Dealing with axion monodromy and other oscillating inflationary models

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Based on DH and Lesgourgues (in prep)

DESY THEORY WORKSHOP
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Institute for Theoretical Particle Physics and Cosmology
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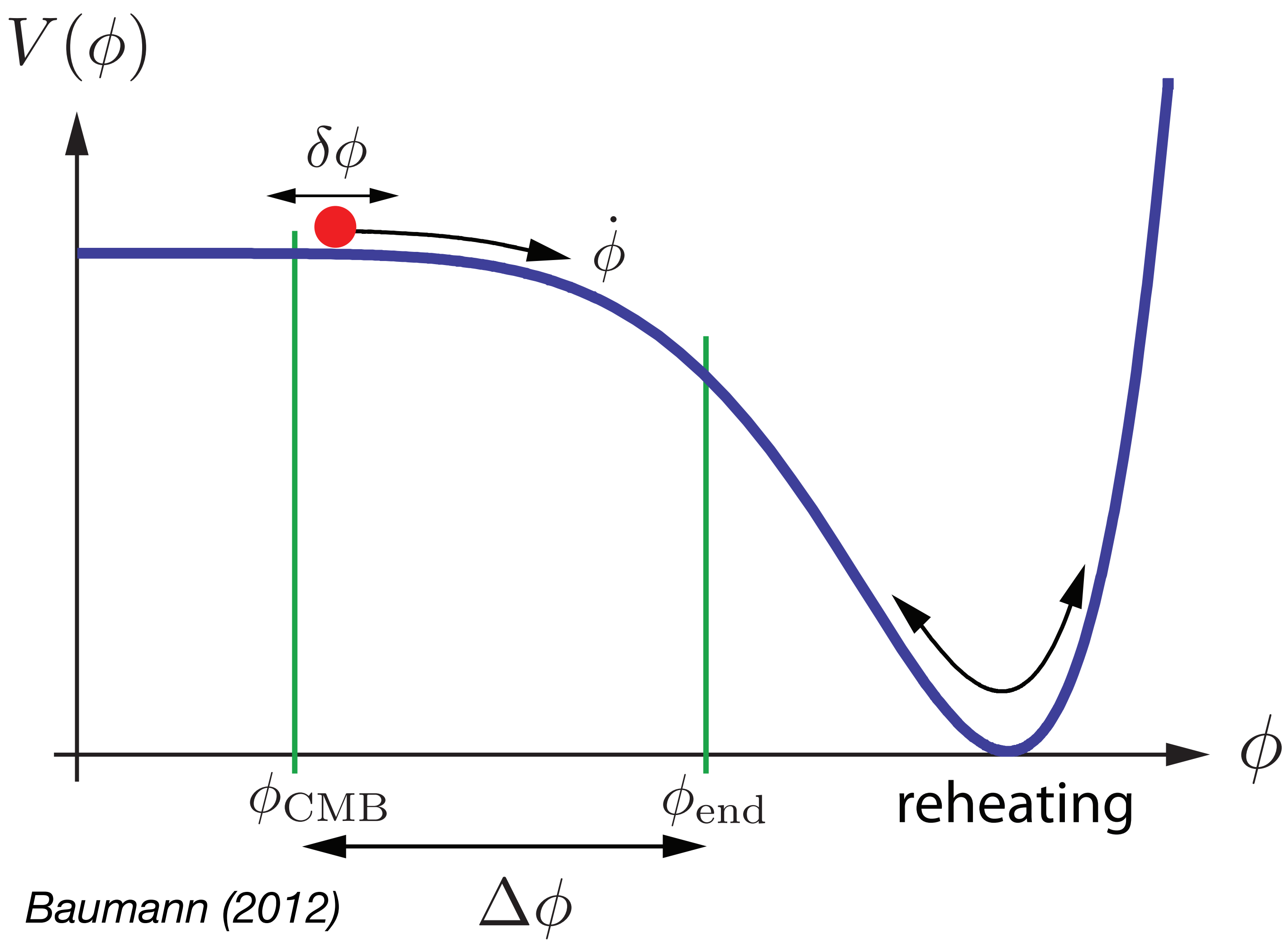
Overview

- Backdrop
  - *Why is this relevant?*
- Axion Monodromy Inflation
  - *Why this model?*
  - *What has been done?*
  - *What are we doing?*
- Comparisons
  - *What did we find?*
  - *What next?*
- Summary
  - *Questions?*

Slow Roll Inflation



Baumann (2012)

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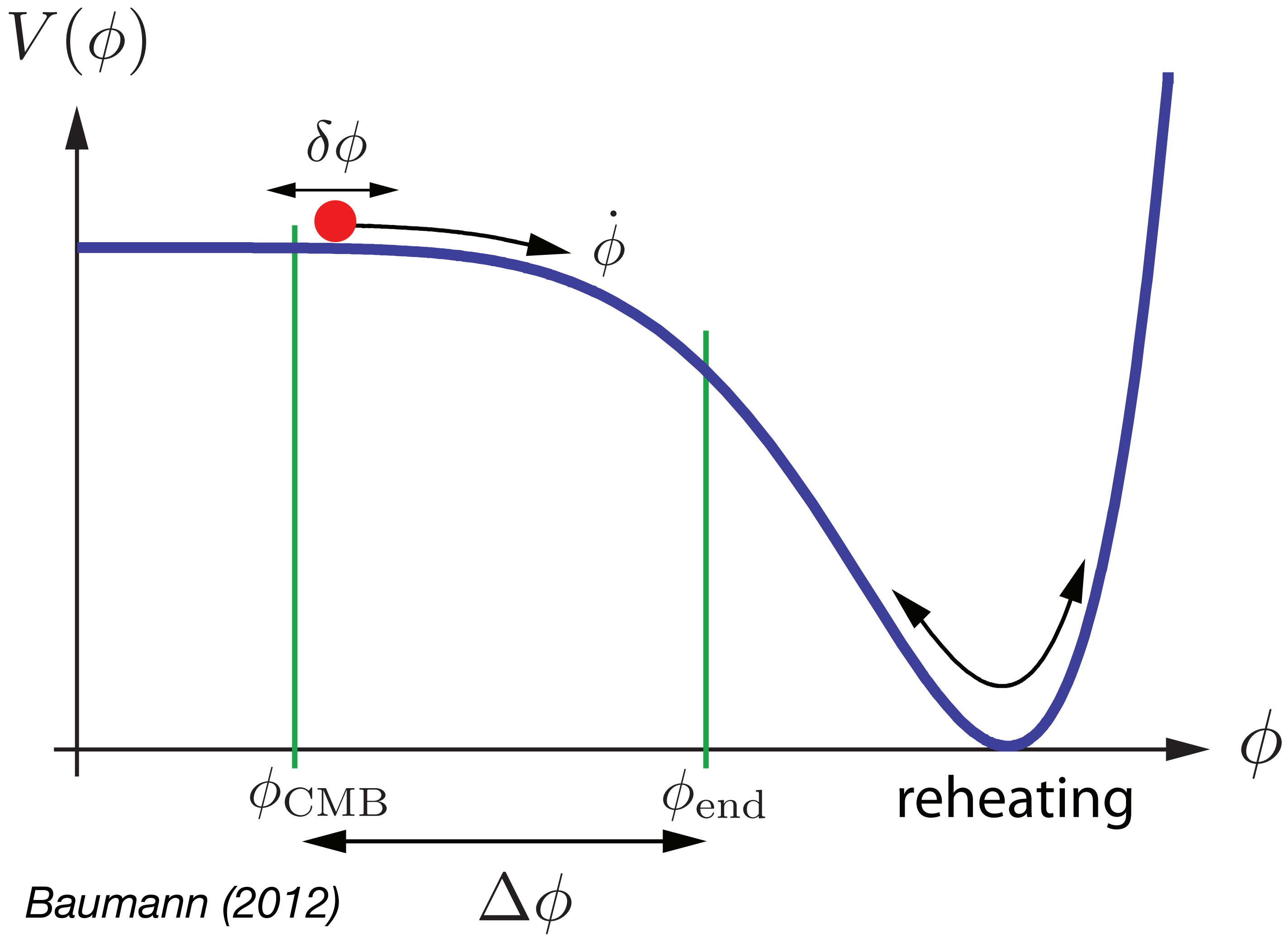

