"IR divergence and gauge-invariant initial state"

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● Initial vacuum in inflationary universe

Initial state of our universe ?

Our proposal

Gauge invariance of initial state

→ Restricts possible initial quantum state

● Presence of gauge modes

$$S = \tfrac{1}{2} \int \sqrt{-g} \left[R - g^{\mu\nu} \phi_{,\mu} \phi_{,\nu} - 2V(\phi) \right] \mathrm{d}^4 x$$

1. Physical degrees of freedom

2. Gauge degrees of freedom

   - Local

   - Non-local

● Presence of gauge modes

$$S = \tfrac{1}{2} \int \sqrt{-g}\, [R - g^{\mu\nu}\phi_{,\mu}\phi_{,\nu} - 2V(\phi)]\mathrm{d}^4 x$$

1. Physical degrees of freedom

2. Gauge degrees of freedom

- ~~Local~~   Gauge cond. at each point

- Non-local   Difficult to remove

● Gauge-invariance on initial state

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Hilbert space $\Bigg\{$ Physical DOFs

Non-local gauge DOFs

Necessary to restrict the initial quantum state
to preserve the gauge invariance → Poster 76