The Quantum Vacuum A Scientific And Philosophical Concept From Electrodynamics To String Theory And The Geometry Of The Microscopic World

The propagation of light in dispersive media is a subject of fundamental as well as practical importance. In recent years attention has focused in particular on how refractive index can vary with frequency in such a way that the group velocities of optical pulses can be much greater or much smaller than the speed of light in vacuum, or in which the refractive index can be negative. Treating these topics at an introductory to intermediate level, Fast Light, Slow Light and Left-Handed Light focuses on the basic theory and describes the significant experimental progress made during the past decade. The book pays considerable attention to the fact that superluminal group velocities are not in conflict with special relativity and to the role of quantum effects in preventing superluminal communication and violations of Einstein causality. It also explores some of the basic physics at the opposite extreme of very slow group velocities as well as stopped and regenerated light, including the concepts of electromagnetically induced transparency and dark-state polaritons. Another very active aspect of the subject discussed concerns the possibility of designing metamaterials in which the refractive index can be negative and propagating light is left-handed in the sense that the phase and group velocities are in opposite directions. The last two chapters are an introduction to some of the basic theory and consequences of negative refractive index, with emphasis on the seminal work carried out since 2000. The possibility that "perfect" lenses can be made from negative-index metamaterials-which has been perhaps the most controversial aspect of the field-is introduced and discussed in some detail.

This is probably the only textbook available that gathers QCD, many-body theory and phase transitions in one volume. The presentation is pedagogical and readable. It provides materials interesting to both students and researchers of astrophysics, nuclear physics and high energy physics.

The 2011 Nobel Prize in Physics was awarded for the discovery of cosmic acceleration due to dark energy, a discovery that is all the more perplexing as nobody knows what dark energy actually is. We put the modern concept of cosmological vacuum energy into historical context and show how it grew out of disparate roots in quantum mechanics (zero-point energy) and relativity theory (the cosmological constant, Einstein's “greatest blunder”). These two influences have remained strangely aloof and still co-exist in an uneasy alliance that is at the heart of the greatest crisis in theoretical physics, the cosmological-constant problem.

This book presents a collection of studies by Romanian philosophers, addressing foundational issues currently debated in contemporary philosophy of science. It offers a historical survey of the tradition of scientific philosophy in Romania. It examines some problems in the foundations of logic, mathematics, linguistics, the natural and social sciences. Among the more specific topics, it discusses scientific explanation, models, and mechanisms, as well as memory, artifacts, and rules of research. The book is useful to those interested in the philosophy of real science, but also to those interested in Romanian philosophy.

In The Quantum Universe, Brian Cox and Jeff Forshaw approach the world of quantum mechanics in the same way they did in Why Does E=mc2? and make fundamental scientific principles accessible—and fascinating—to everyone. The subatomic realm has a reputation for weirdness, spawning any number of profound misunderstandings, journeys into Eastern mysticism, and woolly pronouncements on the interconnectedness of all things. Cox and Forshaw’s contention? There is no need for quantum mechanics to be viewed this way. There is a lot of mileage in the “weirdness” of the quantum world, and it often leads to confusion and, frankly, bad science. The Quantum Universe cuts through the Wu Li and asks what observations of the natural world made it necessary, how it was constructed, and why we are confident that, for all its apparent strangeness, it is a good theory. The quantum mechanics of The Quantum Universe provide a concrete model of nature that is comparable in its essence to Newton’s laws of motion, Maxwell’s theory of electricity and magnetism, and Einstein’s theory of relativity.

