Walking-dilaton hybrid inflation in dynamical scalegenesis

Hiroyuki ISHIDA (Toyama Prefectural U.)

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Collaborators: Jie Liu (Jilin->UESTC)
Shinya Matsuzaki (Jilin)
He-Xu Zhang (CAS)

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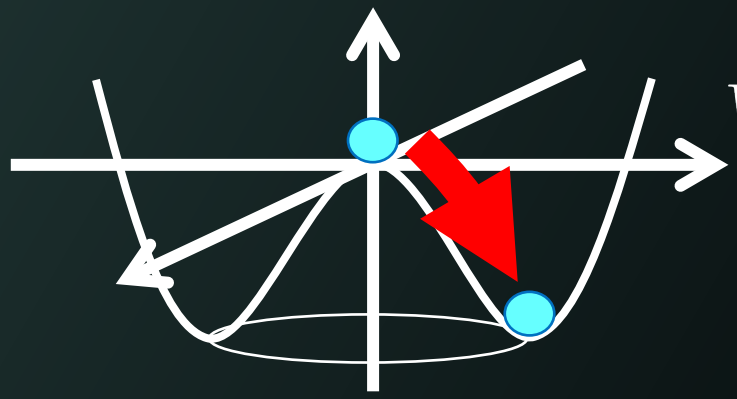
Introduction

HPNP: Higgs as a Probe of New Physics

Origin of mass via electroweak symmetry breaking



$$V(H) = m_H^2 |H|^2 + \lambda_H |H|^4 \quad (m_H^2 < 0)$$

Is this the end of the story?

We have to answer why…

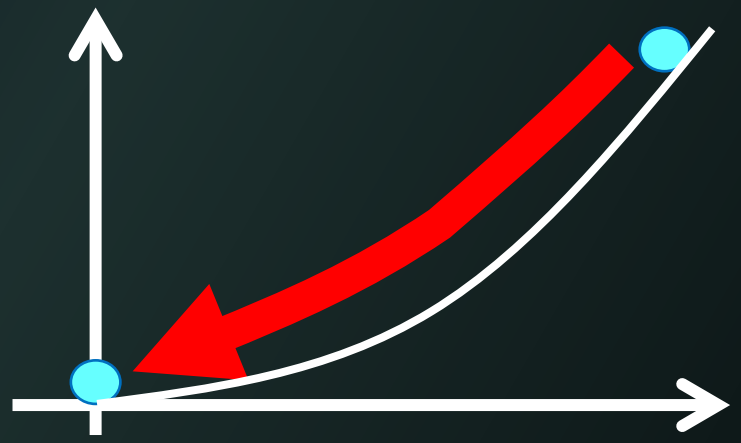
Higgs mass term is negative

this is unique dimensionful parameter

Introduction

Inflation: solve horizon, flatness, and monopole problems

Vacuum energy dominates the universe



The simplest realization: LFI
If inflaton moves slow enough

Is this the end of the story?

We have to answer…

why inflaton potential is flat enough

where is inflation scale (is large field unique solution?)

Introduction

Coleman-W

Generate

even sta

an

Model se

SM w/ cl

+ Hidden

ynamics

=inflaton

Interesti

[Barenboim, Chun, Lee (2013)]

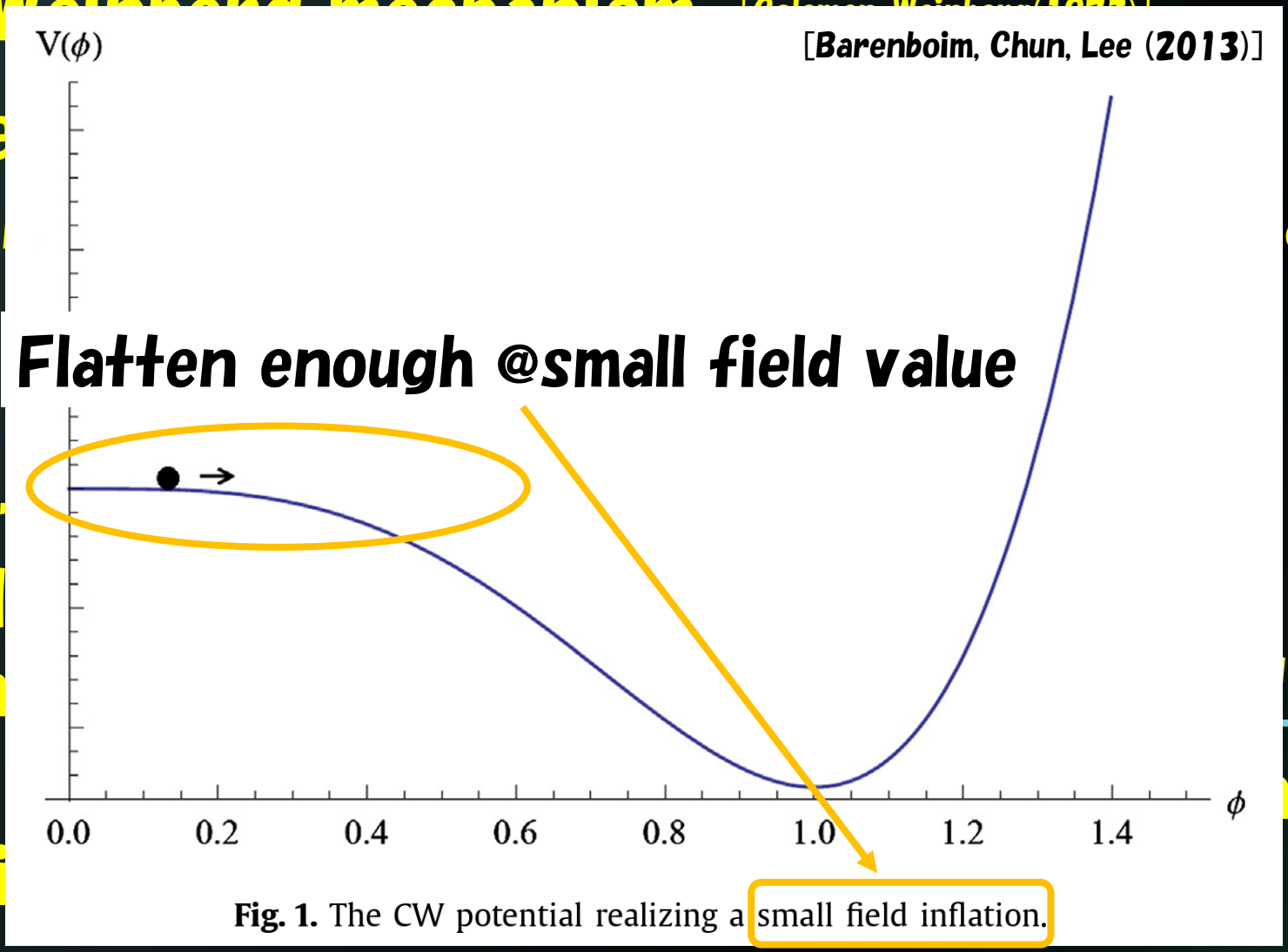


Fig. 1. The CW potential realizing a small field inflation.

