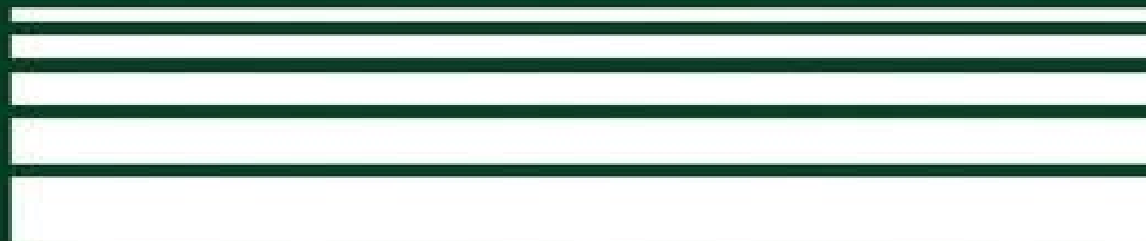


Progress in Mathematics



Chongying Dong  
James Lepowsky

# **Generalized Vertex Algebras and Relative Vertex Operators**



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# Generalized Vertex Algebras And Relative Vertex Operators Progress In Mathematics S

**Chongying Dong, James Lepowsky**



## **Generalized Vertex Algebras And Relative Vertex Operators Progreb In Mathematics S:**

**Generalized Vertex Algebras and Relative Vertex Operators** Chongying Dong, James Lepowsky, 2012-12-06 In the past few years vertex operator algebra theory has been growing both in intrinsic interest and in the scope of its interconnections with areas of mathematics and physics The structure and representation theory of vertex operator algebras is deeply related to such subjects as monstrous moonshine conformal field theory and braid group theory Vertex operator algebras are the mathematical counterpart of chiral algebras in conformal field theory In the Introduction which follows we sketch some of the main themes in the historical development and mathematical and physical motivations of these ideas and some of the current issues Given a vertex operator algebra it is important to consider not only its modules representations but also intertwining operators among the modules Matrix coefficients of compositions of these operators corresponding to certain kinds of correlation functions in conformal field theory lead naturally to braid group representations In the special but important case when these braid group representations are one dimensional one can combine the modules and intertwining operators with the algebra to form a structure satisfying axioms fairly close to those for a vertex operator algebra These are the structures which form the main theme of this monograph Another treatment of similar structures has been given by Feingold Frenkel and Ries see the reference FFR in the Bibliography and in fact the material developed in the present work has close connections with much work of other people as we explain in the Introduction and throughout the text

**Generalized Vertex Algebras and Relative Vertex Operators** Chongying Dong, James Lepowsky, 1993-11-01

**Extensions of the Jacobi Identity for Vertex Operators, and Standard  $A^{\{1\}}_1$ -Modules** Cristiano Hsu, 1993 The main axiom for a vertex operator algebra over a field of characteristic zero the Jacobi identity is extended to multi operator identities Then relative bold capital  $Z_2$  twisted vertex operators are introduced and a Jacobi identity for these operators is established Then these ideas are used to interpret and recover the twisted bold capital  $Z$  operators and corresponding generating function identities developed by Lepowsky and R L Wilson This work is closely related to the twisted parafermion algebra constructed by Zamolodchikov Fateev

**Vertex Operator Algebras and the Monster** Igor Frenkel, James Lepowsky, Arne Meurman, 1989-05-01 This work is motivated by and develops connections between several branches of mathematics and physics the theories of Lie algebras finite groups and modular functions in mathematics and string theory in physics The first part of the book presents a new mathematical theory of vertex operator algebras the algebraic counterpart of two dimensional holomorphic conformal quantum field theory The remaining part constructs the Monster finite simple group as the automorphism group of a very special vertex operator algebra called the moonshine module because of its relevance to monstrous moonshine

**Introduction to Vertex Operator Algebras and Their Representations** James Lepowsky, Haisheng Li, 2012-12-06 Introduces the fundamental theory of vertex operator algebras and its basic techniques and examples Begins with a detailed presentation of the theoretical foundations and proceeds to a

range of applications Includes a number of new original results and brings fresh perspective to important works of many other researchers in algebra lie theory representation theory string theory quantum field theory and other areas of math and physics

*On Axiomatic Approaches to Vertex Operator Algebras and Modules* Igor Frenkel, Yi-Zhi Huang, James Lepowsky, 1993 The basic definitions and properties of vertex operator algebras modules intertwining operators and related concepts are presented following a fundamental analogy with Lie algebra theory The first steps in the development of the general theory are taken and various natural and useful reformulations of the axioms are given In particular tensor products of algebras and modules adjoint vertex operators and contragredient modules adjoint intertwining operators and fusion rules are studied in greater depth This paper lays the monodromy free axiomatic foundation of the general theory of vertex operator algebras modules and intertwining operators

### **Vertex Operator Algebras in Mathematics and Physics**

Stephen Berman, Vertex operator algebras are a class of algebras underlying a number of recent constructions results and themes in mathematics These algebras can be understood as string theoretic analogues of Lie algebras and of commutative associative algebras They play fundamental roles in some of the most active research areas in mathematics and physics Much recent progress in both physics and mathematics has benefited from cross pollination between the physical and mathematical points of view This book presents the proceedings from the workshop Vertex Operator Algebras in Mathematics and Physics held at The Fields Institute It consists of papers based on many of the talks given at the conference by leading experts in the algebraic geometric and physical aspects of vertex operator algebra theory The book is suitable for graduate students and research mathematicians interested in the major themes and important developments on the frontier of research in vertex operator algebra theory and its applications in mathematics and physics

Vertex Algebras and Algebraic Curves Edward Frenkel, David Ben-Zvi, 2004-08-25 Vertex algebras are algebraic objects that encapsulate the concept of operator product expansion from two dimensional conformal field theory Vertex algebras are fast becoming ubiquitous in many areas of modern mathematics with applications to representation theory algebraic geometry the theory of finite groups modular functions topology integrable systems and combinatorics This book is an introduction to the theory of vertex algebras with a particular emphasis on the relationship with the geometry of algebraic curves The notion of a vertex algebra is introduced in a coordinate independent way so that vertex operators become well defined on arbitrary smooth algebraic curves possibly equipped with additional data such as a vector bundle Vertex algebras then appear as the algebraic objects encoding the geometric structure of various moduli spaces associated with algebraic curves Therefore they may be used to give a geometric interpretation of various questions of representation theory The book contains many original results introduces important new concepts and brings new insights into the theory of vertex algebras The authors have made a great effort to make the book self contained and accessible to readers of all backgrounds Reviewers of the first edition anticipated that it would have a long lasting influence on this exciting field of mathematics and would be very useful for graduate students and

researchers interested in the subject This second edition substantially improved and expanded includes several new topics in particular an introduction to the Beilinson Drinfeld theory of factorization algebras and the geometric Langlands correspondence

Lie Algebras, Vertex Operator Algebras and Their Applications Yi-Zhi Huang, Kailash C. Misra, 2007 The articles in this book are based on talks given at the international conference Lie algebras vertex operator algebras and their applications The focus of the papers is mainly on Lie algebras quantum groups vertex operator algebras and their applications to number theory combinatorics and conformal field theory

**Vertex Algebras and Geometry** Thomas Creutzig, Andrew R. Linshaw, 2018-07-20 This book contains the proceedings of the AMS Special Session on Vertex Algebras and Geometry held from October 8 9 2016 and the mini conference on Vertex Algebras held from October 10 11 2016 in Denver Colorado The papers cover vertex algebras in connection with geometry and tensor categories with topics in vertex rings chiral algebroids the Higgs branch conjecture and applicability and use of vertex tensor categories

Vertex Operator Algebras, Number Theory and Related Topics Matthew Krauel, Michael Tuite, Gaywalee Yamskulna, 2020-07-13 This volume contains the proceedings of the International Conference on Vertex Operator Algebras Number Theory and Related Topics held from June 11 15 2018 at California State University Sacramento California The mathematics of vertex operator algebras vector valued modular forms and finite group theory continues to provide a rich and vibrant landscape in mathematics and physics The resurgence of moonshine related to the Mathieu group and other groups the increasing role of algebraic geometry and the development of irrational vertex operator algebras are just a few of the exciting and active areas at present The proceedings center around active research on vertex operator algebras and vector valued modular forms and offer original contributions to the areas of vertex algebras and number theory surveys on some of the most important topics relevant to these fields introductions to new fields related to these and open problems from some of the leaders in these areas

