Supersymmetry And Supergravity

Supersymmetry and SupergravityRevised EditionPrinceton University Press

The theoretical understanding of elementary particle interactions has under gone a revolutionary change during the past one and a half decades. The spontaneously broken gauge theories, which in the 1970s emerged as a prime candidate for the description of electro-weak (as weIl as strong) interactions, have been confirmed by the discovery of neutral weak currents as weIl as the w- and Z-bosons. We now have a field theory of electro-weak interactions at energy scales below 100 GeV-the Glashow-Weinberg-Salam theory. It is a renormalizable theory which enables us to do calculations without en countering unnecessary divergences. The burning question now is: Wh at lies ahead at the next level of unification? As we head into the era of supercolliders and ultrahigh energy machines to answer this question, many ap, pealing possi bilities exist: left-right symmetry, technicolor, compositeness, grand unifica ti on, supersymmetry, supergravity, Kaluza-Klein models, and most recently superstrings that even unify gravity along with other interactions. Experi ments will decide if any one or any combination of these is to be relevant in the description of physics at the higher energies. As an outcome of our con fidence in the possible scenerios for elementary particle physics, we have seen our understanding of the early uni verse improve significantly.

This book offers a comprehensive discussion of developments at the interface of particle physics, supergravity, and cosmology, for graduates and researchers.

This book aims to provide an overview of several topics in advanced differential geometry and Lie group theory, all of them stemming from mathematical problems in supersymmetric physical theories. It presents a mathematical illustration of the main development in geometry and symmetry theory that occurred under the fertilizing influence of supersymmetry/supergravity. The contents are mainly of mathematical nature, but each topic is introduced by historical information and enriched with motivations from high energy physics, which help the reader in getting a deeper comprehension of the subject.

Supersymmetry, supergravity and superstring are the most popular research topics in particle physics. In particular, the phenomenological studies beyond the standard model have become very popular in view of possible identification or exclusion of supersymmetric particles in the future. Also, the lightest supersymmetric particle in most supersymmetric models can be a good candidate for dark matter in the universe.The recent developments in supersymmetry with important applications to particle physics are the main theme of this book, which includes superstring calculations with D-branes, TeV-scale gravity, superstring- and supergravity-inspired interactions, supersymmetric GUT, supergravity

phenomenology, and cosmological implications of LSP.

"Supergravity, together with string theory, is one of the most significant developments in theoretical physics. Although there are many books on string theory, this is the first-ever authoritative and systematic account of supergravity. Written by two ofthe most respected workers in the field, it provides a solid introduction to the fundamentals of supergravity. It starts by reviewing aspects of relativistic field theory in Minkowski spacetime. After introducing the relevant ingredients of differential geometry and gravity, some basic supergravity theories (D=4 and D=11) and the main gauge theory tools are explained. In the second half of the book, complex geometry and N=1 and N=2 supergravity theories are covered. Classical solutions and a chapter on AdS/CFT complete the book. Numerous exercises and examples make it ideal for Ph.D. students and with applications to model building, cosmology and solutions of supergravity theories, it is also invaluable to researchers"--

Ideas and Methods of Supersymmetry and Supergravity: Or a Walk Through Superspace provides a comprehensive, detailed, and self-contained account of four dimensional simple supersymmetry and supergravity. Throughout the book, the authors cultivate their material in detail with calculations and full discussions of the fundamental ideas and motivations. They develop the subject in its superfield formulations but where appropriate for illustration, analogy, and comparison with conventional field theory, they use the component formulation. The book discusses many subjects that, until now, can only be found in the research literature. In addition, it presents a plethora of new results. Combining classical and quantum field theory with group theory, differential geometry, and algebra, the book begins with a solid mathematical background that is used in the rest of the book. The next chapter covers algebraic aspects of supersymmetry and the concepts of superspace and superfield. In the following chapters, the book presents classical and quantum superfield theory and the superfield formulation of supergravity. A synthesis of results and methods developed in the book, the final chapter concludes with the theory of effective action in curved superspaces. After studying this book, readers should be well prepared to pursue independent research in any area of supersymmetry and supergravity. It will be an indispensable source of reference for advanced graduate students, postdoctoral faculty, and researchers involved in quantum field theory, high energy physics, gravity theory, mathematical physics, and applied mathematics.

These lectures give an elementary introduction to the important recent developments of the applications of N=1 supergravity to the construction of unified models of elementary particle interactions. Topics covered include couplings of supergravity with matter, spontaneous symmetry breaking and the super-higgs effect, construction of supergravity unified models, and the phenomenon of SU(2) x U(1) electroweak-symmetry breaking by supergravity. Experimental consequences of N-1 supergravity unified theory, in particular, the possible supersymmetric decays of the W± and Z0 bosons, are also discussed. The treatment presented encompasses a broad class of models, both of the tree breaking as well as the radiative breaking of SU(2) x U(1). Rules of tensor calculus and the explicit construction of the Lagrangian of the Supergravity-matter couplings are given in the appendix. Contents: Front MatterApplied N = 1 SupergravityBack Matter Readership: Theoretical physicists and mathematicians.