Baumann (2012)

$$\epsilon_1 = \frac{M_{\rm Pl}^2}{2}\left(\frac{V'}{V}\right)^2$$

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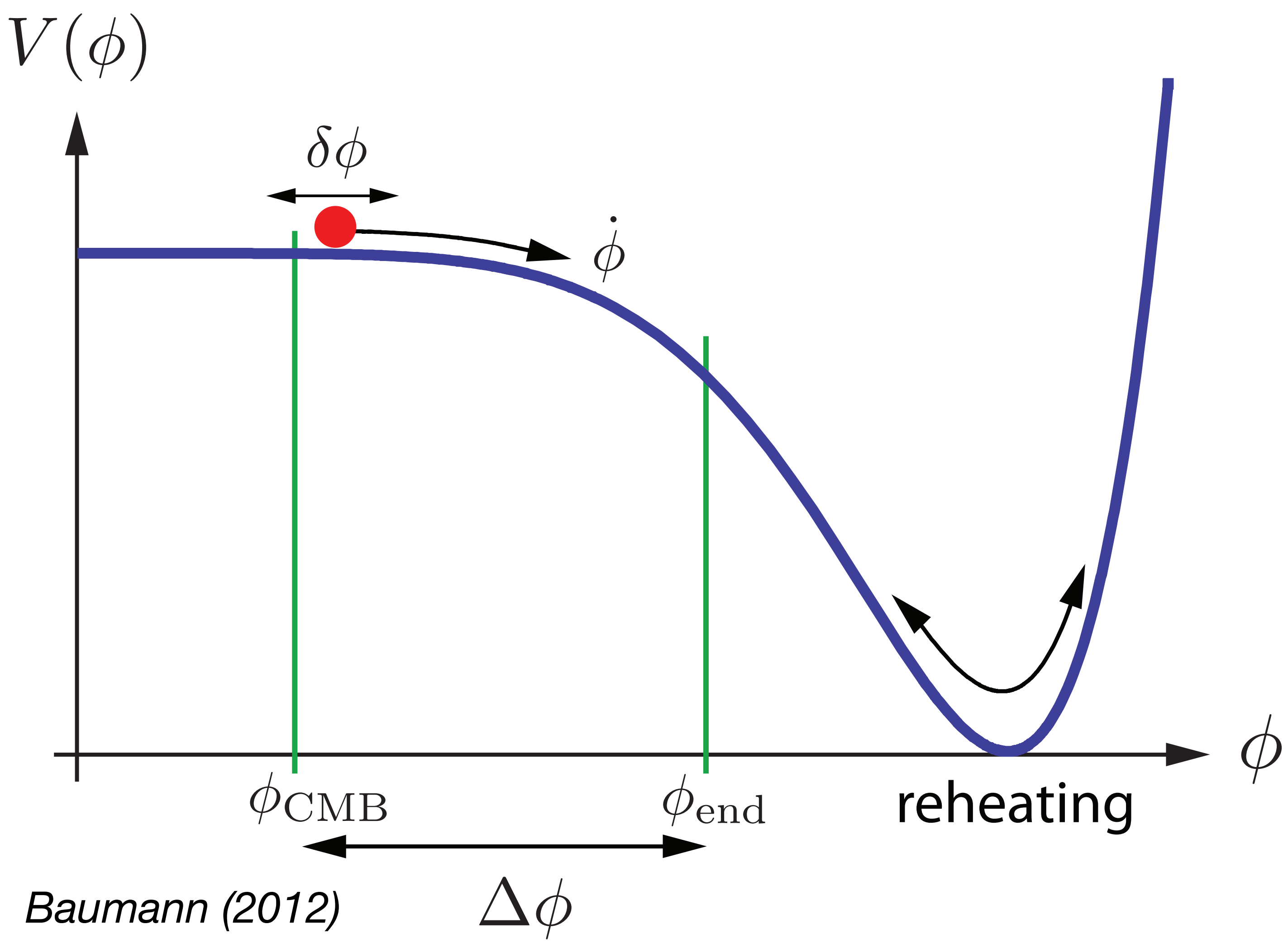

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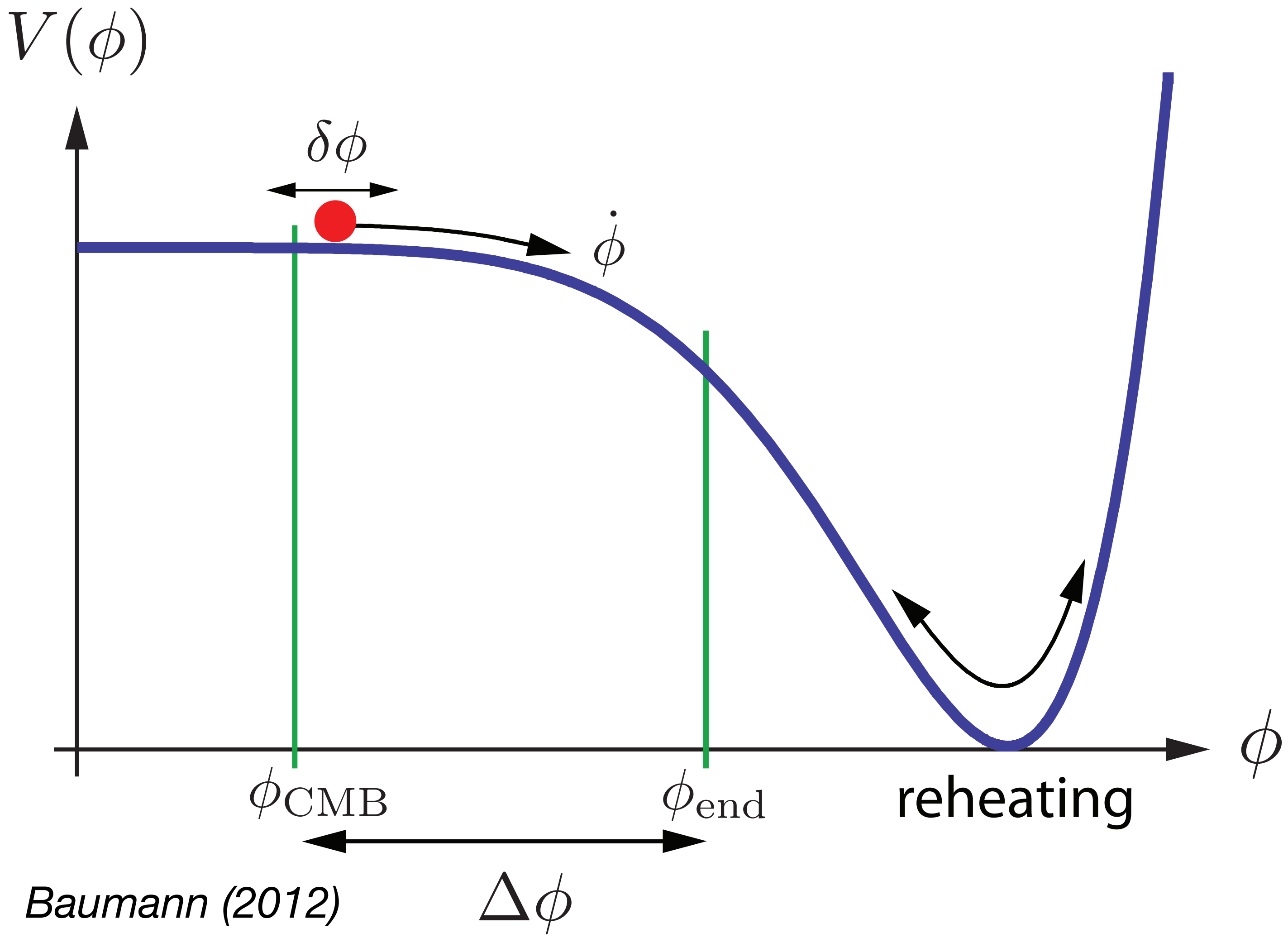

