

General Relativity and Quantum Cosmology

Quantum entanglement and entropy in particle creation

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We investigate the basic theoretical issues in the quantum entanglement of particle pairs created from the vacuum in a time-dependent background field or spacetime. Similar to entropy generation from these processes which depends on the choice of physical variables and how certain information is coarse-grained, entanglement dynamics hinges on the choice of measurable quantities and how the two parties are selected as well as the background dynamics of the field or spacetime. We discuss the conditions of separability of quantum states in particle creation processes and point out the differences in how the von Neumann entropy is used as a measure of entropy generation versus for entanglement dynamics. We show by an explicit construction that adoption of a different set of physical variables yields a different entanglement entropy. As an application of these theoretical considerations we show how the particle number and the quantum phase enter the entanglement dynamics in cosmological particle production.

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