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Quantum effects for a spherical shell in the Milne universe

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The influence of a spherical boundary on the vacuum fluctuations of a massive scalar field is investigated in background of $(D + 1)$ -dimensional Milne universe, assuming that the field obeys Robin boundary condition on the sphere. The normalized mode functions are derived for the regions inside and outside the sphere. For the interior region, the boundary-induced contribution is explicitly extracted in the Wightman function with the help of the generalized Abel-Plana summation formula. The vacuum expectation values (VEVs) of the field squared and of the energy-momentum tensor are investigated for the conformal vacuum. They are decomposed into the boundary-free and boundary-induced contributions. For the latter, rapidly convergent integral representations are provided. In addition to the diagonal components, the vacuum energy-momentum tensor has an off-diagonal component that describes energy flux along the radial direction.

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