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ENERGY SCIENCE, ENGINEERING AND TECHNOLOGY

Lithium-Ion Batteries

Properties, Advantages and Limitations

Chappell Morneau
Editor

NOVA

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Contents

Advances in Astronomy & Astrophysics

A Closer Look at Dark Energy

Edited by Davood Sadatian

The universe is in a period of accelerated expansion; and the observational evidence such as supernova of Ia type, Cosmic Microwave Background radiation (CMB) and Baryon Acoustic Oscillations (BAO) confirm this accelerating expansion [1-3]. Despite the great number of observational evidence, the responsible mechanism for this accelerating expansion is still unknown, and thus several models have been proposed for this phenomenon[4-18].

The simplest proposed model in the general relativity is a cosmic model with a dominant component that is considered as a fluid with negative pressure and constant density[8] (means Dark Energy component) . In this book, we consider effects of Dark Energy content on the universe.

Accordingly, structure of discussions in the present book was on four chapters as follows: chapter 1 : Dark Energy, Motivation and Candidates, chapter 2 : The Equivalence Principle Applicability Boundaries,Measurability, Gravity and Dark Energy Problem, chapter 3 : The Behaviors of a Candidate for Dark Energy from ur-Higgs Boson , and chapter 4 : Non-equilibrium Evolution of Quantum Fields During Inflation and Late Accelerating Expansion .

However, I hope this collection of context will be useful for readers to understand more accurately the dark energy idea.

HB 9781536163483 £134.99 October 2019 Nova Science Publishers 214 pages
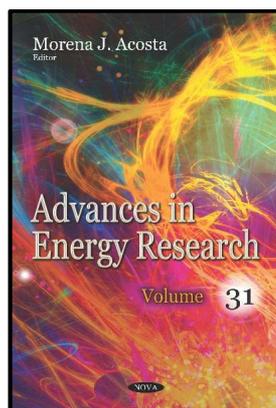
Advances in Energy Research
Volume 31

Edited by Morena J. Acosta

In the past, fossil fuels have been considered a reliable source of energy by many countries. Despite the current measures to reduce the use of fossil fuels for electricity generation, the use of this type of energy source will continue for the foreseeable future. *Advances in Energy Research. Volume 31* examines how, if this situation does not change in the future, then all types of fossil fuels, particularly oil, will be exhausted before the end of the current century.

The use of microholes may potentially enhance the applications of fossil fuels in various energy fields, especially in thermal power plants. Therefore, the morphology variation of micropunch and microhole during the punching with WC/Co micropunches is investigated in this compilation through scanning electron microscopy, energy dispersive spectrometer and confocal laser studies.

Following this, the authors provide a review on experimental and modeling studies performed with direct fuel cells, starting with the fundamentals and main drawbacks of these systems, followed by an exhaustive review on the different studies performed regarding the effects of operating conditions and design parameters.

In the penultimate chapter, a new method for determining the cohesion potential energy in solids is described, and fundamental factors such as internal energy, entropy, temperature and time are examined, in particular the connection of entropy and time to potential energy. The method concerns molecular solids and rests upon measurable thermodynamic quantities: heat of sublimation, heat capacity, and entropy as derived from the latter.

The closing chapter provides an overview of three methods (retarded osmosis method, forward osmosis-electrokinetic method, and diffusio-osmotic method) for sustainable power generation from the salinity gradient energy by using osmosis-based processes.

HB 9781536162714 £210.99 October 2019 Nova Science Publishers 228 pages
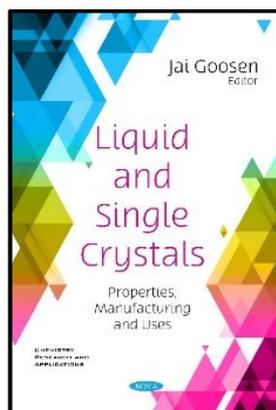
Liquid and Single Crystals
Properties, Manufacturing and Uses
Edited by Jai Goosen

Novel electrolytic systems composed from polymer polyethylene oxide are studied in the opening chapter of *Liquid and Single Crystals: Properties, Manufacturing and Uses*. Being of importance for electrochemical and other applications, the complex electrical impedance spectra and current-voltage characteristics of sodium ion-conductive PEO/E8LC/NaIO4 electrolyte films are analyzed and interrelated to their structural properties and thermal behaviors.

Next, the authors discuss the recent development of various synthetic approaches and possibilities for chemical tuning of phosphates crystal growth by application of molten salts flux-growth technique.

The X-ray single crystal analysis of self-assembled small peptides and peptide mimetics is examined, and the recent advances and future perspectives in this area are discussed. The authors go on to present a broad overview on the use of the molecular dynamics tool in the simulation of properties for emerging nanostructured materials, with special emphasis on the characterization of their mechanical properties.

Heat treatment suitable for the specimen (KCl:Sr2+ single crystal) deformation tests, such as compression and tension, is presented, examined on the basis of the variation of initial dislocation density, the dielectric loss peak due to the divalent impurity-vavancy dipole, and yield stress with a quenching temperature.

In conclusion, organic solar cells, which have lateral junctions, fabricated by organic single crystals and organic crystalline films, including the single crystal organic solar cells using lateral electron transport, the lateral alternating donor/acceptor multilayered junctions, and the doped organic single crystal solar cells, are demonstrated.

HB 9781536165418 £134.99 November 2019 Nova Science Publishers 266 pages
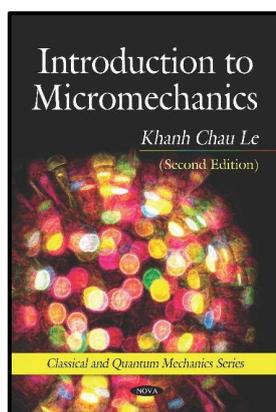
Introduction to Micromechanics
Second Edition
Khanh Chau Le

This is a clearly written introduction to micromechanics for graduate students of mechanical engineering and material science. The textbook contains the rigorous theoretical basis for mechanics of materials as well as a large number of examples, numerical simulations of practical importance, and exercises in phase transition, fracture mechanics, dislocations, homogenization, and plasticity.

