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# Ding-Iohara algebras and quantum vertex algebras

Haisheng Li<sup>a,b1</sup>, Shaobin Tan<sup>b2</sup> and Qing Wang<sup>b3</sup>

<sup>a</sup>Department of Mathematical Sciences

Rutgers University, Camden, NJ 08102, USA

<sup>b</sup>School of Mathematical Sciences, Xiamen University, Xiamen 361005, China

## Abstract

In this paper, we associate quantum vertex algebras to a certain family of associative algebras  $\tilde{\mathcal{A}}(g)$  which are essentially Ding-Iohara algebras. To do this, we introduce another closely related family of associative algebras  $\mathcal{A}(h)$ . The associated quantum vertex algebras are based on the vacuum modules for  $\mathcal{A}(h)$ , whereas  $\phi$ -coordinated modules for these quantum vertex algebras are associated to  $\tilde{\mathcal{A}}(g)$ -modules. Furthermore, we classify their irreducible  $\phi$ -coordinated modules.

## 1 Introduction

This paper is from a vertex algebra point of view to study a family of associative algebras  $\tilde{\mathcal{A}}(g)$  with  $g(z)$  a rational function such that  $g(z)g(1/z) = 1$ . By definition,  $\tilde{\mathcal{A}}(g)$  is the associative unital algebra over  $\mathbb{C}$ , generated by

$$E_n, F_n, \Psi_n \quad (n \in \mathbb{Z}),$$

subject to relations

$$\begin{aligned} E(z)E(w) &= \iota_{w,z}(g(w/z))E(w)E(z), & F(z)F(w) &= \iota_{w,z}(g(z/w))F(w)F(z), \\ \Psi(z)E(w) &= \iota_{w,z}(g(w/z))E(w)\Psi(z), & \Psi(z)F(w) &= \iota_{w,z}(g(z/w))F(w)\Psi(z), \\ [E(z), F(w)] &= \delta\left(\frac{w}{z}\right)\Psi(w), & [\Psi(z), \Psi(w)] &= 0, \end{aligned}$$

where

$$E(z) = \sum_{n \in \mathbb{Z}} E_n z^{-n}, \quad F(z) = \sum_{n \in \mathbb{Z}} F_n z^{-n}, \quad \Psi(z) = \sum_{n \in \mathbb{Z}} \Psi_n z^{-n}.$$

Note that in the special case with

$$g(z) = \prod_{j=1,2,3} \frac{1 - q_j^{-1}z}{1 - q_j z},$$

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