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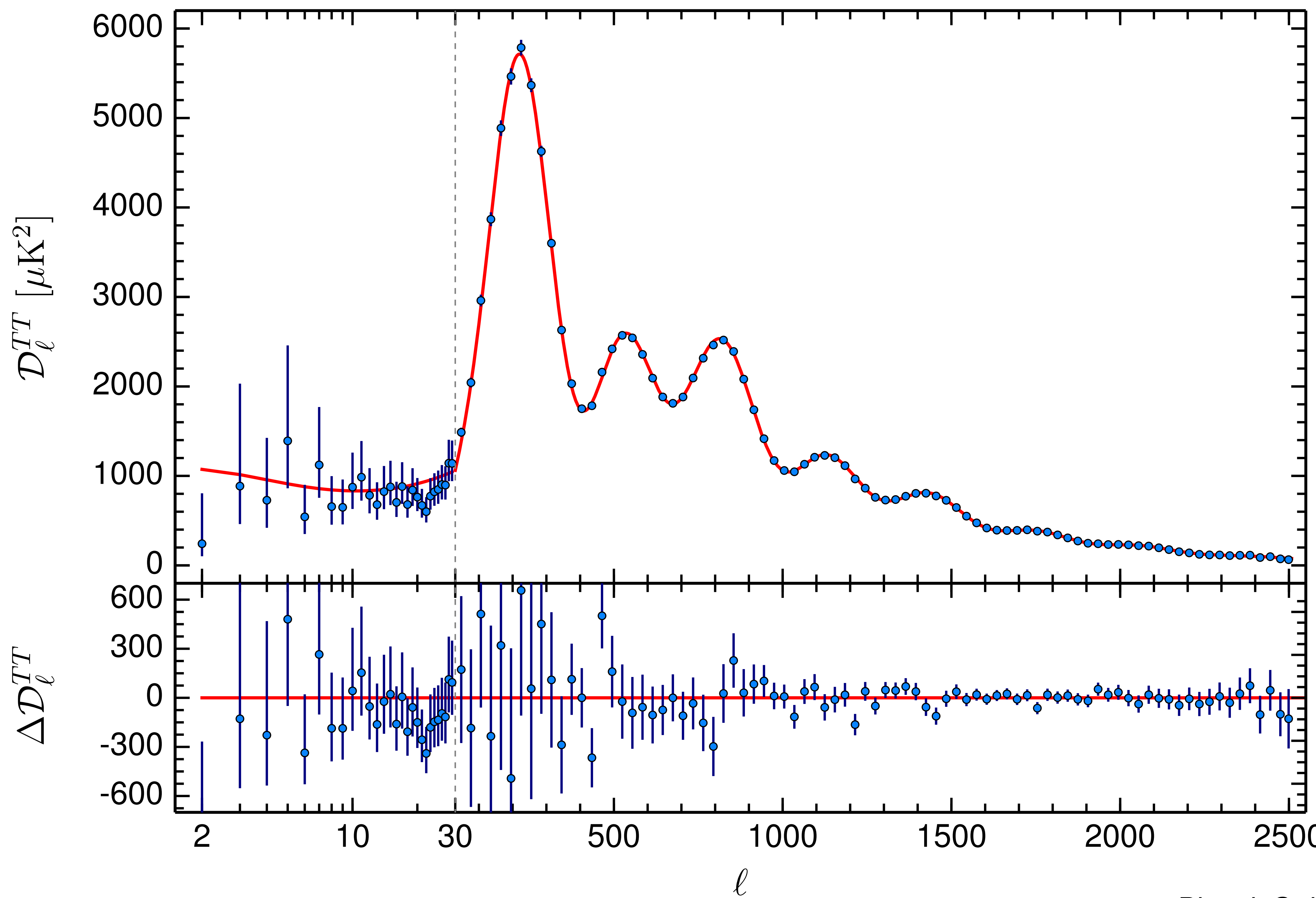
$$\mathcal{P}_{\mathcal{R}}(k) = \left(\frac{V}{24\pi^2\epsilon_1 M_{\rm Pl}^4}\right)\cdot\left(1 - 2(C+1)\epsilon_1 - C\epsilon_2 + \mathcal{O}(\epsilon_i^2)\right)$$

CMB Power Spectra



Planck Collaboration (2015)

Axion Monodromy Inflation

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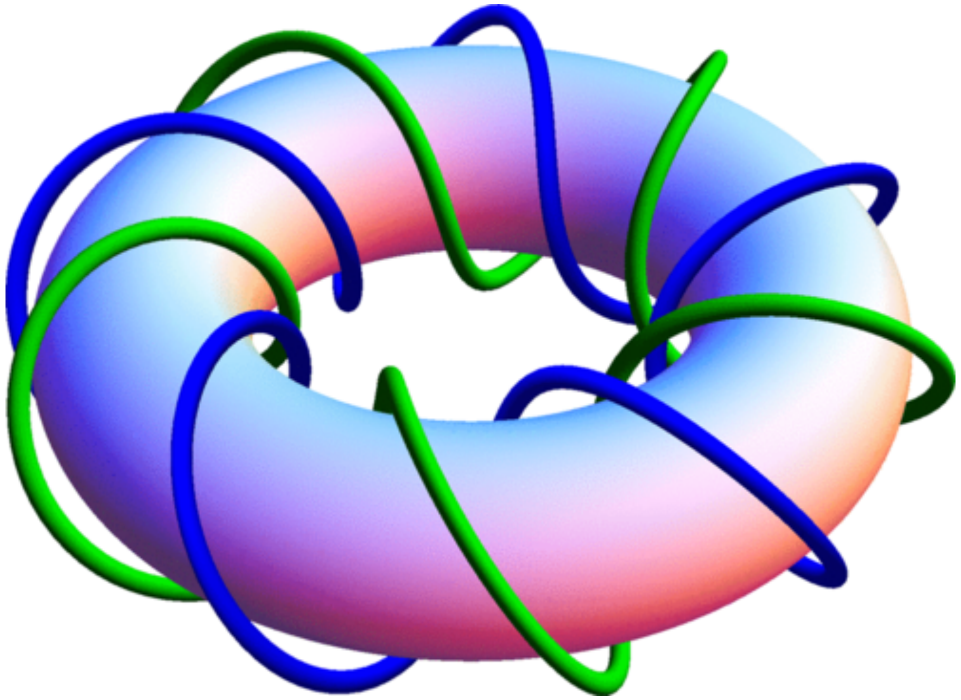

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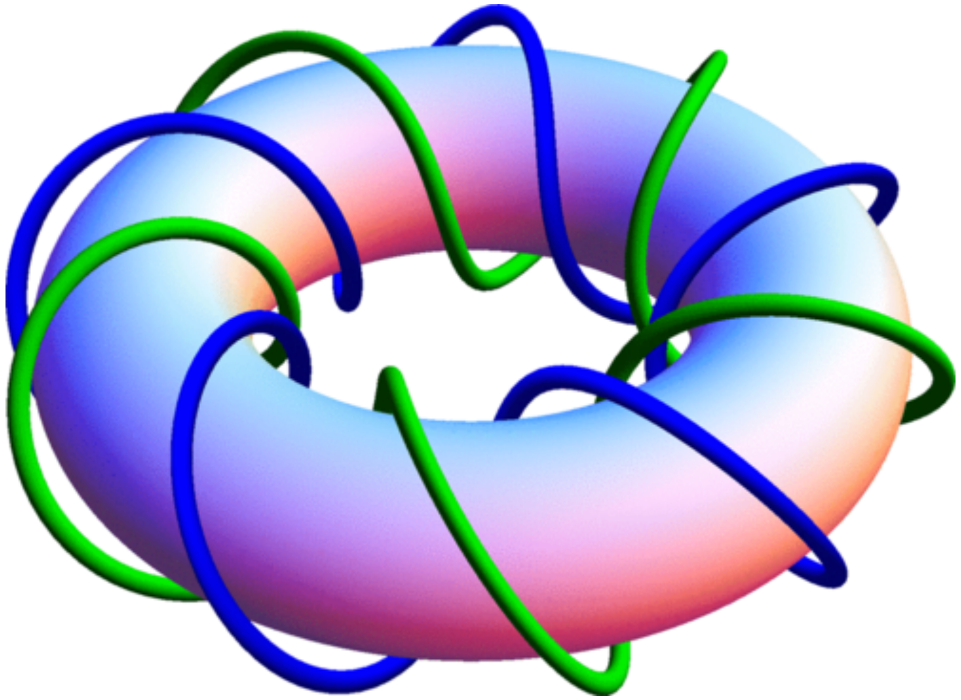

- Axion field is wrapped around a higher-dimension brane
- AMI would produce clear primordial gravitational waves, can be constrained with tensor modes

AMI Potential

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$$V(\phi) = \mu^{4-p}\phi^p + \Lambda_0^4 e^{-C_0\left(\frac{\phi}{\phi_0}\right)^{p_\Lambda}} \cos\left(\gamma_0 + \frac{\phi_0}{f}\left(\frac{\phi}{\phi_0}\right)^{p_f+1}\right)$$

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Mass term

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Osc. Amplitude

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Mass term | Index p=4/3 | Osc. Amplitude | Osc. Frequency

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$$\mathcal{P}_\mathcal{R}(k) = \mathcal{P}_\mathcal{R}(k_\star)\left(\frac{k}{k_\star}\right)^{n_s-1}\left\{1 + \delta n_s \cos\left[\frac{\phi_0}{f'}\left(\frac{\phi_k}{\phi_0}\right)^{p_f+1} + \Delta\phi\right]\right\}$$