*A Generalized Jacobi Identity in Axiomatic Vertex Operator Algebras* Gunnar Mossberg, 1992

Vertex Operator Algebras and Related Areas M. J. Bergvelt, Gaywalee Yamskulna, Wenhua Zhao, 2009-10-01 Vertex operator algebras were introduced to mathematics in the work of Richard Borcherds Igor Frenkel James Lepowsky and Arne Meurman as a mathematically rigorous formulation of chiral algebras of two dimensional conformal field theory The aim was to use vertex operator algebras to explain and prove the remarkable Monstrous Moonshine conjectures in group theory The theory of vertex operator algebras has now grown into a major research area in mathematics These proceedings contain expository lectures and research papers presented during the international conference on Vertex Operator Algebras and Related Areas held at Illinois State University in Normal IL from July 7 to July 11 2008 The main aspects of this conference were connections and interactions of vertex operator algebras with the following areas conformal field theories quantum field theories Hopf algebra infinite dimensional Lie algebras and modular forms This book will be useful for researchers as well as for graduate students in mathematics and physics Its purpose is not only to give an up to date overview of the fields covered

by the conference but also to stimulate new directions and discoveries by experts in the areas

Spinor Construction of Vertex Operator Algebras, Triality, and  $E_8^{(1)}$  Alex J. Feingold, Igor Frenkel, John F. X. Ries, 1991 The theory of vertex operator algebras is a remarkably rich new mathematical field which captures the algebraic content of conformal field theory in physics Ideas leading up to this theory appeared in physics as part of statistical mechanics and string theory In mathematics the axiomatic definitions crystallized in the work of Borcherds and in Vertex Operator Algebras and the Monster by Frenkel Lepowsky and Meurman The structure of monodromies of intertwining operators for modules of vertex operator algebras yield braid group representations and leads to natural generalizations of vertex operator algebras such as superalgebras and para algebras Many examples of vertex operator algebras and their generalizations are related to constructions in classical representation theory and shed new light on the classical theory This book accomplishes several goals The authors provide an explicit spinor construction using only Clifford algebras of a vertex operator superalgebra structure on the direct sum of the basic and vector modules for the affine Kac Moody algebra  $D_n$  1 They also review and extend Chevalley's spinor construction of the 24 dimensional commutative nonassociative algebraic structure and triality on the direct sum of the three 8 dimensional  $D_4$  modules Vertex operator para algebras introduced and developed independently in this book and by Dong and Lepowsky are related to one dimensional representations of the braid group The authors also provide a unified approach to the Chevalley Greiss and  $E_8$  algebras and explain some of their similarities A Third goal is to provide a purely spinor construction of the exceptional affine Lie algebra  $E_8^{(1)}$  a natural continuation of previous work on spinor and oscillator constructions of the classical affine Lie algebras These constructions should easily extend to include the rest of the exceptional affine Lie algebras The final objective is to develop an inductive technique of construction which could be applied to the Monster vertex operator algebra Directed at mathematicians and physicists this book should be accessible to graduate students with some background in finite dimensional Lie algebras and their representations Although some experience with affine Kac Moody algebras would be useful a summary of the relevant parts of that theory is included This book shows how the concepts and techniques of Lie theory can be generalized to yield the algebraic structures associated with conformal field theory The careful reader will also gain a detailed knowledge of how the spinor construction of classical triality lifts to the affine algebras and plays an important role in the spinor construction of vertex operator algebras modules and intertwining operators with nontrivial monodromies

