Title:	Quantum correlators in Friedmann spacetimes: The omnipresent de Sitter spacetime and the invariant vacuum noise
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Abstract:	We discuss several aspects of quantum field theory of a scalar field in a Friedmann universe. (i) We begin by showing that it is possible to map the dynamics of a scalar field with a given mass, in a given Friedmann background to another scalar field of a different mass in another Friedmann universe. In particular one can map the dynamics of (1) a massless scalar field in a universe with power-law expansion to (2) a massive scalar field in the de Sitter spacetime. This allows us to understand several features of either system in a simple manner and clarifies several issues related to the massless limit. (ii) We relate the Euclidean Green's function for the de Sitter spacetime to the solution of a hypothetical electrostatic problem in D = 5 and obtain, in a very simple manner, a useful integral representation for Green's function. This integral representation is helpful in the study of several relevant limits and in recovering some key results which are—though known earlier—not adequately appreciated. One of these results is the fact that, in any Friedmann universe, sourced by a negative pressure fluid, the Wightman function for a massless scalar field is divergent. This shows that the divergence of Wightman function for the massless field in the de Sitter spacetime is just a special limiting case of this general phenomenon. (iii) We provide a generally covariant procedure for defining the power spectrum of vacuum fluctuations in terms of the different Killing vectors present in the spacetime. This allows one to study the interplay of the choice of vacuum state and the nature of the power spectrum in different coordinate systems in the de Sitter universe in a unified manner. (iv) As a specific application of this formalism, we discuss the power spectra of vacuum fluctuations in the static (and Painlevé) vacuum states in the de Sitter spacetime and compare them with the corresponding power spectrum in the Bunch-Davies vacuum. We demonstrate how these power spectra are related to each other in a manner similar to the power spectra detected by the inertial and Rindler observers in flat spacetime. This also gives rise to a notion of an invariant vacuum noise in the corresponding spacetimes which is observer independent. (v) In addition, several conceptual and technical issues regarding quantum fields in general cosmological spacetimes are clarified as a part of this study.
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