HB 9781536165586 £193.99 December 2019 Nova Science Publishers 322 pages
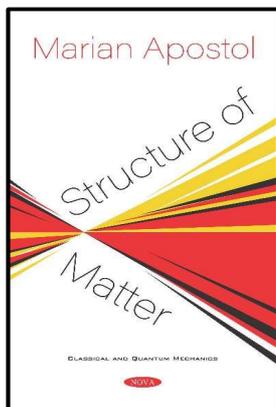
Structure of Matter

Marian Apostol

The Theory of Quanta has a large area of applicability. Any motion, at the fundamental level, is quantum-mechanical, or includes quantum-mechanical motion. Quantum Mechanics encompasses motion forms from atoms, to atomic nuclei, molecules, chemical binding, electric and magnetic fields, electromagnetic radiation, and transport phenomena. The book includes such quantum-mechanical theories, both in their standard form and original versions, with emphasis on their physical contents.

1) Ch. 1, The Atom, besides standard subjects, presents a new, original formulation of the Thomas-Fermi theory, which allows the possibility to arrive at new results like giant dipole oscillations in heavy atoms, atom ionization and chemical bonding.

2) Ch. 2, Molecules, puts emphasis on molecular spectra, including a semi-classical treatment of rotation spectra. The Jahn-Teller effect, with its various implications in many other areas, is discussed in detail.

3) Ch.3, The Atomic Nucleus, includes an original treatment of the nuclear dynamics, based on the mean-field idea. In particular, the Weizsacker mass formula is derived, nuclear instabilities are discussed and the statistical approach is presented.

4) Chs. 5-7 include an original presentation of the Electric and Magnetic Fields effects on atoms. The tunneling, both in static and oscillating electric fields, is presented, with application to atomic ionization, as well as the proton emission and the effect of high-intensity electric fields on alpha decay. The new subject of scattering of charges by laser pulses is presented in detail.

5) An interesting, new subject of transitions under change of parameters, including the dynamical Berry phase is given in Ch. 8, Change of Parameters.

6) Ch. 9, Stimulated Magnetic Resonance, presents a new phenomenon of magnetic resonance, generated by stimulated emission.

7) Ch. 10, Quantized Conductance, presents a new, original way of deriving the quanta of conductance in ballistic transport, or in magnetic field.

8) Ch. 11, Coherence, gives an extended account of the coherent interaction of the electromagnetic radiation with polarizable matter, with implication on the superradiance transition and possible new phenomena occurring in water.

9) Ch. 12, Chemical Bonding, is a description of the original theory of chemical bonding, based on the linearized Thomas-Fermi theory, with its basic application to formation of the metallic clusters.

10) Ch. 13, Quantum Theory of Radiation, is an exposition of the Dirac theory of radiation, and the interaction of the radiation with matter, following Fermi's famous article, a subject seldom presented in usual textbooks, in spite of its fundamental relevance.

11) The book ends with a thorough discussion of the place of the Quantum Mechanics in the realm of the Physical Science disciplines, emphasizing the fundamentally new, and very fruitful, quantum-mechanical vision.
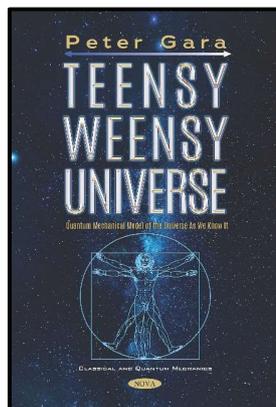
Teensy Weensy Universe
Quantum Mechanical Model of the Universe as We Know It
Peter Gara

Works on quantum mechanics (astronomy, cosmology etc.) often mention that "the laws of quantum mechanics" don't apply in the "macro world". It all depends on what you mean by "macro world". How many atoms constitute the limit, just a couple of them, or a glass of milk, a sizeable house, a city, a continent? Instead, let's dream big, the whole Planet, maybe our Solar system, our Galaxy, or the Universe as we know it... In this book, we don't mean to "extend" quantum mechanics. As physical models go: given a world view we find the boundary conditions, set up a mathematical model corresponding to it, and compare it to the reality... Instead of the "extension" of quantum mechanics we simply take it as it is. Let's examine what kinds of systems correspond to their laws and under which conditions.

The fundamental statements underlying the book are the following: In Solar System-like structures, the individual constituents possess some charge (besides having mass, spin, magnetic moment, just like the particles of atomic structures). This statement allows for the quantum-mechanical modelling and interpretation of Solar System-like structures. All else can be derived from the above statement. The gravitational field and electric field exist independently of each other. The validity of the basic relationships between relativistic quantum mechanics is true for atomic scale systems, as well as for galactic scale systems.

PB 9781536165166 £79.99 December 2019 Nova Science Publishers 170 pages

Energy Science, Engineering & Technology Series

Artificial Photosynthesis
## From Materials to Devices
Edited by Zhiqun Lin

Since the first report on solar fuels production by Fujishima and Honda in 1972, photoelectrochemical/electrochemical production of fuels, such as H_2, carbonhydrates, etc., has significantly advanced over the past few decades with the remarkable development in new catalytic materials, fundamental knowledge, and new applications. In particular, the efficiency for solar fuels production steadily increases, for example, solar H_2 production efficiency has reached 1.1% in term of the solar-to-hydrogen energy conversion efficiency. These progresses render solar fuels as promising candidates for use in modern technology. In the book Artificial Photosynthesis: From Materials to Devices, experts in the photoelectrochemical/electrochemical field discuss new catalytic materials as well as their photophysical properties and applications for artificial photosynthesis.

This book covers the topical research in artificial photosynthesis from conventional particulate catalysts and porous/2D materials to the cutting-edge use of these materials in device fabrication for photoelectrochemistry and electrochemistry, as well as theoretical studies. In terms of applications, this book centers on CO_2 photoreduction to valuable carbohydrates and water dissociation into high energy density H_2. Throughout the book, examples and illustrations of applications are chosen to help the readers comprehend the achievements and trends in this rapidly evolving field.

This book also provides the state-of-the-art research techniques in artificial photosynthesis. This book is informative and helpful for researchers, graduates, and advanced undergraduates interested in the CO_2 reduction and water splitting and will assist them to quickly appreciate the research progresses in this field.

HB 9781536170351 £163.99 March 2020 Nova Science Publishers 288 pages
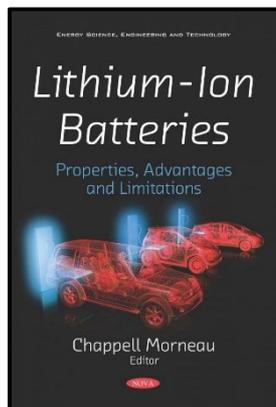
Lithium-Ion Batteries
Properties, Advantages and Limitations
Edited by Chappell Morneau

Lithium-Ion Batteries: Properties, Advantages and Limitations summarizes research progress in anode and cathode binders of lithium ion batteries in the past 20 years. So far, the binders reported in the literature involve polymers, natural extracts, conductive binders and self-healing binders.