Readership: High energy physicists, nuclear physicists, mathematicians and mathematical physicists.

Keywords:Supersymmetry;Supergravity;Super-Higgs Effect;High Energy Physics

This thesis consists of two parts, which explore related but distinct directions. The first part concerns theories of supersymmetry and supergravity with a spontaneously broken supersymmetry -- specifically, a nonlinearly realized supersymmetry and nilpotent multiplets. From a phenomenological perspective, theories of spontaneously broken supersymmetry are relevant due to the lack of experimental evidence for unbroken supersymmetry at low energies. In recent years, theories with nilpotent multiplets have proven to be useful for constructing cosmological models in a supersymmetric context. To this end, we develop a method of obtaining actions (and multiplets) with a nonlinearly realized supersymmetry from the corresponding linear models by taking the masses of certain particles to infinity -- physically, these infinite-mass particles can be thought of as being integrated out. This generalizes previous work done by Komargodski and Seiberg to (a) all energy scales and (b) to theories with local supersymmetry (supergravity) as well. The supergravities with non-linearly realized supersymmetry have de Sitter vacua with a positive cosmological constant. In the second part, we study scattering amplitudes in two different physical systems -- the N=1 Volkov-Akulov theory, and U(1) anomalous amplitudes in extended supergravities. Anomalies have always been important in theoretical physics, as they give insight into the extent to which classical symmetries control quantum physics. Motivated by work done by Marcus in the 1980s, we study anomalies in extended supergravities from the perspective of anomalous scattering amplitudes. We develop the formalism of linearized superconformal chiral superfields for these theories, and construct candidate one-loop anomalous superinvariants. We find that in N = 5, 6, and 8 supergravities one-loop anomalous amplitudes are absent, which implies a possibility of an improved UV behavior.

In theoretical physics, supergravity (supergravity theory; SUGRA for short) is a field theory that combines the principles ofsupersymmetry and general relativity. Together, these imply that, in supergravity, the supersymmetry is a local symmetry (in contrast to non-gravitational supersymmetric theories, such as the Minimal Supersymmetric Standard Model). Since the generators of supersymmetry (SUSY) are convoluted with the Poincare group to form a super-Poincare algebra, it can be seen that supergravity follows naturally from supersymmetry. All traditional literature on supergravity is generally written in terms of Cartan connections. Like any field theory of gravity, a supergravity theory contains a spin-2 field whose quantum is the graviton. Supersymmetry requires the graviton field to have a superpartner. This field has spin 3/2 and its quantum is the gravitino. The number of gravitino fields is equal to the number of supersymmetries. SUGRA, or supergravity, was discovered in 1976 by Dan Freedman, Sergio Ferrara and Peter van Nieuwenhuizen, but was quickly generalized to many different theories in various numbers of dimensions and additional (N) supersymmetry charges. Supergravity theories with N>1 are usually referred to as extended supergravity (SUEGRA). Some supergravity theories were shown to be equivalent to certain higher-dimensional supergravity theories via dimensional reduction (e.g. N = 1 11-dimensional supergravity is dimensionally reduced on S7 to N = 8, d = 4 SUGRA). The resulting theories were sometimes referred to as Kaluza-Klein theories as Kaluza and Klein constructed in 1919 a 5-dimensional gravitational theory, that when dimensionally reduced on circle, its 4-dimensional non-massive modes describe electromagnetism coupled to gravity. This book gives an overview of supergravity and the applicable theories using the latest peer-reviewed information."

Offers a concise treatment of the pedagogical aspects of supersymmetry and supergravity. Addresses other areas of quantum field theory

including Schwinger's Action Principle and quantum phase transitions. Examines the utilization of thermofield dynamics in supersymmetry and supergravity along with concepts of higher dimensional spaces and compactification.

This widely acclaimed introduction to N = 1 supersymmetry and supergravity is aimed at readers familiar with relativistic quantum field theory who wish to learn about the supersymmetry algebra. In this new volume Supersymmetry and Supergravity has been greatly expanded to include a detailed derivation of the most general coupling of super-symmetric gauge theory to supergravity. The final result is the starting point for phenomenological studies of supersymmetric theories. The book is distinguished by its pedagogical approach to supersymmetry. It develops several topics in advanced field theory as the need arises. It emphasizes the logical coherence of the subject and should appeal to physicists whose interests range from the mathematical to the phenomenological. In praise of the first edition: "A beautiful exposition of the original ideas of Wess and Zumino in formulating N = 1 supersymmetry and supergravity theories, couched in the language of superfields introduced by Strathdee and the reviewer.... [All] serious students of particle physics would do well to acquire a copy."--Abdus Salam, Nature "An excellent introduction to this exciting area of theoretical physics."--C. J. Isham, Physics Bulletin

This book presents a pedagogical introduction of supersymmetry, supergravity and string theories and deals also with advanced related topics. Request Inspection Copy

This book provides a comprehensive, detailed and self-contained account of four dimensional simple supersymmetry and supergravity. It will be an indispensable source of reference for advanced graduate students, postdoctoral and faculty researchers alike working in quantum field theory, high energy physics, gravity theory, mathematical physics and applied mathematics. The authors develop the subject in its superfield formulation but where appropriate for illustration, analogy and comparison with conventional field theory, they use the component formulation. Throughout the book the authors develop their material in detail with calculation and full discussions of the fundamental ideas and motivations. They discuss many subjects which until now could only be found in the research literature. In addition they present a plethora of new results. The result is the most comprehensive book yet produced on the fundamentals of supersymmetry and supergravity. After studying this book readers should be well prepared to pursue independent research in any area of supersymmetry and supergravity.

