Woit, Peter

Not even wrong. The failure of string theory and the search for unity in physical law. (English) Zbl 1128.81025

New York, NY: Basic Books (ISBN 0-465-09275-6/hbk; 978-0-465-09276-5/pbk). xix, 291 p. 26.95/hbk; $ 16.95/pbk (2006).

This book is interesting and useful in getting to know the active interplay between the frontiers of physics and those of mathematics. The description is highly condensed and modest. The first nine chapters deal with a quick review of modern physics from the birth of quantum theory around the turn between the 19th century and the 20th century to the establishment of the standard model in the early 1970s. The tenth chapter is devoted to the dazzling interactions between quantum field theory and mathematics. This chapter is most interesting to the reviewer. It deals with various topics such as:

1. Instantons in Yang-Mills theory and in mathematics such as seen in Donaldson theory;
2. Lattice gauge theory;
3. t'Hooft's interesting idea of generalizing quantum chromodynamics from an $SU(3)$ gauge theory involving three colors to one where the number of colors is some arbitrary large number N and the corresponding symmetry group is $SU(N)$;
4. Two-dimensional quantum field theories including conformal field theories, which culminated in the Wess-Zumino-Witten model in 1983;
5. Very little being known about the theory of representations of groups of gauge symmetries in four dimensions, and renormalization being much tricker in four dimensions than in two dimensions, while a great deal being known about the two-dimensional case, because things in two dimensions are determined by certain Kac-Moody groups whose representations are well understood;
6. Witten's topological quantum field theory in four dimensions whose Hilbert space is the Floer homology of the boundary three-dimensional space, and whose observable quantities are Donaldson's topological invariants;
7. The Chern-Simons-Witten theory, which bestowed a Fields medal on Edward Witten in Kyoto in 1990;
8. A topological sigma model, which has a great deal to do with algebraic geometry (in particular, the Candelas group's success in getting a stunning formula, which gives the number of analytic fields for all degrees at once.

The remaining 9 chapters are devoted to string theory, which is very unstable as a physical theory and at the same time is unwarrantably established as an institution. This ambivalence is the very cause of numerous tragedies and commedies caused by this theory. The author's description of string theory is more contained and modest than radical. This book as well as [*L. Smolin*, The trouble with physics. The rise of string theory, the fall of a science and what comes next. Boston, MA: Houghton Mifflin (2006; Zbl 1195.81003)] gives a good opportunity for considering and assessing string theory.

Reviewer: Hirokazu Nishimura (Tsukuba)

MSC:

83E30	String and superstring theories
81-02	Research monographs (quantum theory)
00A08	Mathematical recreation
81T30	String and superstring theories
00A79	Physics
81-01	Textbooks (quantum theory)
83-01	Textbooks (relativity)
81T40	Two-dimensional field theories, conformal field theories, etc.
81T45	Topological field theories
81R10	Infinite-dimensional groups and algebras motivated by physics
14J80	Topology of surfaces (Donaldson polynomials, Seiberg-Witten invariants)
81T13	Yang-Mills and other gauge theories
14D21	Applications of vector bundles and moduli spaces in mathematical physics
81T25	Quantum field theory on lattices
81V05	Strong interaction, including quantum chromodynamics

Keywords:

string theory; quantum field theory; topological quantum field theory; conformal field theory; Kac-Moody groups; Chern-Simons-Witten theory; topological sigma model; mirror symmetry; gauge theory; Wess-Zumino-Witten model; M-theory; Maldacena conjecture; self-duality equations; Donaldson theory; Witten's magical equation