Additionally, the authors provide a comprehensive review of state-of-the-art progress in graphite-silicon anodes, from novel structure design to electrode fabrication, from half-coin-cell testing to pouch-full-cell evaluation, and from fundamental mechanistic studies to applied research.

High-performance polymeric separators, which serve as an important component in lithium-ion batteries, are also attracting increased attention. The requirements for the separators, their types, preparation methods and latest developments are summarized.

Following this, recent advancements in ab initio screening of electrode materials for lithium-ion batteries by the construction of activity-stability Volcano plots are summarized. The underlying approach may also be applied in the investigation of catalytic reactions.

In closing, the authors examine the diffusion equation in curvilinear coordinates by using the method of characteristics. This method is commonly applied to solve first order partial differential equations.

PB 9781536168457 £90.99 January 2020 Nova Science Publishers 166 pages
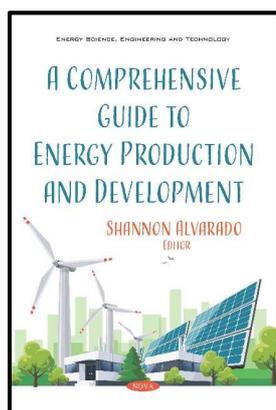
A Comprehensive Guide to Energy Production and Development
Edited by Shannon Alvarado

In *A Comprehensive Guide to Energy Production and Development*, a comprehensive analysis of existing examples in international practice regarding methods for massive implementation of renewable energy technology is provided.

Following this, the authors assess alternative pathways for a future European energy system through the active involvement of relevant stakeholders according to their performance in key areas, such as the regulatory framework, market maturity, economic factors and stakeholder awareness towards a sustainable energy system, by using a multicriteria decision aid method. Recent developments in the field of electricity generation and distribution in Germany are presented, and decentralized forms of electricity generation and distribution are analyzed.

As the consumption of power is increasing day by day, the power generation requirement is also increasing. As such, the authors discuss how renewable systems may be very useful in remote areas.

The concluding paper studies the failure modes of wind turbine gearboxes and their causes. Factors affecting the gearbox reliability in both design and manufacturing processes are then analyzed.

PB 9781536167283 £79.99 December 2019 Nova Science Publishers 212 pages
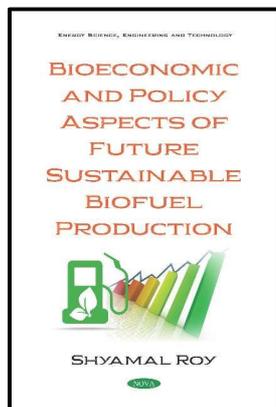
Bioeconomic and Policy Aspects of Future Sustainable Biofuel Production
Shyamal Roy

This book states developments in the bioenergy market and related policies. Recent bioenergy developments, often induced by policies, lead to a greater connection between energy and agricultural markets and influenced relative food and feed prices and land-use changes. An analytical framework is explained that places bioenergy within the bioeconomy. The impacts of supply push and demand pull polices are discussed, and the reasons for policy interventions are explained.

The effectiveness of policy intervention is likely to increase if they are directly linked to a target such as the reduction of emissions or the stimulation of economic growth. Because the bioeconomy is an immature or infant industry, policies that temporarily encourage its development might be analyzed. Technological change and full biomass utilization for food, feed, energy, materials and chemicals may lead to a competitive bio-economy sector. Regulation can possibly deal with indirect effects of bioenergy such as social (land grabbing) and environmental effects (land, water, biodiversity). Given the importance of private sector investments in the development of biotechnologies, excessive regulation might create a disincentive to innovation.

PB 9781536161366 £68.99 October 2019 Nova Science Publishers 120 pages
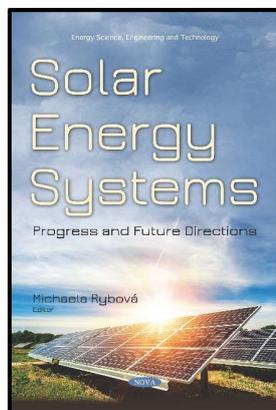
Solar Energy Systems
### Progress and Future Directions
Edited by Michaela Rybová

Solar Energy Systems: Progress and Future Directions presents some new concepts and ideas regarding future steps in the development and progress of solar thermal energy. Preliminary results for advanced control of solar plants are presented using effective defocusing mechanisms.

The authors discuss the sizing ratio of grid-connected photovoltaic systems and the relationship of this parameter with the maximum available power. Additionally, the optimum value of the sizing ratio of a grid-connected photovoltaic system is defined as one that maximizes the yearly energy efficiency in the photovoltaic installation considered.

The concluding study makes a comparative econometric analysis on the relationship between the solar energy consumption that is produced by solar energy systems and the economic growth for the group of G-7 & G-20 countries. The econometric analysis includes panel data techniques with a chosen appropriate production function.

PB 9781536161427 £68.99 October 2019 Nova Science Publishers 148 pages
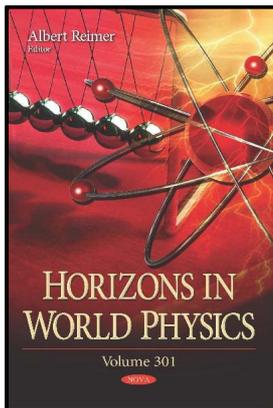
Horizons in World Physics
Volume 301
Edited by Albert Reimer

Horizons in World Physics. Volume 301 opens with a discussion on how symplectic difference schemes are of great interest because they possess a number of fundamental properties of Hamiltonian differential equations. In particular, they inherit integral invariants such as momentum, angular momentum, and integrals, which are determined by the symplectic structure of the phase space, including the phase-space volume.

Following this, the authors describe the dependence of amplified spontaneous emission on the length through the geometrical gain coefficient. In addition, its accuracy in various media with excitation lengths of 200 and 84 cm for N2 and KrF lasers, respectively, is described, and even in small 2-mm-long polymer or few-centimeter-long Ar x-ray lasers.

Later, a simple two-dimensional nonstationary problem is formulated for describing the dispersion of a pollutant in a limited area. Its solutions, as well as solutions of an adjoint problem, are used to obtain dual estimates of the pollutant concentration at a point.

One study focuses on the dynamics of charged particles subjected to the Lorentz force inside particle accelerators and the correct derivation of their equations of motion and, ultimately, of their trajectories. As we will see, the reason for the increased challenge is the presence of accelerated motion.

