Three and Four Point Functions of Stress Energy Tensors in $D = 3$ for the Analysis of Cosmological Non-Gaussianities

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Conformal field theories in $D > 2$ are significantly less known compared to their $D = 2$ counterparts, where exact results stemming from the presence of an underlying infinite dimensional symmetry have allowed to proceed with their classification. In fact, as one moves to higher spacetime dimensions, the finite dimensional character of the conformal symmetry allows to fix, modulo some overall constants, only the structure of 2- and 3-point functions [1, 2]. In 4-D, for instance, free field theory realizations of these specific correlators allow the identification of their explicit expressions, performing a direct comparison with their general form, which is predicted by the symmetry [3]. Among these correlators, a special role is taken by those involving insertions of the energy momentum tensor (EMT), which can be significant in the context of several phenomenological applications. For instance, in $D = 4$, correlators involving insertions of the EMT describe the interaction of a given theory with gravity around the flat spacetime limit. Their study is quite involved due to the appearance of a trace anomaly [4, 5, 6, 7]. They are part of the anomalous effective action of gravitons at higher order, but they also find application in the description of dilaton interactions and of the Higgs-dilaton mixing at the LHC [8, 9].

In 3 dimensions their computation simplifies considerably, due to the absence of anomalies, but it remains quite significant, especially in the context of the ADS/CFT correspondence [10] and supersymmetry in general [11]. In particular, using a holographic approach, these correlators allow to describe the curvature gravitational perturbations in a pre-inflationary phase of the early universe characterized by strong gravity [12, 13, 14]. They play a crucial role in the study of the non-gaussian contributions to such perturbations at the level of the bispectrum (via the TTT correlator) and of the trispectrum (via the $TTTT$), while the power spectrum is determined by the TT [15].

The study of holographic cosmological models is probably at its beginning and there is little doubt that the interest in these models will be growing in the near future. In these formulations, the metric perturbations of a cosmological inflationary phase characterized by strong gravity can be expressed in terms of correlation functions involving stress energy tensors in simple 3-D field theories. We have presented an independent derivation of all the amplitudes which are part of the 3-T correlators and extended the analysis to the fully traced component of the 4-T one. The analysis is rather involved and is based on an extension of the approach developed in [3], which dealt with the 3-T case in D=4. In D=3, the absence of anomalies simplifies considerably the treatment, but the perturbative expression of the 4-T amplitude carries the same level of difficulty of the 4-D case. The extension of our approach to a discussion of the full 4-T case, with the derivation of all the amplitudes, is, at the moment, hampered by the remarkable difficulties present in the computation of all the tensor reductions of a rank-8 correlator.

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