<<粒子物理学中的超对称>>

图书基本信息

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前言

This book is intended to be an elementary and practical introduction to supersymmetry in particle physics. More precisely, I aim to provide an accessible, self-contained account of the basic theory required for a working understanding of the 'Minimal Supersymmetric Standard Model' (MSSM), including 'soft' symmetry breaking.Some simple phenomenological applications of the model are also developed in the later chapters. The study of supersymmetry (SUSY) began in the early 1970s, and there is now a very large, and still growing, research literature on the subject, as well as many books and review articles. However, in my experience the existing sources are generally suitable only for professional (or intending) theorists. Yet searches for SUSY have been pursued in experimental programmes for some time, and are prominent in experiments planned for the Large Hadron Collider at CERN. No direct evidence for SUSY has yet been found. Nevertheless, for the reasons outlined in Chapter 1,supersymmetry at the TeV scale has become the most highly developed framework for guiding and informing the exploration of physics beyond the Standard Model.This dominant role of supersymmetry, both conceptual and phenomenological, suggests a need for an entry-level introduction to supersymmetry, which is accessible to the wider community of particle physicists. The first difficulty presented by conventional texts on supersymmetry - and it deters many students - is one of notation. Right from the start, discussions tend to be couched in terms of a spinor notation that is generally not familiar from standard courses on the Dirac equation - namely, that of either 'dotted and undotted 2-component Weyl spinors', or '4-component Majorana spinors'. This creates somethiag of a conceptual discontinuity between what most students already know,and what they are trying to learn; it becomes a pedagogical barrier. By contrast,my approach builds directly on knowledge of Dirac spinors in a conventional representation, using 2-component ('half-Dirac') spinors, without necessarily requiring the more sophisticated dotted and undotted formalism. The latter is, however, At roughly the half-way stage in the book, all the elements necessary for understanding the construction of the MSSM (or variants thereof) are now in place. The model is defined in Chapter 8, and immediately applied to exhibit gauge-coupling unification. Elementary ideas of SUSY breaking are introduced in Chapter 9, together with the phenomenolgically important notion of 'soft'supersymmetry-breaking parameters. The remainder of the book is devoted to simple applications: Higgs physics (Chapter 10), sparticle masses (Chapter 1 I) and sparticle production processes (Chapter 12).

内容概要

This book is intended to be an elementary and practical introduction to supersymmetry in particle physics. More precisely， I aim to provide an accessible， self-contained account of the basic theory required for a working understanding of the Minimal Supersymmetric Standard Model (MSSM)， including soft symmetry breaking.Some simple phenomenological applications of the model are also developed in the later chapters.

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章节摘录

插图：Accepting that （1.34） captures the essence of the matter, we can now begin to seewhat a radical idea supersymmetry really is. Equation （1.34） says, roughly speaking,that if you do two SUSY transformations generated by the Q terms, one after theother, you get the energy-momentum operator. Or, to put it even more strikingly （butquite equivalently）, you get the space-time translation operator, i.e. a derivative.Turning it around, the SUSY spinorial Q's are like square roots of 4-momentum, orsquare roots of derivatives！
It is rather like going one better than the Dirac equation,which can be viewed as providing the square root of the Klein-Gordon equation:how would we take the square root of the Dirac equation？
It is worth pausing to take this in properly. Four-dimensional derivatives arefirmly locked to our notions of a four-dimensional space-time. In now entertainingthe possibility that we can take square roots of them, we are effectively extendingour concept of space-time itself, just as, when the square root of - 1 is introduced,we enlarge the real axis to the complex （Argand） plane. That is to say, if we takeseriously an algebra involving both Pu and the Q's we shall have to say that thespace-time co-ordinates are being extended to include further degrees of freedom,which are acted on by the Q's, and that these degrees of freedom are connected tothe standard ones by means of transformations generated by the Q's. These furtherdegrees of freedom are, in fact, fermionic. So we may say that SUSY invites usto contemplate 'fermionic dimensions', and enlarge space-time to 'superspace'.SUSY is often thought of in terms of （approximately） degenerate multiplets ofbosons and fermions. Of course, that aspect is certainly true, phenomenologicallyimportant, and our main concern in this book; nevertheless, the fermionic enlarge-ment of space-time is arguably a more striking concept, and we shall provide anintroduction to it in Chapter 6.One final remark on motivations: if you believe in String Theory （and it still seemsto be the most promising framework for a consistent quantum theory of gravity）,then the phenomenologically most attractive versions incorporate supersymmetry,some trace of which might remain in the theories that effectively describe physicsat presently accessible energies.

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