Goldstone Inflation

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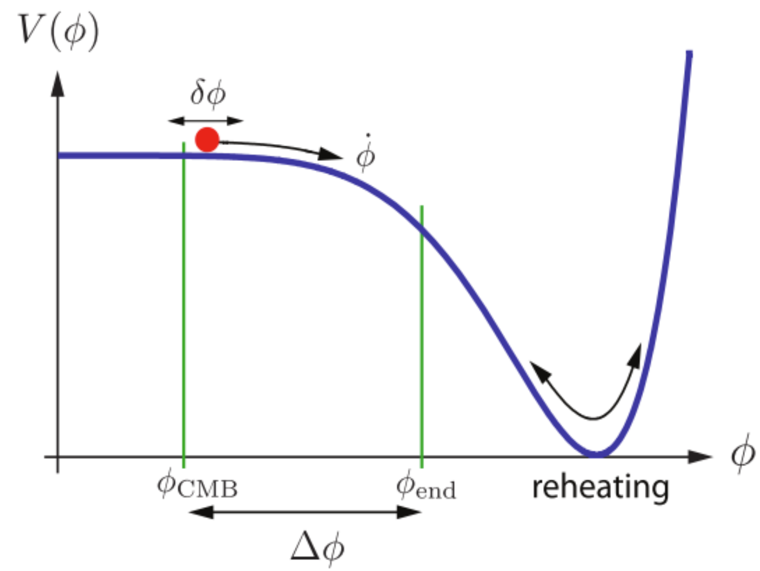
With Djuna Croon & Veronica Sanz

Can we generate a ‘naturally’ flat potential for the inflaton?

Slow-roll Inflation

Successful inflation requires an 'unnaturally' flat potential!

$$\left.\begin{aligned} \frac{M_{pl}^2}{2}\left(\frac{V'}{V}\right)^2 &\ll 1 \\ M_{pl}^2\left(\frac{V''}{V}\right) &\ll 1 \end{aligned}\right\} \text{ Slow-roll conditions}$$



Source: Baumann 2008

Need a flat enough potential to give 60 e-foldings, and a nearly scale invariant power spectrum ($n_s \approx 1$).

ϕ is a scalar field – unstable under radiative corrections.

Natural Inflation

Inflaton is an axion – the Goldstone boson of a broken Peccei-Quinn symmetry.

Generically these models acquire following potential via non-perturbative effects:

$$V(\phi) = \Lambda^4(1 \pm \cos(\phi/f))$$

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Can we generate a ‘naturally’
flat potential for the inflaton,
with sub-Planckian values of f?

Alternatives

- More complex symmetry groups, e.g.

  $SO(N) \to SO(N-1)$

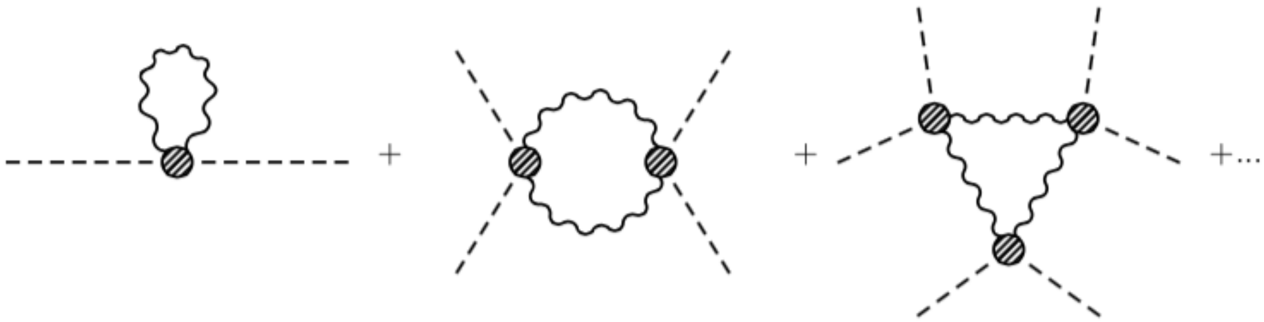
- Non-perturbative $\longrightarrow$ Pertubative: Coleman-Weinberg mechanism.

- Contributions to the potential from particles that do not transform under the global symmetry.

