2. Choice of a vacuum where inflation ends

In order to realize our observable universe, inflation must come to an end in the right vacuum. The exit must happen such that the relevant degrees of freedom required for the BBN, i.e. the relativistic SM degrees of freedom, and right abundance for the cold dark matter can be excited. There are only few models where inflation can end right in the SM vacuum; the SM Higgs inflation [86], and the MSSM inflation [87]. In many particle physics models of inflation, the existence of a hidden sector coupling to the MSSM or the SM sector is common, see [10]. All these models require extra set of assumptions in order to make sure that the inflaton energy density gets transferred into the MSSM or the SM degrees of freedom. Note that a hidden sector inflaton can excite hidden degrees of freedom as the couplings between the two hidden sectors are not barred by any symmetry. Furthermore, gravity will always couple one such sector to the another. Therefore, it is desirable to end inflation where one can directly excite the SM quarks and leptons [22].

In the case of stringy models, there exists no construction where inflation ends right in the MSSM or the SM sector. The problem becomes more challenging with an introduction of a string landscape, since there are nearly 10^{500} to even 10^{1000} vacua [45, 57, 58], with the vast majority of those having large cosmological constants. In such cases exiting inflation from the string landscape and exiting the inflation in our own vacuum becomes even more challenging task [284].

3. Quantum to classical transition

The initial sub-Hubble perturbations are quantum in nature. The perturbations are then stretched outside the Hubble patch during inflation, therefore the correlation function, $\langle \delta\phi(x)\delta\phi(x')\rangle$, evolves during inflation. It has been shown that the evolution is similar to that of a squeezed state [301–306], the squeezing happening due to the exponential expansion. For very long wavelength (super Hubble) modes the quantum correlation between the two inflating regimes dies away exponentially by the number of e-foldings of inflation $\sim e^{-N}$.

[22] Suppose inflation ends in a GUT vacuum, it does not guarantee automatically that the GUT would be broken down to the SM vacuum. There are many ways to break it and one requires special care in realizing such a scenario. See Sec. III F