Introduction

Initial condition problem in CW inflation

[Barenboim, Chun, Lee (2013)]

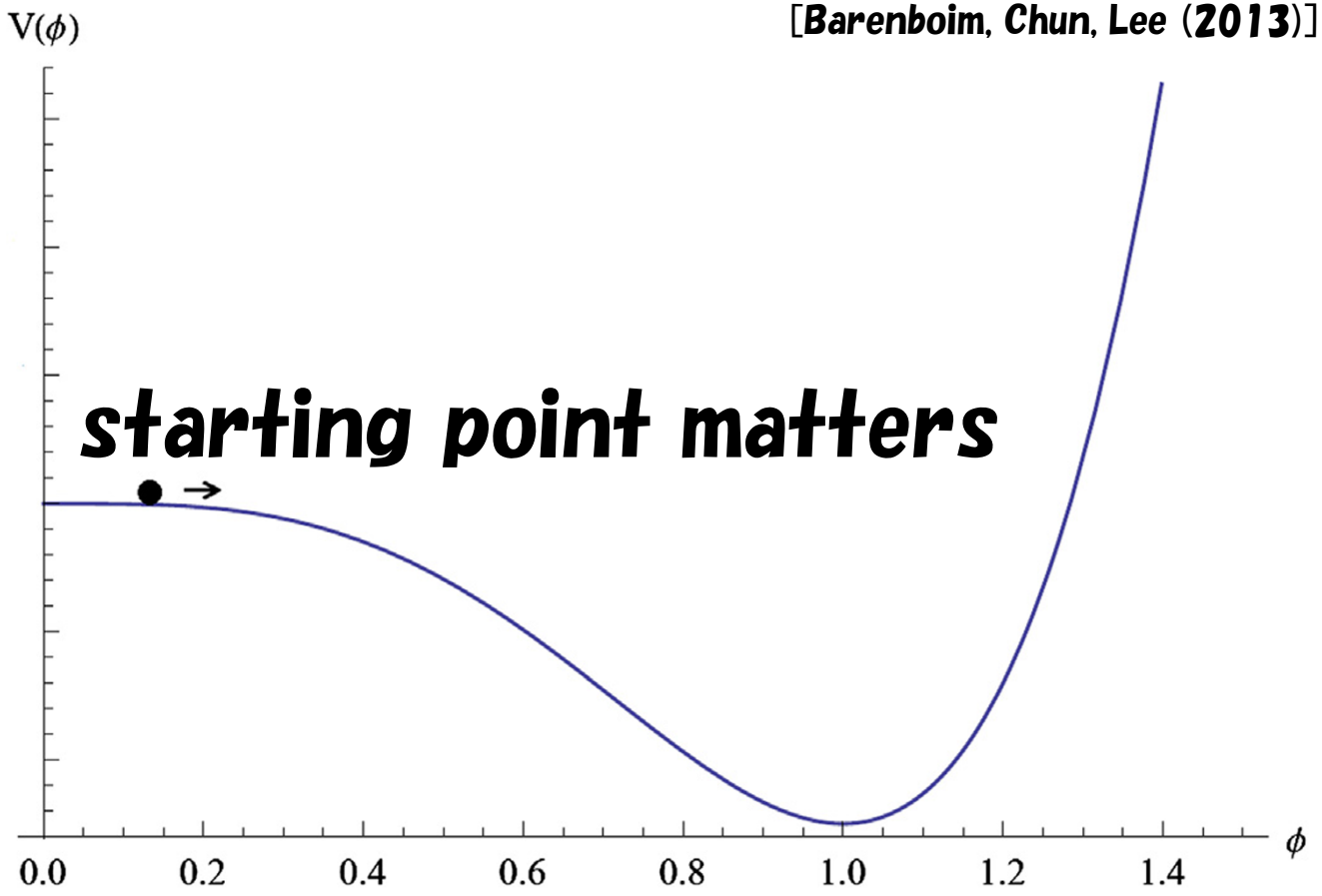
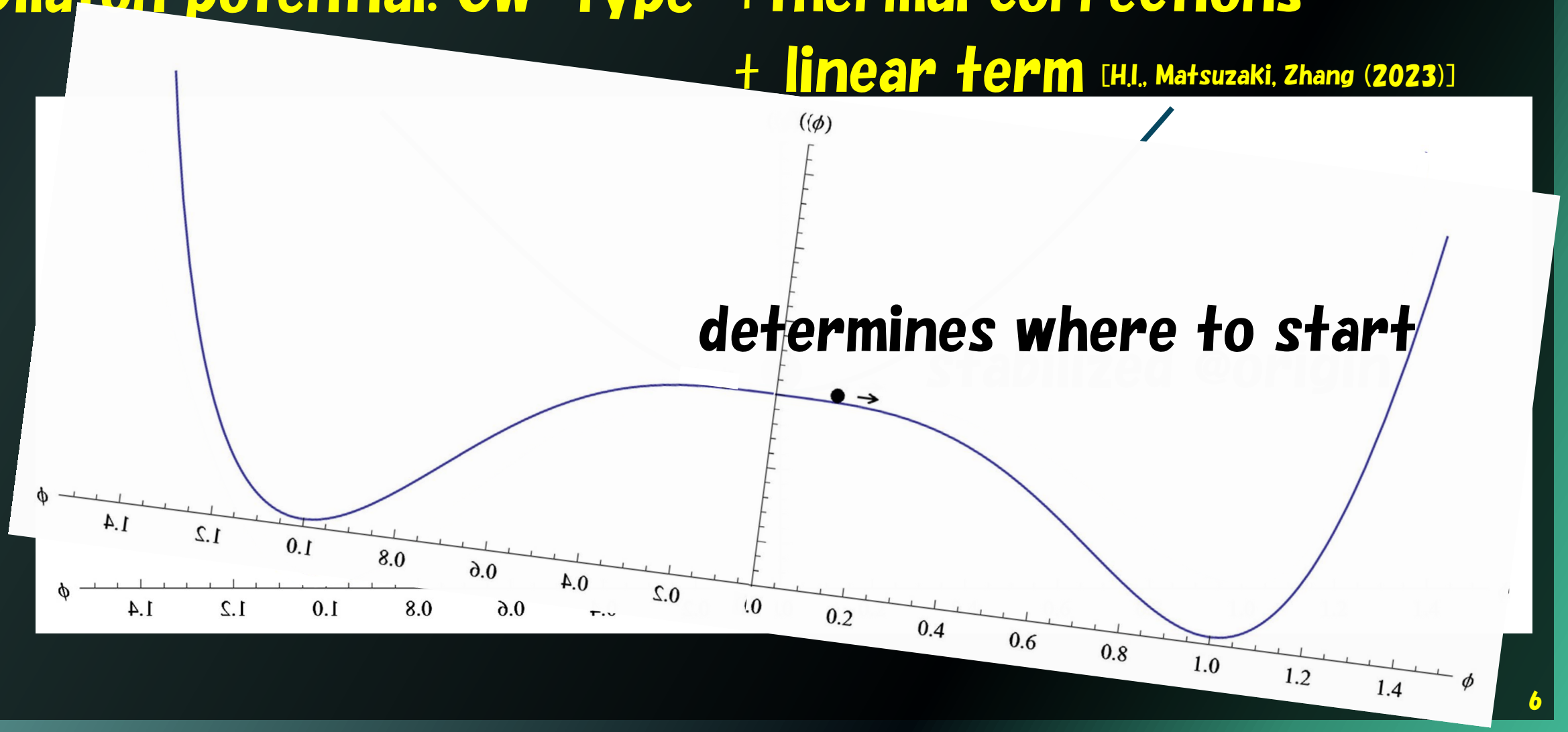


