The Quantum Dice

An Introduction to Stochastic Electrodynamics

by

Luis de la Peña and
Ana María Cetto
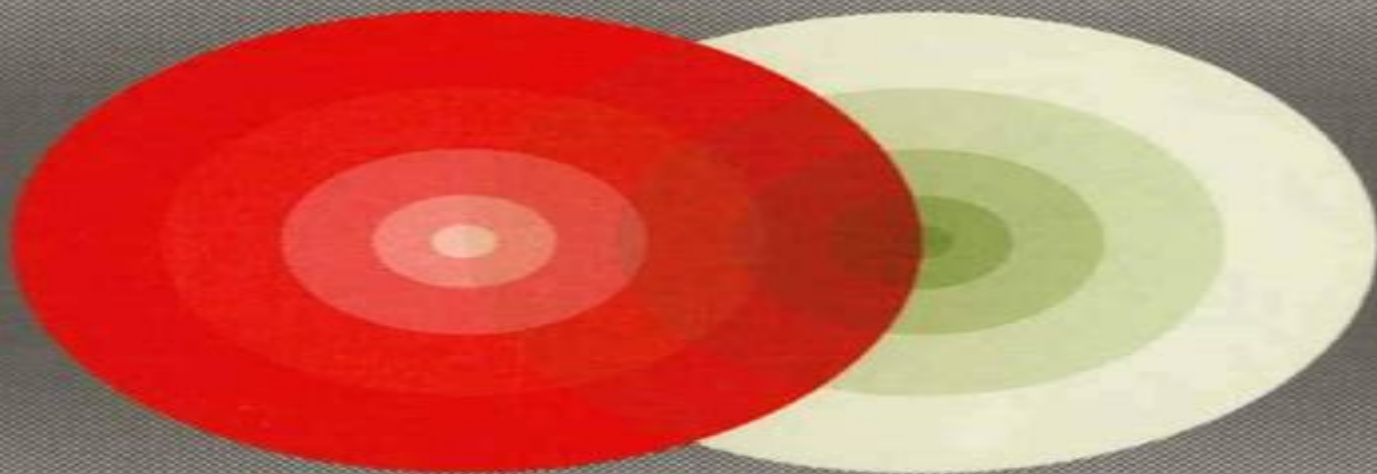
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   The Quantum Dice Luis de la Peña,A.M. Cetto,1995-12-31 In spite of the impressive predictive power and strong mathematical structure of quantum mechanics the theory has always suffered from important conceptual problems Some of these have never been solved Motivated by this state of affairs a number of physicists have worked together for over thirty years to develop stochastic electrodynamics a physical theory aimed at finding a conceptually satisfactory realistic explanation of quantum phenomena This is the first book to present a comprehensive review of stochastic electrodynamics from its origins to present day developments After a general introduction for the non specialist a critical discussion is presented of the main results of the theory as well as of the major problems encountered A chapter on stochastic optics and some interesting consequences for local realism and the Bell inequalities is included In the final chapters the authors propose and develop a new version of the theory that brings it in closer correspondence with quantum mechanics and sheds some light on the wave aspects of matter and the linkage with quantum electrodynamics Audience The volume will be of interest to scholars and postgraduate students of theoretical and mathematical physics foundations and philosophy of physics and teachers of theoretical physics and quantum mechanics electromagnetic theory and statistical physics stochastic processes

   The Quantum Dice Luis de la Peña,A.M. Cetto,2013-03-09 In spite of the impressive predictive power and strong mathematical structure of quantum mechanics the theory has always suffered from important conceptual problems Some of these have never been solved Motivated by this state of affairs a number of physicists have worked together for over thirty years to develop stochastic electrodynamics a physical theory aimed at finding a conceptually satisfactory realistic explanation of quantum phenomena This is the first book to present a comprehensive review of stochastic electrodynamics from its origins to present day developments After a general introduction for the non specialist a critical discussion is presented of the main results of the theory as well as of the major problems encountered A chapter on stochastic optics and some interesting consequences for local realism and the Bell inequalities is included In the final chapters the authors propose and develop a new version of the theory that brings it in closer correspondence with quantum mechanics and sheds some light on the wave aspects of matter and the linkage with quantum electrodynamics Audience The volume will be of interest to scholars and postgraduate students of theoretical and mathematical physics foundations and philosophy of physics and teachers of theoretical physics and quantum mechanics electromagnetic theory and statistical physics stochastic processes

