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Particle creation in the Early Universe: comparing canonical and path integral approaches

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We consider particle creation of a non-conformal scalar field in the Early Universe. The deviation from conformality is assumed to be small, which allows us to treat the terms describing the non-conformal scalar field as a perturbation. We derive the Schrödinger equation for the system of gravitational and scalar fields from the path integral making use of a holomorphic representation for the scalar field. In the conformal case, the equation is solved exactly. In the case of a non-conformal field, we use the perturbation theory, and some new features are revealed. When deriving the Schrödinger equation, we obtain an operator that maps the states of the Fock space with a certain number of particles and antiparticles at time t to states corresponding to a subsequent moment of time. The operator appears entirely due to changing of a basis in the Fock space with time. We compare our results with those obtained using the method of diagonalizing the Hamiltonian in the canonical formalism and find that the results are fully consistent. In perspective, we consider the path integral approach as an additional tool for studying particle creation in a gravitational field and cosmological perturbations.

Primary author(s): SHESTAKOVA, Tatyana (Department of Theoretical and Computational Physics, Southern Federal University)

Co-author(s): AYALA OÑA, Roger Ivan (Southern Federal University)

Presenter(s): SHESTAKOVA, Tatyana (Department of Theoretical and Computational Physics, Southern Federal University)

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