Fig. 1. The CW potential realizing a small field inflation.

Walking dilaton inflation [H.I., Matsuzaki (2020)]

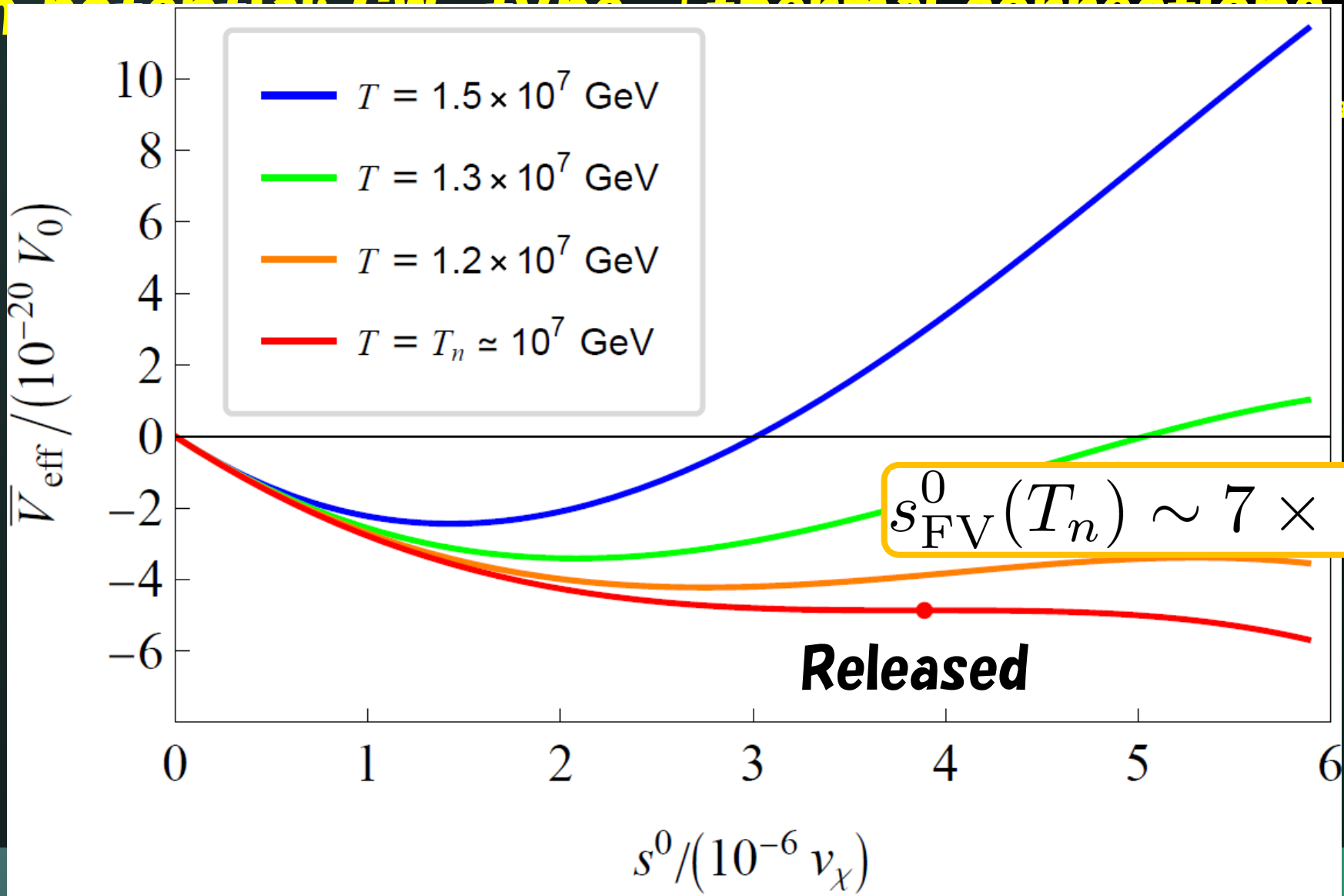
Dilaton potential: CW-type +thermal corrections + linear term [H.I., Matsuzaki, Zhang (2023)]



determines where to start

Walking dilaton inflation [H.I., Matsuzaki (2020)]