   An Introduction to Quantum Optics and Quantum Fluctuations Peter W. Milonni,2019-01-31 This is an introduction to the quantum theory of light and its broad implications and applications A significant part of the book covers material with direct relevance to current basic and applied research such as quantum fluctuations and their role in laser physics and the theory of forces between macroscopic bodies Casimir effects The book includes numerous historical sidelights throughout and approximately seventy exercises The book provides detailed expositions of the theory with emphasis on general physical

principles Foundational topics in classical and quantum electrodynamics are addressed in the first half of the book including the semiclassical theory of atom field interactions the quantization of the electromagnetic field in dispersive and dissipative media uncertainty relations and spontaneous emission The second half begins with a chapter on the Jaynes Cummings model dressed states and some distinctly quantum mechanical features of atom field interactions and includes discussion of entanglement the no cloning theorem von Neumann s proof concerning hidden variable theories Bell s theorem and tests of Bell inequalities The last two chapters focus on quantum fluctuations and fluctuation dissipation relations beginning with Brownian motion the Fokker Planck equation and classical and quantum Langevin equations Detailed calculations are presented for the laser linewidth spontaneous emission noise photon statistics of linear amplifiers and attenuators and other phenomena Van der Waals interactions Casimir forces the Lifshitz theory of molecular forces between macroscopic media and the many body theory of such forces based on dyadic Green functions are analyzed from the perspective of Langevin noise vacuum field fluctuations and zero point energy **Electromagnetism And The Structure Of Matter** Daniele Funaro,2008-06-16 The classical theory of electromagnetism is entirely revised in this book by proposing a variant of Maxwell equations that allows solitonic solutions photons The Lagrangian is the standard one but it is minimized on a constrained space that enforces the wave packets to follow the rules of geometrical optics Exact solutions are explicitly shown this opens a completely new perspective for the study of light wave phenomena In the framework of general relativity the equations are written in covariant form A coupling with the metric is obtained through the Einstein equation whose solutions are computed exactly in a lot of original situations Finally the explicit construction of elementary particles consisting of rotating photons is indicated The results agree qualitatively and quantitatively with what it is actually observed This opens the path to an understanding of the structure of matter and its properties also aimed to provide a causal explanation to quantum phenomena Euclidean Quantum Gravity on Manifolds with Boundary Giampiero Esposito,A.Yu. Kamenshchik,G. Pollifrone,2012-12-06 This book reflects our own struggle to understand the semiclassical behaviour of quantized fields in the presence of boundaries Along many years motivated by the problems of quantum cosmology and quantum field theory we have studied in detail the one loop properties of massless spin l 2 fields Euclidean Maxwell the ory gravitino potentials and Euclidean quantum gravity Hence our book begins with a review of the physical and mathematical motivations for studying physical theories in the presence of boundaries with emphasis on electrostatics vacuum v Maxwell theory and quantum cosmology We then study the Feynman propagator in Minkowski space time and in curved space time In the latter case the corre sponding Schwinger DeWitt asymptotic expansion is given The following chapters are devoted to the standard theory of the effective action and the geometric im provement due to Vilkovisky the manifestly covariant quantization of gauge fields zeta function regularization in mathematics and in quantum field theory and the problem of boundary conditions in one loop quantum theory For this purpose we study in detail Dirichlet Neumann and Robin boundary

