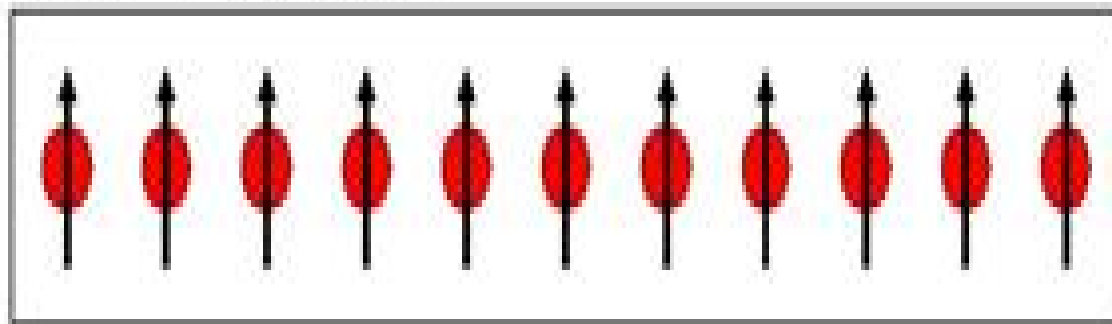
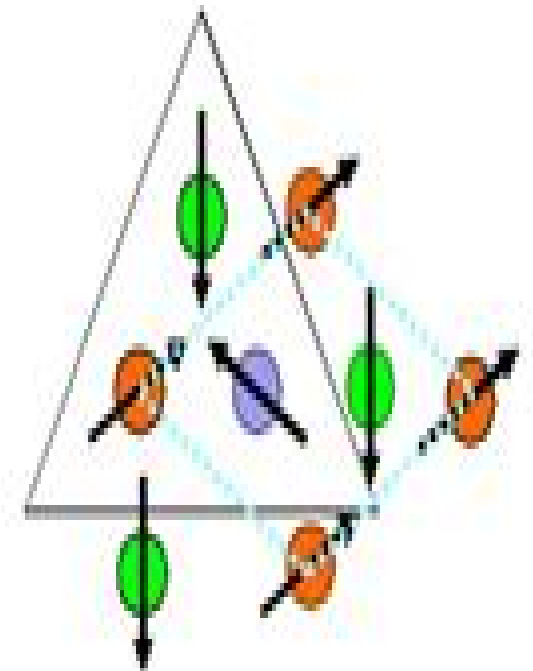
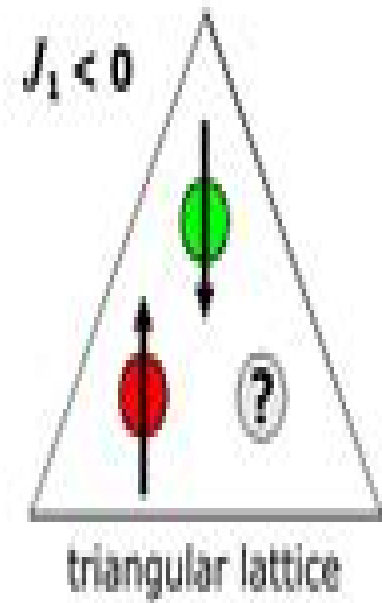
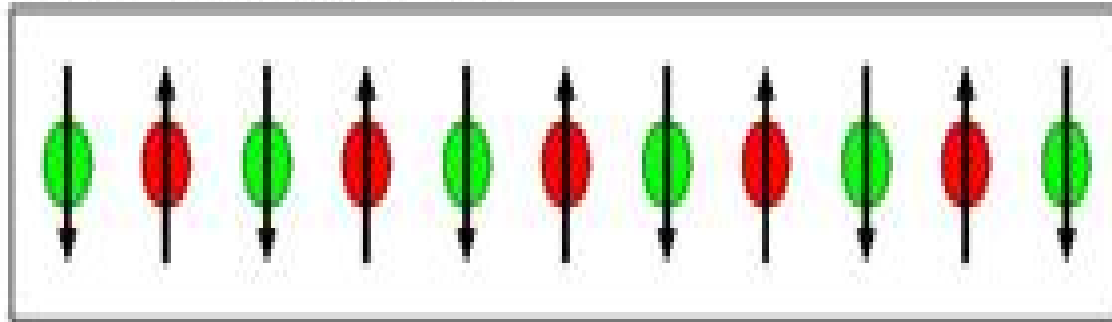