With this new volume, one finds a detailed survey of supersymmetry and supergravity theory. Altogether this covers a very important field of research and endeavour in theoretical physics over the past decade. The overall result of this book is a survey of fascinating field with challenging problems and high promises.

The publication of the first edition of “Introduction to Supersymmetry and Supergravity” was a remarkable success. This second edition contains a substantial amount of new material especially on two-dimensional supersymmetry algebras, their irreducible representations as well as rigid and local (i.e. supergravity) theories of 2-dimensional supersymmetry both in x-space and superspace. These theories include the actions for the superstring and the heterotic string. In addition, a chapter is devoted to a discussion on superconformal algebras in two dimensions and contains an account of super operator product expansion. Request Inspection Copy

This is the first volume in a series of books on the general theme of Supersymmetric Mechanics; the series is based on lectures and discussions held in 2005 and 2006 at the INFN-Laboratori Nazionali di Frascati. The selected topics include supersymmetry and supergravity, the attractor mechanism, black holes, fluxes, noncommutative mechanics, super-Hamiltonian formalism and matrix models. Incorporates in extensive write-ups the results of animated discussion sessions which followed the individual lectures.

Supersymmetry is at an exciting stage of development. It extends the Standard Model of particle physics into a more powerful theory that

both explains more and allows more questions to be addressed. Most important, it opens a window for studying and testing fundamental theories at the Planck scale. Experimentally we are finally entering the intensity and energy regions where superpartners are likely to be detected, and then studied. There has been progress in understanding the remarkable physics implications of supersymmetry, including the derivation of the Higgs mechanism, the unification of the Standard Model forces, cosmological connections such as a candidate for the cold dark matter of the universe and the scalar fields that drive inflation and their potential, the relationship to Planck scale theories, and more.While there are a number of reviews and books where the mathematical structure and uses of supersymmetry can be learned, there are few where the particle physics is the main focus. This book fills that gap. It begins with an excellent pedagogical introduction to the physics and methods and formalism of supersymmetry, by S Martin, which is accessible to anyone with a basic knowledge of the Standard Model of particle physics. Next is an overview of open questions by K Dienes and C Kolda, followed by chapters on topics ranging from how to detect superpartners to connections with Planck scale theories, by leading experts.This invaluable book will allow any interested physicist to understand the coming experimental and theoretical progress in supersymmetry, and will also help students and workers to quickly learn new aspects of supersymmetry they want to pursue.

This is the seventh volume in a series on the general topics of supersymmetry, supergravity, black objects (including black holes) and the attractor mechanism. The present volume is based on lectures held in March 2013 at the INFN-Laboratori Nazionali di Frascati during the Breaking of supersymmetry and Ultraviolet Divergences in extended Supergravity Workshop (BUDS 2013), organized by Stefano Bellucci, with the participation of prestigious speakers including P. Aschieri, E. Bergshoeff, M. Cederwall, T. Dennen, P. Di Vecchia, S. Ferrara, R. Kallosh, A. Karlsson, M. Koehn, B. Ovrut, A. Van Proeyen, G. Ruppeiner. Special attention is devoted to discussing topics related to the cancellation of ultraviolet divergences in extended supergravity and Born-Infeld-like actions. All talks were followed by extensive discussions and subsequent reworking of the various contributions a feature which is reflected in the unique "flavor" of this volume.

This volume contains papers presented at the Nuffield Workshop on supersymmetry and its applications held at Cambridge in the summer of 1985 and attended by many of the leading experts in the field. In physical terms, supersymmetry is a symmetry or gauge invariance which connects bosons (particles with integer spin) with fermions (particles with half integer spin). The study of supersymmetry has led to the construction of Yang-Mills theories, which are the first field theories to be free of the divergences that usually occur in quantum theories, with an infinite number of degrees of freedom. It has also led to the construction of supergravity and superstring theories which seem to be the best hope for a complete unified theory of all physical interactions including gravity. Supersymmetry and its Applications reviews a number of recent advances in the area of anomalies, the topology of gauge theories, superstrings, supergravity and super Yang-Mills theory.The papers, written by both physicists and mathematicians, include both expository articles and progress reports describing most recent developments.

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their irreducible representations as well as rigid and local (i.e. supergravity) theories of 2-dimensional supersymmetry both in x-space and superspace. These theories include the actions for the superstring and the heterotic string. In addition, a chapter is devoted to a discussion on superconformal algebras in two dimensions and contains an account of super operator product expansion.