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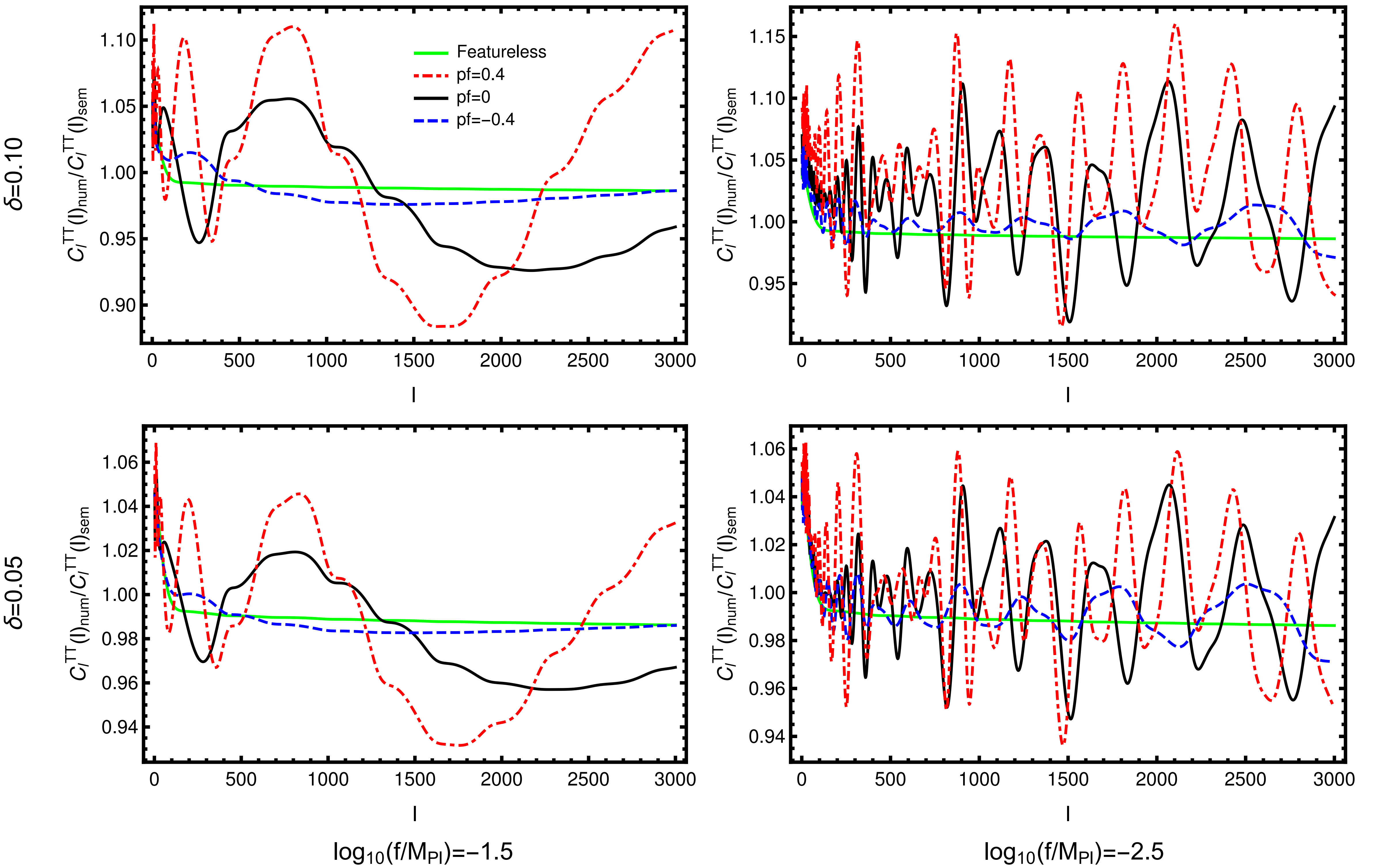
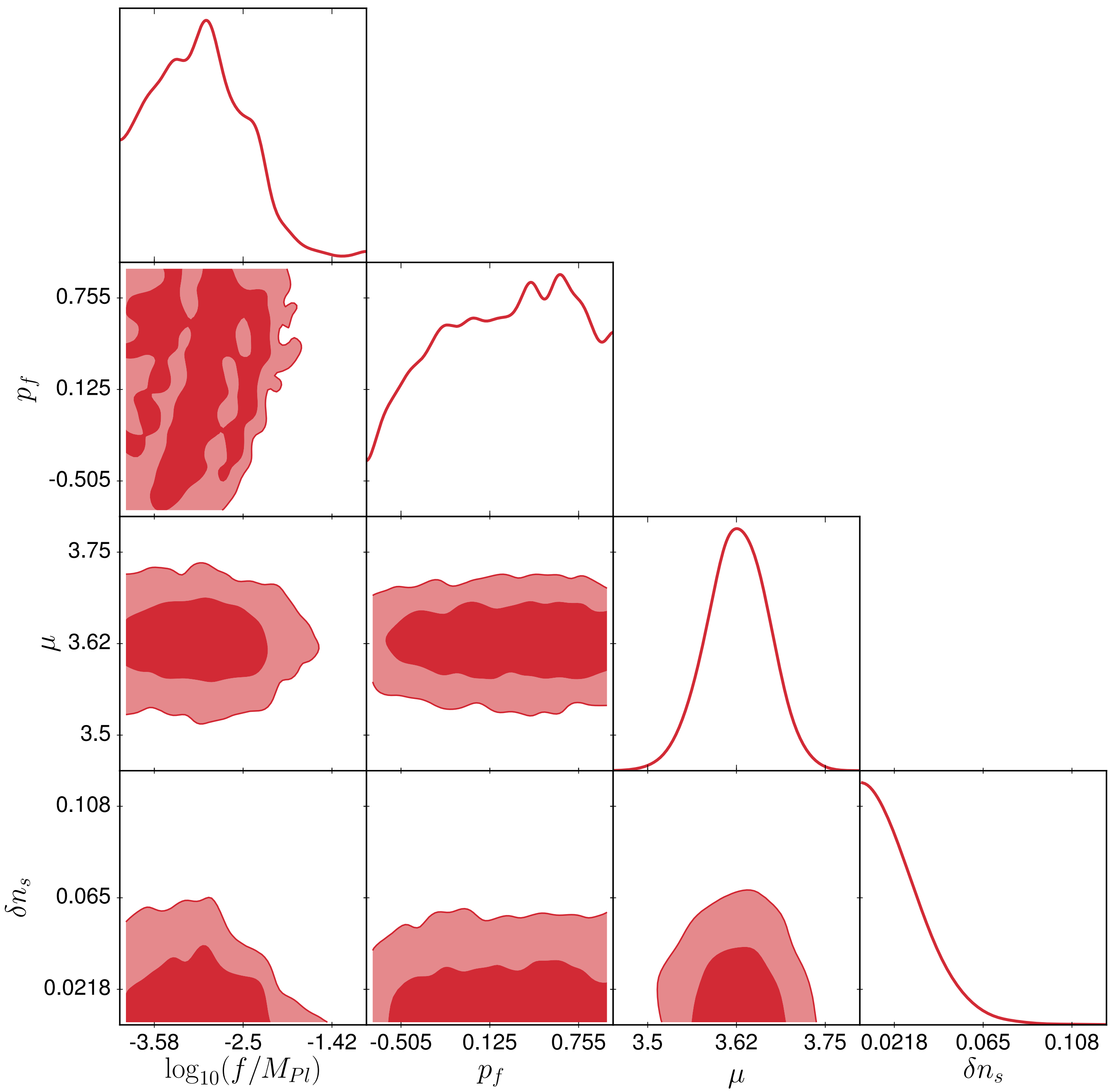
$$\delta n_s = 3b\left(\frac{2\pi}{\alpha}\right)^{1/2} \quad \rightarrow \quad \begin{cases} \alpha = (1+p_f)\frac{\phi_0}{2fN_0}\left(\frac{\sqrt{2pN_0}}{\phi_0}\right)^{1+p_f} \\ b = \frac{\Lambda_0^4}{p\mu^{4-p}\phi^{p-1}f}(1+p_f)\left(\frac{\phi}{\phi_0}\right)^{p_f} \end{cases}$$

