Higgs dynamics in the early universe

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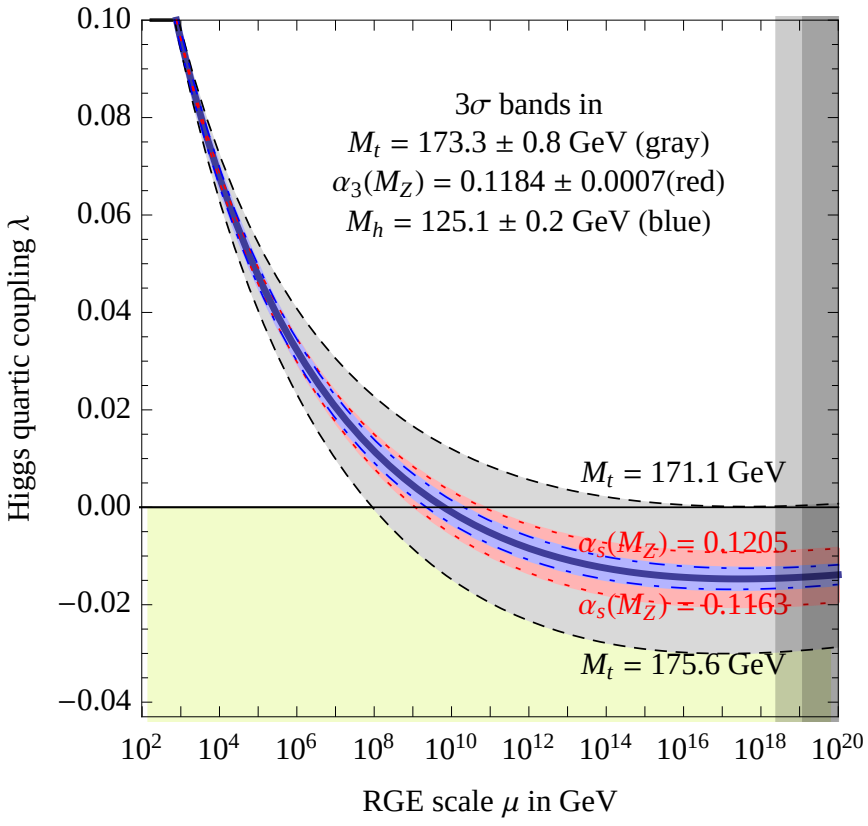
C. Gross, O. Lebedev, MZ 1506.05106

Running of the Higgs self coupling

Buttazzo et al., 1307.3536

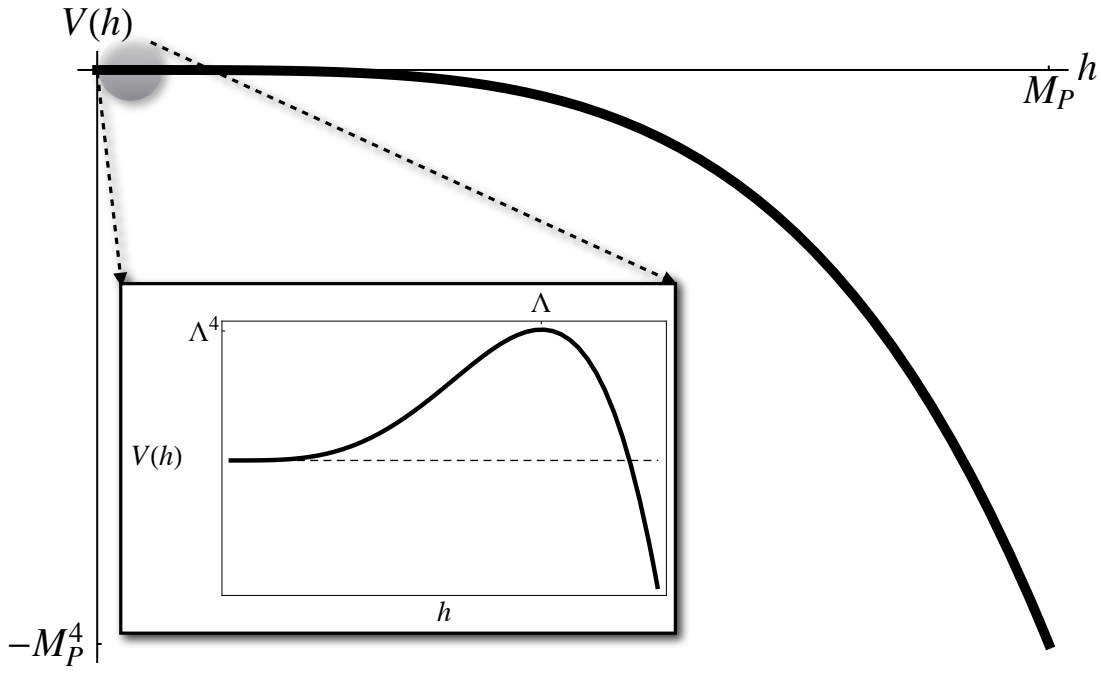


Main contribution at one loop

$$\frac{\mathrm{d}\lambda}{\mathrm{d}\ln\mu} \propto \alpha m_H^4 - \beta m_t^4$$

λ turns negative at $\Lambda \sim 10^{10}\mathrm{GeV}$!

Correct Higgs potential



During inflation $\langle \delta h^2 \rangle \sim H^2$

How the Higgs ended up in the false vacuum?

Minimal Beyond SM setup:

Lebedev&Westphal, 1210.6987

$$\frac{1}{4}\lambda_{h\phi}h^2\phi^2 \longrightarrow m_h^2 = \lambda_{h\phi}\phi_0^2/2$$

The effective mass makes h roll towards the origin

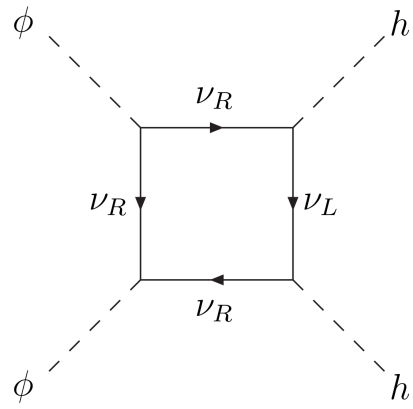
Reheating requires the Higgs-inflaton coupling

More: the coupling $h^2\phi^2$ is required by renormalizability.

Right-handed neutrino example

$$-\Delta\mathcal{L} = \lambda_\nu \phi \nu_R \nu_R/2 + y_\nu h \bar{\nu}_L \nu_R/\sqrt{2} + M \nu_R \nu_R/2 + \text{h.c.}$$

At one-loop



Need to add the counterterm

Thank you