



Walking-Dilaton Hybrid Inflation in a Model with Dynamical Scalegenesis

Hiroyuki ISHIDA (Toyama Prefectural U.)

@KEK-PH2026Winter, 16/02/2026

Collaborators: Jie Liu (UESTC)

Shinya Matsuzaki (Jilin)

He-Xu Zhang (CAS)

Ref. : JHEP 10 069 (2024)

Introduction

Unsatisfactory points of electroweak symmetry breaking

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

assume *negativeness* for unique dimensionful term

Simplest solution : scale invariance

$$V(H) = \cancel{m_H^2 |H|^2} + \lambda_H |H|^4$$

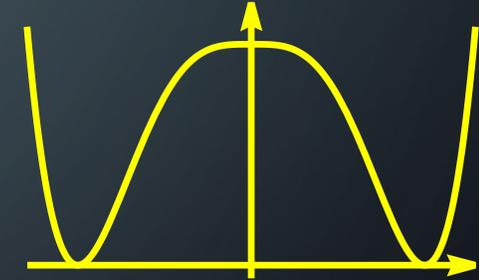
How to generate scale becomes problem

Introduction

Coleman-Weinberg mechanism [Coleman, Weinberg (1973)] [Barenboim, Chun, Lee (2013)]

**Generates scale by quantum effects
even starting from scale symmetric Lagrangian**

$$V_{\text{CW}}(H) = \lambda_H |H|^4 (\log H/v + A)$$



Another unsatisfactory point : cannot apply to EWSB

However, CW potential is naturally flat near the origin

➡ suitable for realizing inflation

Introduction

Small field inflation by CW potential [Barenboim, Chun, Lee (2013)]

