(Minkowski functional) has lead so far a negatively preferred value for $f_{NL} \sim -60 \pm 60$. This discrepancy has not yet been fully resolved [13]. The future observations from PLANCK and the galaxy distribution should be able to constrain a deviation up to $|f_{NL}| \gtrsim 5$ [273–276].

F. Dynamical challenges for inflation

Inflation has several dynamical challenges which have been discussed in the literature.

1. Initial conditions for inflation

The question of initial condition is a worrisome factor. universe could have started either cold or hot. Whether universe began hot or cold, once vacuum energy density takes over it would always yield a cold universe. However there are nontrivial initial conditions to be satisfied.

- Homogeneity problem:
  In an Einstein gravity inflation does not solve the homogeneity problem, instead inflation requires an initial patch of the universe, r, to be sufficiently homogeneous on scales larger than the Hubble patch, $r \gg H^{-1}$, before inflation could begin see Refs. [277–282]. Initial conditions if set at the Planckian scale do not suffer through this problem as shown by Refs. [4, 145, 283]. Low scale models of inflation require earlier phases of inflation in order to set the initial conditions.

- Chaotic initial conditions:
  For sufficiently flat potential the only constraint is given by: $(1/2)\dot{\phi}^2 + (1/2)(\partial_i\phi)^2 + V(\phi) \leq M_{\rm P}^4$, see Refs. [4, 145, 187, 283]. The initial conditions are set by: $(1/2)\dot{\phi}^2 \sim (1/2)(\partial_i\phi)^2 \sim V(\phi) \sim \mathcal{O}(M_{\rm P})$. If by any chance $(1/2)\dot{\phi}^2 + (1/2)(\partial_i\phi)^2 \leq V(\phi)$ in a particular domain, the inflation begins and within a Planck time the potential energy density, $V(\phi)$, starts dominating over kinetic term. In domains where $(1/2)\dot{\phi}^2 + (1/2)(\partial_i\phi)^2 > V(\phi)$, inflation does not take place and do not exist classically. The above mentioned conditions are naturally satisfied when $\phi \geq M_{\rm P}$ for a simple chaotic type potential, $V \sim m^2\phi^2$, where there exists a window, $\mathcal{O}(100-10)M_{\rm P} > \phi > \mathcal{O}(M_{\rm P})$, where universe enters a process of eternal self-reproduction [145, 283].