

# Preface to the Second Edition

The positive response to our text published two decades ago and its quick sell-out encouraged us after careful consideration to produce this second and L<sup>A</sup>T<sub>E</sub>X-typed version. We observed that our text was used or recommended in courses at several universities. Naturally, the most positive response (particularly from the US) came from those for whom the text was written, namely students and others without prior knowledge of supersymmetry. We thank our readers for this feedback and other comments. This success assured us that indeed there was a definite demand for a text like our's with explicit calculational details. In this second edition we have corrected writing errors we became aware of. We have also made minor changes here and there, and we cite more literature.

In the course of the last 20 years since the publication of the First Edition, a vast amount of literature on supersymmetry and related topics has been published. Various non-technical books on supersymmetry, *e.g.* D. Hooper [58], G. Kane [62], L. Randall [95], and the books by B. Greene [52, 53] are now available. There are several introductory texts on supersymmetry, *e.g.* I.J.A. Aitchinson [1, 2], A. Bilal [15], M. Drees [32], N. Polonsky [89], S.P. Misra [73], U. Lindström [69], J.D. Lykken [70], S.P. Martin [71]. Books on superstrings generally include brief introductions to supersymmetry, see *e.g.* the monographs by M.B. Green, J.H. Schwarz and E. Witten [51], M. Kaku [61] and J. Polchinski [88]. Phenomenological implications and astrophysical and cosmological aspects of supersymmetry — subjects which we do not cover in this text — can be found in M. Dine [28], K.A. Olive [80] and S.P. Martin [71]. The Minimal Supersymmetric Standard Model (MSSM) — *i.e.* the minimal extension to the Standard Model of particle physics that realizes supersymmetry with a strong emphasis on phenomenological aspects — is discussed in I.J.A. Aitchinson [1] and in the review article by S.P. Martin [71]. This subject is also treated in the monograph by S. Weinberg [118], Chapter

28.4. Non-perturbative methods of supersymmetry are discussed in A. Wipf [129], J. Terning [111] and M. Bianchi *et al.* [13]. More advanced topics such as the Seiberg–Witten duality — an important development of non-perturbative methods in supersymmetric Yang–Mills Theory — is presented in the pedagogical reviews of L. Alvarez–Gaumé and S.L. Hassan [5], A. Bilal [14], and W. Lerche [68]. The book by D.I. Olive and P.C. West [79] is also devoted to this topic. Recently the books of S. Duplij, W. Siegel, and J. Bagger [33], J. Terning [112], M. Dine [29], and P. Binetruy and K. Hentschel [16] appeared, which cover the developments of the last two decades in supersymmetry.

A few years ago, the discovery of supersymmetry celebrated its 30<sup>th</sup> anniversary. The exceptional history of supersymmetry is discussed in the book by G. Kane and M. Shifman [63], in particular we recommend the comprehensive contribution of R. Di Stefano [30]. See also the recollections of J. Wess [122] and the overview of D. Olive and P. West in [79].

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# Preface to the First Edition

This text is a detailed version of material presented by both of us in seminars and lectures in the theory group of this department. Except for parts of Chapters 9 and 10 the material has also been covered in a series of seminars by one of us (M.-K.) in the Department of Physics of the University of Adelaide, Adelaide, Australia, in August and September 1985 and in the Department of Physics of Shanxi University, Taiyuan, China, in March and April 1987. The interest and criticism of the audience at these departments and, in particular, the support and enthusiasm of Prof. A.W. Thomas (Adelaide) and Professor Zhang Jianzu (Taiyuan) are gratefully acknowledged.

The text was compiled with the belief that the majority of potential readers is more interested in actually using or applying supersymmetry in some model theory than in painstakingly rediscovering the results of others for themselves. It seemed plausible, therefore, to revise various relevant concepts and in particular, to include the proof or verification of almost every formula. In this way the reader can select the problems he wants to tackle himself, compare his solutions with the calculations given here, and thus gain the confidence in his own calculations which he needs for his discussions of supersymmetry in other contexts. It has been our experience that except for the last two chapters, the material presented here can be covered in a one-semester course for graduate or post graduate students with some knowledge of field theory.

In compiling this text we have, of course, used previous reviews. The choice of our sequence of topics was motivated by the lecture notes of F. Legovini [67]. Standard texts which we have consulted are the monograph by J. Wess and J. Bagger [123] and the review by P. Fayet and S. Ferrara [35]. For the detailed treatment of the on-shell Wess–Zumino model we consulted the lecture notes of M. de Roo [25]. In the text we do not discuss any experimental signatures of supersymmetry. For an introduction into this topic we refer to articles by H.E. Haber and G.L. Kane [55, 56]; further details can be found in the Proceedings of the Thirteenth SLAC Summer

Institute on Particle Physics [92] and in the reviews by P. Nilles [77] and N. Dragon, U. Ellwanger and M. Schmidt [31]. As further general references we refer to the nontechnical review by J. Wess [121], to a very brief review of topics covered here by B.A. Campbell and G. Fogleman [20] and to the lectures by J. Wess [120], S. Ferrara [37] and E. Witten [132]. A more advanced text is the book by S.J. Gates, M.T. Grisaru, M. Roček and W. Siegel [46]. The very readable review by M. Sohnius [109] appeared after completion of the first draft of our text. Meanwhile several other texts have been published, each, however, with its emphasis in a different direction. We refer here to the books by P. West [127], P.P. Srivastava [110] and P.G.O. Freund [44]. For more specific topics we refer to the article by A. Salam and J. Strathdee [101], to the Proceedings of the 28th Scottish Universities Summer School in Physics [90], and to the Proceedings of the NATO Advanced Study Institute on Supersymmetry [91]. All considerations of this text refer to a four-dimensional Minkowski space. For the basic technicalities in the context of supersymmetric quantum mechanics we refer to the work of F. Cooper and B. Freedman [24], whereas those of two-dimensional field theories can be found in reference [74].

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