conditions for scalar fields local and non local boundary conditions for massless spin l 2 fields mixed boundary conditions for gauge fields and gravitation This is the content of Part I Part II presents our investigations of Euclidean Maxwell theory simple super gravity and Euclidean quantum gravity   Towards a Local Realist View of the Quantum Phenomenon Alberto Casado,Ana Maria Cetto,Karl Hess,Andrea Valdés-Hernández,2021-05-03   *Causality and Locality in Modern Physics* G. Hunter,Stanley Jeffers,J.P. Vigier,2013-06-29 The Symposium entitled Causality and Locality in Modern Physics and As tronomy Open Questions and Possible Solutions was held at York University Toronto during the last week of August 1997 It was a sequel to a similar sym posium entitled The Present Status of the Quantum Theory of Light held at the same venue in August 1995 These symposia came about as a result of discussions between Professor Stanley Jeffers and colleagues on the International Organizing Committee Professor Jeffers was the executive local organizer of the symposia The 1997 symposium attracted over 120 participants representing 26 different countries and academic institutions The broad theme of both symposia was the enigma of modern physics the non local and possibly superluminal interactions implied by quantum mechanics the structure of fundamental particles including the photon the reconciliation of quantum mechanics with the theory of relativity and the nature of gravity and inertia Jean Pierre Vigier was the guest of honour at both symposia He was a lively contributor to the discussions of the presentations The presentations were made as 30 minute lectures or during an evening poster session Some participants did not submit a written account of their presentation at the symposium and not all of the articles submitted for the Proceedings could be included because of the publisher s page limit The titles and authors of the papers that had to be excluded are listed in an appendix   **Beyond the Quantum** Theo M. Nieuwenhuizen,2007 Already Einstein could never see quantum mechanics as a complete theory Nowadays many researchers including t Hooft view quantum mechanics as a statistical description of some underlying reality The workshop Beyond the Quantum organized in Spring 2006 at the Lorentz Center in Leiden The Netherlands was one of the first meetings completely devoted to physics that may need an explanation beyond quantum mechanics A broad variety of subjects was covered The present book reflects this   **The Quantum Dissidents** Olival Freire Junior,2014-12-26 This book tells the fascinating story of the people and events behind the turbulent changes in attitudes to quantum theory in the second half of the 20th century The huge success of quantum mechanics as a predictive theory has been accompanied from the very beginning by doubts and controversy about its foundations and interpretation This book looks in detail at how research on foundations evolved after WWII when it was revived until the mid 1990s when most of this research merged into the technological promise of quantum information It is the story of the quantum dissidents the scientists who brought this subject from the margins of physics into its mainstream It is also a history of concepts experiments and techniques and of the relationships between physics and the world at large touching on themes such as the Cold War McCarthyism Zhdanovism and the unrest of the late 1960s   The Geometry of Higher-Order Lagrange Spaces R. Miron,1997-01-31 This monograph is devoted to the problem of the geometrizing of

Lagrangians which depend on higher order accelerations It presents a construction of the geometry of the total space of the bundle of the accelerations of order k 1 A geometrical study of the notion of the higher order Lagrange space is conducted and the old problem of prolongation of Riemannian spaces to k osculator manifolds is solved Also the geometrical ground for variational calculus on the integral of actions involving higher order Lagrangians is dealt with Applications to higher order analytical mechanics and theoretical physics are included as well Audience This volume will be of interest to scientists whose work involves differential geometry mechanics of particles and systems calculus of variation and optimal control optimization optics electromagnetic theory and biology   **Hierarchical Methods** V. Kulish,2006-04-11 Everybody is current in a world surrounded by computer Computers determine our professional activity and penetrate increasingly deeper into our everyday life Therein we also need increasingly refined c puter technology Sometimes we think that the next generation of c puter will satisfy all our dreams giving us hope that most of our urgent problems will be solved very soon However the future comes and il sions dissipate This phenomenon occurs and vanishes sporadically and possibly is a fundamental law of our life Experience shows that indeed systematically remaining problems are mainly of a complex tech logical nature the creation of new generation of especially perfect croschemes elements of memory etc But let us note that amongst these problems there are always ones solved by our purely intellectual efforts alone Progress in this direction does not require the invention of any superchip or other similar elements It is important to note that the results obtained in this way very often turn out to be more significant than the fruits of relevant technological progress The hierarchical asymptotic analytical numerical methods can be garded as results of such purely intellectual efforts Their application allows us to simplify essentially computer calculational procedures and consequently to reduce the calculational time required It is obvious that this circumstance is very attractive to any computer user   **Quantum-Classical Correspondence** A. O. Bolivar,2013-04-09 At what level of physical existence does quantum behavior begin How does it develop from classical mechanics This book addresses these questions and thereby sheds light on fundamental conceptual problems of quantum mechanics Quantum Classical Correspondence elucidates the problem by developing a procedure for quantizing stochastic systems e g Brownian systems described by Fokker Planck equations The logical consistency of the scheme is then verified by taking the classical limit of the equations of motion and corresponding physical quantities Perhaps equally important conceptual problems concerning the relationship between classical and quantum physics are identified and discussed Physical scientists will find this an accessible entr e to an intriguing and thorny issue at the core of modern physics   Classical Relativistic Many-Body Dynamics M.A. Trump,W.C. Schieve,2013-03-09 in this work we must therefore assume several abstract concepts that hardly need defending at this point in the history of mechanics Most notably these include the concept of the point particle and the concept of the inertial observer The study of the relativistic particle system is undertaken here by means of a particular classical theory which also exists on the quantum level and which is especially suited to the many body system in flat spacetime In its fundamental

