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Sinopsis

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The first edition of this book is a collection of a series of lectures given by Professor Victor Kac at the TIFR, Mumbai, India in December 1985 and January 1986. These lectures focus on the idea of a highest weight representation, which goes through four different incarnations.
The first is the canonical commutation relations of the infinite dimensional Heisenberg Algebra (= oscillator algebra). The second is the highest weight representations of the Lie algebra gl_{∞} of infinite matrices, along with their applications to the theory of soliton equations, discovered by Sato and Date, Jimbo, Kashiwara and Miwa. The third is the unitary highest weight representations of the current (= affine Kac Moody) algebras. These Lie algebras appear in the lectures in connection to the Sugawara construction, which is the main tool in the study of the fourth incarnation of the main idea, the theory of the highest weight representations of the Virasoro algebra. In particular, the book provides a complete proof of the Kac determinant formula, the key result in representation theory of the Virasoro algebra.

The second edition of this book incorporates, as its first part, the largely unchanged text of the first edition, while its second part is the collection of lectures on vertex algebras, delivered by Professor Kac at the TIFR in January 2003. The basic idea of these lectures was to demonstrate how the key notions of the theory of vertex algebras such as quantum fields, their normal ordered product and lambda-bracket, energy-momentum field and conformal weight, untwisted and twisted representations simplify and clarify the constructions of the first edition of the book. This book should be very useful for both mathematicians and physicists. To mathematicians, it illustrates the interaction of the key ideas of the representation theory of infinite dimensional Lie algebras and of the theory of vertex algebras; and to physicists, these theories are turning into an important component of such domains of theoretical physics as soliton theory, conformal field theory, the theory of two-dimensional statistical models, and string theory.