Book Description Demystifying the Akasha: Consciousness and the Quantum Vacuum Duality, including the spiritual/material and mind/body dichotomies, has been the basis of the Western paradigm for four hundred years, and has been blamed for major world problems. Meanwhile, in the East, nonduality has prevailed. While science is generally seen in opposition to nonduality, this book sets out to prove the compatibility of the scientifi c outlook and the spiritual nonduality of India by constructing a mathematical model of cosmic consciousness. The ideas and their history are presented non technically in Part One, while the full mathematical details are presented in Part Two. Ralph Abraham is Professor of Mathematics at the University of California at Santa Cruz, one of the pioneers of chaos theory. He is the author or coauthor of several math texts, including Foundations of Mechanics, Dynamics the Geometry of Behavior, and Chaos in Discrete Dynamical Systems. He has also written books on the history of math, philosophy, and the arts, such as Chaos, Creativity, and Cosmic Consciousness and The Evolutionary Mind. Sisir Roy is Professor of Theoretical Physics, Indian Statistical Institute, Kolkata. His field of interest covers foundations of quantum mechanics, cosmology, functional geometry and brain function. He has published more than 100 papers in peer reviewed international journals and nine research and edited monographs by Kluwer Academic, World Scientific etc. publishers. Praise for Demystifying the Akasha: Consciousness and the Quantum Vacuum "A key contribution to bringing the concept of the Akasha into the ambit of contemporary science, and relating it to our understanding of consciousness. A book for all serious students of cosmos and consciousness." Dr. Ervin Laszlo, Author of Science and the Akashic Field

The New York Times bestselling author of The Physics of Wall Street “deftly explains all you wanted to know about nothingness—a.k.a. the quantum vacuum” (Priyamvada Natarajan, author of Mapping the Heavens). James Owen Weatherall’s bestselling book, The Physics of Wall Street, was named one of Physics Today’s five most intriguing books

of 2013. In this work, he takes on a fundamental concept of modern physics: nothing. The physics of stuff—protons, neutrons, electrons, and even quarks and gluons—is at least somewhat familiar to most of us. But what about the physics of nothing? Isaac Newton thought of empty space as nothingness extended in all directions, a kind of theater in which physics could unfold. But both quantum theory and relativity tell us that Newton's picture can't be right. Nothing, it turns out, is an awful lot like something, with a structure and properties every bit as complex and mysterious as matter. In his signature lively prose, Weatherall explores the very nature of empty space—and solidifies his reputation as a science writer to watch. Included on the 2017 Best Book List by the American Association for the Advancement of Science (AAAS) "An engaging and interesting account."—The Economist "Readers get a dose of biography while following such figures as Einstein, Dirac, and Newton to see how top theories about the void have been discovered, developed, and debunked. Weatherall's clear language and skillful organization adroitly combines history and physics to show readers just how much 'nothing really matters.'"—Publishers Weekly

Matthieu Ricard trained as a molecular biologist, working in the lab of a Nobel prize—winning scientist, but when he read some Buddhist philosophy, he became drawn to Buddhism. Eventually he left his life in science to study with Tibetan teachers, and he is now a Buddhist monk and translator for the Dalai Lama, living in the Shechen monastery near Kathmandu in Nepal. Trinh Thuan was born into a Buddhist family in Vietnam but became intrigued by the explosion of discoveries in astronomy during the 1960s. He made his way to the prestigious California Institute of Technology to study with some of the biggest names in the field and is now an acclaimed astrophysicist and specialist on how the galaxies formed. When Matthieu Ricard and Trinh Thuan met at an academic conference in the summer of 1997, they began discussing the many remarkable connections between the teachings of Buddhism and the findings of recent science. That conversation grew into an astonishing correspondence exploring a series of fascinating questions. Did the universe have a beginning? Or is our universe one in a series of infinite universes with no end and no beginning? Is the concept of a beginning of time fundamentally flawed? Might our perception of time in fact be an illusion, a phenomenon created in our brains that has no ultimate reality? Is the stunning fine-tuning of the universe, which has produced just the right conditions for life to evolve, a sign that a "principle of creation" is at work in our world? If such a principle of creation undergirds the workings of the universe, what does that tell us about whether or not there is a divine Creator? How does the radical interpretation of reality offered by quantum physics conform to and yet differ from the Buddhist conception of reality? What is consciousness and how did it evolve? Can consciousness exist apart from a brain generating it? The stimulating journey of discovery the authors traveled in their discussions is re-created beautifully in The Quantum and the Lotus, written in the style of a lively dialogue between friends. Both the fundamental teachings of Buddhism and the discoveries of contemporary science are introduced with great clarity, and the reader will be profoundly impressed by the many correspondences between the two streams of thought and revelation. Through the course of their dialogue, the authors reach a remarkable meeting of minds, ultimately offering a vital new understanding of the many ways in which science and Buddhism confirm and complement each other and of the ways in which, as Matthieu Ricard writes, "knowledge of our spirits and knowledge of the world are mutually enlightening and empowering."

The 100 Greatest Lies in physics is a follow-up to Ray Fleming's The Zero-Point Universe as he continues to explore the importance of zero-point energy to modern physics. Since before the start of this century, evidence has mounted that space is not empty. Space is filled with quantum vacuum fluctuations called zero-point energy, and this energy is a modern form of aether. Most of the physics of the past century, which led to today's standard model, fails to account for this modern aether. In relativity theory there are two types of relativity, one that includes aether and one that rejects it. Physicists choose poorly and wrongly champion the theory that rejects the modern aether. Even though many theories like this are now known to be invalid, physicists still cling to the physics of the past. The mainstream physics of the last century is a complete disaster due to physicists' failure to incorporate zero-point energy into their explanations of forces and every day phenomena. The 100 Greatest Lies in Physics catalogs many of the most outrageous mistakes in physics in hopes that physicists will do their jobs and stop lying to everyone.

The Euclidean approach to Quantum Gravity was initiated almost 15 years ago in an attempt to understand the difficulties raised by the spacetime singularities of classical general relativity which arise in the gravitational collapse of stars to form black holes and the entire universe in the Big Bang. An important motivation was to develop an approach capable of dealing with the nonlinear, non-perturbative aspects of quantum gravity due to topologically non-trivial spacetimes. There are important links with a Riemannian geometry. Since its inception the theory has been applied to a number of important physical problems including the thermodynamic properties of black holes, quantum cosmology and the problem of the cosmological constant. It is currently at the centre of a great deal of interest.This is a collection of survey lectures and reprints of some important lectures on the Euclidean approach to quantum gravity in which one expresses the Feynman path integral as a sum over Riemannian metrics. As well as papers on the basic formalism there are sections on Black Holes, Quantum Cosmology, Wormholes and Gravitational Instantons.

Advances made by physicists in understanding matter, space, and time and by astronomers in understanding the universe as a whole have closely intertwined the question being asked about the universe at its two extremesâ€"the very large and the very small. This report identifies 11 key questions that have a good chance to be answered in the next decade. It urges that a new research strategy be created that brings to bear the techniques of both astronomy and sub-atomic physics in a cross-disciplinary way to address these questions. The report presents seven recommendations to facilitate the necessary research and development coordination. These recommendations identify key priorities for future scientific projects critical for realizing these scientific opportunities.

Presents the unifying world-concept long sought by scientists, mystics, and sages: an Integral Theory of Everything • Explains how modern science has rediscovered the Akashic Field of perennial philosophy • New edition updates ongoing

scientific studies, presents new research inspired by the first edition, and includes new case studies and a section on animal telepathy Mystics and sages have long maintained that there exists an interconnecting cosmic field at the roots of reality that conserves and conveys information, a field known as the Akashic record. Recent discoveries in vacuum physics show that this Akashic Field is real and has its equivalent in science's zero-point field that underlies space itself. This field consists of a subtle sea of fluctuating energies from which all things arise: atoms and galaxies, stars and planets, living beings, and even consciousness. This zero-point Akashic Field is the constant and enduring memory of the universe. It holds the record of all that has happened on Earth and in the cosmos and relates it to all that is yet to happen. In Science and the Akashic Field, philosopher and scientist Ervin Laszlo conveys the essential element of this information field in language that is accessible and clear. From the world of science he confirms our deepest intuitions of the oneness of creation in the Integral Theory of Everything. We discover that, as philosopher William James stated, "We are like islands in the sea, separate on the surface but connected in the deep."