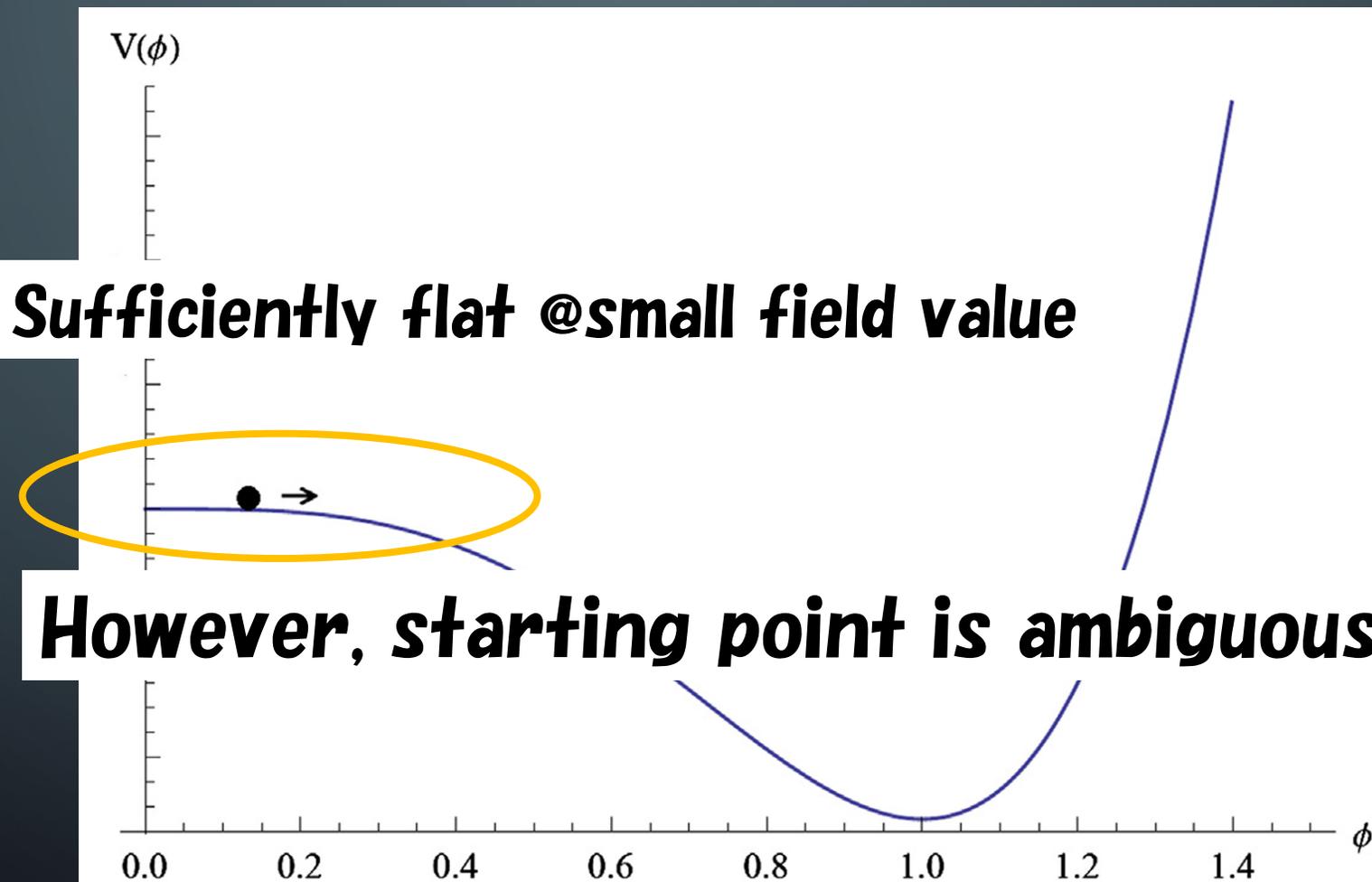


Fig. 1. The CW potential realizing a small field inflation.

Introduction

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

Model setup:

