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Scalar vacuum densities on Beltrami pseudosphere

The combined effects of spatial curvature and topology are investigated on the properties of the vacuum state for a charged scalar field localized on the (2+1)-dimensional Beltrami pseudosphere. It is assumed that the field obeys the quasiperiodicity condition along azimuthal angle with a constant phase. As important local characteristics of the vacuum state the vacuum expectation values (VEVs) of the field squared and energy-momentum tensor are evaluated. The VEVs are decomposed into compactified and uncompactified parts. The contributions in the VEVs coming from geometry with an uncompactified azimuthal coordinate are divergent, whereas the compact counterparts are finite. The renormalization of the VEVs is reduced to that for the uncompactified parts only. As an important special case we have discussed the conformally coupled massless scalar field. The geometry for the Beltrami pseudosphere is conformally related to the (2+1)-dimensional Rindler spacetime and the corresponding VEVs of the energy-momentum tensor in these two spacetimes are conformally related as well. The topological contributions are analysed asymptotically for the limiting values of the ratio of radial coordinate and compactification length. This ratio corresponds to the inverse of the proper radius of the compactified dimension measured in units of the curvature radius. For small values of the ratio, the decay of the compact counterpart in the energy density follows a power-law. The effect of nontrivial topology is strong for the radial and azimuthal stresses at small values of the radial coordinate in the conformally coupled massless case. The nontrivial topology is essential also in the opposite asymptotic limit, where the magnitudes of VEVs are increasing by a power-law.

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