Heisenberg exchange
$$E_H = -\sum_{i,j} J_{ij} \mathbf{S}_i \cdot \mathbf{S}_j$$

$J_1 > 0$ ferromagnetic



$J_1 < 0$ antiferromagnetic



Magnetic Interactions And Spin Transport

Evgeny Y. Tsymbal, Igor Žutić



Magnetic Interactions And Spin Transport:

Magnetic Interactions and Spin Transport Almadena Chtchelkanova, Stuart A. Wolf, Yves Idzerda, 2013-11-11 Stuart Wolf This book originated as a series of lectures that were given as part of a Summer School on Spintronics in the end of August 1998 at Lake Tahoe Nevada It has taken some time to get these lectures in a form suitable for this book and so the process has been an iterative one to provide current information on the topics that are covered There are some topics that have developed in the intervening years and we have tried to at least alert the readers to them in the Introduction where a rather complete set of references is provided to the current state of the art The field of magnetism once thought to be dead or dying has seen a remarkable rebirth in the last decade and promises to get even more important as we enter the new millennium This rebirth is due to some very new insight into how the spin degree of freedom of both electrons and nucleons can play a role in a new type of electronics that utilizes the spin in addition to or in place of the charge For this new field to mature and prosper it is important that students and postdoctoral fellows have access to the appropriate literature that can give them a sound basis in the fundamentals of this new field and I hope that this book is a very good start in this direction

Handbook of Spin Transport and Magnetism Evgeny Y. Tsymbal, Igor Zutic, 2016-04-19 In the past several decades the research on spin transport and magnetism has led to remarkable scientific and technological breakthroughs including Albert Fert and Peter Grunberg's Nobel Prize winning discovery of giant magnetoresistance GMR in magnetic metallic multilayers Handbook of Spin Transport and Magnetism provides a comprehensive bal **Spintronics Handbook, Second Edition:**

Spin Transport and Magnetism Evgeny Y. Tsymbal, Igor Žutić, 2019-05-20 The second edition offers an update on the single most comprehensive survey of the two intertwined fields of spintronics and magnetism covering the diverse array of materials and structures including silicon organic semiconductors carbon nanotubes graphene and engineered nanostructures It focuses on seminal pioneering work together with the latest in cutting edge advances notably extended discussion of two dimensional materials beyond graphene topological insulators skyrmions and molecular spintronics The main sections cover physical phenomena spin dependent tunneling control of spin and magnetism in semiconductors and spin based applications

Magnetic Interactions in Molecules and Solids Anshul Pandey, 2025-02-20 Magnetic Interactions in Molecules and Solids provides an in depth journey into the captivating world of magnetism perfect for both seasoned researchers and those keen to explore the fundamentals Written by leading experts we illuminate the intricate magnetic forces at play within molecules and solid materials combining foundational theories with advanced insights to appeal to readers of varying expertise We start with core magnetism principles spin magnetic moment and magnetic fields preparing readers to delve into complex molecular magnetic interactions Through clear explanations and examples we explore paramagnetism diamagnetism and ferromagnetism providing a comprehensive understanding of molecular magnetism As the focus shifts to solid state magnetism we examine interactions within crystal structures covering topics like magnetic ordering

domains and the influence of crystal symmetry Bridging physics chemistry and materials science our interdisciplinary approach offers a unified view of magnetic phenomena Highlighting practical applications from magnetic data storage to MRI technology we connect theory with real world innovations Magnetic Interactions in Molecules and Solids is an essential resource for understanding magnetic interactions offering clarity and depth to students professionals and researchers alike