SM w/ classical scale invariance

+ many flavor hidden strong dynamics

walking dynamics is realized

dilaton=inflaton

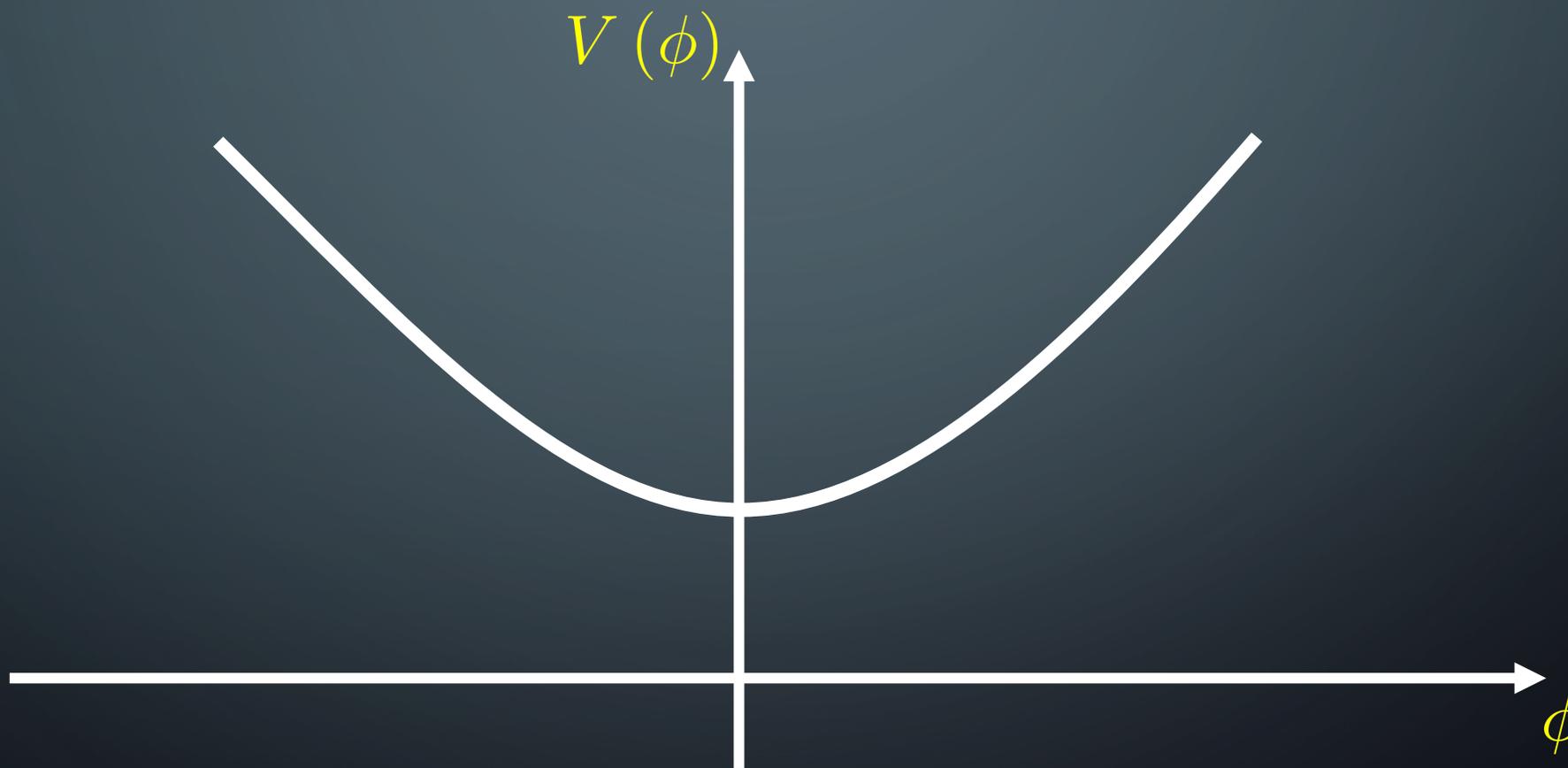
Further benefits (skip all the detail) :

