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Entanglement in an expanding universe

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I discuss the evolution of entanglement entropy for a massless field within a spherical region in an expanding background. The formalism is applied to the inflationary period and the subsequent era of radiation domination, starting from the Bunch-Davies vacuum. Each field mode evolves towards a squeezed state upon horizon exit during inflation, with additional squeezing when radiation domination sets in. This results in the enhancement of the entanglement entropy. A volume term develops in the radiation-dominated era, and becomes the leading contribution to the entropy at late times. I discuss the interpretation of the entropy in the light of the quantum to classical transition for modes exiting the horizon during inflation. Entranglement could be a means to track the quantum origin of weakly interacting fields, such as gravitational waves resulting from tensor modes during inflation. On the other hand, an observer with no knowledge of the degrees of freedom beyond the horizon would interpret the entropy as thermal. From this point of view, the reheating after inflation would be a result of quantum entanglement. I present results on the precise expression for the entropy in de Sitter space. I also speculate on the possibility to check these results in analogue gravity experiments.

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