<<统一理论和超对称>>

图书基本信息

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前言

The new millennium has brought new hope and vigor to particle physics.The menacing clouds of despair and discontent that enveloped the fieldfollowing the collapse of SSC have all but vanished. The discovery of neu-trino mass has brought the first light of new physics beyond the standardmodel. The LEP-SLC data has given strong hints of a light Higgs boson,which is widely hoped, will be discovered soon either at the Tevatron of LHC. LEP may quite possibly have missed it by a hair. Many neutrinoexperiments are either underway or are in the planning stages, and a roughoutline of neutrino mixing is appearing on the horizon. There are discussions of pulling resources internationally to build a linear collider after theLHC. Many major breakthroughs in the sister discipline of cosmology havelightened up the sky. Even the job situation in the field is showing signs of improvement after a long plateau.All this hope and optimism about a bright future for the field seem tobe resting on two ideas: unification and supersymmetry. The first is based on the amazing success of the standard model, giving credence to the possibility that the final theory of particle physics could come from gaugetheories and string theory, from which the gauge symmetries follow. The belief in supersymmetry arises not only from its beauty and elegance and its ability to truly unify matter and forces but also from the way it em- braces gravity into the fold of particle physics. Its hold on the field is almost as pervasive as that of gauge theories. Even though there are many other competing ideas vying for the attention of theorists, the general direction seems to be largely set towards supersymmetry, supergravity, and super- strings.

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内容概要

本书是作者依据其为马里兰大学高年级研究生授课时所用的讲义编著而成，详细介绍了人们尝试建立一个能够描述自然界中各种基本相互作用的大统一理论的最新进展。
本书包罗甚广，涉及到粒子物理学中的大统一理论和超对称理论中的许多议题，例如自发对称破缺，大统一理论，超对称性和超引力等。
作者在简要回顾了基本粒子理论之后，详细介绍了复合夸克，轻子，希格斯玻色子和CP破坏等论题，最后讨论超对称的大统一方案。
这是本书的第三版，进一步修订了书中内容，添入该领域的最新进展，特别是近年来实验方面的诸多进展。
对这些新进展的集中介绍很有意义，使得本书成为该领域中连接传统理论与研究前沿的有益桥梁。
无论对该领域的研究生还是对研究人员来讲，本书都是一部很有价值的教科书和参考文献。

作者简介

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书籍目录

章节摘录

插图：three-quark bound states, whereas meson spectroscopy arises from nonrela tivistic quark-antiquark bound states. Accepting quarks as the constituents of hadrons, we have to search for a field theory that provides the bindingforce between the quarks.In trying to understand the Fermi statistics for baryons （such as ）, itbecame clear that if they are S-wave bound states, then the space part oftheir wave function is totally symmetric; since a particle such as consists of three strange quarks, and has spin 3/2, the spin part of its wave functionis symmetric. If there were no other degree of freedom, this would be indisagreement with the required Fermi statistics. A simple way to resolvethis problem is to introduce [11] a threefold degree of freedom for quarks,called color （quarks being color triplets） and assume that all known baryonsare singlet under this new SU（3）. Since an SU（3）c-singlet constructed outof three triplets is antisymmetric in the interchange of indices （quarks）, thetotal baryon wave function is antisymmetric in the interchange of any twoconstituents as required by Fermi statistics.It is now tempting to introduce strong forces by making SU（3）c into alocal symmetry. In fact, if this is done, we can show that exchange of theassociated gauge bosons provides a force for which the SU（3）c color singletis the lowest-lying state; and triplet, sextet, and octet states all have highermass. By choosing this mass gap large, we can understand why excitedstates corresponding to the color degree of freedom have not been found.While this argument in favor of an SU（3）c gauge theory of strong inter-action was attractive, it was not conclusive. The most convincing argumentin favor of SU（3）c gauge theory came from the experimental studies of deepinelastic neutrino and electron scattering off nucleons. These experimentsinvolved the scattering of very-high-energy （E） electronsand neutrinoswith the exchange of very high momentum transfers （i.e., q2 large）. It wasfound that the structure functions, which are analogs of form factors forlarge q2 and E, instead of falling with q2, became scale-invariant functionsdepending only on the ratio q2/2mE. This was known as the phenomenonof scaling [12]. Two different theoretical approaches were developed to un-derstand this problem. The first was an intuitive picture called the partonmodel suggested by Feynman [13] and developed by Bjorken and Paschos[14], where it was assumed that, at very high energies, the nucleon can bethought of as consisting of free pointlike constituents. The experimentalresults also showed that these pointlike constituents were spin-l/2 objects,like quarks, and the scaling function was simply the momentum distri-bution function for the partons inside the nucleon. These partons couldbe identified with quarks, thus providing a unified description of the nu-cleon as consisting of quarks at low, as well as at high, energies. The maindistinction between these two energy regimes uncovered by deep inelas-tic scattering experiments is that at low energies the forces between thequarks are strong, whereas at high energies the forces vanish letting thequarks float freely inside the nucleons.

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