scale can be generated via bosonic seesaw mechanism

[Calmet (2003): Kim (2005): Haba, Kitazawa, Okada (2009): Antipin, Redi, Strumia (2015): Haba, H. I., Okada, Yamaguchi (2016): Haba, H. I., Kitazawa, Yamaguchi (2016): H. I., Matsuzaki, Yamaguchi (2016): H. I., Matsuzaki, Yamaguchi (2017): Haba, Yamada (2017): Haba, Yamada (2017): H. I., Matsuzaki, Okawa, Omura (2017)]

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

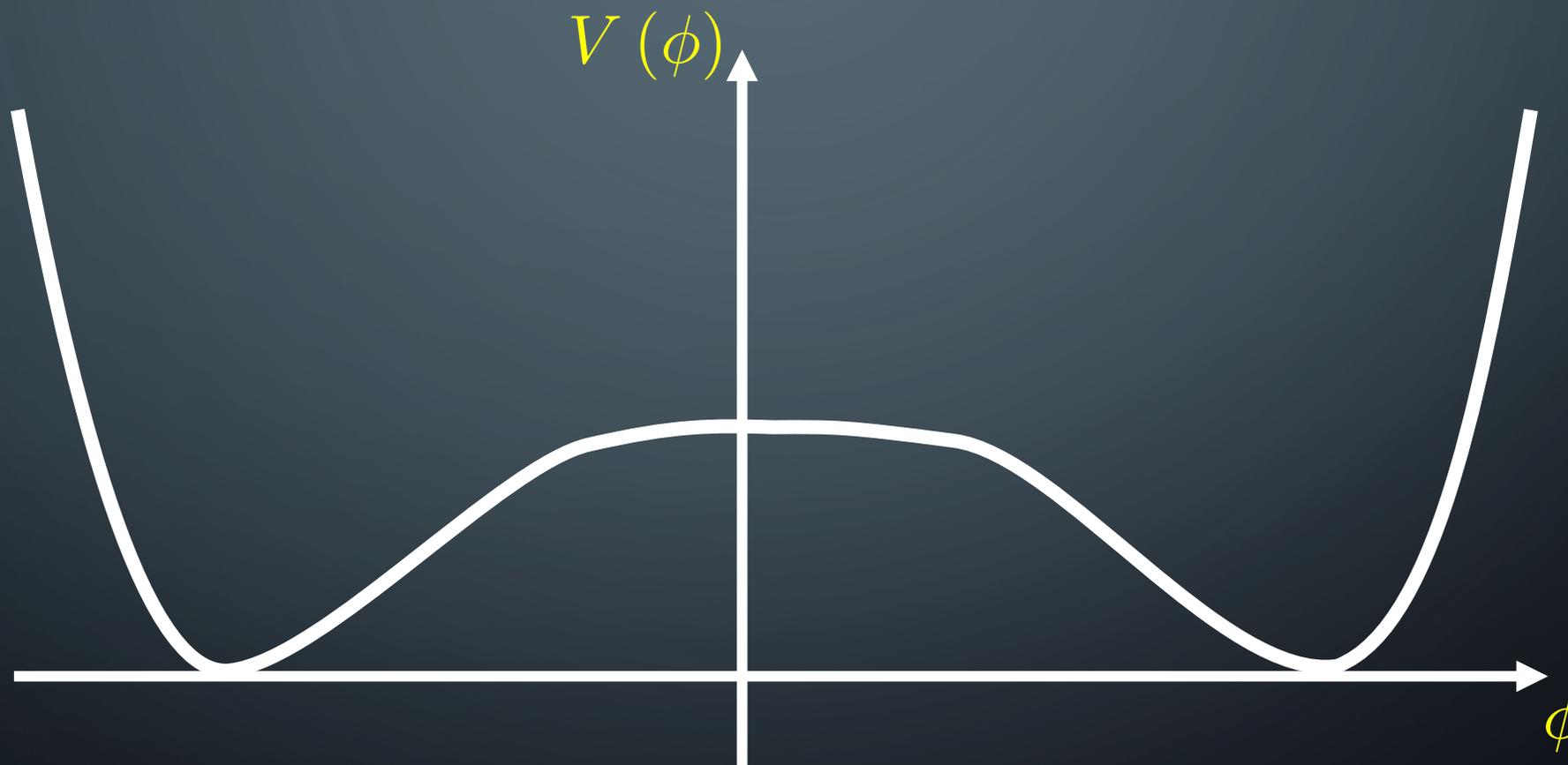
Dilaton potential: CW-type + thermal corrections