postulates the theory may be consid ered to be primarily the work of E C G Stiickelberg in the 1940 s and of L P Horwitz and C Piron in the 1970 s who may be said to have provided the generalization of Stiickelberg s theory to the many body system The references for these works may be found in Chapter 1 The theory itself may be legitimately called off shell Hamiltonian dynamics parameterized relativistic mechanics or even classical event dynamics The most important feature of the theory is probably the use of an invariant world time parameter usually denoted T which provides an evolution time for the system in such as way as to allow manifest co variance within a Hamiltonian formalism In general this parameter is neither a Lorentz frame time nor the proper time of the particles in the system   New Foundations for Classical Mechanics David Hestenes,1999-09-30 This book provides an introduction to geometric algebra as a unified language for physics and mathematics It contains extensive applications to classical mechanics in a textbook format suitable for courses at an intermediate level The text is supported by more than 200 diagrams to help develop geometrical and physical intuition Besides covering the standard material for a course on the mechanics of particles and rigid bodies the book introduces new coordinate free methods for rotational dynamics and orbital mechanics developing these subjects to a level well beyond that of other textbooks These methods have been widely applied in recent years to biomechanics and robotics to computer vision and geometric design to orbital mechanics in government and industrial space programs as well as to other branches of physics The book applies them to the major perturbations in the solar system including the planetary perturbations of Mercury s perihelion Geometric algebra integrates conventional vector algebra along with its established notations into a system with all the advantages of quaternions and spinors Thus it increases the power of the mathematical language of classical mechanics while bringing it closer to the language of quantum mechanics This book systematically develops purely mathematical applications of geometric algebra useful in physics including extensive applications to linear algebra and transformation groups It contains sufficient material for a course on mathematical topics alone The second edition has been expanded by nearly a hundred pages on relativistic mechanics The treatment is unique in its exclusive use of geometric algebra and in its detailed treatment of spacetime maps collisions motion in uniform fields and relativistic precession It conforms with Einstein s view that the Special Theory of Relativity is the culmination of developments in classical mechanics **Nuclear Matter in Different Phases and Transitions** Jean-Paul Blaizot,Xavier Campi,Marek Ploszajczak,2012-12-06 Nuclei in their ground states behave as quantum fluids Fermi liquids When the density or the temperature of that fluid increases various phase transitions may occur Thus for moderate excitation energies of the order of a few MeV per nucleon nuclear matter behaves as an ordinary fluid with gaseous and liquid phases and a coexistence region below a critical temperature For higher excitation energies of the order of a few Ge V per nucleon the composition of nuclear matter changes nucleons being gradually turned into baryonic resonances of various kinds Finally when 3 the energy density exceeds some few GeV fm nuclear matter turns into a gas of weakly interacting quarks and gluons This new phase of matter has been