Many geometrical optics models have been proposed to describe the propagation of paraxial Gaussian beam. However, those paraxial ray-optics models are inapplicable in the paraxial condition. As such, the penultimate chapter introduces a skew line ray-based model to represent the propagation properties of nonparaxial Gaussian beam under the oblate spheroidal coordinates. The free-space evolution of light beam's complex wavefront, including amplitude and phase, is derived via this model.

HB 9781536164725 £210.99 November 2019 Nova Science Publishers 251 pages
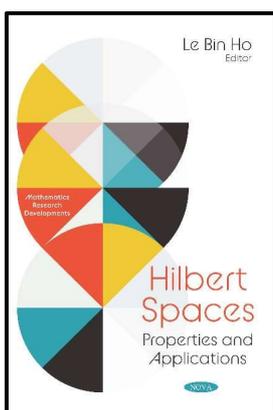
Hilbert Spaces
Properties and Applications
Edited by Le Bin Ho

This collective book presents selected topics in the modern research of Hilbert space. Throughout this book, various mathematical properties of the Hilbert space and extended Hilbert space are given, accompanied by reliable solutions and exciting applications to scientific and engineering problems. It first provides some general viewpoints on convex sets, projections, and orthogonality in Hilbert spaces and then focuses on the mild solutions, the stability, and the controllability of various classes of differential equations in Hilbert spaces and applications. It also is devoted to a discussion of the extended Hilbert space, including the hypercomplex Hilbert space, the Bargmann-Hilbert space, and the enlarged Hilbert space where various mathematical and physical applications are given. A reduced Hilbert space for model Hamiltonians is also given. Together, the book presents to readers a picture of the modern theory of Hilbert space in its complexness and usefulness. The book is accessible for graduate students and could be served as a reference for scholars.

PB 9781536166330 £79.99 January 2020 Nova Science Publishers 196 pages
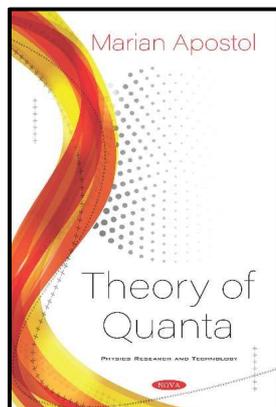
Theory of Quanta

Marian Apostol

Quantum Mechanics is a fundamental scientific discipline. At the same time, it is viewed as being very difficult. This book attempts to present the Theory of Quanta as a scientific discipline which has emerged naturally from experiment, making use of general concepts of the Classical Mechanics and enlarging their nature and applicability. According to the historical development, the first natural way of introducing the quantum-mechanical concepts is the matricial theory, followed by the very useful approach of the undulatory theory. The core of the Theory of Quanta is the quasi-classical theory, described at large in the book. The book does not circumvent the so-called philosophical problems of the Quantum Mechanics.

1) Ch. 1, Beginnings, includes all the experimental, preliminary indications of the necessity of a new theory. The usual textbooks say little about this aspect. In particular, Double Slit and Particle and Waves sections are completely new.

2) Ch. 2, Classical Mechanics, is seldom included in the usual textbooks. In addition, it is formulated here on the basis of the Hamilton-Jacobi equation, though rarely used, it is the direct way of passing from the Classical Mechanics to the Theory of Quanta. The Lenz vector in the central field is emphasized, the only way to deduce the hydrogen atom by using the Matricial Theory, a fundamental result.

3) Ch. 3, Quantum Mechanics, is the exposition of the matricial method. This is the core of the Theory of Quanta, which exhibits the basic ingredients. The Matricial theory is not included today in textbooks, which prefer the Wave Mechanics (Schrodinger equation). It is shown here the direct way to Schrodinger equation from the Matricial Theory. This chapter is written from the little-known book by Born and Jordan, Matricial Mechanics (cited there).

4) Chs. 4 to 8 are standard, technical subjects, with many novelties: Coulomb degeneracy, adiabatic hypothesis, second quantization and many-body theories (the latter is never included in textbooks).

5) Ch. 9, Quasi-Classical Quantum Mechanics, is completely new. In particular, the Tunneling, the Chemical Reactivity, Adiabatic Transitions, Reflexion above Barrier (with many applications, to ionization, for instance) are described in detail. Also, in this chapter the "philosophical" problems of the Theory of Quanta are discussed. The Quasi-Classical Mechanics is the most interesting subject in the Theory of Quanta.

6) Ch. 10, Scattering, includes a completely new formulation. Usually, the scattering theory is presented in a very fastidious way. There is a much simpler way, leading directly to results, which is present in this chapter. The clue to the scattering theory is the solution of the Helmholtz equation, usually overlooked.

7) Finally, Ch. 11 includes the much discussed problem of Measurement. The most advanced result in this direction belongs to Pauli (in his book on Quantum Mechanics). The result is still unsatisfactory. A more direct description of the measurement is given here, based on the very quantum-mechanical principles. The results are perfectly convincing, and, of course, new.

8) It is indeed hard to believe that something new can be said about the Theory of Quanta. A great impediment in understanding the Quantum Mechanics is because there are too many books published on the subject. The subject was distorted in all imaginable ways, every author trying to be original. I hope that I have succeeded to be as close as possible to the original meaning of the subject, without being too original.
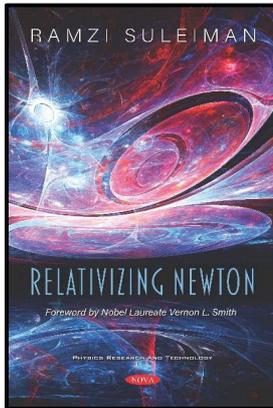
Relativizing Newton

Ramzi Suleiman

Relativizing Newton is a first step towards a simple and beautiful theory of everything. The theory, termed "Information Relativity" (IR) takes an innovative approach to physics that overlooks all post-Newtonian physics. It stands on the shoulders of Newtonian dynamics, but modifies it by accounting for the time-travel of information from one reference-frame to another, a fact which somehow was ignored by Galileo Galilee and Isaac Newton, and which remained ill-treated by all post-Newtonian theories, including Einstein's relativity and quantum theories. Except for the aforementioned correction of classical physics, IR has no axiomatic presumptions, nor arbitrary free parameters.

Astonishingly, accounting for the aforementioned delays in information results in a set of simple and beautiful transformations, which explain and predict a great deal of physical phenomena. Most importantly, IR's transformations reveal the mysteries of dark matter, dark energy, and gravity. They also provide a unifying platform for the physics of the too-big (astrophysics and cosmology), and the too-small (small particles dynamics and quantum mechanics).

