

Entanglement Evolution in Slow-Roll vs Ultra-Slow-Roll Inflation

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With S. Brahma, J. Calderón-Figueroa & D. Seery
arXiv:2411.08632 (2024) and ongoing work

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USR enhances small scales

USR has a specific set of slow roll parameters $\{\epsilon^{(n)}\}$ such that:

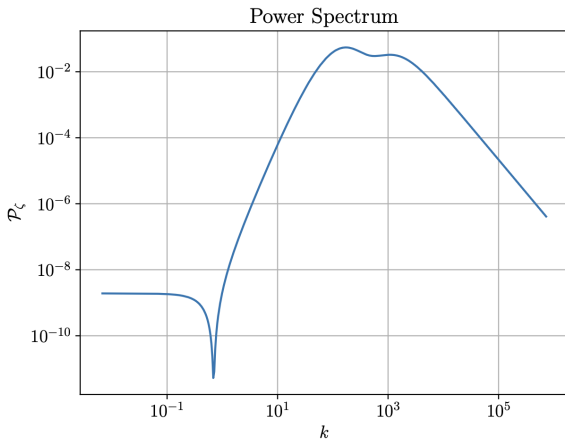


Figure 1: Amplification of small-scale modes.

\Rightarrow A potential mechanism for generating primordial black holes.

Open EFT of the two-field model

We are going to investigate the impact of USR in the entanglement structure of curvature perturbation using the open EFT method.

$$\mathcal{L} = a^2 \epsilon M_{\text{Pl}}^2 (\zeta'^2 - (\partial_i \zeta)^2) + \frac{1}{2} a^2 (\mathcal{F}'^2 - (\partial_i \mathcal{F})^2) \\ - \frac{1}{2} m^2 a^4 \mathcal{F}^2 + \lambda a^3 \sqrt{2\epsilon} M_{\text{Pl}} \zeta' \mathcal{F}.$$

Purity evolution

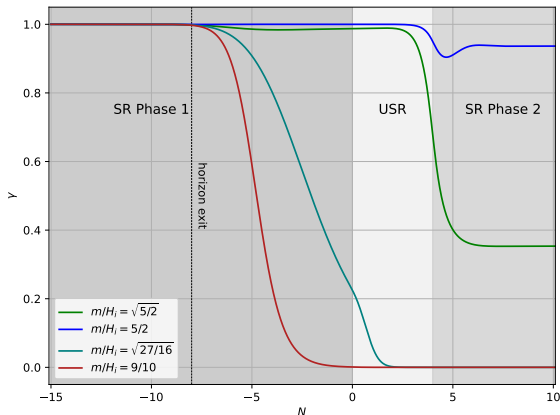


Figure 2: Purity of a given k mode in a sandwich model. The USR phase leads to efficient decoherence of the curvature perturbation mode and possesses less non-Markovianity.

Real-space entanglement in USR

Cosmic bell test requires space separation.

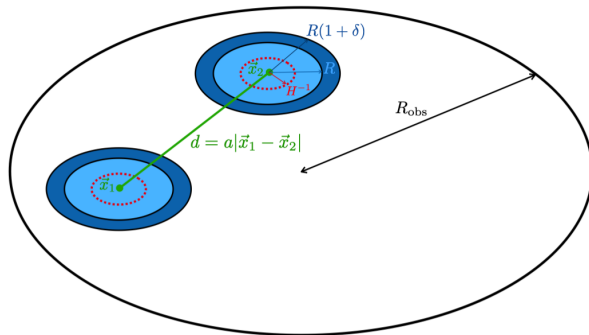


Figure 3: Real-Space Entanglement (Martin, Vennin; arXiv:2106.14575, arXiv:2106.15100)

Wands duality

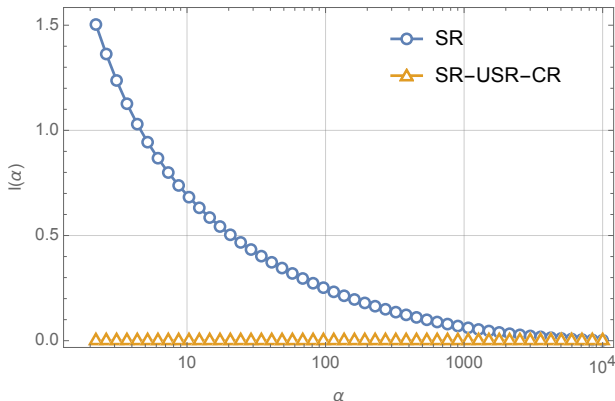
SR and USR has same mutual information and quantum discord.
It turns out backgrounds linked by Wand's duality have same:

- ▶ symplectic eigenvalues
- ▶ mutual information
- ▶ quantum discord

including SR and USR pair.

Realistic transitions

A transient USR phase embedded inside SR leads to a strong reduction of mutual information between spatial regions.



⇒ The smoothness of the transition between backgrounds is crucial.

Thank you!