called the quark gluon plasma and its existence is a prediction of Quantum Chromodynamics Collisions of heavy ions produce nuclear matter with various degrees of excitation In fact by selecting the impact parameter and the bombarding energy one can produce nuclear matter with specified baryonic density and excitation energy Several major experimental programs are under way for instance at GANIL with the detector INDRA at GSI with the detector ALADIN at the CERN SPS at the AGS of Brookhaven etc or are in preparation RRIC LHC etc The goal of these experiments is to get evidence for the different phases of nuclear matter predicted by the theory and to study their properties **Quantum Mechanics: Theory and Applications** Ajoy Ghatak,S. Lokanathan,2004-02-29 An understanding of quantum mechanics is vital to all students of physics chemistry and electrical engineering but requires a lot of mathematical concepts the details of which are given with great clarity in this book Various concepts have been derived from first principles so it can also be used for self study The chapters on the JWKB approximation time independent perturbation theory and effects of magnetic field stand out for their clarity and easy to understand mathematics Two complete chapters on the linear harmonic oscillator provide a very detailed discussion of one of the most fundamental problems in quantum mechanics Operator algebra is used to show the ease with which one can calculate the harmonic oscillator wave functions and study the evolution of the coherent state Similarly three chapters on angular momentum give a detailed account of this important problem Perhaps the most attractive feature of the book is the excellent balance between theory and applications and the large number of applications in such diverse areas as astrophysics nuclear physics atomic and molecular spectroscopy solid state physics and quantum well structures **Statistical Geometry and Applications to Microphysics and Cosmology** S. Roy,2012-12-06 Recent results from high energy scattering and theoretical developments of string theory require a change in our understanding of the basic structure of space time This book is about the advancement of ideas on the stochastic nature of space time from the 1930s onward In particular the author promotes the concept of space as a set of hazy lumps first introduced by Karl Menger and constructs a novel framework for statistical behaviour at the microlevel The various chapters address topics such as space time fluctuation and random potential non local fields and the origin of stochasticity Implications in astro particle physics and cosmology are also explored Audience This volume will be of interest to physicists chemists and mathematicians involved in particle physics astrophysics and cosmology *Classical Statistical Mechanics* G.A. Martynov,2012-12-06 Statistical mechanics deals with systems in which chaos and randomness reign supreme The current theory is therefore firmly based on the equations of classical mechanics and the postulates of probability theory This volume seeks to present a unified account of classical mechanical statistics rather than a collection of unconnected reviews on recent results To help achieve this one element is emphasised which integrates various parts of the prevailing theory into a coherent whole This is the hierarchy of the BBGKY equations which enables a relationship to be established between the Gibbs theory the liquid theory and the theory of nonequilibrium phenomena As the main focus is on the complex theoretical subject matter attention to applications

is kept to a minimum The book is divided into three parts The first part describes the fundamentals of the theory embracing chaos in dynamic systems and distribution functions of dynamic systems Thermodynamic equilibrium dealing with Gibbs statistical mechanics and the statistical mechanics of liquids forms the second part Lastly the third part concentrates on kinetics and the theory of nonequilibrium gases and liquids in particular Audience This book will be of interest to graduate students and researchers whose work involves thermophysics theory of surface phenomena theory of chemical reactions physical chemistry and biophysics **Quantum Cybernetics** Gerhard Grössing,2012-12-06 Some 350 years ago in his Discorsi e Dimostrationi Matematici Galilei Galileo Galilei discussed whether or not light propagated with a finite though very high velocity or with infinite speed instantaneously The ques tion was an open one then with prominent proponents for either position For example Rene Descartes argued on philosophical grounds that light dispersed itself into all of space instantaneously whereas Galileo was more inclined toward the idea of a finite velocity In fact he even reported about an early experiment which however would have to be refined and per 1 formed again to reach a definite conclusion Sagredo However of which kind and how high might we estimate the velocity of light Is the appearance instantaneous momentaneous or like other movements temporal Could one decide this experimentally Simplicio Daily experience teaches us that the spreading of light be instantaneous if in a large distance the artillery per forms shooting exercises we see the glare of the flame without the ear perceives the sound only after some time delay while considerable time **Theory of Nucleus** A. Sitenko,V. Tartakovskii,2012-12-06 Modern nuclear physics is a well developed branch of physical science with wide ranging applications of its results in engineering and industry At the same time the development of a consistent theory of nuclei and nuclear processes presents certain problems It is well known that the most important aim of nuclear physics is the study of nuclear structure and the explanation of properties on the basis of the interaction between nucleons which constitute nuclei Difficulties of a modern theory of the nucleus are caused by both an insufficient knowledge of nuclear interactions and the multi particle character of nuclear systems Experimental data on nuclear interactions do not contradict the hypothesis of the pair character of nuclear forces However the absence of rigorous meth ods of calculations of many particle nuclear systems with strong interaction makes it necessary to use macroscopic nuclear models to describe particular nuclear properties Nuclear models have been developed in different ways and the models themselves have been modified and complicated In spite of the visible discrepancy different models of the nucleus significantly supple ment one another The development of nuclear models has led to considerable progress in the understanding of atomic nuclei The current results of theo retical nuclear physics are reported in numerous scientific papers The most important and relevant experimental and theoretical results can be found in many monographs the best of which are written by well known experts in the field

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