This invaluable book provides a broad and comprehensive introduction to the fascinating and beautiful subject of timeless approaches in physics, focusing the attention in particular on significant models developed recently by the author. It presents relevant and novel perspectives in 21st century theoretical physics as regards the arena of physical processes and its geometry (both in special relativity, quantum mechanics, the quantum gravity domain and about the quantum vacuum). The timeless approach may be used as a source of reference by researchers in theoretical physics and at the same time it is also suitable for graduate students in physics who wish to have an extend view of some of the classic and fundamental models in the subject.

Bestselling author and acclaimed physicist Lawrence Krauss offers a paradigm-shifting view of how everything that exists came to be in the first place. "Where did the universe come from? What was there before it? What will the future bring? And finally, why is there something rather than nothing?" One of the few prominent scientists today to have crossed the chasm between science and popular culture, Krauss describes the staggeringly beautiful experimental observations and mind-bending new theories that demonstrate not only can something arise from nothing, something will always arise from nothing. With a new preface about the significance of the discovery of the Higgs particle, A Universe from Nothing uses Krauss's characteristic wry humor and wonderfully clear explanations to take us back to the beginning of the beginning, presenting the most recent evidence for how our universe evolved—and the implications for how it's going to end. Provocative, challenging, and delightfully readable, this is a game-changing look at the most basic underpinning of existence and a powerful antidote to outmoded philosophical, religious, and scientific thinking.

Zeta regularization is a method to treat the divergent quantities appearing in several areas of mathematical physics and, in particular, in quantum field theory; it is based on the fascinating idea that a finite value can be ascribed to a formally divergent expression via analytic continuation with respect to a complex regulating parameter. This book provides a thorough overview of zeta regularization for the vacuum expectation values of the most relevant observables of a quantized, neutral scalar field in Minkowski spacetime; the field can be confined to a spatial domain, with suitable boundary conditions, and an external potential is possibly present. Zeta regularization is performed in this framework for both local and global observables, like the stress-energy tensor and the total energy; the analysis of their vacuum expectation values accounts for the Casimir physics of the system. The analytic continuation process required in this setting by zeta regularization is deeply linked to some integral kernels; these are determined by the fundamental elliptic operator appearing in the evolution equation for the quantum field. The book provides a systematic illustration of these connections, devised as a toolbox for explicit computations in specific configurations; many examples are presented. A comprehensive account is given of the existing literature on this subject, including the previous work of the authors. The book will be useful to anyone interested in a mathematically sound description of quantum vacuum effects, from graduate students to scientists working in this area. Contents: General Theory: Zeta Regularization for a Scalar FieldThe Zeta Regularized Stress-Energy VEV in Terms of Integral KernelsTotal Energy and Forces on the BoundarySome Variations of the Previous SchemesApplications: A Massless Field on the SegmentA Massless Field Between Parallel HyperplanesA Massive Field Constrained by Perpendicular HyperplanesA Massless Field in a Three-Dimensional WedgeA Scalar Field with a Harmonic Background PotentialA Massless Field Inside a Rectangular BoxAppendices: The "Improved" Stress-Energy TensorOn the Regularity of Some Integral KernelsA Contour Integral Representation for Mellin TransformsSome Identities for the Dirichlet Kernel in a Slab ConfigurationDerivation of Some Results on Boundary ForcesAn Explicit Expression for the Renormalized Dirichlet Kernel of Half-Integer Order Readership: Graduate students and researchers including academics in theoretical physics. Keywords: Quantum Field Theory;Zeta Regularization;Casimir Effect;Stress-Energy TensorReview: Key Features: Zeta regularization is used in a systematic way for both local and global aspects related to the vacuum state of a quantized field, marking a difference with respect to the existing literature, in which local aspects (say, the stress-energy tensor) do not receive the full attention they would deserve (especially, in the presence of boundary conditions)Explicit computations are carried out for several configurations, applying in a uniform way the general algorithmsGive a more intuitive approach to the subject by implementing the regularization using canonical quantization in a Lorentzian framework