First comparisons



SAT fits


0.755
0.125
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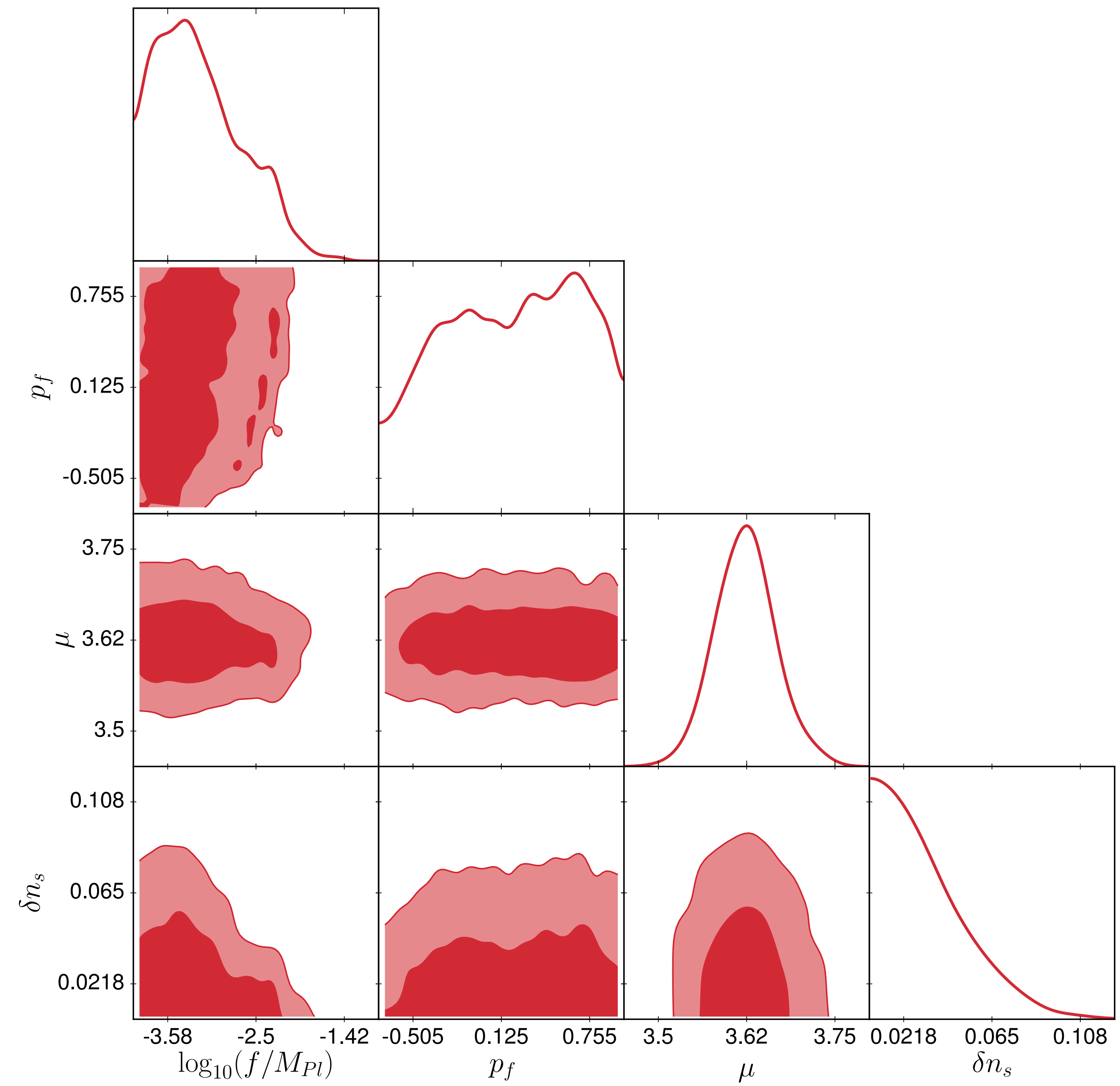
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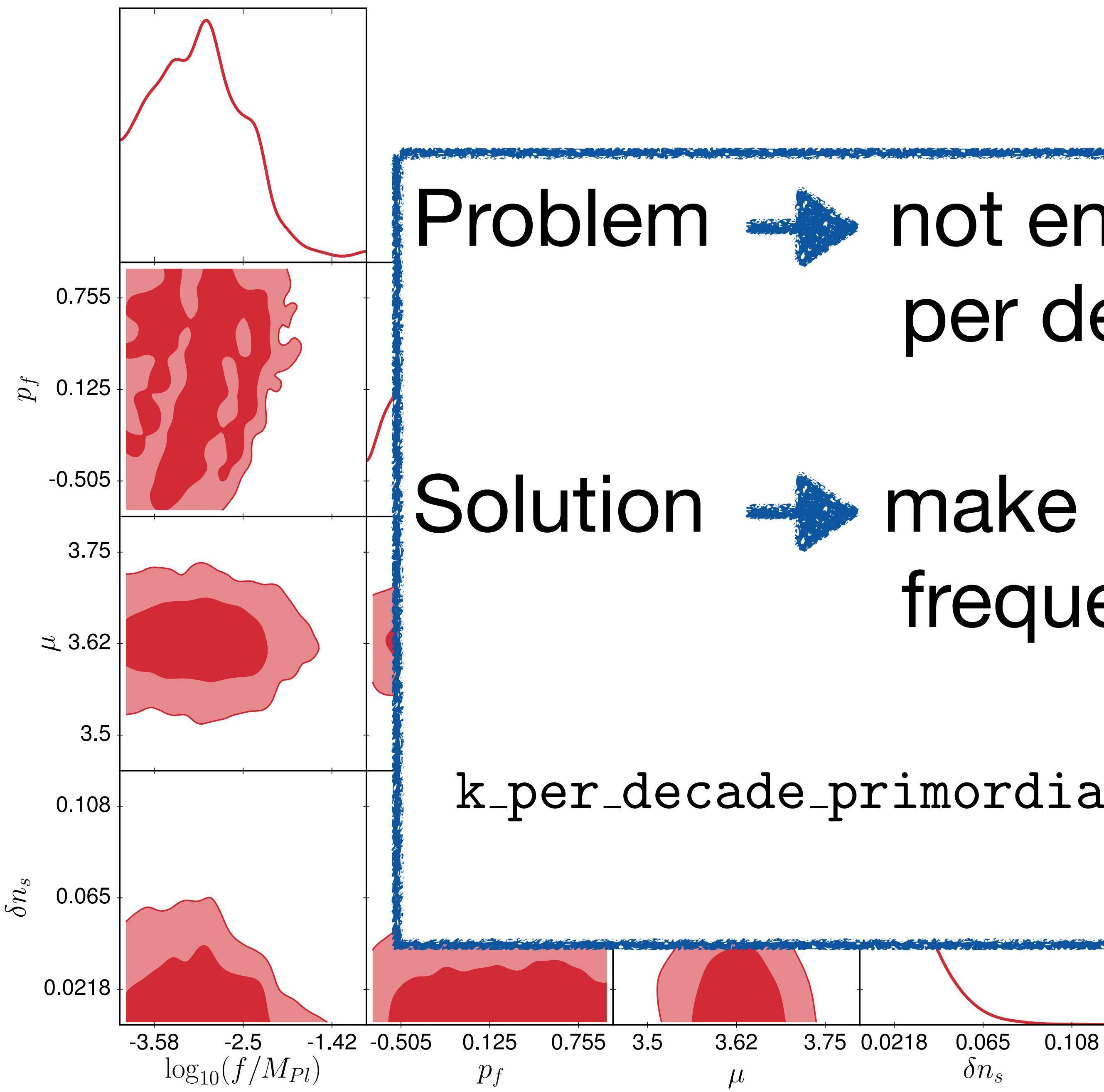
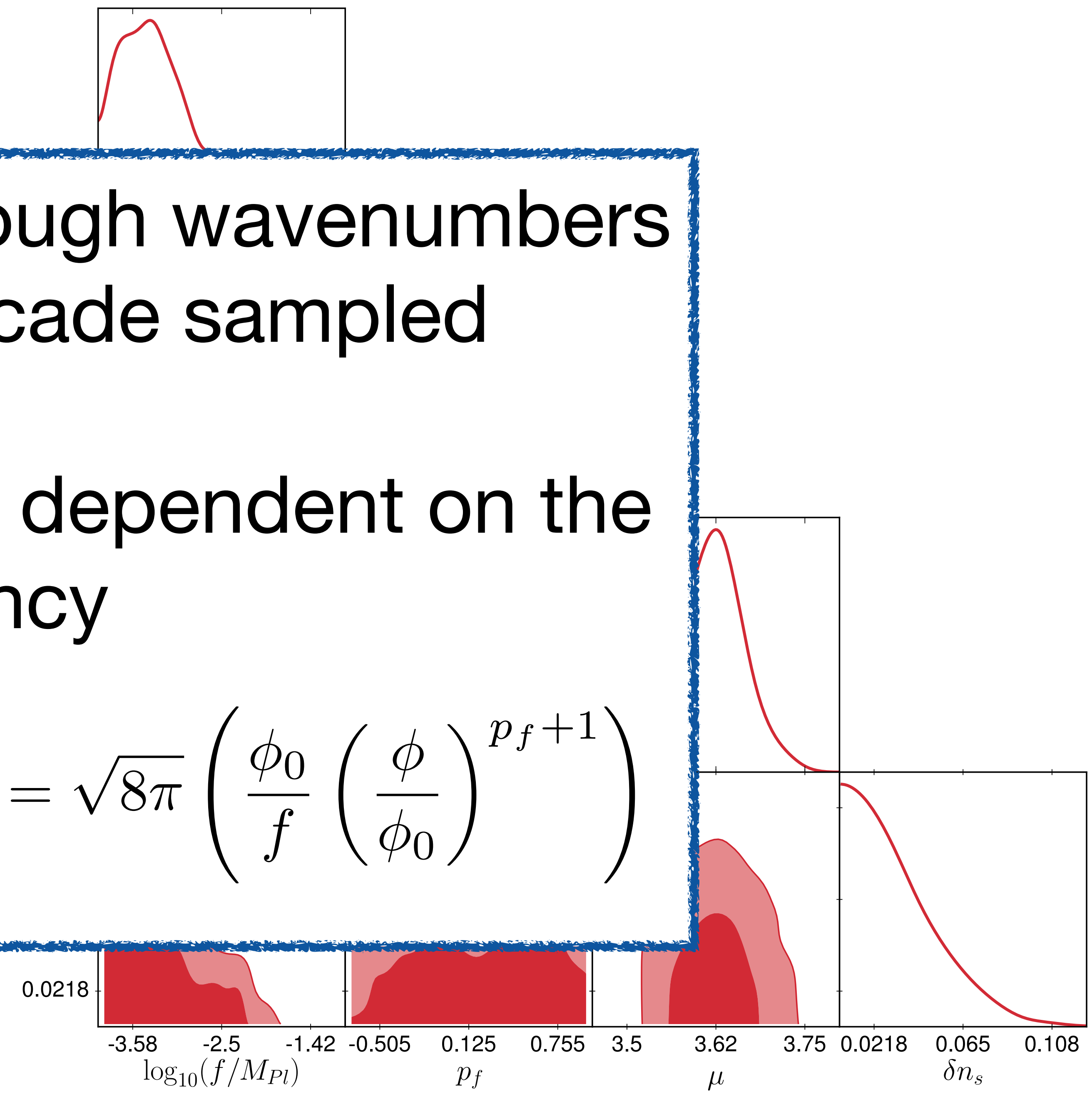


