

Quantum Mechanics In Biology

Masoud Mohseni,Yasser Omar,Gregory S. Engel,Martin B. Plenio

Quantum Effects in Biology Masoud Mohseni,Yasser Omar,Gregory S. Engel,Martin B. Plenio,2014-08-07 Quantum mechanics provides the most accurate microscopic description of the world around us, yet the interface between quantum mechanics and biology is only now being explored. This book uses a combination of experiment and theory to examine areas of biology believed to be strongly influenced by manifestly quantum phenomena. Covering subjects ranging from coherent energy transfer in photosynthetic light harvesting to spin coherence in the avian compass and the problem of molecular recognition in olfaction, the book is ideal for advanced undergraduate and graduate students in physics, biology and chemistry seeking to understand the applications of quantum mechanics to biology.

Solid Clues Gerald Feinberg,1985

Quantum Mechanics of Biological Systems Mohammad Ashrafuzzaman,Jack A Tuszyński,2025-11-18 Quantum Mechanics of Biological Systems begins with a brief history of quantum biology, and explores ways in which quantum mechanics methods have made breakthroughs in addressing the molecular basis of diseases and drug discovery.

Quantum Biological Information Theory Ivan B. Djordjevic,2015-10-05 This book is a self-contained, tutorial-based introduction to quantum information theory and quantum biology. It serves as a single-source reference to the topic for researchers in bioengineering, communications engineering, electrical engineering, applied mathematics, biology, computer science, and physics. The book provides all the essential principles of the quantum biological information theory required to describe the quantum information transfer from DNA to proteins, the sources of genetic noise and genetic errors as well as their effects. Integrates quantum information and quantum biology concepts; Assumes only knowledge of basic concepts of vector algebra at undergraduate level; Provides a thorough introduction to basic concepts of quantum information processing, quantum information theory, and quantum biology; Includes in-depth discussion of the quantum biological channel modelling, quantum biological channel capacity calculation, quantum models of aging, quantum models of evolution, quantum models on tumor and cancer development, quantum modeling of bird navigation compass, quantum aspects of photosynthesis, quantum biological error correction.

Quantum Aspects of Life Derek Abbott,P. C. W. Davies,Arun K. Pati,2008 A quantum origin of life? -- Quantum mechanics and emergence -- Quantum coherence and the search for the first replicator -- Ultrafast quantum dynamics in

photosynthesis -- Modelling quantum decoherence in biomolecules -- Molecular evolution -- Memory depends on the cytoskeleton, but is it quantum? -- Quantum metabolism and allometric scaling relations in biology -- Spectroscopy of the genetic code -- Towards understanding the origin of genetic languages -- Can arbitrary quantum systems undergo self-replication? -- A semi-quantum version of the game of life -- Evolutionary stability in quantum games -- Quantum transmemetic intelligence -- Dreams versus reality : plenary debate session on quantum computing -- Plenary debate: quantum effects in biology : trivial or not? -- Nontrivial quantum effects in biology : a skeptical physicists' view -- That's life! : the geometry of p electron clouds.

Quantum Biology S. P. Gupta, 1996-07 The Book Aims At Providing The Fundamental Concepts Of Quantum Theory And Its Applications To Biological Problems. Since The Advent Of Quantum Theory, Physicists Started Thinking That It Must Play An Important Role In Biology, Because Organisms, Like Everything Else, Are Made Of Matter And It Is One Of The Functions Of Quantum Theory To Describe The Matter. The Quantum Mechanics, The Subject Dealing With The Quantum Theory And Its Applications, Stands Today To Explain Almost All Biological Phenomena Ranging From The Growth Of A Cell To The Death Of An Organism. Therefore, A Need Has Always Been Felt To Have A Book On The Subject Which Specifically Deals With The Quantum Mechanical Methods Applicable To Biology. The Present Book Fulfills This Need And Is Expected To Be Highly Useful Not Only To The Students Graduating In Biological Sciences But Also To Those Doing Research In Any Area This Branch Of Science. The Book Starts With The Fundamental Concept Of Quantum Theory And Goes Upto Explaining, Eloquently, Its Applications To Various Biological Phenomena Including Drug-Receptor Interactions. It Covers All, Simplest To Sophisticated, Quantum Mechanical (Molecular Orbital) Methods Developed So Far, And Presents Them In A Very Lucid Way. To Understand The Book, A Reader Does Not Require More Than A Background In College-Level Physics, Chemistry, And Mathematics.

