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The Polyakov Path Integral Over Bordered Surfaces

III. The BRST Extended Closed String Off-Shell Amplitudes

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Abstract. The geometrical approach to the functional integral over Faddeev-Popov ghost fields is developed and applied to construct the BRST extension of the off-shell closed string amplitudes in the constant curvature gauge. In this gauge the overlap path integral for off-shell amplitudes is evaluated. It leads to the nonlocal sewing procedure generating all off-shell amplitudes from the cubic interaction vertex. The general scheme of the reconstruction of a covariant closed string field theory from the off-shell amplitudes is discussed within the path integral framework.

1. Introduction

In the present paper we complete our study of the Polyakov path integral over bordered surfaces initiated in [1, 2]. The interest in this object can be traced back to Alvarez's pioneering paper [3] where the string ansatz for the Wilson loop was considered. The main development in calculating this functional integral was achieved in the context of the closed string off-shell amplitudes [4–11]. This approach was aimed to derive a covariant closed string field theory (CCSFT) from off-shell amplitudes defined in terms of a functional integral over surfaces connecting closed contours in the target space [11]. In spite of a very suggestive physical and geometrical picture and of important progress in the calculating techniques involved [11, 12] this program did not succeed. It seems that it does not mean a principal invalidity of the basic idea but rather reflects the fact that the functional integral techniques are much less developed than for instance the operator ones [13]. In fact the major recent achievement in constructing CCSFT – the nonpolynomial theory [14–18] – is based on the operator formulation of conformal field theories on punctured Riemann surfaces. There is yet another, well developed approach to CCSFT – the improved [19] covariantized light cone theory [20] in which the relation between an off-shell string diagram and a path integral over bordered surfaces is even less transparent.

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