Preface

The study of two-dimensional conformal field theories has been a highly successful undertaking in theoretical physics. One reason for this is the intrinsic elegance of these theories, which are among the few interesting quantum field theories for which exact results can be obtained with relative ease. The other reason is the wide range of applications of conformal field theory in string theory, in the theory of critical phenomena and, recently, in a variety of quantum impurity problems such as the Kondo effect and the Callan-Rubakov effect.

Since its introduction in 1985, $\mathcal{W}$-symmetry has evolved to become one of the central notions in the study of conformal field theory. Nine years of effort, by theoretical physicists and, increasingly, by mathematicians (in the context of so-called 'vertex operator algebras'), have led to a large body of knowledge on $\mathcal{W}$-algebras, their representation theory, and the role they play in rational conformal field theories and other physical theories. In the process, interesting connections with the theory of affine Lie algebras (affine Kac-Moody algebras) and with hierarchies of integrable differential equations (such as the Korteweg-de Vries (KdV) and Kadomtsev-Petviashvili (KP) hierarchies) have been unraveled.

It is the purpose of the present book to offer a collection of reprints of some of the important papers on $\mathcal{W}$-symmetry. We have organized the material in seven chapters, each of which is preceded by a short reading guide. Among other things, these introductions serve the important goal of pointing out results in the literature which, due to lack of space, could not be included in this book. We include an extensive list of references on various aspects of $\mathcal{W}$-symmetry. The regular reference numbers (such as [1]) in the reading guides refer to this list, whereas the bold-face reference numbers (such as **[1.1]**) refer to the papers reprinted here.

The selection of the reprints included in this book was made at the end of 1993 and the list of references was finalized in February, 1994. As is inevitable in such matters, our choice of material reflects our own knowledge and interest within the wide field that we have tried to cover. We apologize to authors who feel that their contributions have not been properly recognized in this book.

For readers who need some background information on topics that are closely related to $\mathcal{W}$-symmetry, we recommend the following sources. Two earlier volumes in the 'Advanced

Series in Mathematical Physics' have been devoted to the algebraic structures that underlie conformal field theory: Vol. 2, by V.G. Kac and A.K. Raina, discusses the representation theory of a number of infinite dimensional Lie algebras and Vol. 3, by P. Goddard and D. Olive, reviews a variety of results on affine Lie algebras and on the Virasoro algebra. Pre-1988 conformal field theory has been reviewed in a reprint volume by C. Itzykson, H. Saleur and J.-B. Zuber [210]; another useful reference is [85]. A textbook on 'Conformal Field Theory in Two Dimensions,' by W. Nahm, is about to appear. We also refer to the abovementioned literature for extensive lists of references on background material such as, in particular, conformal field theory.

In a recent issue of Physics Reports [79], the present authors have presented an extensive overview of $\mathcal{W}$-symmetry. The organization of the present reprint volume has been motivated by the structure of this review paper and we recommend that the interested reader consult both texts in parallel.

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