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The Structure of Perturbative Quantum Gravity on a de Sitter Background

N.C. Tsamis[1*], **R.P. Woodard**[2**]

[1] Department of Physics, University of Crete, Iraklion, Crete 71409, Greece
[2] Department of Physics, University of Florida, Gainesville, FL 32611, USA

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Abstract: Classical gravitation on de Sitter space suffers from a linearization instability. One consequence is that the causal response to a spatially localized distribution of positive energy cannot be globally regular. We use this fact to show that no causal Green's function can give the correct linearized response to certain bilocalized distributions, even though these distributions obey the constraints of linearization stability. We avoid the problem by working on the open submanifold spanned by conformal coordinates. The retarded Green's function is first computed in a simple gauge, then the rest of the propagator is inferred by analyticity – up to the usual ambiguity about real, analytic and homogeneous terms. We show that the latter can be chosen so as to give a propagator which does not grow in any direction. The ghost propagator is also given and the interaction vertices are worked out.

1. Introduction

The study of graviton fluctuations on a de Sitter background is fascinating because infrared effects in quantum gravity may provide a mechanism through which an initially positive cosmological constant relaxes to zero. It is therefore frustrating that we lack a perturbative formalism which is even valid at tree order! Of course the vertices can be worked out with a bit of patience, and various solutions for the gauge fixed propagator have been reported [1–3]. The imaginary parts of these propagators ought to give Green's functions which describe how the classical theory responds to external stress energy. The trouble is that the linearized response inferred in this way is wrong, even for the trivial case of a freely falling point mass [3].

* E-mail: TSAMIS @ IESL.FORTH.GR
** E-mail: WOODARD @ UFHEPA.PHYS.UFL.EDU