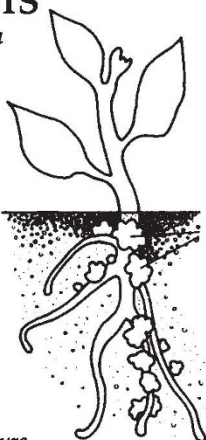


SYMBIOSIS

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Vernon Ahmadjian and Surindar Paracer

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W. Charles Kerfoot and Andrew Sih, editors

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Stringing along in search of a theory of everything

Paul K. Townsend

Superstring Theory. By M.B. Green, J.H. Schwarz and E. Witten. *Cambridge University Press: 1987. Vol.1 Introduction, pp. 469, £32.50, \$39.50. Vol. 2 Loop Amplitudes, Anomalies and Phenomenology, pp. 596, £37.50, \$49.50.*

MANY a physicist too young or too sceptical to have learned much about string theory on the occasion of its previous rise to prominence (in the context of hadron physics in the early 1970s) has bemoaned the absence of an up-to-date and comprehensive reference work on the subject. The publication of this new two-volume text has therefore been eagerly awaited. The title reflects the favoured position of supersymmetric string theories as candidates for a "theory of everything" (as the optimists put it), but all types of string theory are dealt with. Indeed, the scope of the books is enormous.

The first volume is intended to be a modern and self-contained introduction to the basic elements of string theory, covering all aspects of the classical mechanics of string theory from the point of view of the quantum mechanics of the string "worldsheet" (the first-quantized string theory). For example, the string spectrum is successively analysed by old-covariant, light-cone and modern-covariant methods, the aim being to "approach the bosonic string from many different points of view" as "each adds important ingredients to an overall understanding of string theory". The authors succeed admirably, although at the cost of some inconsistencies in the notation (about which we are warned in the preface).

The first chapter is itself an excellent review of the basic ideas of string theory, emphasizing the role of the "rubber-sheet" geometry of the two-dimensional string worldsheet, and the insights to be gained from a pictorial representation of string processes. The quantum theory of strings is also introduced here as a sum over surfaces, in analogy to Feynman's sum-over-paths approach to the quantum mechanics of particles. This modern, and geometrically appealing, approach is not given as much prominence in the second volume, where the subject of second-quantized string theory is taken up again in more detail. This is perhaps a pity, but it is in keeping with the authors' multifaceted approach to their subject.

The latter half of the first volume

introduces the complementary versions of superstring theory with, respectively, worldsheet or spacetime supersymmetry, and discusses the various types of superstring theory, including the heterotic string for which the prospects of ultimate success seem brightest. In particular, the emergence of the Yang-Mills gauge fields of the heterotic string theory is explained through the idea of toroidal compactification.

The first volume ends with a chapter on the computation of scattering amplitudes for the particles that constitute the excitation spectrum of strings. It was from the attempt to find such amplitudes, with suitable properties, that string theory was born, so this is something that one can read about in all the older reviews. Again, however, the treatment is up to date and includes a brief discussion of some very recent developments.

The second volume — *Loop Amplitudes, Anomalies and Phenomenology* — is for the more ambitious reader who wishes to find out how far string theory has gone, and how far it has yet to go, towards being a realistic theory of elementary particle physics. It effectively falls into two parts. The first deals with the quantum theory and the issues of anomalies and ultraviolet infinities at the one-loop level. The second covers the ten-dimensional supergravity equations, and the question of whether a suitable Kaluza-Klein-type solution can be found for which spacetime is effectively four-dimensional and, if so, whether a phenomenologically successful four-dimensional model can emerge. This second volume is less cohesive than the first, but such is the wealth of information contained in it that one cannot complain. Many readers will find the chapters summarizing such relatively new mathematical ideas as complex manifolds and algebraic geometry to be especially helpful.

Both volumes of *Superstring Theory* are likely to remain standard reference works for years to come; certainly, there is no serious rival at present. As the authors themselves point out, however, many topics are not covered (principally multi-loop amplitudes and string field-theory). My colleagues have also drawn my attention to a number of mistakes, dubious arguments and misprints. Such blemishes are not surprising considering the speed with which the books must have been written. This speed of delivery is perhaps partly accounted for by various passages which appear to have been taken wholesale from the authors' previous articles and reviews, without revision. One hopes that these defects will be corrected in the editions that will surely follow. □

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