Analytical approximation for $\langle\varphi^2\rangle$ of a quantized scalar field in ultrastatic asymptotically flat spacetimes

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Abstract

Analytical approximations for $\langle\varphi^2\rangle$ of a quantized scalar field in ultrastatic asymptotically flat spacetimes are obtained. The field is assumed to be both massive and massless, with an arbitrary coupling ξ to the scalar curvature, and in a zero or nonzero temperature vacuum state. The expression for $\langle\varphi^2\rangle$ is divided into low- and high-frequency parts. The expansion for the high-frequency contribution to this quantity is obtained. This expansion is analogous to the DeWitt-Schwinger one. As an example, the low-frequency contribution to $\langle\varphi^2\rangle$ is calculated on the background of the small perturbed flat spacetime in a quantum state corresponding to the Minkowski vacuum at the asymptotic. The limits of the applicability of these approximations are discussed.