It is commonly thought superluminal or faster-than-light physics phenomena should be excluded from mainstream physics and considered an exotic subject to be confined at most to science fiction, since their existence should be in contrast with the predictions of currently accepted main physical theories. On the other hand, several theoretical and experimental results collected during the last decades (like those related, for example, to hypothetical tachyons, astrophysical quasars, anomalous dispersion in material media, quantum tunneling of single photons or e.m. fields, and quantum entanglement) gave founded evidence of the occurrence of superluminal processes. Unfortunately, the study of such phenomena has been often compromised by misleading analyses, scientific prejudices and/or misunderstandings, preventing a balanced and in-depth assessment. This discourages the realization of further experimental and theoretical examinations. In this book, the authors explored these possibilities by adopting an open mind and rigorous approach. Some of the most intriguing and fascinating aspects of superluminal phenomena physics by describing and discussing, from a radically new standpoint related to the picture of QED coherence in matter, a series of theoretical explorations probing the possibility that superluminal particles and fields actually exist were proposed. In particular, they also considered the hypothesis according to which the higher performance capabilities of the human brain, including consciousness, could be explained from the standpoint of quantum computation, invoking superluminal particles like tachyons. As shown in this monograph, superluminal fields and particles emerging from quantum vacuum coherent dynamics could be responsible for new types of physical process, providing new and valuable insights into the fields of fundamental physics, condensed matter physics, astrophysics, cosmology and biophysics. Additionally, superluminal fields indicate the need for an honest and deep revision of the currently accepted framework of theoretical and applied physics, as well as historically well-established scientific knowledge.

Discusses multidimensional reality, poltergeists, human consciousness, the paranormal, and new implications of quantum physics

The subject of this book is the Casimir effect, a manifestation of zero-point oscillations of the quantum vacuum resulting in forces acting between closely spaced bodies. For the benefit of the reader, the book assembles field-theoretical foundations of this phenomenon, applications of the general theory to real materials, and a comprehensive description of all recently performed measurements of the Casimir force with a comparison between experiment and theory. There is an urgent need for a book of this type, given the increase of interest in forces originating from the quantum vacuum. Numerous new results have been obtained in the last few years which are not reflected in previous books on the subject, but which are very promising for fundamental science and nanotechnology. The book is a unique source of information presenting a critical assessment of all the main results and approaches from hundreds of journal papers. It also outlines new ideas which have not yet been universally accepted but which are finding increasing support from experiment.

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.

This book has two sections. The section Selected Topics in Applications of Quantum Mechanics provides seven chapters about different applications of quantum mechanics in science and technology. The section Selected Topics in Foundations of Quantum Mechanics provides seven chapters about the foundations of quantum mechanics. This book is written by a community of expert scientists from different research institutes and universities from all over the world. Without a doubt, quantum mechanics is the greatest discovery of the 20th century. Therefore, its history and foundations are of great interest to scientists and students. This book covers some of the applications of quantum mechanics in nuclear physics, medical science, information technology, atomic physics and material science, as well as selected topics of quantum mechanics through different bases and ideas about quantum mechanics. The basic idea of the publication of this book is to make scientists and researchers, as well as graduate students, familiar with the foundations of quantum mechanics.

An amazing book on faster than light flight! H. David Froning, a 30-year veteran engineer who worked on several designs for future space travel propulsion, gives us this exceptional compilation of his discoveries, struggles and experiences in the realm of faster than light space travel. Central to the concept of faster than light travel is that the vacuum of space itself (the spacetime metric) can be utilized in propulsion systems. “Engineering the vacuum,” as this is called, involves discovering how space can be altered to provide energy/thrust for future spacecraft. Packed with diagrams, some of which show how, as a starship accelerates away from Earth, it disappears and reappears in only seconds. But during these seconds of disappearance, the ship, in effect, leaps high above space-time and over stupendous distances to reach speeds that are billions of times greater than light-speed. Lots of great material on quantum vacuum power, anti-gravity propulsion effects, the velocity of light in spacetime altered regions, effective mass in spacetime-altered regions, warp drives, and tons more!

