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# Properties of hyperbolic and Bunch-Davies vacua in de Sitter spacetime

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The Hadamard function and the vacuum expectation values (VEVs) of the field squared and energy-momentum tensor are evaluated for a massless conformally coupled scalar field in de Sitter (dS) spacetime with general number of spatial dimensions, described by coordinates with negative constant spatial curvature. It is assumed that the field is prepared in the hyperbolic vacuum state. An integral representation for the difference of the Hadamard functions corresponding to the hyperbolic and Bunch-Davies vacua is provided which is well adapted for the evaluation of the VEVs in the coincidence limit. The relations obtained for the difference in the VEVs for the hyperbolic and Bunch-Davies vacua are compared with the corresponding relations for the Fulling-Rindler and Minkowski vacua in flat spacetime. The similarity between those relations is explained by the conformal connection of dS spacetime with hyperbolic foliation and Rindler spacetime. As a limiting case, the VEVs for the conformal vacuum in the Milne universe are discussed. It is shown that the Bunch-Davies state is interpreted as thermal with respect to the hyperbolic vacuum. An expression for the corresponding density of states is provided. The thermal distribution is of Bose-Einstein type for odd number of spatial dimensions and of Fermi-Dirac type for even number of spatial dimensions. It is emphasized that this feature is also present in relations between the VEVs in Fulling-Rindler and Minkowski vacua in flat spacetime.

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