Extensions of the Jacobi Identity for Vertex Operators and Standard  $A_1$ -Modules Cristiano Hsu, 2014-08-31 This work extends the Jacobi identity the main axiom for a vertex operator algebra to multi operator identities Based on constructions of Dong and Lepowsky relative  $\mathbb{Z}/2$  twisted vertex operators are then introduced and a Jacobi identity for these operators is established Hsu uses these ideas to interpret and recover the twisted  $\mathbb{Z}$  operators and corresponding generating function identities developed by Lepowsky and Wilson for the construction of the standard  $A_1$  modules The point of view of the Jacobi identity also shows the equivalence between these

twisted  $Z$  operator algebras and the twisted parafermion algebras constructed by Zamolodchikov and Fateev The Lepowsky Wilson generating function identities correspond to the identities involved in the construction of a basis for the space of  $C$  disorder fields of such parafermion algebras

### **From Vertex Operator Algebras to Conformal Nets and Back**

Sebastiano Carpi, Yasuyuki Kawahigashi, Roberto Longo, Mihály Weiner, 2018-08-09 The authors consider unitary simple vertex operator algebras whose vertex operators satisfy certain energy bounds and a strong form of locality and call them strongly local They present a general procedure which associates to every strongly local vertex operator algebra  $V$  a conformal net  $AV$  acting on the Hilbert space completion of  $V$  and prove that the isomorphism class of  $AV$  does not depend on the choice of the scalar product on  $V$  They show that the class of strongly local vertex operator algebras is closed under taking tensor products and unitary subalgebras and that for every strongly local vertex operator algebra  $V$  the map  $W \mapsto AW$  gives a one to one correspondence between the unitary subalgebras  $W$  of  $V$  and the covariant subnets of  $AV$

String Path Integral Realization of Vertex Operator Algebras Haruo Tsukada, 1991 We establish relations between vertex operator algebras in mathematics and string path integrals in physics In particular we construct the basic representations of affine Lie algebras of *italic capitals D* type using a method of string path integrals

*Vertex Algebras and Integral Bases for the Enveloping Algebras of Affine Lie Algebras* Shari A. Prevost, 1992 We present a new proof of the identities needed to exhibit an explicit bold  $Z$  basis for the universal enveloping algebra associated to an affine Lie algebra We then use the explicit bold  $Z$  bases to extend Borchers' description via vertex operator representations of a bold  $Z$  form of the enveloping algebras for the simply laced affine Lie algebras to the enveloping algebras associated to the unequal root length affine Lie algebras

**Introduction to Vertex Operator Superalgebras and Their Modules** Xiaoping Xu, 1998-09-30 This book presents a systematic study on the structures of vertex operator superalgebras and their modules Related theories of self dual codes and lattices are included as well as recent achievements on classifications of certain simple vertex operator superalgebras and their irreducible twisted modules constructions of simple vertex operator superalgebras from graded associative algebras and their anti involutions self dual codes and lattices Audience This book is of interest to researchers and graduate students in mathematics and mathematical physics

*Vertex Operators in Mathematics and Physics* J. Lepowsky, S. Mandelstam, I.M. Singer, 1985-01-15 James Lepowsky The search for symmetry in nature has for a long time provided representation theory with perhaps its chief motivation According to the standard approach of Lie theory one looks for infinitesimal symmetry Lie algebras of operators or concrete realizations of abstract Lie algebras A central theme in this volume is the construction of affine Lie algebras using formal differential operators called vertex operators which originally appeared in the dual string theory Since the precise description of vertex operators in both mathematical and physical settings requires a fair amount of notation we do not attempt it in this introduction Instead we refer the reader to the papers of Mandelstam Goddard Olive Lepowsky Wilson and Frenkel Lepowsky Meurman We have tried to maintain consistency of terminology and to some extent

notation in the articles herein To help the reader we shall review some of the terminology We also thought it might be useful to supplement an earlier fairly detailed exposition of ours [37] with a brief historical account of vertex operators in mathematics and their connection with affine algebras Since we were involved in the development of the subject the reader should be advised that what follows reflects our own understanding For another view see [29, 1] t Partially supported by the National Science Foundation through the Mathematical Sciences Research Institute and NSF Grant MCS 83 01664 1 We would like to thank Igor Frenkel for his valuable comments on the first draft of this introduction

## Reviewing **Generalized Vertex Algebras And Relative Vertex Operators Progreb In Mathematics S**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Generalized Vertex Algebras And Relative Vertex Operators Progreb In Mathematics S**," an enthralling opus penned by a very acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book's central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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