The phenomena explained and predicted successfully by IR include the "time-dilation" of decaying muons, the neutrino velocities measured by OPERA and other collaborations, particle diffraction in the double-slit experiment, Sagnac Effects, the quantization of orbits in Bohr's hydrogen atom, entanglement, quantum criticality, confinement, asymptotic freedom, solar light bending, gravitational redshift, the Pioneer anomaly, dark matter in galaxies, and the Schwarzschild's black hole.

HB 9781536166354 £163.99 December 2019 Nova Science Publishers 250 pages
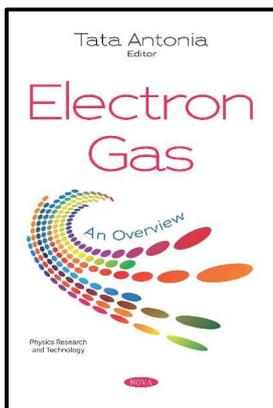
Electron Gas
An Overview

Edited by Tata Antonia

In *Electron Gas: An Overview*, the results of theoretical studies of the thermodynamic, kinetic, and high-frequency properties of the electron gas on the surface of a nanotube in a magnetic field in the presence of a longitudinal superlattice are presented.

Following this, an interpretation of the basic transport characteristics of metals, superconductors in the normal state, and very strongly doped semiconductors with degenerate electron gas is presented. An application of the effective density of randomly moving electrons allows for an explanation of the conductivity of metals, and the electron transport characteristics such as the average diffusion coefficient, the average mobility, the mean free path, and the electron scattering mechanisms in a wide temperature range.

Finally, the authors demonstrate high-performance InGaN-based light-emitting diodes with tunneling-junction-induced 2-D electron gas at an AlGaN/GaN heterostructure, which is inserted in the middle of the P++-GaN contact layer of a conventional LED structure.

HB 9781536164282 £134.99 October 2019 Nova Science Publishers 226 pages
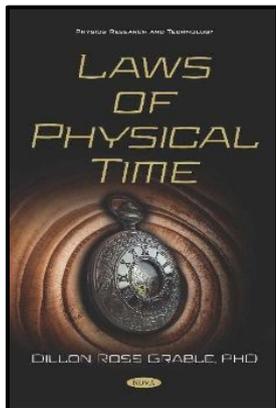
Laws of Physical Time

Dillon Ross Grable

Physics leaves big questions unanswered. For example, why does time seem to move only from the past toward the future? In fact, there is no good definition of past, present, and future. Experiments show there is no universal "flowing river of time." Is time "the fourth dimension?" Is there a "place" we can visit called "the past?" Is there no unifying theory to join the theories of quantum mechanics and relativity? The nature of time is critical in answering these questions. Physics is not wrong – simply incomplete. More facts have been learned about our universe in the last thirty years than have been learned in all of previous history. Mostly what has been learned is how little we actually know. The nature of time is a good example. This book describes experiments that have proved that gravity, velocity, and acceleration slow time. Analysis shows that (1) perception of distance and time depends on relative velocity, (2) time can slow and stop, (3) time gets really strange near black holes, (4) photons traveling toward each other at the speed of light see the other moving only at the speed of light, due to time effects; and there are other strange effects. The truth is that most time experiment results have no real explanation. In physics there is no good definition for time and no logic foundation for a definition of time – until this book.

Enter the new science and technology of time. Here the relatively new sciences of computer technology and communication theory have an important contribution to make. At the heart of the science we find the computer logic of state machines and the physical structure of information as a physical entity. In this world, "state change" is the pivot around which the world turns. We learn that logic is essential for understanding how time works. We discover how state change is essential for the very existence of time! Logic symbols provide a framework for thought about time. We even find a basis for some of the definitions physics has been searching for. We find an information-based state- transition-based definition of time. There is a way to define past, present, and future.

In this book we find very compelling motivation for some interesting conclusions. For example, time is essentially the result of state transitions. If nothing happens, there is no evidence of time passing. We find that energy exchange motivates time. There is no experience of time without sequence of events.

Could the new science and technology of time be the next leap forward in physics? Many current science writers seem to think so.

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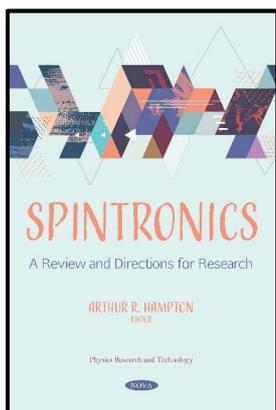
Spintronics
## A Review and Directions for Research

Edited by Arthur R. Hampton

This compilation first presents a brief literature overview of ferromagnetism in zinc oxide, as well as a survey on ion implantation and irradiation-mediated ferromagnetism. The authors highlight the intrinsic and extrinsic origins of ferromagnetism in 200 KeV Ni+2 ion implanted ZnO (Ni: ZnO)/undoped ZnO.

The authors also discusse spin dynamics studies that have been carried out on graphene-based derivatives such as graphene-like nano carbon, nitrogen derivative graphene-like nano carbo, reduced graphene oxide and tellurium-incorporated reduced-graphene oxide for using electron spin resonance.

Lastly, Spintronics: A Review and Directions for Research establishes the inducing of spintronic behaviour in a semiconductor-based multiferroic material, BiFeO3, through the site-engineering approach. The unique electronic band structure of a spintronic material with 100% spin polarization impacts the electron transport mechanism significantly, with an increase in the efficiency in the performance of memory storage devices.

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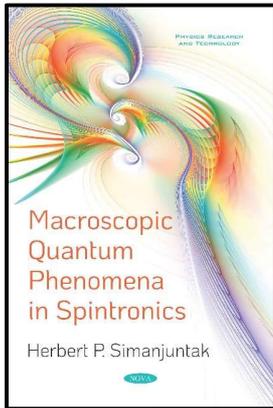
Macroscopic Quantum Phenomena in Spintronics

Herbert P. Simanjuntak

Although the discussion is general, this book focuses on the problem of macroscopic quantum phenomena using systems of spintronics. The spintronics considered are ferromagnetic and antiferromagnetic spintronics. To represent the macroscopic quantum phenomena in spintronics, transitions from one state to another of the magnetization of ferromagnetic spintronics are considered, and of the Néel vector of antiferromagnetic spintronics. The authors have studied transitions from a metastable state to a more stable one, as well as quantum coherence between two degenerate stable states.

