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Trace of energy-momentum tensor and gravitational backreaction of Schwinger scalars in the 3D de Sitter spacetime

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Abstract

In this paper, we consider a massive charged scalar field coupled to a uniform background electric field in a 3 dimensional de Sitter spacetime. We also consider the constant value of the dimensionless coupling of the scalar field to the scalar curvature of a 3 dimensional de Sitter spacetime equal to $1/8$. We compute the expectation value of the trace of the energy-momentum tensor in the in-vacuum state, showing that by using the adiabatic subtraction regularization method, the linear ultraviolet divergence is removed and a finite expression is obtained. We investigate the behavior of the regularized trace with different intensities of the scalar field mass and electric fields. We show that the trace as a function of the electric field has a discontinuity where it changes the sign. In the case of a scalar field conformally coupled to the de Sitter spacetime, we show that the trace vanishes and there is no trace anomaly. We discuss the gravitational backreaction effect of the created Schwinger pairs.

Keywords: de Sitter spacetime, Scalar field, Schwinger effect, trace of energy-momentum tensor, Adiabatic subtraction regularization

For full article, refer to the Persian section