Quantum Mechanics in Physics and Chemistry with Applications to Biology Rabi Majumdar, 2011

Introduction to Quantum Mechanics Sy M. Blinder, 2012-12-02 Introduction to Quantum Mechanics provides a lucid, up-to-date introduction to the principles of quantum mechanics at the level of undergraduates and first-year graduate students in chemistry, materials science, biology and related fields. It shows how the fundamental concepts of quantum theory arose from classic experiments in physics and chemistry, and presents the quantum-mechanical foundations of modern techniques including molecular spectroscopy, lasers and NMR. Blinder also discusses recent conceptual developments in quantum theory, including Schrödinger's Cat, the Einstein-Podolsky-Rosen experiment, Bell's theorem and quantum computing. - Clearly presents the basics of quantum mechanics and modern developments in the field - Explains applications to molecular spectroscopy, lasers, NMR, and MRI - Introduces new concepts such as Schrödinger's Cat, Bell's Theorem, and quantum computing - Includes full-color illustrations, proven pedagogical features, and links to online materials

Life on the Edge Johnjoe McFadden, Jim Al-Khalili, 2014 Originally published in hardcover in Great Britain as *Life on the Edge* by Bantam Press, an imprint of Transworld Publishers, a division of Penguin Random House Ltd. in 2014.--Title page verso.

Quantum Systems in Physics, Chemistry, and Biology Alia Tadjer, Rossen Pavlov, Jean Maruani, Erkki J. Brändas, Gerardo Delgado-Barrio, 2017-05-30 This book reviews the most significant developments in quantum methodology applied to a broad variety of problems in chemistry, physics, and biology. In particular, it discusses atomic and molecular structure, dynamics and spectroscopy as well as applications of quantum theory to biological and condensed matter systems. The volume contains twenty-four selected, peer-reviewed contributions based on the presentations given at the Twentieth International Workshop on Quantum Systems in Chemistry, Physics, and Biology (QSCP-XX), held in Varna, Bulgaria, in September 2015. It is divided into five sections containing the most relevant papers written by leading experts in the fields. This book will appeal to advanced graduate students, researchers, and academics involved in theoretical, quantum or statistical and computational chemical physics and physical chemistry.

NeuroQuantology: Quantum Physics in Brain SULTAN TARLACI, 2022-08-30 Although quantum mechanics has been around since the beginning of the 20th century, it is only in the last twenty or thirty years that it has begun to find practical applications in everyday life. And in the past twenty years in particular, those working on quantum mechanics and neuroscience have begun to take an interest in each other's fields. First physicists took an interest in the nervous system, and later, not to be outdone, neuroscientists started to look at quantum physics. In addition, despite there not being a suitable platform, conferences on quantum physics strangely became the scene for discussions on the concepts of consciousness, conscious measurement, and the observer. At neuroscience conferences, discussion started as to whether quantum physics had a place in the communication between nerve cells, and whether the description by classical physics only was insufficient to explain some of the workings of the brain. And after 2000, academic meetings attended by both neuroscientists and quantum physicists started to be held under the title of Quantum Mind/Brain. The speakers at these conferences were not New Age writers or amateurs who ascribe everything to quantum physics; most of them were leading physicists and neuroscientists. What they did and what they wrote was not outside objective scientific practice. NeuroQuantology (2001) is first and foremost a new scientific discipline, just like neuroanatomy (1895), neurobiology (1910), neuroendocrinology, neurochemistry (1920-25), neuropharmacology (1950), neurophilosophy (1989), and neurotheology (1994). It was an approach that blended neuroscience and quantum physics to search with the help of quantum physics for answers to questions which neuroscience alone could not answer. Following the sowing of this first seed, the word NeuroQuantology was used for the first time in 2001, and I became the founder and father first of a journal and then of a potential new field of science. The name was as much a product of inspiration as it was of logic. Of course, there are plenty of