Transport of Information-Carriers in Semiconductors and Nanodevices El-Saba, Muhammad,2017-03-31 Rapid developments in technology have led to enhanced electronic systems and applications When utilized correctly these can have significant impacts on communication and computer systems Transport of Information Carriers in Semiconductors and Nanodevices is an innovative source of academic material on transport modelling in semiconductor material and nanoscale devices Including a range of perspectives on relevant topics such as charge carriers semiclassical transport theory and organic semiconductors this is an ideal publication for engineers researchers academics professionals and practitioners interested in emerging developments on transport equations that govern information carriers Future Solar Energy Devices Mihaela Girtan,2017-09-18 This book addresses electronics and the rise of photonics and asks what the future holds in store for this technology It highlights the latest research on all types of solar cells and photonic devices and a new approach combining photonics and electronics Beyond simply explaining the existing systems or providing a synthesis of the current state of knowledge the book also offers readers new perspectives for their own research Lastly drawing on the interconnections between electronics and photonics the book suggests a possible means of using solar energy directly with the aid of future photonic devices **Nano-Semiconductors** Krzysztof Iniewski,2018-09-03 With contributions from top international experts from both industry and academia Nano Semiconductors Devices and Technology is a must read for anyone with a serious interest in future nanofabrication technologies Taking into account the semiconductor industry s transition from standard CMOS silicon to novel device structures including carbon nanotubes CNT graphene quantum dots and III V materials this book addresses the state of the art in nano devices for electronics It provides an all encompassing one stop resource on the materials and device structures involved in the evolution from micro to nanoelectronics The book is divided into three parts that address Semiconductor materials i e carbon nanotubes memristors and spin organic devices Silicon devices and technology i e BiCMOS SOI various 3D integration and RAM technologies and solar cells Compound semiconductor devices and technology This reference explores the groundbreaking opportunities in emerging materials that will take system performance beyond the capabilities of traditional CMOS based microelectronics Contributors cover topics ranging from electrical propagation on CNT to GaN HEMTs technology and applications Approaching the trillion dollar nanotech industry from the perspective of real market needs and the repercussions of technological barriers this resource provides vital information about elemental device architecture alternatives that will lead to massive strides in future development *Functional Supramolecular Nanoassemblies of Π -Conjugated Molecules* Penglei Chen,Bin Wu,2020-01-13

conjugated systems of delocalized aromatic electrons along their backbones including conjugated small molecules oligomers polymers and carbonaceous materials etc have received considerable attention from a wide variety of scientific and technical communities Compared to inorganic materials the advantages of those based on tectons lie in their broad diversity flexibility and tunability with regard to structure geometry morphology processability composition functionality electronic band structure etc In terms of sophisticated molecular engineering these features endow them not only with excellent self assembly properties but also with unique optical electrical mechanical photophysical photochemical and biochemical attributes This renders them promising scaffolds for advanced functional materials AFMs in numerous areas of general interest such as electronics optics optoelectronics photovoltaics magnetic and piezoelectric devices sensors catalysts biomedicines and others With regard to the design synthesis of novel tectons the launch of diverse assembly fabrication protocols theoretical calculations etc the past several decades have witnessed tremendous advancements along this direction Thus far a vast array of high performance tectons based AFMs have been initiated To some extent the cooperative principle of stacking and other noncovalent interactions has been revealed and the structure property relationships have been disclosed Despite the existing progress this field still faces challenges for example i the need for scalable assembly manufacture under ambient conditions with low cost facile environmentally friendly protocols ii clearer correlations bridging the underlying intricate relationships of each successive step in assembly manufacture iii corresponding theoretical calculations for guiding the rational design of tectons that elucidate the cooperative principle of stacking and other noncovalent interactions as well as the principle of structure performance correlation iv stability and durability among the most important concerns regarding their commercialization The advancements accumulated during the past decades have established a solid foundation for the further development of conjugated systems based AFMs We believe that with unrelenting efforts from both scientific and technical communities of various backgrounds their practical applications will eventually be fulfilled This Research Topic aims to address the above mentioned challenges

Materials Science for Future Applications Abhijeet R. Kadam, Kranti Zakde, Sanjay J. Dhoble, Hendrik C. Swart, 2025-06-20 Materials Science for Future Applications Emerging Development and Future Perspectives offers an overview of the materials used for progressive energy systems such as solar cells luminescent energy sensors and detectors and energy storage devices Today's worldwide energy and materials production is going through important changes which are developing novel prospects These developments and innovative technologies are changing the way energy is manufactured transported and spent The materials emphasis in this book conveys a new perspective and highlights the many challenges that are often overlooked in other literature An understanding of these challenges can be critical when working with new energy material technologies Particular devotion is given to the key materials and their conversion productivity extensive duration of permanency materials expenses and energy materials sustainability Materials Science for Future Applications offers a comprehensive

introduction for students and researchers in both academia and industry who are interested in understanding the properties of emerging materials and their challenges

