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Tripartite entanglement of bosonic systems in a noninertial frame beyond the single- mode approximation

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Abstract

In this work, we generalize the entanglement of three-qbit Bosonic systems beyond the single-mode approximation when one of the observers is accelerated. For this purpose, we review the effects of acceleration on field modes and quantum states. The single-mode approximation and beyond the single-mode approximation methods are introduced. After this brief introduction, the main problem of this paper, tripartite entanglement of bosonic systems in a noninertial frame beyond the single- mode approximation is investigated. The tripartite entangled states have different classes with GHZ and W states being most important. Here, we choose π-tangle as a measure of tripartite entanglement. If the three parties share GHZ state, the corresponding π-tangle will increase by increasing acceleration for some Unruh modes. This phenomenon, increasing entanglement, has never been observed in the single-mode approximation for bosonic case. Moreover, the π-tangle dose not exhibit a monotonic behavior with increasing acceleration. In the infinite acceleration limit, the π-tangle goes to different nonzero values for distinct Unruh modes. Unlike GHZ state, the entanglement of the W state shows only monotonically increasing and decreasing behaviors with increasing acceleration. Also, the entanglement for all possible choices of Unruh modes approaches only 0.176 in the high acceleration limit. Therefore, according to the quantum entanglement, there is no distinction between the single-mode approximation and beyond the single-mode approximation methods in this limit.

Keywords: Bosonic field, Bogoliubov coefficients, entanglement, beyond the single-mode approximation, π-tangle

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