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Decoherence of Friedmann-Robertson-Walker geometries in the presence of massive vector fields with U(1) or SO(3) global symmetries. (English) Zbl 0990.83518

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Summary: Retrieval of classical behaviour in quantum cosmology is usually discussed in the framework of midi superspace models in the presence of scalar fields and the inhomogeneous modes corresponding either to gravitational or scalar fields. In this work, we propose an alternative model to study the decoherence of homogeneous and isotropic geometries where the scalar field is replaced by a massive vector field with a global internal symmetry. We study here the cases with $U(1)$ and SO(3) global internal symmetries. The presence of a mass term breaks the conformal invariance and allows for the longitudinal modes of the spin-1 field to be present in the Wheeler-DeWitt equation. In the case of the $U(1)$ global internal symmetry, we have only one single "classical" degree of freedom while in the case of the SO(3) global symmetry, we are led to consider a simple two-dimensional minisuperspace model. These minisuperspaces are shown to be equivalent to a set of coupled harmonic oscillators where the kinetic term of the longitudinal modes has a coefficient proportional to the inverse of the scale factor. The conditions for a suitable decoherence process and correlations between coordinates and momenta are established. The validity of the semi-classical Einstein equations when massive vector fields (Abelian and non-Abelian) are present is also discussed.

MSC:

83C45 Quantization of the gravitational field
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