clinical and theoretical terms beginning with neuro-, so I was surprised that this particular expression as NeuroQuantology had not been used previously. Up to that time, interdisciplinary articles on neuroscience and related quantum physics had been published in various pioneering physics and neuroscience journals under the heading of “quantum mind/brain”. These were generally articles trying to explain the relationship between measurement and observer problems in quantum physics. Moreover, occasionally, space was given in some cognitive science journals to articles discussing whether quantum physics would solve unanswered questions of free will, choice, decision-making and consciousness. International conferences were organised under the heading of “quantum mind”. But there was no academic journal which covered all such topics. Since 2003, neuroscience and quantum physics have been growing together by examining two main topics under the NeuroQuantology. One of these is the problem of measurement in quantum mechanics. The measurement problem has brought many other still unanswered questions in its train. In classical physics, there is only an observer, but quantum mechanics has become embroiled in unending discussion about whether this person is an observer, a participant in the measurement, or even a reporter of the result of the measurement. There is increasing discussion in many articles on whether consciousness operates on measurement, and if it does, to what extent. The Copenhagen interpretation, which has been around since the beginning of quantum mechanics, while suggesting solutions to multiple worlds and the theory of hidden variables, has not been part of a clear answer to the question of what role the observer plays. Eugene Wigner, John Carew Eccles, David Bohm, Stuart Hameroff, Roger Penrose, Ewan Harris Walker, Henry Stapp, Jack Sarfatti and many other distinguished people have produced mathematical equations or theoretical framework to show the role of consciousness in quantum mechanics, but so far there is no generally accepted approach. If a conscious observer really does have an effect on quantum measurements, many of our equations will have to be drastically changed. The other main topic of NeuroQuantology is quantum neurobiology: that is, the brain operates not only at a classical, macroscopic level, but also at a quantum, microscopic level. It covers the question of where this level begins and whether it has a bearing on our consciousness, mind, memory and decision-making processes. And, last subtopic is quantum biology. Quantum biology refers to applications of quantum mechanics to biological objects and problems. Usually, it is taken to refer to applications of the non-trivial quantum features such as superposition, nonlocality, entanglement and tunneling, as opposed to the trivial but ubiquitous quantum mechanical nature of chemical bonding, ionization, and other phenomena that are the basis of the fundamental biophysics and biochemistry of organisms. Many biological processes involve the conversion of energy into forms that are usable for chemical transformations and are quantum mechanical in nature. Such processes involve chemical reactions, light absorption, formation of excited electronic states, transfer of excitation energy, and the transfer of electrons and protons (hydrogen ions) in chemical processes such as photosynthesis and cellular respiration. The last decade has produced some significant work showing how quantum effects can occur in biological systems, with advances in three areas utilizing three of

the key ideas from quantum physics having been particularly prominent in the media, although often with a certain amount of controversy: superposition in photosynthesis, entanglement in magnetoreception and quantum tunneling in smell perception. The last decade has also seen some significant advances in our understanding of the brain, from research into how quantum computation might create consciousness through coherence in microtubules, to calls for the emergence of a new field of quantum psychiatry/psychopathology to use our understanding of quantum effects in the brain to help tackle mental illness. Discussions focused on the manner in which quantum effects might not just be occurring in the healthy brain, but also creating pathological symptoms, including mental illnesses such as depression and schizophrenia. The first peoples to suggest that quantum mechanics could operate in biology, even though they were the godfathers of quantum mechanics (Niels Bohr, Erwin Schrödinger, Herbert Fröhlich, Walter Heitler, and Max Delbrück), now after 100 years have passed have been squeezed into quantum mechanics and the physics and chemistry of solid, dead matter. Thus, the biological structures that are taught from primary school are made up of physical and chemical structures. Erwin Schrödinger was also one of the first scientists to suggest a study of quantum biology in his 1944 book *What Is Life?* Incomprehensibly, there has been resistance for a century to quantum biology. NeuroQuantology provides the motivation to break down this resistance and open further a new door to quantum neurobiology.