Thermal potential traps dilaton at origin

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

Dilaton potential: CW-type

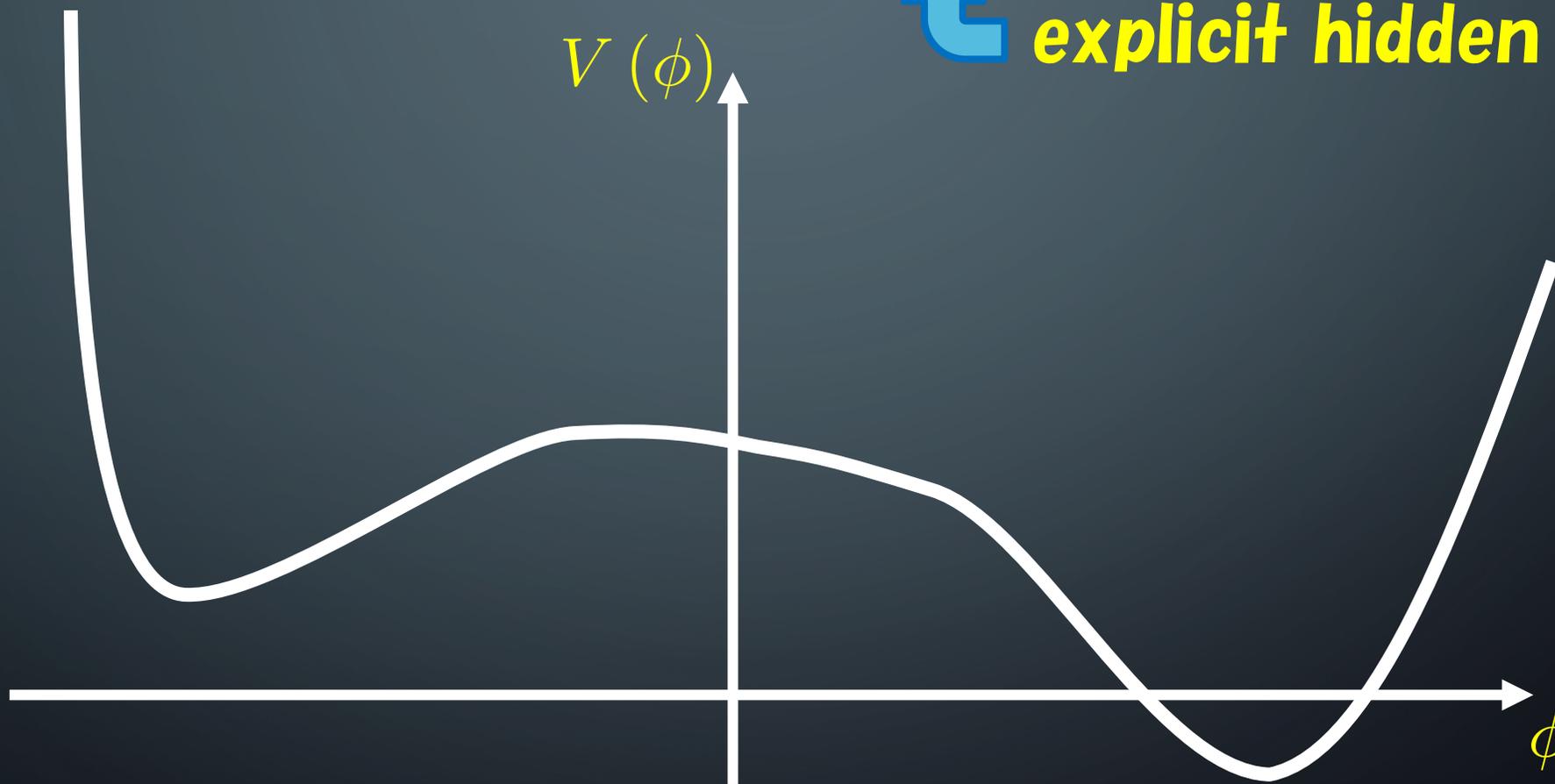


CW potential becomes dominant but still not to roll down

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

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

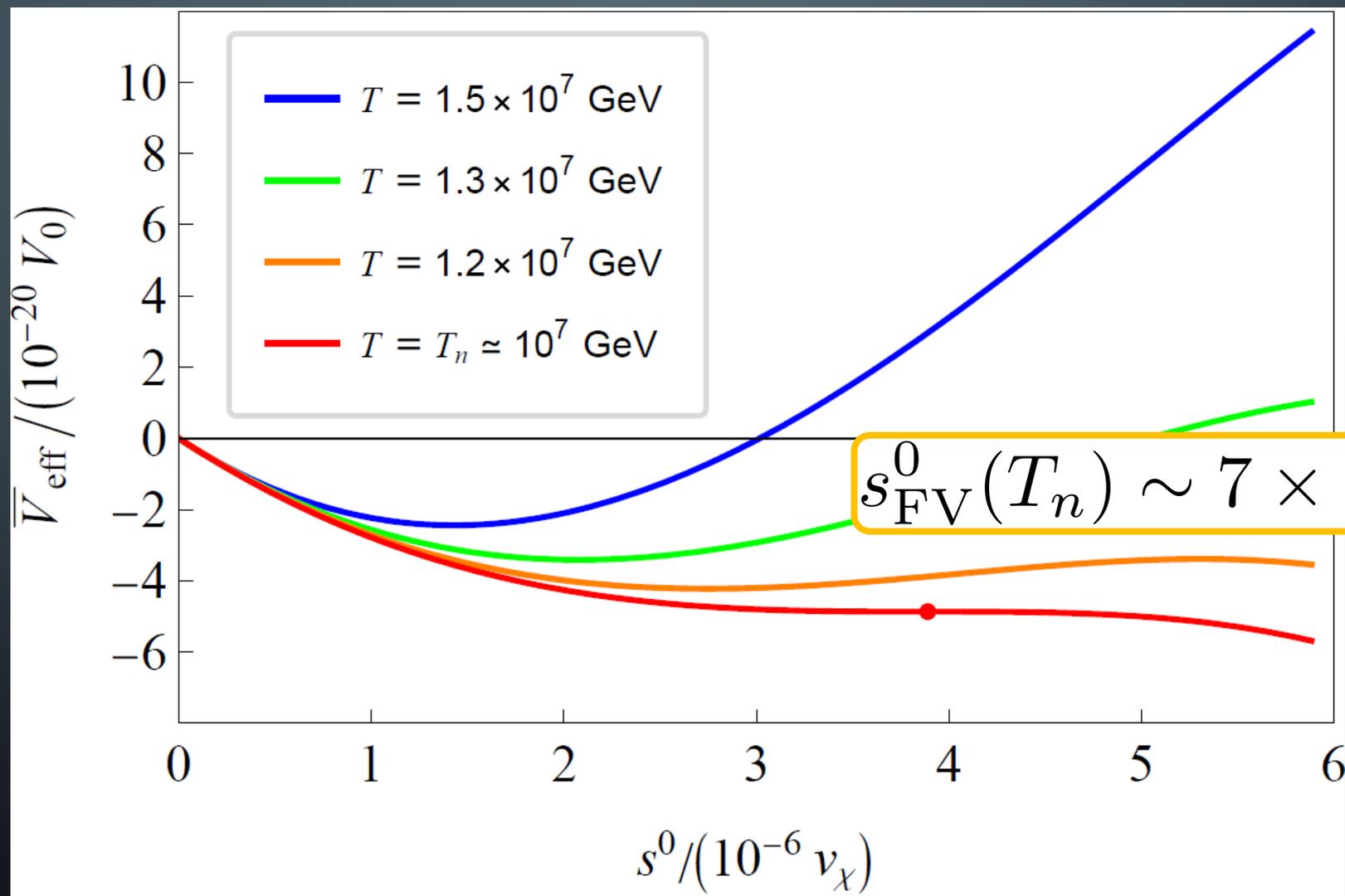
explicit hidden χ SB



Linear term determines where to start

Walking dilaton inflation w/ linear term [H.I., Matsuzaki, Zhang (2023)]

Temperature evolution of dilaton potential



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

Short summary

- **Classical scale invariance + hidden strong dynamics**

**Walking dynamics gives a scalar, dilaton,
which can be an inflaton**

- **CW-type potential of dilaton**

**Flatten potential at around the origin
is naturally realized**

Inflation itself can be explained by the current setup

Is there any possible phenomenological extension?

Model [H.I., Matsuzaki, Zhang (2023)]

Particle contents: **B-L breaking**

walking

	$SU(3)_{HC}$	$U(1)_{B-L}$	$SU(3)_c$	$SU(2)_W$	$U(1)_Y$
$\psi_{L/R}^1$	3	+1	1	1	0
$\psi_{L/R}^2$	3	-1	1	1	0
$\psi_{L/R}^3$	3	0	1	1	0
\vdots	\vdots	\vdots	\vdots	\vdots	\vdots
$\psi_{L/R}^8$	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

can be extended to EWSB

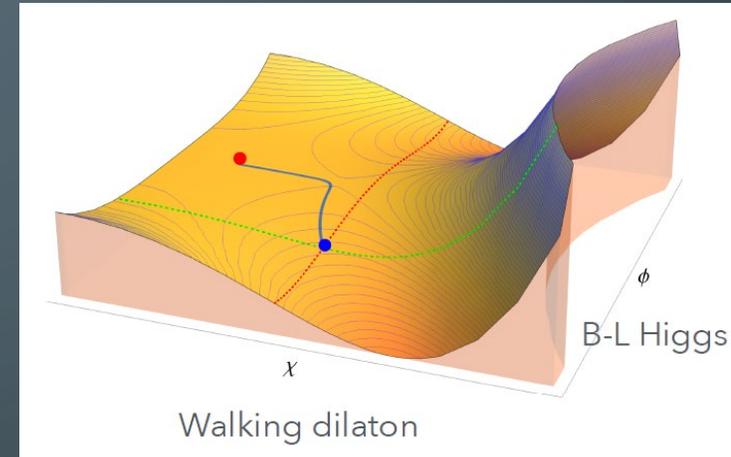
Walking-dilaton hybrid inflation [Liu, H.I., Matsuzaki, Zhang (2024)]

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 of the inflation

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

Predictions (all the details are skipped)

$$r \lesssim 10^{-25}$$

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

B-L breaking scale

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

Lightest hidden pion mass

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

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

Predictions (all the details are skipped)

$$r \lesssim 10^{-25}$$

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

B-L breaking scale

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

Lightest hidden pion mass

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

Majorana mass scale

Type-I seesaw

Thermal leptogenesis $\longleftrightarrow T_R \lesssim 10^5 \text{ GeV}$

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 symmetry breaking

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

The lightest hidden pion mass is light: $m_\pi \sim 500$ GeV

Thanks for your attentions!