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Stochastic inflation and entropy bound in de Sitter spacetime

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We analyze the entropy behavior of the de Sitter spacetime during the inflationary phase. A cosmological horizon in de Sitter spacetime that constrains the causally accessible region of an observer exhibits thermal properties analogous to the event horizon of a black hole. According to the principles of holography, the entropy within a causally connected region for an observer is limited by its boundary. This entropy bound is violated during the late inflation stage. To address the issue of entropy bound violations from a quantum information perspective, we adopted a stochastic approach to cosmic inflation. We consider Shannon entropy of the probability distribution of the inflaton field, which shows the same behavior as the entanglement entropy of a Hubble-size region in stochastic inflation. Adopting the volume-weighted probability distribution for the inflaton field, we show a meaningful entropy behavior in the de Sitter spacetime.

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