Quantum and classical rates of transitions are presented as functions of temperature, magnetic field and the spin-polarized current flowing through the spintronics. With this method, one can immediately observe the effect of the spin-polarized current on the transitions of the magnetization and the Néel vector when comparing the results to those of the earlier ones on magnetic systems that did not have spin-polarized current. Specifically, while dissipations in magnetic system are intrinsic, the book shows how the total dissipation in spintronics can be controlled and eliminated by varying the spin-polarized current appropriately that depends on the temperature.

The study of transitions from a metastable state to a more stable one in ferromagnetic spintronics shows that the rate of transitions of the magnetization at low temperatures is low and vanishes at zero temperature, so that the magnetization is relatively more stable than that in ferromagnetic materials without existence of spin-polarized currents. In the case of antiferromagnetic spintronics, the behavior and characteristics of transitions of the Néel vector is in contrast to those of ferromagnetic spintronics, where the low-temperature rate of transitions in antiferromagnetic spintronics varies exponentially small in temperature and is finite and non-vanishing at zero temperature.

In addition to the theoretical aspects, the book also discusses experimental and technological aspects that one may obtain.

Measurements of the rate of transitions can be used to provide an independent method to determine certain parameters being involved, such as the anisotropy parameter K_c of tetragonal crystals, which is an important parameter but usually difficult to obtain. Eliminating dissipation in ferromagnetic and antiferromagnetic spintronics would be desired so as not to have unnecessary loss of energy. Low rate of transitions corresponds to the initial state that is relatively stable. Technologically, the stability of the states of the magnetization and Néel vector in spintronics are important, for example, for memory storage.

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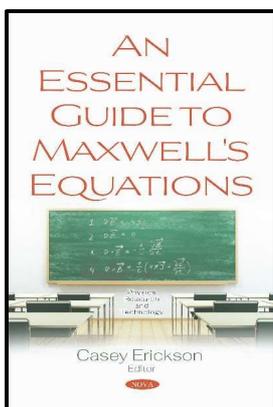
An Essential Guide to Maxwell's Equations

Edited by Casey Erickson

An Essential Guide to Maxwell's Equations first reviews the Ranada field line solutions of Maxwell's equations in a vacuum, describing a topologically non-trivial electromagnetic field, as well as their relation with the knot theory. Also, the authors present a generalization of these solutions to the non-linear electrodynamics recently published in the literature.

Next, this compilation reviews the gravitating electromagnetic field in the 1+3 formalism on a general hyperbolic space-time manifold, discussing the recent results regarding the existence of local field line solutions to the Einstein-Maxwell equations.

Lastly, the authors consider the existence of a weak solution to a class of an evolutionary Maxwell-Stokes type problem containing a p-curlcurl system in a multi-connected domain.

HB 9781536166804 £134.99 November 2019 Nova Science Publishers 233 pages
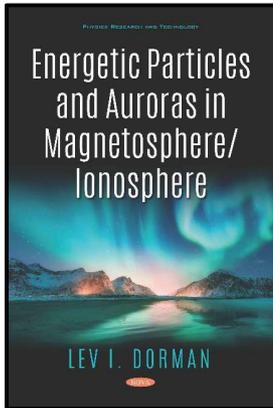
Energetic Particles and Auroras in Magnetosphere/Ionosphere

Lev I. Dorman

The importance and actuality of the Geomagnetosphere's research are based on following three factors:

1. The Geomagnetosphere is the nearest giant natural Laboratory, where is possible by a lot of satellites and ground measurements investigate in details many different plasmas and energetic processes in space, caused finally by interaction of high kinetic energy solar wind plasmas and its perturbations (Interplanetary Coronal Mass Ejections – ICMEs, Interplanetary Shock Waves – ISWs, Interplanetary Interaction Regions – IIR) with frozen in Interplanetary Magnetic Fields – IMF with the rotated main geomagnetic field. This interaction leads to dynamic transformation magnetic fields in Geomagnetosphere, generation and trapping high energy particles (which can be called as Magnetospheric Cosmic Rays – MCR), generation of many types instabilities and electromagnetic radiations. These processes are in principle similar to processes in magnetospheres of other planets and their moons, in the atmosphere of the Sun and other stars, in interplanetary and in interstellar space, in many different astrophysical objects, i.e. this research is important basis for fundamental Space and Astrophysical science.

2. In the modern time the Technology, Economics, Navigation, TV, Internet, Radio-Connections, Military aspects, and the life of people on our planet are strong connected with the work of many satellites, moving inside the Geomagnetosphere. Different processes and MCR in the Geomagnetosphere influenced on the satellites work and often lead to satellite malfunctions up to full destroying work of their electronics – satellites became 'dead'. The described research can be considered as basis for developing methods of forecasting dangerous situation for satellites on different orbits and to decrease the risk of satellite malfunctions and loosing, i.e. this research has important practical application.

3. The interaction of ICME, ISW, and IIR with Geomagnetosphere leads to generation big magnetic storms accompanied with Forbushdecreases and precursory effects in Galactic Cosmic Ray (GCR) intensity. These magnetic storms are dangerous not only for satellites, but also on the Earth's surface for technology, radio-connections, car accidents, people health (e.g., increasing frequency of infarct myocardial and brain strokes). Investigations of causes of magnetic storms can help to develop methods of their forecasting and decreasing the level of magnetic storms hazards. Therefore, the other practical application of this research is connected with the problem of space weather and space climate influence on the technology, radio-connections, navigation, transportation, and people health on the Earth in dependence of altitude and geomagnetic latitude.

The present book "Energetic Particles in Geomagnetosphere/Ionosphere" contains the following Chapters:

Chapter 1. Experimental Evidences on Energetic Particles in the Earth's Environment
Chapter 2. Theories/Models/Simulations of Energetic Particles Acceleration and Propagation in the Geomagnetosphere
Chapter 3. Energetic Particles in Geomagnetosphere and Ionosphere: Related Phenomena
Chapter 4. Auroras and Magnetospheric/Ionospheric Acceleration Processes
Chapter 5. Magnetospheric/Ionospheric Acceleration and Propagation Processesat High-Latitudes and in Polar Regions

We hope that this review-book will be interesting and useful for researches, engineers, students of corresponding specialties, and all people interested in developing of modern technologies in space and in problems of Geomagnetosphere, Ionosphere, Upper and Low Atmosphere, Space Weather and Space Climate, and how they influence on the Earth's Civilization.
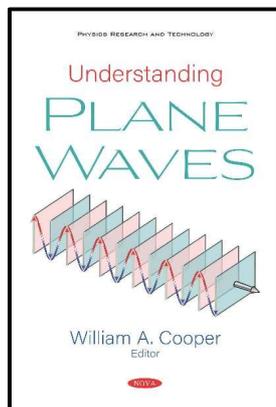
Understanding Plane Waves

Edited by William A. Cooper

As a critical theoretical advance, *Understanding Plane Waves* discusses the acoustic Goos-Hänchen effect. The important applications of this effect are discussed, including plane wave propagating inside transversely isotropic elastic-solids, reflection/refraction at interface between two anisotropic rocks, and acoustical applications to petroleum logging and seismic exploration.

