Algebraic Structure of Topological Superconformal Field Theory on Riemann Surfaces

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Abstract. The algebraic structure of a topological superconformal field theory on a compact Riemann surface is investigated. The Krichever–Novikov [K–N] global operator formalism is used to obtain an $N = 4$ super K–N algebra on a Riemann surface. Subsequently this $N = 4$ algebra is shown to possess an $N = 3$ K–N subalgebra. The $N = 3$ subalgebra is then twisted to derive a topological version of the Krichever–Novikov algebra with a residual $N = 2$ superconformal structure. The BRST charge of the associated topological field theory on the Riemann surface is shown to be genus dependent in this formalism and the global generalization of the BRST derivative conditions are obtained. The complete BRST structure of the theory is explicitly elucidated.

I. Introduction

Recently topological field theories have assumed considerable significance in the context of the nonperturbative aspects of string theories. It was earlier shown by Witten [1] that these theories may be constructed by twisting an $N = 2$ supersymmetric non-linear sigma model. Following this line of investigation Eguchi and Yang [2] constructed topological conformal field theories in two dimensions by twisting an $N = 2$ superconformal field theory (SCFT)[3]. Furthermore, it was shown in later investigations that the minimal versions [4] of these models, when coupled to two dimensional topological gravity [5], are equivalent to the matrix model [6, 7] description of non-critical string theories. In addition, the supersymmetric generalizations of the gravity sector have also been investigated [8].

The generators of an $N = 2$ SCFT[3] are: a weight two energy momentum tensor $T(z)$, two supercharges $G^{\pm}(z)$ of weight $\frac{3}{2}$, and a $U(1)$ current $J(z)$ of weight 1. In ref. [2] it was observed that upon twisting the energy momentum tensor of these theories via the $U(1)$ current, a centerless conformal algebra with a background charge is obtained. Moreover the two supercharges are transformed to a weight two and a weight one operator with respect to the redefined energy momentum tensor. In addition, the new operator of dimension 1 now plays the role of a BRST current such that the BRST charge obtained from it is nilpotent and the