Traces the colorful, turbulent life of the Nobel Prize-winning physicist, from the death of his childhood sweetheart during the Manhattan Project to his rise as an icon in the scientific community.

A vacuum, classically understood, contains nothing. The quantum vacuum, on the other hand, is a seething cauldron of nothingness: particle pairs going in and out of existence continuously and rapidly while exerting influence over an enormous range of scales. Acclaimed mathematical physicist and natural philosopher Luciano Boi expounds the quantum vacuum, exploring the meaning of nothingness and its relationship with physical reality. Boi first provides a deep analysis of the interaction between geometry and physics at the quantum level. He next describes the relationship between the microscopic and macroscopic structures of the world. In so doing, Boi sheds light on the very nature of the universe, stressing in an original and profound way the relationship between quantum geometry and the internal symmetries underlying the behavior of matter and the interactions of forces. Beyond the physics and mathematics of the quantum vacuum, Boi offers a profoundly philosophical interpretation of the concept. Plato and Aristotle did not believe a vacuum was possible. How could nothing be something, they asked? Boi traces the evolution of the quantum vacuum from an abstract concept in ancient Greece to its fundamental role in quantum field theory and string theory in modern times. The quantum vacuum is a complex entity, one essential to understanding some of the most intriguing issues in twentieth-century physics, including cosmic singularity, dark matter and energy, and the existence of the Higgs boson particle. Boi explains with simple clarity the relevant theories and fundamental concepts of the quantum vacuum. Theoretical, mathematical, and particle physicists, as well as researchers and students of the history and philosophy of physics, will find The Quantum Vacuum to be a stimulating and engaging primer on the topic.

In virtue of its features, Bohm's quantum potential introduces interesting and relevant perspectives towards a satisfactory geometrodynamic description of quantum processes. This book makes a comprehensive state-of-the-art review of some of the most significant elements and results about the geometrodynamic picture determined by the quantum potential in various contexts. Above all, the book explores the perspectives about the fundamental arena subtended by the quantum potential, the link between the geometry associated to the quantum potential and a fundamental quantum vacuum. After an analysis of the geometry subtended by the quantum potential in the different fields of quantum physics (the non-relativistic domain, the relativistic domain, the relativistic quantum field theory, the quantum gravity domain and the canonical quantum cosmology), in the second part of the book, a recent interpretation of Bohm's quantum potential in terms of a more fundamental entity called quantum entropy, the approach of the symmetryzed quantum potential and the link between quantum potential and quantum vacuum are analysed, also in the light of the results obtained by the author. Contents: Introduction The Geometry of the Quantum Potential in Different Contexts Quantum Entropy and Quantum Potential Immediate Quantum Information and Symmetryzed Quantum Potential The Quantum Potential ... and the

Quantum Vacuum Conclusions References Index Readership: Researchers interested in the link between the geometrodynamic action of the quantum potential and a fundamental quantum vacuum, in the different contexts of quantum physics. Keywords: Entropy;Quantum;Potential;Symmetry;Geometry;GeometrodynamicReview: Key Features: This book provides a complete guide to the geometrodynamic features of the quantum potential as key of reading and understanding of the different fields of quantum physics To explore relevant perspectives about the fundamental arena of quantum processes which determines the action of the quantum potential and its geometry This book introduces, in the light of relevant current research, interesting and novel perspectives as regards the link between the geometrodynamic action of the quantum potential and a fundamental quantum vacuum, in the different contexts of quantum physics

The untold story of the heretical thinkers who dared to question the nature of our quantum universe Every physicist agrees quantum mechanics is among humanity's finest scientific achievements. But ask what it means, and the result will be a brawl. For a century, most physicists have followed Niels Bohr's Copenhagen interpretation and dismissed questions about the reality underlying quantum physics as meaningless. A mishmash of solipsism and poor reasoning, Copenhagen endured, as Bohr's students vigorously protected his legacy, and the physics community favored practical experiments over philosophical arguments. As a result, questioning the status quo long meant professional ruin. And yet, from the 1920s to today, physicists like John Bell, David Bohm, and Hugh Everett persisted in seeking the true meaning of quantum mechanics. What Is Real? is the gripping story of this battle of ideas and the courageous scientists who dared to stand up for truth.