Next, the authors explore a newly developed acoustic-measurement system with emphasis on measurement process and recent improvements that make an acoustic-measurement more accurate.

Three approaches which are used to analyze the evolution of the plane longitudinal and transverse waves that are propagated in a nonlinear hyperelastic medium are discussed: the method of successive approximations, the method of slowly varying amplitudes and the method of restriction on the displacement gradient.

Lastly, the subject of relativistic quantum particles interacting with classical plane wave fields is examined from the standpoint of space-time symmetries which have been found to be encoded in the solutions of relativistic equations.

HB 9781536167795 £68.99 March 2020 Nova Science Publishers 119 pages
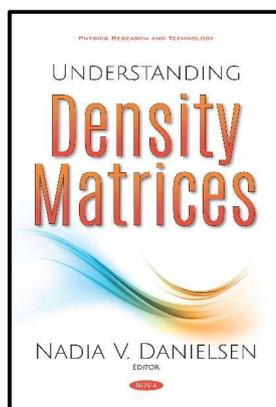
Understanding Density Matrices

Edited by Nadia V Danielsen

In *Understanding Density Matrices*, the modulus and phase degrees-of-freedom of molecular states are examined, the relevant continuity relations are identified, and corresponding contributions to the resultant gradient information are summarized. The geometric and physical factors in contributions to the overall gradient information content in a quantum state are also identified.

Following this, a formalism is presented for the one- and two-body density matrices in coordinate space and their Fourier transforms in momentum space of a non-relativistic, self-bound, finite-size quantum system. The formalism based upon the so-called Cartesian representation in quantum mechanics is applied to atomic nuclei with a focus on nucleon momentum distributions which reveal important information on short-range correlations.

Next, the authors investigate the problem of preparing a target initial state for a two-level system from a system-environment equilibrium or correlated state by an external field. By using the time evolutions of the population difference, the state trajectory in the Bloch sphere representation, and the trace distance between two reduced system states of the open quantum system, the effect of initial system-environment correlations on the preparation of a system state is studied. The authors also study the role of the density matrix in a cryptographic problem called quantum bit commitment and show how it can be used as a clue for finding secure quantum bit commitment protocols.

In subsequent chapter, optical bistability in ladder-plus-Y double quantum dot structure in a unidirectional ring-cavity was modeled using the density matrix theory in parallel with the momentum matrix elements of each transition, which was used to specify Rabi frequencies. Additionally, the phase transition temperatures of the two-dimensional lattice gas of the basal and prism planes of the wurtzite crystal structure were explored using the density-matrix renormalization-group method.

In the closing chapter, the mathematical methods of the description of the evolution of states of quantum many-particle systems by means of the possible modifications of the density operator are considered.

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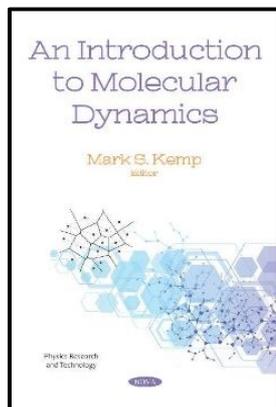
An Introduction to Molecular Dynamics

Edited by Mark S. Kemp

In the opening chapter of *An Introduction to Molecular Dynamics*, the method of statistical geometry, based on the construction of a Voronoi polyhedral, is applied to the pattern recognition of atomic environments and to the investigation of the local order in molecular dynamics-simulated materials.

Next, the authors discuss the methodology of bimolecular simulations and their advancements, as well as their applications in the field of nanoparticle-biomolecular interactions. The theory of molecular dynamics simulation and some of the recent molecular dynamics methods such as steered molecular dynamics, umbrella sampling, and coarse-grained simulation are also discussed.

The use of auxiliary programs in the cases of modified cyclodextrins is discussed. Additionally, results from molecular dynamics studies on cases of inclusion compounds of molecules of different sizes and shapes encapsulated in the same host cyclodextrin have been examined and compared.

In closing, the authors discuss the methodology of molecular dynamics simulation with a non-constant force field. In the context of molecular simulations, the term "force field" refers to a set of equations and parameters for the calculation of forces acting on the particles of the system and its potential energy.

PB 9781536160543 £79.99 August 2019 Nova Science Publishers 184 pages
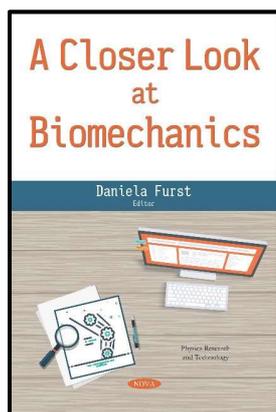
A Closer Look at Biomechanics

Edited by Daniela Furst

The research presented in the opening chapter of *A Closer Look at Biomechanics* discusses the use of bone cements, and tests how a novel bone cement, medical grade two-component injectible polymer on silicone basis, can be used.

The second chapter demonstrates that the use of finite element modeling to simulate static and dynamic behavior in an anterior cervical plate design shows that load transmission is superior when the plate works dynamically.

The third chapter continues to examine the purpose of simulate static and dynamic behavior with the same anterior cervical plate design in two different clinical scenarios: in the immediate postoperative state and after simulated graft subsidence by means of biomechanical assays.

There are contradictory results from previous studies on the effects of laterality on walking, such as the existence of symmetry or asymmetry as well as the role of the dominant leg. Thus, the effects of laterality on walking asymmetry during walking on a treadmill is examined in this compilation.

The penultimate chapter discusses the localization of the body's center of mass and how that helps in the analyses of sport technique, while information on moment of inertia helps in explaining body angular movements.

The final chapter aims to show how the large number of pedobarographic parameters, which vary from 72 to 198 per foot, can be aggregated into a single indicative parameter: the Relative Midfoot Index. This indicates that clinicians do not have to analyze hundreds of pedobarographic parameters in order to reach a meaningful interpretation.

