On the predictivity of single field inflationary models.

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Based on C.P. Burgess, S.P Patil, M. Trott, arXiv:1402.1476; to appear, JHEP

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- $\exists$ a *single* effectively light degree of freedom at $\sim \epsilon^{1/4} 10^{16} GeV$. BICEP2 $\to 10^{16} GeV$?
  - whose field modes began in the relevant vacuum state (BD)
  - whose self interactions and interactions with other fields are sufficiently weak or irrelevant *throughout* inflation
  - which at the same time couples strongly enough to some sector that contains the standard model so that efficient (pre)heating occurs...

Effective field theory

How does these requirements sit with our understanding of Effective field theory? Obtaining *enough* inflation requires field excursions.

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- By thinking about this problem honestly, can rule out a lot of models a priori.

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- Not predictive ↔ need to know UV conmpletion.

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- N.B. kinetic mixing of the radial mode (singlet) and the Goldstone modes! – crucially distinction between Higgs inflation and singlet scalar field w/ quartic potential.

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- For ~ 58 efolds, $n_s \simeq 0.967, r \simeq 0.0031$

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- The guilty interactions:
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- You are *only just* OK! However, you will be riding just below the floating cut-off all throughout RG running.
- 'Threshold' effects could affect your observables if you want to connect to low energy EW physics (one of the major attractions of Higgs Inflation).

RGE Improved potential

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- Discovery of the Higgs 2012 $\rightarrow$ have to take SM parameters up to three sigma away from their central values to obtain positive quartic coupling at $M_{pl}/\sqrt{\xi}$.

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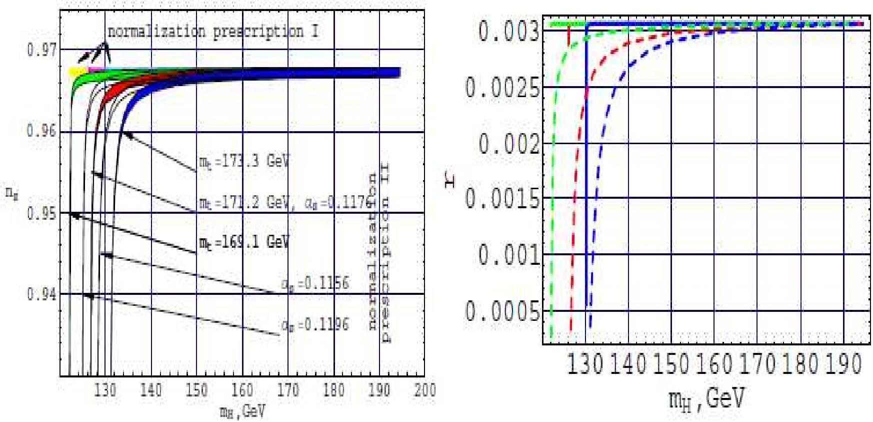

- From Bezrukov 2013.

Running up to inflation

In order to implement the running honestly, had to run up from the SM parameters at top mass (computed at 2 loops to NNLO):

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- $\lambda(m_t) = 0.12711, y_t(m_t) = 0.93558, g'(m_t) = 0.35761,$ $g(m_t) = 0.64822, g_s(m_t) = 1.1666, \xi_0 = 2300 + \delta\xi$

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- Compute effective potential during inflation, CMB observables determined from COBE normalization and fixing the number of e-folds.
- But what about the fact that $\Lambda_{int} \simeq 4\pi\bar{\phi}$ during inflation? Threshold effects at M_{pl}/ξ ?

Higgs effective inflation

Higgs inflation is not renormalizable. Obliged to treat it as an effective description. D=6 SM operators mix into the running of SM parameters under RGE, even at one loop. Jenkins, Manohar, Trott 2013

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- Wilson coefficients affect the running substantially. Unless we know the UV completion (i.e. can specify all the coefficients), have to allow for them to represent a *theoretical uncertainty* in the predictions of Higgs inflation.

Higgs effective inflation

Can repeat the analysis done by others allowing for the theoretical uncertainty represented by these unknown Wilson coefficients, and compute the effects on CMB observables. C.P.Burgess, S.P.Patil, M.Trott, arXiv:1402.1476

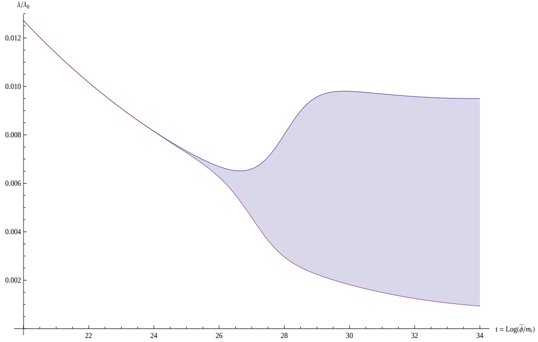


Figure : The effect of the unknown UV completion on the running of the quartic coupling in the Higgs inflation scenario.

