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Quantum entanglement of two bosonic modes in de Sitter space

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In recent years, extensive studies on quantum correlations in various scenarios, such as non-inertial frames, curved spacetime, and an expanding universe have been performed [1–6]. In the framework of the theory of open systems based on completely positive quantum dynamical semigroups, we investigate the time evolution of Gaussian quantum entanglement of two bosonic modes associated with a scalar quantum field in de Sitter space and in interaction with a thermal reservoir. We show that quantum entanglement strongly depends on the squeezing of the bimodal state, the parameters characterizing the thermal environment, the curvature parameter of de Sitter space, and the mass parameter. The thermal environment and the curvature have a destructive influence on the entanglement, whose survival time depends on the competition between the contrary effects provided by the squeezing of the bimodal state, the curvature, and the thermal bath. The entanglement is minimized for values 1/2 and 3/2 of the mass parameter, corresponding to the conformally coupled scalar field, respectively minimally coupled massless field [7].

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Primary author: ISAR, Aurelian (National Institute of Physics and Nuclear Engineering, Bucharest-Magurele, Romania, Faculty of Physics, University of Bucharest, Romania)

Co-author: CALAMANCIUC, Madalin (National Institute of Physics and Nuclear Engineering, Bucharest--Magurele, Romania, Faculty of Physics, University of Bucharest, Romania)

Presenter: ISAR, Aurelian (National Institute of Physics and Nuclear Engineering, Bucharest-Magurele, Romania, Faculty of Physics, University of Bucharest, Romania)

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