Quantum Adaptivity in Biology: From Genetics to Cognition Masanari Asano, Andrei Khrennikov, Masanori Ohya, Yoshiharu Tanaka, Ichiro Yamato, 2015-04-14 This book examines information processing performed by bio-systems at all scales: from genomes, cells and proteins to cognitive and even social systems. It introduces a theoretical/conceptual principle based on quantum information and non-Kolmogorov probability theory to explain information processing phenomena in biology as a whole. The book begins with an introduction followed by two chapters devoted to fundamentals, one covering classical and quantum probability, which also contains a brief introduction to quantum formalism, and another on an information approach to molecular biology, genetics and epigenetics. It then goes on to examine adaptive dynamics, including applications to biology, and non-Kolmogorov probability theory. Next, the book discusses the possibility to apply the quantum formalism to model biological evolution, especially at the cellular level: genetic and epigenetic evolutions. It also presents a model of the epigenetic cellular evolution based on the mathematical formalism of open quantum systems. The last two chapters of the book explore foundational problems of quantum mechanics and demonstrate the power of usage of positive operator valued measures (POVMs) in biological science. This book will appeal to a diverse group of readers including experts in biology, cognitive science, decision making, sociology, psychology, and physics; mathematicians working on problems of quantum probability and information and researchers in quantum foundations.

Quantum Processes in Biology José Antonio Fornés, 2024-06-05 In recent years, extensive research on stochastic processes such as neuron networks, molecular motors, dynamics models, anomalous diffusion, and disordered media has led

to the development of various methods for applying the Classical and Quantum Smoluchowski Equation to these phenomena. This book focuses on presenting the solution to the Fokker-Planck equation using the Crank-Nicholson formalism. This method is particularly effective for handling systems with numerous interactions, requiring vector and matrix-oriented approaches suitable for implementation in Matlab. Among the topics treated in the book are: Dynamics of protons in DNA, Photosynthesis and the quantum mechanochemical model, Entanglement, coherence and decoherence, Excitons in the Fenna-Mathews-Olson complex, and Energy exchange between cells. The author has made an incredible work in facilitating the understanding of these complex topics. This book includes a brief and clear explanation of the Quantum theory and also includes code to build useful software to use in research environments. This volume is particularly helpful for graduate students in physics and biology interested in understanding biological processes with the use of quantum physics tools.

Biology & Quantum Mechanics Aleksandr Sergeevich Davydov, 1982 Biophysical questions are presented in a language comprehensive both to physicists who do not know biology, and to biologists who do not have a complete up-to-date mathematical knowledge for quantum mechanics. An elementary description of the interaction of atoms of molecules and their interaction with water precedes an account of basic biological phenomena. The author also describes in detail the molecular mechanism of muscle contraction in animals based on his hypothesis of the role of solutions in the conversion of chemical energy into mechanical movement

Nature's Longest Threads: New Frontiers In The Mathematics And Physics Of Information In Biology Janaki Balakrishnan, B V Sreekantan, 2014-07-11 Organisms endowed with life show a sense of awareness, interacting with and learning from the universe in and around them. Each level of interaction involves transfer of information of various kinds, and at different levels. Each thread of information is interlinked with the other, and woven together, these constitute the universe — both the internal self and the external world — as we perceive it. They are, figuratively speaking, Nature's longest threads. This volume reports inter-disciplinary research and views on information and its transfer at different levels of organization by reputed scientists working on the frontier areas of science. It is a frontier where physics, mathematics and biology merge seamlessly, binding together specialized streams such as quantum mechanics, dynamical systems theory, and mathematics. The topics would interest a broad cross-section of researchers in life sciences, physics, cognition, neuroscience, mathematics and computer science, as well as interested amateurs, familiarizing them with frontier research on understanding information transfer in living systems.