Dilaton potential: CW type + thermal corrections [H.I., Matsuzaki, Yang (2023)]



$$s^0_{\rm FV}(T_n) \sim 7 \times 10^9\,{\rm GeV}$$

Model

Particle contents:

can be extended to EWSB

walking

	$\mathrm{SU}(3)_{\mathrm{HC}}$	$\mathrm{U}(1)_{B-L}$	$\mathrm{SU}(3)_c$	$\mathrm{SU}(2)_W$	$\mathrm{U}(1)_Y$
$\psi^1_{L/R}$	3	$+1$	1	1	0
$\psi^2_{L/R}$	3	-1	1	1	0
$\psi^3_{L/R}$	3	0	1	1	0
$\vdots$	$\vdots$	$\vdots$			$\vdots$
$\psi^8_{L/R}$	3	0	1	1	0
ϕ	1	$+2$	1	1	0
N_R	1	-1	1	1	0
q_L	1	$1/3$	3	2	$1/6$
l_L	1	-1	1	2	$-1/2$
u_R	1	$1/3$	3	1	$2/3$
d_R	1	$1/3$	3	1	$-1/3$
e_R	1	-1	1	1	-1
H	1	0	1	2	$1/2$

B-L braking

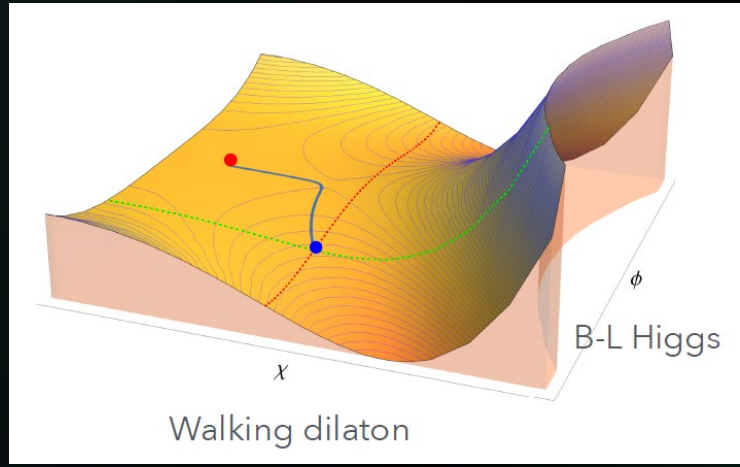
Walking-dilaton hybrid inflation [Liu, H.I., Matsuzaki, Zhang (2024)]

B-L gauge symmetry is introduced

Two directions:

walking dilaton

B-L Higgs



Rough sketch of inflation dynamics:

walking dilaton dynamics determines initial condition

B-L Higgs determines end point

Walking-dilaton hybrid inflation [Liu, H.I., Matsuzaki, Zhang (2024)]

Predictions (all the details are skipped)

$r \lesssim 10^{-25}$

Requirements: $N|_{\rm obs} \simeq 40\text{–}60, \quad \Delta^2_{\rm R}|_{\rm obs} \simeq 2.137 \times 10^{-9}, \quad n_s|_{\rm obs} \simeq 0.968\,.$

B-L breaking scale

$v_{\text{B-L}} \sim 10^9 \text{ GeV}$

Lightest hidden pion mass

$m_\pi \sim 500 \text{ GeV}$

Majorana mass scale

Good target on colliders

Type-I seesaw

Low scale leptogenesis $\Leftrightarrow$ $T_R \lesssim 10^5 \text{ GeV}$

Conclusions

Origin of mass & inflation are still open questions

Walking-dilaton hybrid inflation can give solution

SM w/ classical scale invariance
+ hidden strong dynamics w/ many flavor
+ B-L gauge symmetry
+ Bosonic seesaw mechanism for negative sign

B-L breaking scale is tightly constrained $v_{\mathrm{B\text{-}L}} \sim 10^9\ \mathrm{GeV}$

The lightest hidden pion mass is light $m_\pi \sim 500\ \mathrm{GeV}$

OOKINI!

(Thank you in Osaka dialect)