This book is devoted to an investigation of the vacuum of quantum elec trodynamics (QED), relying on the perturbative effective action approach. If the vacuum is probed with external perturbations, the response of the system can be analyzed after averaging over the high energy degrees of freedom. This results in an effective description of the properties of the vacuum, which are comparable to the properties of a classical medium. We concentrate primarily on the physics of slowly varying fields or soft photons by integrating out the high energy degrees of freedom, i.e. the elec trons, employing Schwinger's proper time method. We derive a new represen tation of the one loop photon polarization tensor, coupling to all orders to an arbitrary constant electromagnetic field, fully maintaining the dependence on the complete set of invariants. On the basis of effective Lagrangians, we derive the light cone condition for low frequency photons propagating in strong fields. Our formalism can be extended to various external perturbations, such as temperature and Casimir situations. We give a proof of the "unified formula" for low energy phenom ena that describes the refractive indices of various perturbed quantum vacua. In the high energy domain, we observe similarities between a vacuum with a superstrong magnetic field and a magnetized plasma. The question of mea surability of the various effects is addressed; a violation of causality is not found.

Forces of the Quantum Vacuum presents a number of theoretical approaches to Casimir, van der Waals and Casimir–Polder forces that have been fruitfully employed in mainstream research, and also reviews the experimental evidence for Casimir forces. Beginning with basic ideas in quantum mechanics and building its way to a sophisticated form of macroscopic QED, the book provides an inspiring training manual for graduate students to develop in a natural progression the ideas needed for modern theoretical research on Casimir forces.

The problem of how the brain produces consciousness, subjectivity and "something it is like to be" remains one of the greatest challenges to a complete science of the natural world. While various scientists and philosophers approach the problem from their own unique perspectives and in the terms of their own respective fields, Biophysics of Consciousness: A Foundational Approach attempts a consilience across disparate disciplines to explain how it is possible that an objective brain produces subjective experience. This volume unites the crème de la crème of physicists, neuroscientists, and psychiatrists in the attempt to understand consciousness through a foundational approach encompassing ontological, evolutionary, neurobiological, and Freudian interpretations with the focus on conscious phenomena occurring in the brain. By integrating the perspectives of these diverse disciplines with the latest research and theories on the biophysics of the brain, the book tries to explain how consciousness can be an adaptive and causal element in the natural world.

Renowned physicist and mathematician Freeman Dyson is famous for his work in quantum mechanics, nuclear weapons policy and bold visions for the future of humanity. In the 1940s, he was responsible for demonstrating the equivalence of the two formulations of quantum electrodynamics OCo Richard Feynman''s diagrammatic path integral formulation and the variational methods developed by Julian Schwinger and Sin-Itiro Tomonoga OCo showing the mathematical consistency of QED. This invaluable volume comprises the legendary lectures on quantum electrodynamics first given by Dyson at Cornell University in 1951. The late theorist Edwin Thompson Jaynes once remarked, OC For a generation of physicists they were the happy medium: clearer and better motivated than Feynman, and getting to the point faster than SchwingerOCO. This edition has been printed on the 60th anniversary of the Cornell lectures, and includes a foreword by science historian David Kaiser, as well as notes from Dyson''s lectures at the Les Houches Summer School of Theoretical Physics in 1954. The Les Houches lectures, described as a supplement to the original Cornell notes, provide a more detailed look at field theory, a careful and rigorous derivation of Fermi''s Golden Rule, and a masterful treatment of renormalization and Ward''s Identity. Future generations of physicists are bound to read these lectures with pleasure, benefiting from the lucid style that is so characteristic of Dyson''s exposition.