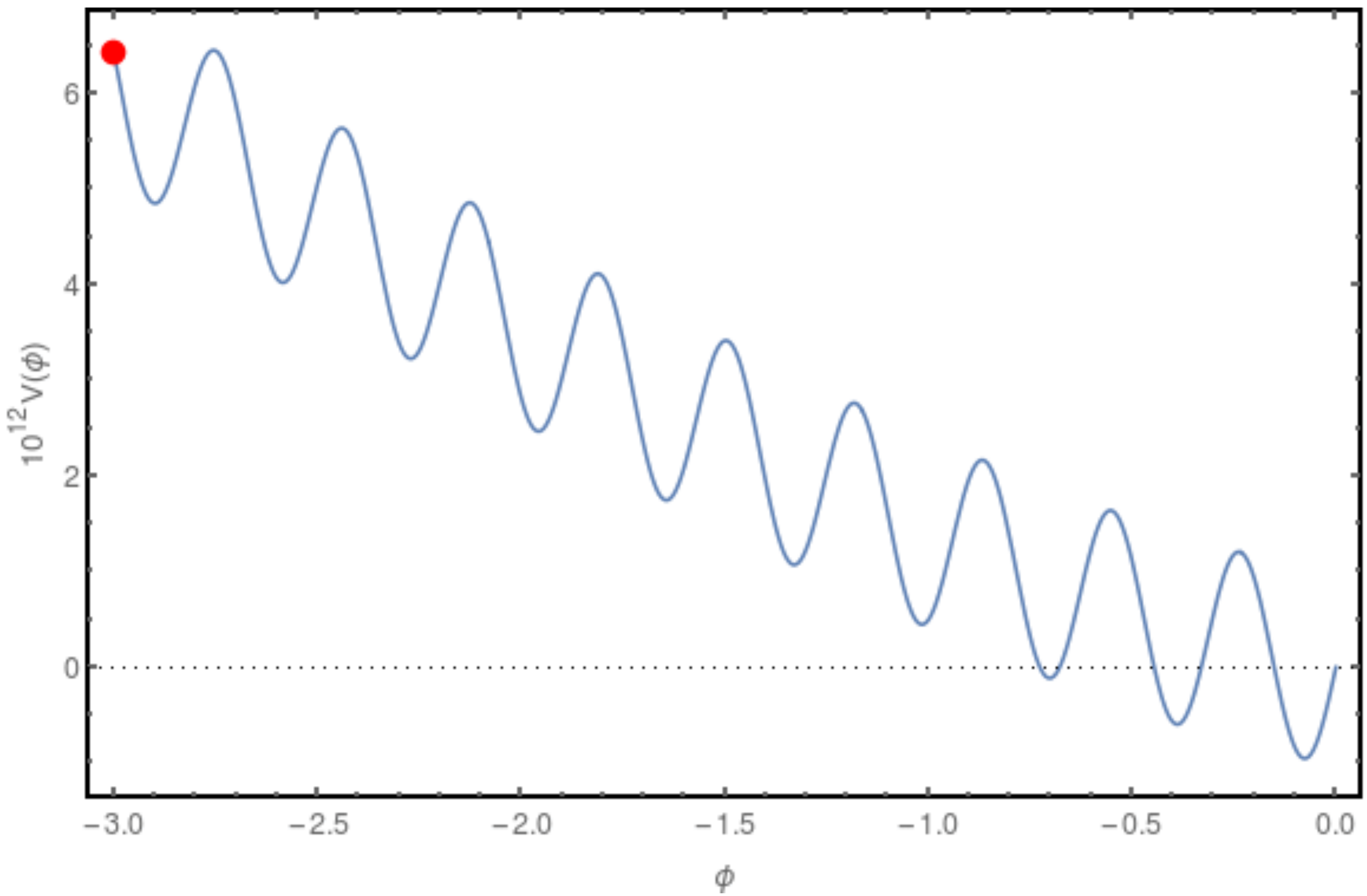


Problem → not enough wavenumbers per decade sampled

Solution → make it dependent on the frequency

$$\texttt{k\_per\_decade\_primordial} = \sqrt{8\pi}\left(\frac{\phi_0}{f}\left(\frac{\phi}{\phi_0}\right)^{p_f+1}\right)$$

Dealing with non-monotonic potentials



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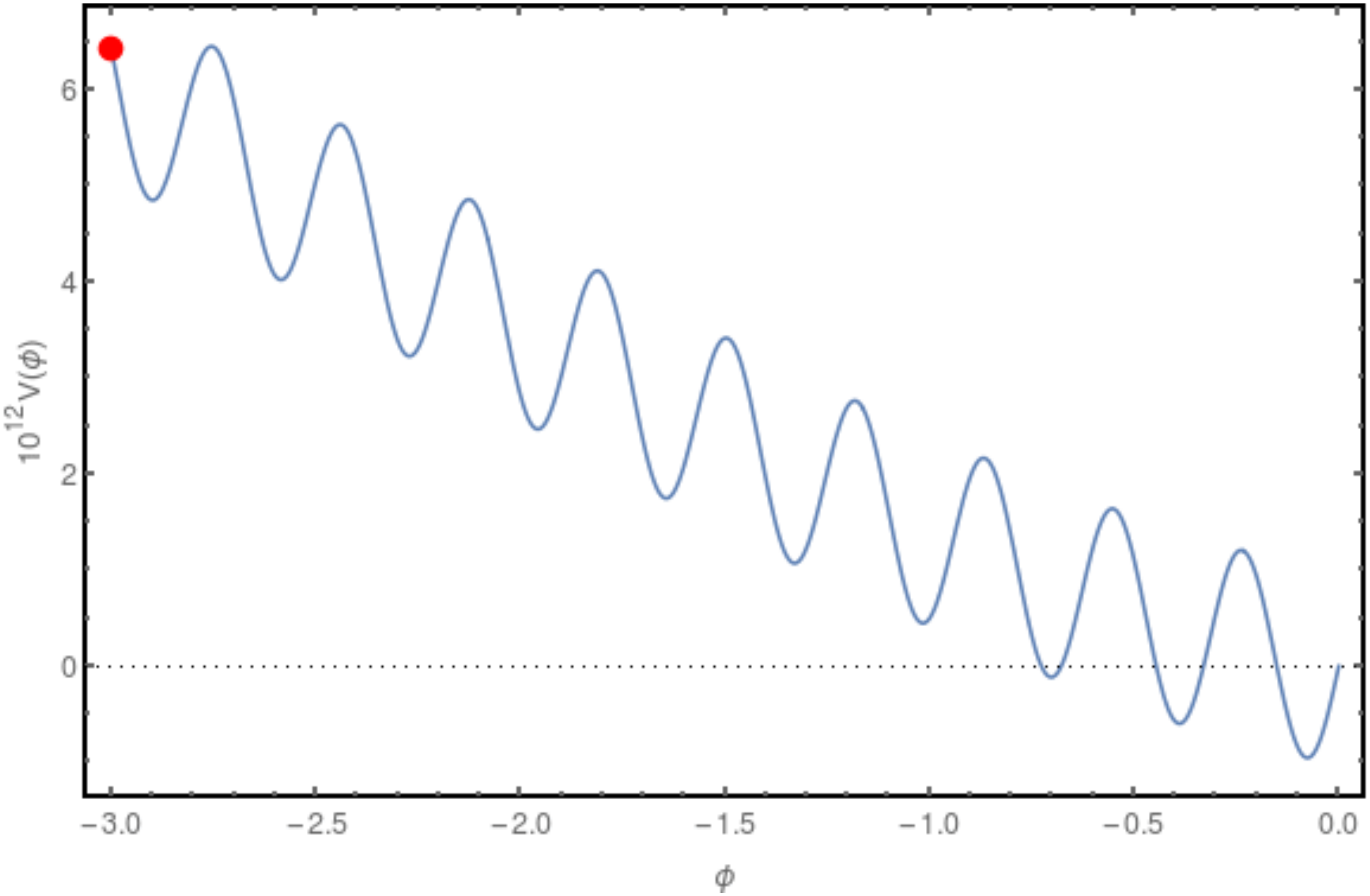

