A Noisy Quantum Channel Model for the Cosmological Horizon in de Sitter Spacetime

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Abstract

Quantum entanglement of the free scalar field has been studied in de Sitter spacetime. We analyze the quantum correlation between two observers across the cosmological horizon and investigate the retrieval of the information behind the cosmological horizon. It is shown that effect of the universe's expansion can be described as a noisy quantum channel model having a complete positive map with an operator sum representation. This investigation shows that distillable entanglement is degraded when the expansion rate is increased, and asymptotically there is non-vanishing quantum entanglement. We also show positive relation between bipartite mutual information and tripartite mutual information in terms of recent discussions on the scrambling. This analysis means that quantum channel can be used to denote measurement beyond the cosmological horizon. In addition, there is a scrambling effect in the quantum task across the cosmological horizon in de Sitter spacetime like black hole event horizon.