wedge B_2 \]
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\]

There is a CS coupling... which creates the monodromy
\[
\int_{10d} B_2 \wedge F_p \wedge F_{8-p} \rightarrow M \int_{4d} \phi F_4 \quad \text{Kaloper, Sorbo, Lawrence}
\]

So that the physical RR\((\rho + 2)\) flux is
\[
\tilde{F}_{\rho+2} = dC_{\rho+1} + F_p \wedge B_2
\]

The 4d potential for the inflaton comes from
\[
\int_{10d} |\tilde{F}_{\rho+2}|^2 \sim m^2 \phi^2
\]
F-term Axion Monodromy in Flux-Compactifications

The monodromy $\phi \to \phi + \Delta \phi$ increases the flux

$$\Delta \left( \int_{\Sigma_2 \times \Pi_p} \tilde{F}_{p+2} \right) = M \Delta \phi$$

Theory contains domain walls connecting branches:
- $D(6 - p)$-branes wrapping the $\Pi'_{4-p} \Rightarrow$ change $\tilde{F}_{p+2}$
Warped Throats

Fluxes:
- Stabilize moduli
- Create monodromy
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A nice scenario to work on it: *Warped Throats*

\[ m_{\text{bottom}} \sim m_{\text{bulk}} \exp \left( -\frac{2\pi K}{M_{G_s}} \right) \]

Randall, Sundrum; Giddings, Kachru, Polchinski; Verlinde; Klebanov, Strassler

From Ibáñez & Uranga

Type IIB Flux compactification:
\[ \int_{10d} B_2 \wedge F_3 \wedge F_5 \quad (p = 3) \]
Warped Throats

Fluxed Cycles from *Geometric Transitions*: The conifold

For Toric geometries, described in terms of \((p,q)\) webs:
Example of a toric CY 3-fold: Cone over $\text{dP3}$
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This throat admits a *holographic* dual description in terms of quiver/dimer diagrams.

Franco, Hanany, Uranga

\[ W \sim Q_{12} Q_{24} Q_{45} Q_{51} \]
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RG flow
Cascade of Seiberg Dualities
Axion Monodromy $\equiv$ Seiberg Dualities
Franco, Galloni, A.R, Uranga

Axion: $\phi = \int_{\Pi_2} B_2 \Rightarrow$ Gauge coupling in Holographic Th.

Monodromy increases $(\text{Regular D3-s }): N \rightarrow N + 3M$

NOT DUE TO RG FLOW
Type IIA Scenarios

This time define

\[ \int_{\Pi_2} F_2 = M \quad ; \quad \int_{\Sigma_2} B_2 = \phi \quad ; \quad \int_{\Pi'_2} F_6 = F_4 \]

so that \[ \int_{10d} B_2 \wedge F_2 \wedge F_6 \] creates the monodromy.

- Inflaton potential from kinetic term of \( \tilde{F}_4 = dC_3 + F_2 \wedge B_2 \)
- Similar systematics of those seen in Type IIB
- Other possible potentials \( V \sim \phi^n \) \( (n > 2) \)
  from RR \( F_0 = dC_{-1} \) fluxes

Marchesano, Shiu, Uranga; McAllister, Silverstein, Westfall
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  Marchesano, Shiu, Uranga; McAllister, Silverstein, Westfall
- Better for global embeddings
Summary

- F-term Monodromy Inflation in Flux Compactifications
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  - Bulk(moduli) scale (UV) VS. Inflation Scale (IR)
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- **Warped Throats** are nice to generate hierarchy between...
  - Bulk(moduli) scale (UV) VS. Inflation Scale (IR)
- Throats admit dual Holographic description
- Axion-Monodromy = Seiberg Dualities (not RG)
- Still much to do...
  - Global embedding
  - Saxion issues...
  - Reheating...
Thank you :}