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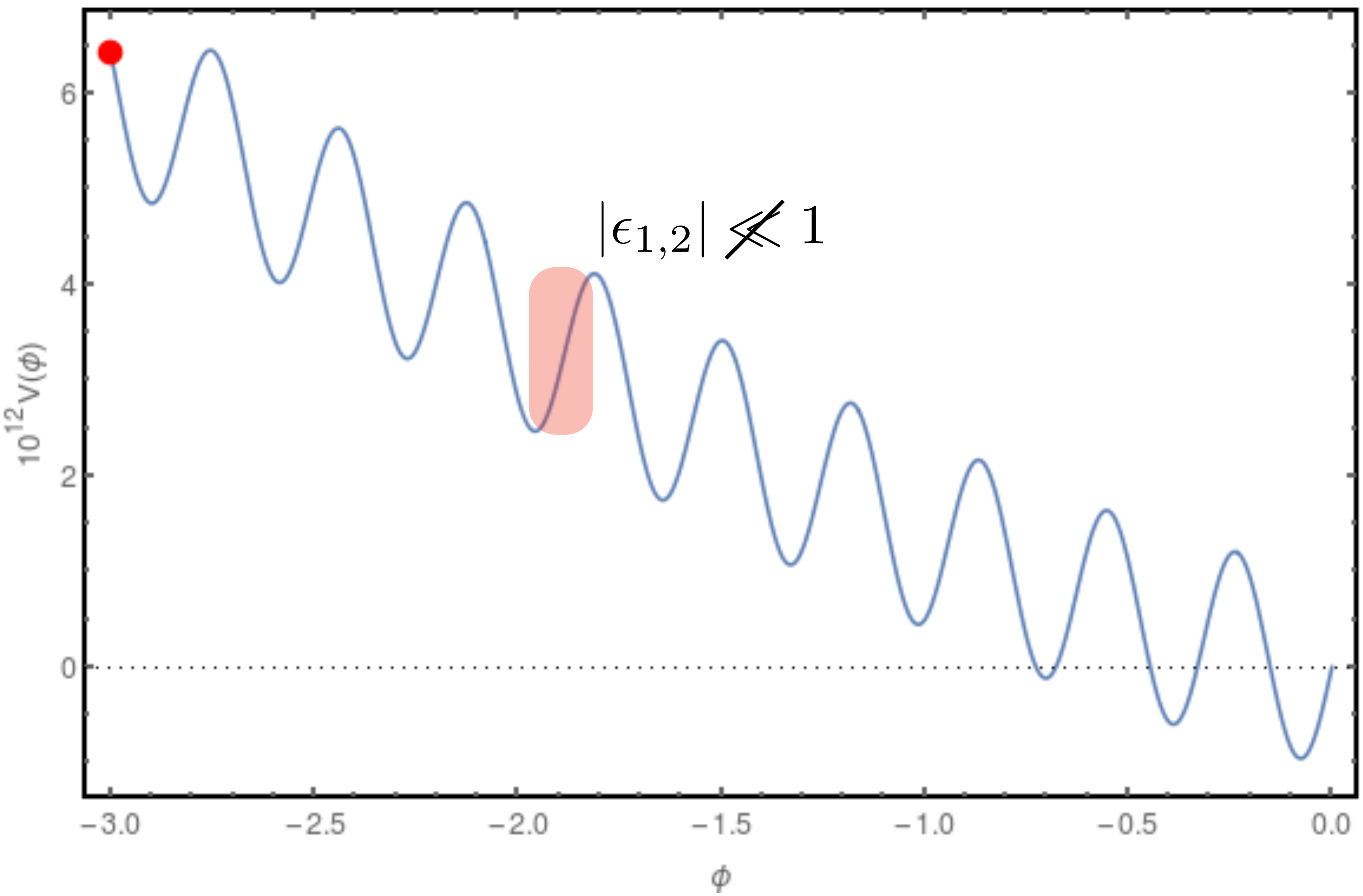

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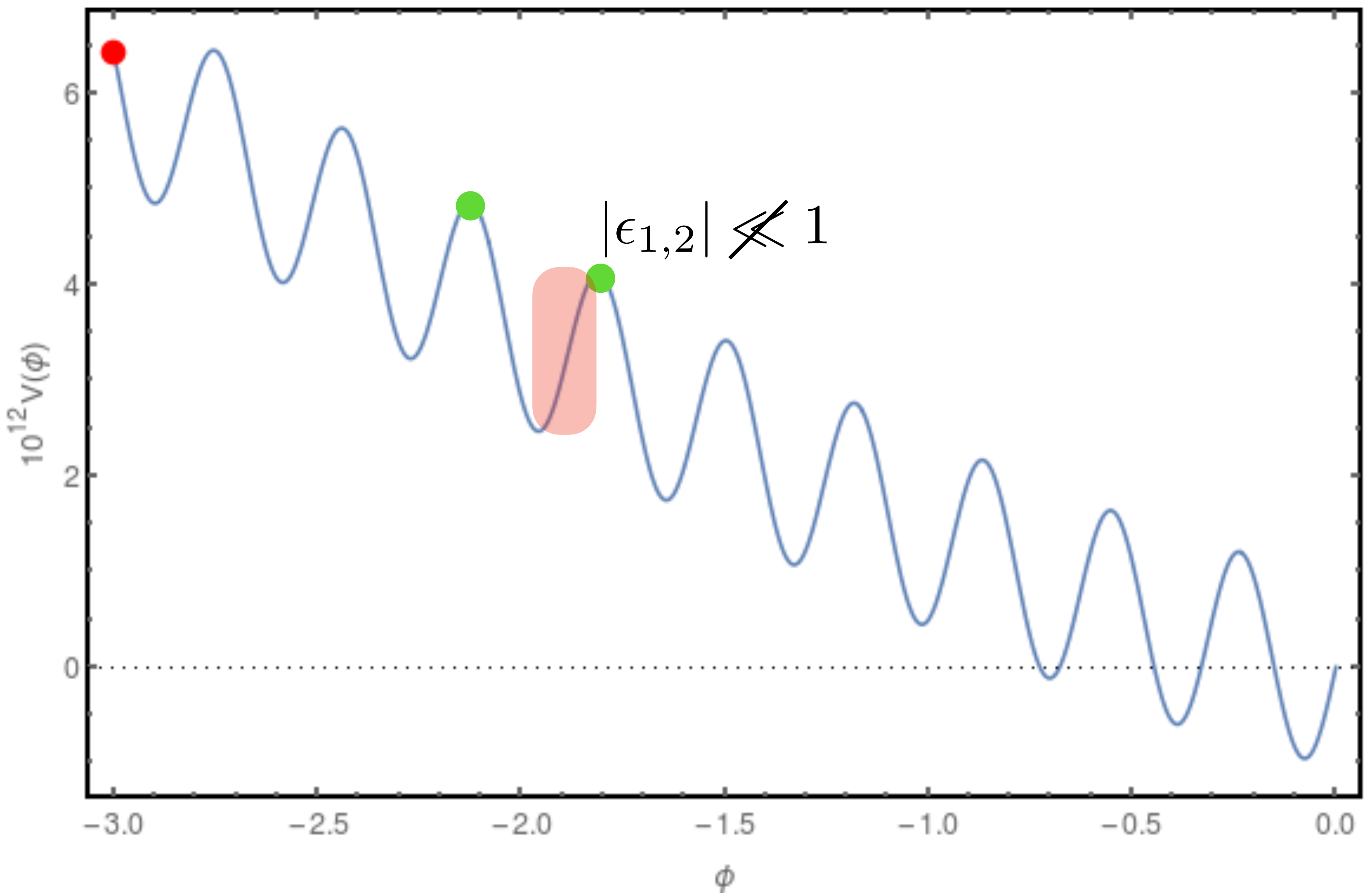