Open Quantum Systems in Biology, Cognitive and Social Sciences Andrei Y. Khrennikov, 2023-06-03 This book mathematically analyzes the basic problems of biology, decision making and psychology within the framework of the theory of open quantum systems. In recent years there has been an explosion of interest in applications of quantum theory in fields beyond physics. The main areas include psychology, decision-making, economics, finance, social science as well as genetics

and molecular biology. The corresponding models are referred to as quantum-like; they don't concern any genuine physical processes in the human brain. Quantum-like models reflect the special features of information processing in biological, cognitive, and social systems which match well with the quantum formalism. This formalism gives rise to the quantum probability model (QP) which differs essentially from Kolmogorov's classical probability model. QP also serves as the basis for quantum information theory. Recently QP has been widely applied to the resolution of the basic paradoxes of decision making theory and to modeling experimental data stemming from cognition, psychology, economics, and finance thereby shedding light on probability fallacies and irrational behavior. In this book, the theory of quantum instruments and the quantum master equation are applied to the modeling of biological and cognitive processes, in particular, to the stability of complex biological and social systems interacting with their environment. An essential part of the book is devoted to the theory of the social laser and the Fröhlich condensate.

NeuroQuantology Sultan Tarlaci, 2014-05-10 Since 2003, neuroscience and quantum physics have been growing together by examining two main topics under NeuroQuantology. One of these is the measurement problem in quantum mechanics. The other topic of NeuroQuantology is quantum neurobiology: that is, the brain operates not only at a classical, macroscopic level, but also at a quantum microscopic level. It covers the question of where this level begins and whether it has a bearing on our consciousness, mind, memory and decision-making processes. The last subtopic is quantum biology. Quantum biology refers to applications of quantum mechanics to biological objects. The first people to suggest that quantum mechanics could operate in biology, even though they were the godfathers of quantum mechanics, now after 100 years have passed, have been squeezed into quantum mechanics and the physics and chemistry of solid, dead matter. This book provides the motivation to break down this resistance and open further a new door to quantum neurobiology. This book gives the reader a distinctly better understanding of interdisciplinary approach of the brain, including quantum mechanics and neuroscience. This book is about the edge of new science, briefly NeuroQuantology in a nutshell.

Theoretical Physics for Biological Systems Paola Lecca, Angela Re, 2019-01-30 Quantum physics provides the concepts and their mathematical formalization that lend themselves to describe important properties of biological networks topology, such as vulnerability to external stress and their dynamic response to changing physiological conditions. A theory of networks enhanced with mathematical concepts and tools of quantum physics opens a new area of biological physics, the one of systems biological physics.

Advances in Quantum Methods and Applications in Chemistry, Physics, and Biology Matti Hotokka, Erkki J. Brändas, Jean Maruani, Gerardo Delgado-Barrio, 2013-09-13 Advances in Quantum Methods and Applications in Chemistry, Physics, and Biology includes peer-reviewed contributions based on carefully selected presentations given at the 17th International Workshop on Quantum Systems in Chemistry, Physics, and Biology. New trends and state-of-the-art

developments in the quantum theory of atomic and molecular systems, and condensed matter (including biological systems and nanostructures) are described by academics of international distinction.

Molecules in Physics, Chemistry, and Biology J. Maruani, 2012-12-06 Volume 1: General Introduction to Molecular Sciences Volume 2: Physical Aspects of Molecular Systems Volume 3: Electronic Structure and Chemical Reactivity Volume 4: Molecular Phenomena in Biological Sciences

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