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Title:	Unequal time commutators in Friedmann universes:
Other Titles:	deterministic evolution of massless fields
Authors:	Lochan, Kinjalk (/jspui/browse?type=author&value=Lochan%2C+Kinjalk)
Keywords:	Metrics Friedmann universes Unequal time
Issue Date:	2022
Publisher:	Springer Nature
Citation:	General Relativity and Gravitation, 54(9), 43556.
Abstract:	We analyze minimally coupled massless scalar field in a Friedmann (FRW) universe in conformal co-ordinates to model the evolution of tensor perturbations and study the structure of the Wightman function therein. Using a duality map from a power law FRW universe to the de Sitter universe for such fields we obtain unequal time commutation relations between quantum field variables. We demonstrate that the commutation relations are invariant under state change and/or vacuum state selection. Using such commutators it is then possible to construct out of time ordered commutators (OTOC) in the FRW universes. The OTOCs are supposed to suggest the onset of chaotic behavior during the quantum evolution, we see that in case of Friedmann universes, unlike the scalar perturbations, the causal structure arrests the growth of quantum tensor perturbations for all the relevant epochs of the universe e.g. the de Sitter phase, the radiation dominated and the matter dominated era. Therefore the semi classical results of having a large backreaction and omnipresent noise in certain branches of the Friedmann universes with massless fields such as the tensor perturbations remain robust and stable.
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