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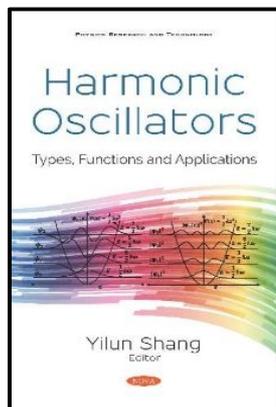
Harmonic Oscillators
**Types, Functions and Applications**
Yilun Shang

This book gathers state-of-the-art advances on harmonic oscillators including their types, functions, and applications. In Chapter 1, Neetik and Amlan have discussed the recent progresses of information theoretic tools in the context of free and confined harmonic oscillator. Confined quantum systems have provided appreciable interest in areas of physics, chemistry, biology, etc., since its inception. A particle under extreme pressure environment unfolds many fascinating, notable physical and chemical changes.

The desired effect is achieved by reducing the spatial boundary from infinity to a finite region. Similarly, in the last decade, information measures were investigated extensively in diverse quantum problems, in both free and constrained situations. The most prominent amongst these are: Fisher information, Shannon entropy, Renyi entropy, Tsallis entropy, Onicescu energy and several complexities. Arguably, these are the most effective measures of uncertainty, as they do not make any reference to some specific points of a respective Hilbert space. These have been invoked to explain several physic-chemical properties of a system under investigation. Kullback Leibler divergence or relative entropy describes how a given probability distribution shifts from a reference distribution function. This characterizes a measure of discrimination between two states. In other words, it extracts the change of information in going from one state to another. In Chapter 2, Nabakumar, Subhasree, and Paulami have revisited classical-quantum correspondence in the context of linear Simple Harmonic Oscillator (SHO). According to Bohr's correspondence principle, quantum mechanically calculated results match with the classically expected results when quantum number is very high. Classical quantum correspondence may also be visualized in the limit when the action integral is much greater than Planck's constant. When de-Broglie wave length associated with a particle is much larger than system size, then quantum mechanical results also match with the classical results. In the context of dynamics, Ehrenfest equation of motion is used in quantum domain, which is analogous to classical Newton's equation of motion. SHO is one of the most important systems for several reasons. It is one of the few exactly solvable problems. Any stable molecular potential can be approximated by SHO near the equilibrium point. This builds the foundation for the understanding of complex modes of vibration in large molecules, the motion of atoms in a solid lattice, the theory of heat capacity, vibration motion of nuclei in molecule etc. The authors have revisited the common solution techniques and important properties of both classical and quantum linear SHO. Then they focused on probability distribution, quantum mechanical tunneling, classical and quantum dynamics of position, momentum and their actuations, viral theorems, etc. and also analyzed how quantum mechanical results finally tend to classical results in the high quantum number limit.

In Chapter 3, Neeraj has discussed the nature of atomic motions, sometimes referred to as lattice vibrations. The lattice dynamics deals with the vibrations of the atoms inside the crystals. In order to write the dynamic equations of the motion of crystal atoms, we need to describe an inter-atomic interaction. Therefore, it is natural to start the study of the lattice dynamics with the case of small harmonic vibrations. The dynamics of one-dimensional and two-dimensional vibrations of monatomic and diatomic crystals can be understood by using the simple model forces based on harmonic approximation. This harmonic approximation is related to a simple ball-spring model. According to this model, each atom is coupled with the neighboring atoms by spring constants. The collective motion of atoms leads to a distinct traveling wave over the whole crystal, leading to the collective motion, so-called phonon. The simple ball-spring model enlightens us some of the significant common features of lattice dynamics that have been discussed throughout this chapter. Further, this chapter helps in understanding the quantization energy of a harmonic oscillation and the concept of phonon.
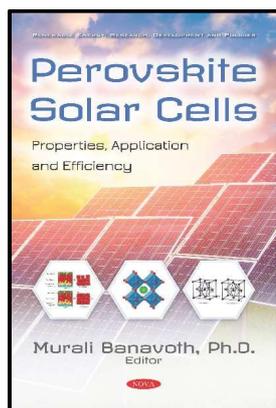
Perovskite Solar Cells
Properties, Application and Efficiency
Edited by Murali Banavoth

Hybrid organic and inorganic perovskites (HOIP) have shown remarkable progress since the first realization of efficient PSCs with a PCE of 3.9% in 2009; the record PCE reached 23.3% in 2018. The next step will undoubtedly be developing scale-up techniques for transitioning small-area devices to large-area modules. Most books outline only the basic theoretical background, fabrication methods and/or applications.

To bridge the gap between academia and industry, a profound understanding of the recent advancements in the HOIPs field is necessary. Experts' insights in this book present an in-depth overview of information regarding the materials synthesis methodologies, effects of dopants, optimized optoelectronic properties, suitable deposition methods, engineering and improving the stability of various device architectures using printing methods for flexible large-area PSC modules, including the module concept, discuss various challenges and issues that can open the door for the researchers towards commercialization of durable perovskite solar cells.

Moreover, this book also covers the developments on the zero-, two-, and three-dimensional non-toxic perovskite/non-perovskite materials, the radiation degradation of solar cells, the synergetics of cooperative phenomena in tandem systems and provide some recommendations to overcome the challenges for improving the photoconversion efficiency.

HB 9781536158588 £193.99 August 2019 Nova Science Publishers 366 pages

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Understanding
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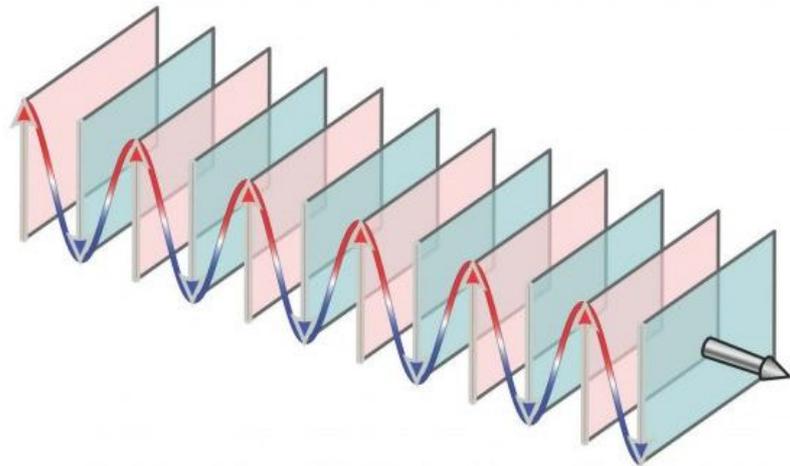
William A. Cooper

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