Information Processing with Quantum Gravity Environment

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Abstract

The theory of quantum gravity is aimed to fuse general relativity with quantum theory into a more fundamental framework. The space of quantum gravity provides both the non-fixed causality of general relativity and the quantum uncertainty of quantum mechanics. In a quantum gravity scenario, the causal structure is indefinite and the processes are causally non-separable. In this work, we provide a model for the information processing structure of quantum gravity. We show that the quantum gravity environment is an information resource-pool from which valuable information can be extracted. We analyze the structure of the quantum gravity space and the entanglement of the space-time geometry. We study the information transfer capabilities of quantum gravity space and define the quantum gravity channel. We reveal that the quantum gravity space acts as a background noise on the local environment states. We characterize the properties of the noise of the quantum gravity space and show that it allows the separate local parties to simulate remote outputs from the local environment state, through the process of remote simulation. We characterize the information transfer of the gravity space and the correlation measure functions of the gravity channel. We investigate the process of stimulated storage for quantum gravity memories, a phenomenon that exploits the information resource-pool property of quantum gravity. The results confirm the perception that the benefits of the quantum gravity space can be exploited in quantum computations, particularly in the development of quantum computers.