Higgs effective inflation

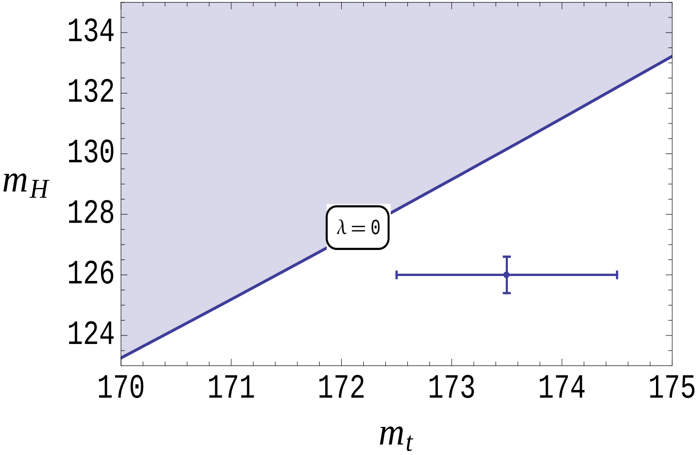


Figure : Initial conditions that separate $\lambda < 0$ from $\lambda > 0$ at $M_{pl}/\sqrt{\xi}$

Higgs effective inflation

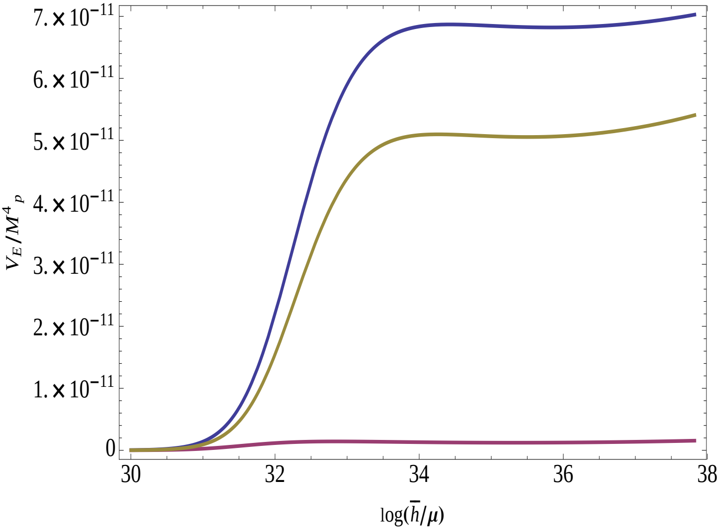
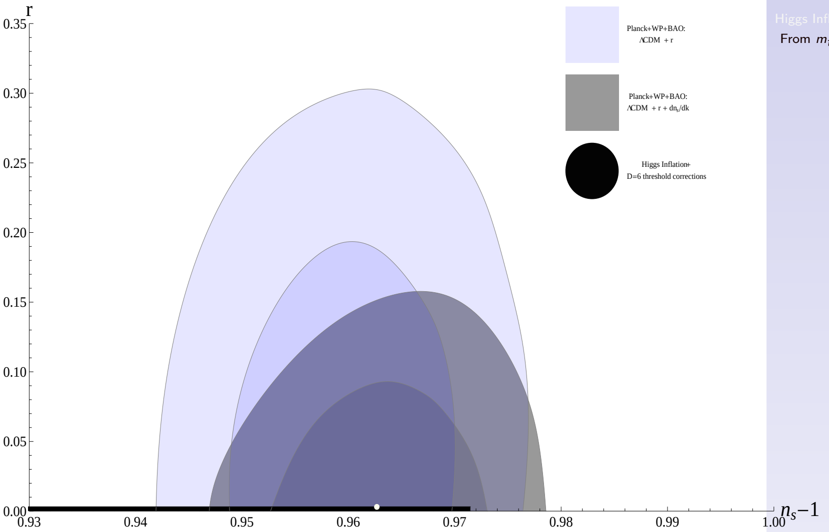


Figure : Effective potential over the range of Wilson coefficients

Higgs effective inflation



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- A related question to predictivity– is inflation falsifiable?