is driving inflation in order to obtain an effective potential similar to Eq. (283) with an appropriate level of CMB temperature anisotropies. The theory is based on the following potential (Φ still represents the GUT Higgs in the adjoint, and H_5 represents the Higgs in the fundamental representation which is realizing the electro-weak breaking) [682] (see also [494, 686, 687] for recent reviews)

$$\begin{aligned} V^{\rm new}(\chi,\Phi,H_5) = &\frac{1}{4}a(\mathrm{tr}\,\Phi^2)^2+\frac{1}{2}b\mathrm{tr}\,\Phi^4-\alpha(H_5^\dagger H_5)\mathrm{tr}\,\Phi^2+\frac{\gamma}{4}(H_5^\dagger H_5)^2-\beta H_5^\dagger\Phi^2 H_5 \\ &+\frac{\lambda_1}{4}\chi^4-\frac{\lambda_2}{2}\chi^2\mathrm{tr}\,\Phi^2+\frac{\lambda_3}{2}\chi^2 H_5^\dagger H_5\ . \end{aligned} \tag{284}$$

The inflaton develops a Coleman-Weinberg potential due to its coupling to Φ and H_5. Its precise expression is obtained by minimizing the above potential for Φ which settles the system in the inflationary valley. Indeed, the breaking $SU(5)\to G_{\rm SM}$ is realized in the usual $T_{24}\propto \mathrm{Diag}(1,1,1,-3/2,-3/2)$ direction, the VEV of Φ being a function of that of χ because of the coupling λ_2,

$$\langle\Phi\rangle=\sqrt{\frac{2}{15}}\phi\ \mathrm{Diag}(1,1,1,-3/2,-3/2)\ ,\quad \text{with}\quad \phi^2=(2\lambda_2/\lambda_c)\chi^2\ . \tag{285}$$

($\lambda_c\equiv a+7b/15$ represents the mixture of the Φ^4 terms in V.) Discarding the pure H_5 sector (relevant at the EW scale) and computing the masses of the triplet and doublet in H_5 that enter the Coleman-Weinberg formula, one can reduce the potential to $V(\phi,\chi)$ and then to the effective inflationary potential using Eq. (285) [682]

$$V_{\rm eff}^{\rm new}(\chi)=A\chi^4\left[\ln\left(\frac{\chi}{\chi_0}\right)-\frac{1}{4}\right]+\frac{A\chi_0^4}{4}\ , \tag{286}$$

where χ_0 is the position of the minimum of $V_{\rm eff}^{\rm new}(\chi)$ and A is a function of the couplings λ_2, λ_c and the gauge coupling g_5. The system after inflation is trapped in the global minimum at $\chi=\chi_0$ and $\phi=\phi_0=\sqrt{2\lambda_2/\lambda_c}$. The mass of the superheavy gauge bosons inducing the proton decay is proportional to ϕ_0,

$$M_X=\sqrt{\frac{5}{3}}\frac{g\phi_0}{2}\ , \tag{287}$$

Thus the phase of inflation take place at an energy close to the mass scale involved in the proton decay, $M_X\sim 2V_0^{1/4}$, and its stability constrains the inflationary scale.

The predictions for $SU(5)$ singlet inflation [3, 5, 682, 683, 685] is similar to that of the potential; $V=V_0[1-\lambda_\chi(\chi/\mu)^4]$, with $\lambda_\chi=A\ln\chi/\chi_0$. The predictions depend on A or alternatively on V_0, and for $V_0^{1/4}\in[2\times10^{15},4\times10^{16}]$ GeV, they are found in the range: