Therefore, fields coupled to either $H_u,\ H_d$ or $L$ will remain massless by virtue of their zero VEV, and subject to large quantum fluctuations of order $H_{inf}/2\pi$ during inflation. It is possible to convert these fluctuations when the inflaton decays to the MSSM quanta at the time of reheating.

The effective coupling for the inflaton to decay either via $H_uH_d$ or $LH_u$ is given by:

$$g = g\left(1 + \frac{\langle S\rangle}{M_*} + ...\right) , \tag{463}$$

where $S$ is the VEV of the field which couples to either $H_u,\ H_d,\ L$, then the inflaton decay will generate a quasi-thermal bath. The initial decay width of the inflaton will generate a plasma with a temperature $T \propto \Gamma_d^{1/2} \propto g$. Therefore, fluctuations in temperature induced by $\langle S\rangle \sim H_{inf}/2\pi$, would lead to

$$\frac{\delta T}{T} \sim \left.\frac{H_{inf}}{2\pi S}\right|_{decay} , \qquad \text{or} \qquad \left.\frac{\delta T}{T} \sim \frac{H_{inf}}{2\pi M_*}\right|_{decay} , \tag{464}$$

depending on whether the inflaton decays via non-renormalizable or renormalizable operators. In order to match the seed perturbations for CMB, $\delta T/T \sim 10^{-5}$, either the VEV of $S$ or the scale of new physics should be around $10^5 H_{inf}$.

## VIII. STRING THEORY MODELS OF INFLATION

One of the best motivated framework of quantum gravity is the string theory. Therefore it is natural to seek whether string theory can shed some light on inflation. There are many reviews dedicated to stringy inflation [8, 46–54]. Since, there are many models of inflation with large VEVs close to the Planck scale, which are particularly sensitive to the UV properties of the field theory, it is possible that string theory can provide some insight into the shape and stability of the potential. String theory also involves many degrees of freedom with equally large number of *physical* solutions, which makes it vulnerable when it comes to making concrete predictions, such as selecting the right vacuum at low energies. It is hoped that cosmological observations along with particle phenomenology beyond the SM would help us constructing inflationary models [108].

[108] With the discovery of branes [866, 867], string theory has influenced string phenomenology and cosmology in a radical way, see [47, 52]. As a consequence, not all interactions see the same number of space-