CW potential

$$\Sigma(x) = \exp(iT^{\hat{a}}\phi^{\hat{a}}(x)/f)\Sigma_0$$

$$\mathcal{L}_{eff} = \frac{1}{2}(P_T)^{\mu\nu}\left[\Pi_0^A(p^2)Tr\{A_\mu A_\nu\} + \Pi_1^A(p^2)\Sigma^T A_\mu A_\nu \Sigma\right]$$



$$V = \frac{3(N-2)}{2}\int \frac{d^4p}{(2\pi)^4}\log\left[1+\frac{1}{2}\frac{\Pi_1^A}{\Pi_0^A}\sin^2(\phi/f)\right] \quad \to \gamma\sin^2(\phi/f)$$

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← *Non-linear σ-model*

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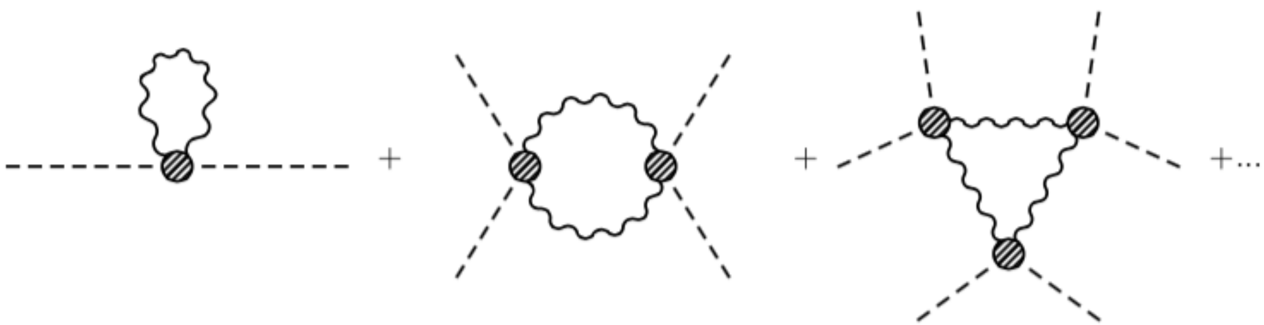

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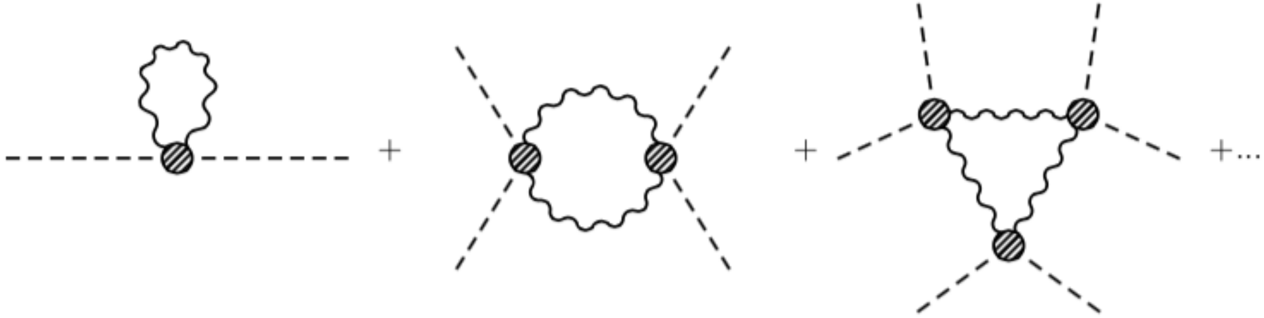
Effective Lagrangian with gauge fields



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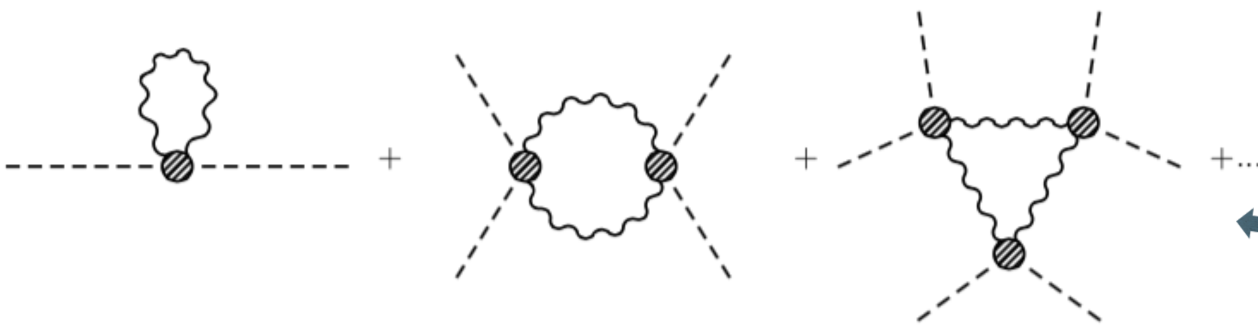

Loops of gauge fields generate inflaton potential

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Results

- Can achieve successful inflation and fit the CMB data [1] with the potential

$$V(\phi) = \Lambda^4 \left(C_\Lambda + \alpha \cos(\phi/f) + \beta \sin^2(\phi/f)\right)$$

- Fermions embedded in a spinor representation of $SO(N)$
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Thank you!

For more info:

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