In the last thirty years of his life Albert Einstein searched for a unified theory - a theory which could describe all the forces of nature in a single framework. But the time was not right for such a discovery in Einstein's day.Neither was the time right when, in 1988, Professor Stephen Hawking wrote A Brief History of Time in which he took us on a journey through classical physics, Einstein's theory of relativity, quantum physics and string theory in order to explain the universe that we live in. He concluded, like Einstein, that science may soon arrive at the long sought after 'Theory of Everything'.In this groundbreaking new work, Professor Hawking and renowned science writer Leonard Mlodinow have drawn on forty years of Hawking's own research and a recent series of extraordinary astronomical observations and theoretical breakthroughs to reveal an original and controversial theory. They convincingly argue that scientific obsession with formulating a single new model may be misplaced, and that by synthesising existing theories we may discover the key to finally understanding the universe's deepest mysteries.Written with the clarity and lively style for which Hawking is famous, The Grand Design is an account of Hawking's quest to fuse these different strands of scientific theory. It examines the differences between past and future, explains the nature of reality and asks an all-

important question: How far can we go in our search for understanding and knowledge?

In modern physics, the classical vacuum of tranquil nothingness has been replaced by a quantum vacuum with fluctuations of measurable consequence. In The Quantum Vacuum, Peter Milonni describes the concept of the vacuum in quantum physics with an emphasis on quantum electrodynamics. He elucidates in depth and detail the role of the vacuum electromagnetic field in spontaneous emission, the Lamb shift, van der Waals, and Casimir forces, and a variety of other phenomena, some of which are of technological as well as purely scientific importance. This informative text also provides an introduction based on fundamental vacuum processes to the ideas of relativistic quantum electrodynamics and quantum field theory, including renormalization and Feynman diagrams. Experimental as well as theoreticalaspects of the quantum vacuum are described, and in most cases details of mathematical derivations are included. Chapter 1 of The Quantum Vacuum - published in advance in The American Journal of Physics (1991)-was later selected by readers as one of the Most Memorable papers ever published in the 60-year history of the journal. This chapter provides anexcellent beginning of the book, introducing a wealth of information of historical interest, the results of which are carefully woven into subsequent chapters to form a coherent whole. Does not assume that the reader has taken advanced graduate courses, making the text accessible to beginning graduate students Emphasizes the basic physical ideas rather than the formal, mathematical aspects of the subject Provides a careful and thorough treatment of Casimir and van der Waals forces at a level of detail not found in any other book on this topic Clearly presents mathematical derivations

The aim of this book is twofold: to provide a comprehensive account of the foundations of the theory and to outline a theoretical and philosophical interpretation suggested from the results of the last twenty years.There is a need to provide an account of the foundations of the theory because recent experience has largely confirmed the theory and offered a wealth of new discoveries and possibilities. On the other side, the following results have generated a new basis for discussing the problem of the interpretation: the new developments in measurement theory; the experimental generation of ?Schr”dinger cats?; recent developments which allow, for the first time, the simultaneous measurement of complementary observables; quantum information processing, teleportation and computation.To accomplish this task, the book combines historical, systematic and thematic approaches.

Practical Conversion of Zero-Point Energy is the authoritative guide to the latest discoveries, tools and high-school level physics behind the most ubiquitous source of energy for the future. One year in the making, it is profusely illustrated and exhaustively researched with almost 300 references by an engineering physicist and noted expert in the field of emerging energy technology. Revised edition now contains a complete summary guide to the quantum "tricks of the trade." Quite possibly the most advanced electrical energy source book available today.

"Frontiers of Propulsion Science" is the first-ever compilation of emerging science relevant to such notions as space drives, warp drives, gravity control, and faster-than-light travelthe kind of breakthroughs that would revolutionize spaceflight and enable human voyages to other star systems. Although these concepts might sound like science fiction, they are appearing in growing numbers in reputable scientific journals.

About time as the numerical order of material changes -- Three-dimensional Euclid space and special relativity -- Three-dimensional non-Euclid space as a direct information medium and quantum phenomena -- About quantum cosmology in a background space as an immediate information medium -- The gravitational space in an a-temporal quantum-gravity space theory -- A three-dimensional timeless quantum vacuum as the fundamental bridge between gravitation and the quantum behavior