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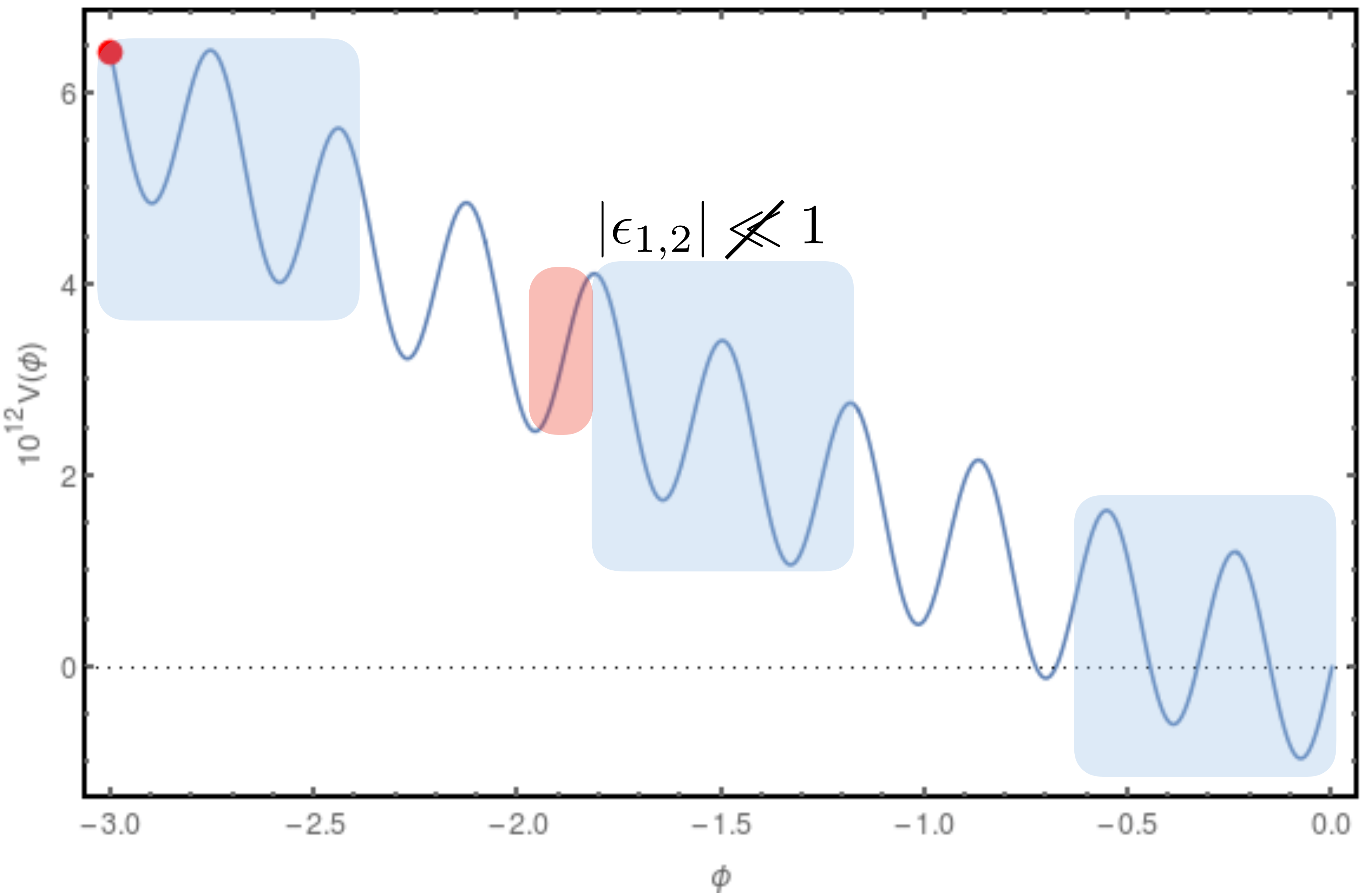
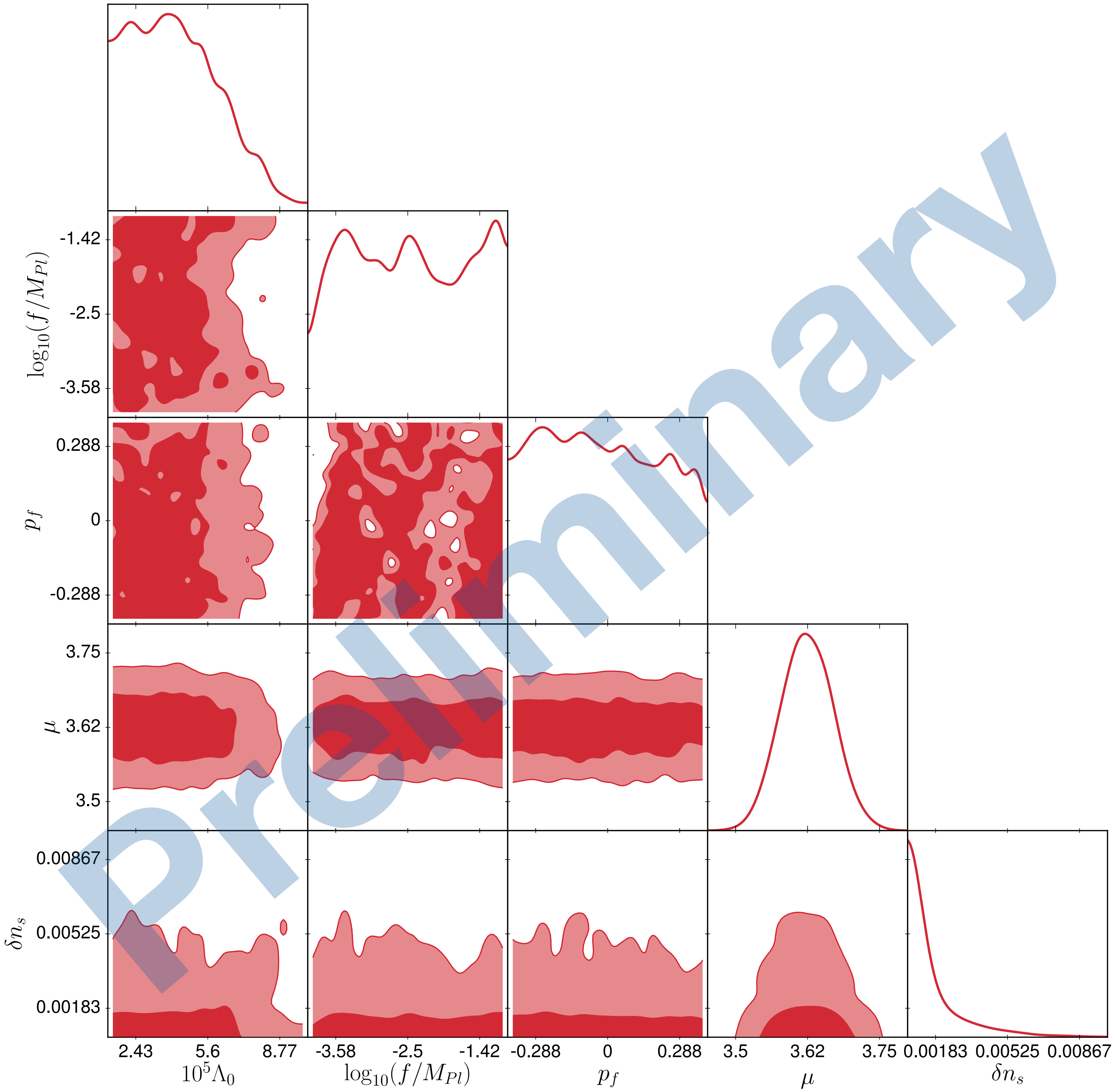


MultiNest Fits



Summary

- The search for oscillating inflaton fields is motivated by high energy models
- These models can violate the SR conditions, and require special treatment
- We propose a method to treat oscillating potentials numerically
- Tested on the string-theory motivated AMI
- Strong framework in place to constrain these models with Planck data (and BKP)

Thank you for your attention