Commun. Math. Phys. 177, 305–326 (1996)

Communications in Mathematical Physics

Background Independent Algebraic Structures in Closed String Field Theory

Ashoke Sen[1,★], **Barton Zwiebach**[2,★★]

[1] Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400005, India
[2] Center for Theoretical Physics, LNS and Department of Physics, MIT, Cambridge, Massachusetts 02139, USA

Received: 11 August 1994

Abstract: We construct a Batalin–Vilkovisky (BV) algebra on moduli spaces of Riemann surfaces. This algebra is background independent in that it makes no reference to a state space of a conformal field theory. Conformal theories define a homomorphism of this algebra to the BV algebra of string functionals. The construction begins with a graded-commutative free associative algebra $\mathscr{C}$ built from the vector space whose elements are orientable subspaces of moduli spaces of punctured Riemann surfaces. The typical element here is a surface with several connected components. The operation Δ of sewing two punctures with a full twist is shown to be an odd, second order derivation that squares to zero. It follows that $(\mathscr{C}, \Delta)$ is a Batalin–Vilkovisky algebra. We introduce the odd operator $\delta = \partial + \hbar\Delta$, where ∂ is the boundary operator. It is seen that $\delta^2 = 0$, and that consistent closed string vertices define a cohomology class of δ. This cohomology class is used to construct a Lie algebra on a quotient space of $\mathscr{C}$. This Lie algebra gives a manifestly background independent description of a subalgebra of the closed string gauge algebra.

1. Introduction and Summary

At present the formulation of closed string field theory requires two choices. A choice of a set of string vertices, and a choice of a conformal field theory representing a string background. It is now known that the use of two different nearby sets of string vertices leads to the same string field theory [1]. Furthermore the use of two nearby conformal field theories also leads to the same string field theory [2]. This latter property is called background independence. Since a fundamental goal in string theory is the writing of a manifestly background independent formulation of the theory, investigation of background independent structures is an important endeavor.

★ E-mail address: sen@theory.tifr.res.in, sen@tifrvax.bitnet.
★★ E-mail address: zwiebach@irene.mit.edu, zwiebach@mitlns.bitnet.
Supported in part by D.O.E. contract DE-AC02-76ER03069.