Emerging Two Dimensional Materials and Applications Arun Kumar Singh, Ram Sevak Singh, Anar Singh, 2022-11-21 This book details 2D nanomaterials and their important applications including recent developments and related scalable technologies crucial to addressing strong societal demands of energy environmental protection and worldwide health concerns are systematically documented It covers syntheses and structures of various 2D materials electrical transport in graphene and different properties in detail Applications in important areas of energy harvesting energy storage environmental monitoring and biosensing and health care are elaborated Features Facilitates good understanding of concepts of emerging 2D materials and its applications Covers details of highly sensitive sensors using 2D materials for environmental monitoring Outlines the role of 2D materials in improvement of energy harvesting and storage Details application in biosensing and health care for the realization of next generation biotechnologies for personalized health monitoring and so forth Provides exclusive coverage of inorganic 2D MXenes compounds This book is aimed at graduate students and researchers in materials science and engineering nanoscience and nanotechnology and electrical engineering

Magnetism in Carbon Nanostructures Frank Hagelberg, 2017-07-13 Magnetism in carbon nanostructures is a rapidly expanding field of current materials science Its progress is driven by the wide range of applications for magnetic carbon nanosystems including transmission elements in spintronics building blocks of cutting edge nanobiotechnology and qubits in quantum computing These systems also provide novel paradigms for basic phenomena of quantum physics and are thus of great interest for fundamental research This comprehensive survey emphasizes both the fundamental nature of the field and its groundbreaking nanotechnological applications providing a one stop reference for both the principles and the practice of this emerging area With equal relevance to physics chemistry engineering and materials science senior undergraduate and graduate students in any of these subjects as well as all those interested in novel nanomaterials will gain an in depth understanding of the field from this concise and self contained volume

Nanocarbons Ashwini P. Alegaonkar, Prashant S. Alegaonkar, 2023-02-13 This book provides a practical platform to the readers for facile preparation of various forms of carbon in its nano format investigates their structure property relationship and finally realizes them for a variety of applications taking the route of application engineering It covers the preparation and evaluation of nanocarbons variety of carbon nanotubes graphene graphite additively manufactured 3D carbon fibres their properties and various factors associated with them A summary and outlook of the nanocarbon field is included in the appendices Features Presents comprehensive information on nanocarbon synthesis and properties and some specific applications Covers the growth of carbon nanoparticles nanotubes ribbons graphene graphene derivatives porous spongy phases graphite and 3D carbon fabrics Documents a large variety of characterizations and evaluations on the nature of growth causing effect on structure properties Contains dedicated chapters on miniaturized flat and 2D devices Discusses a

variety of applications from military to public domains including prevalent topics related to carbon This book is aimed at researchers and graduate students in materials science and materials engineering and physics **Wide Energy Bandgap Electronic Devices** Fan Ren, John C Zolper, Hadis Morkoc, 2003-07-14 This book provides a summary of the current state of the art in SiC and GaN and identify future areas of development The remarkable improvements in material quality and device performance in the last few years show the promise of these technologies for areas that Si cannot operate because of its smaller bandgap We feel that this collection of chapters provides an excellent introduction to the field and is an outstanding reference for those performing research on wide bandgap semiconductors In this book we bring together numerous experts in the field to review progress in SiC and GaN electronic devices and novel detectors Professor Morkoc reviews the growth and characterization of nitrides followed by chapters from Professor Shur Professor Karmalkar and Professor Gaska on High Electron Mobility Transistors Professor Pearson and co workers on ultra high breakdown voltage GaN based rectifiers and the group of Professor Abernathy on emerging MOS devices in the nitride system Dr Baca from Sandia National Laboratories and Dr Chang from Agilent review the use of mixed group V nitrides as the base layer in novel Heterojunction Bipolar Transistors There are 3 chapters on SiC including Professor Skowronski on growth and characterization Professor Chow on power Schottky and pin rectifiers and Professor Cooper on power MOSFETs Professor Dupuis and Professor Campbell give an overview of short wavelength nitride based detectors Finally Jihyun Kim and co workers describe recent progress in wide bandgap semiconductor spintronics where one can obtain room temperature ferromagnetism and exploit the spin of the electron in addition to its charge

Handbook of Nanophysics Klaus D. Sattler, 2010-09-17 Providing the framework for breakthroughs in nanotechnology this landmark publication is the first comprehensive reference to cover both fundamental and applied physics at the nanoscale After discussing the theoretical principles and measurements of nanoscale systems the organization of the set follows the historical development of nanoscience Each peer reviewed chapter presents a didactic treatment of the physics underlying the nanoscale materials applications and detailed experimental results State of the art scientific content is enriched with fundamental equations and illustrations many in color

Comprehensive Nanoscience and Technology, 2010-10-29 From the Introduction Nanotechnology and its underpinning sciences are progressing with unprecedented rapidity With technical advances in a variety of nanoscale fabrication and manipulation technologies the whole topical area is maturing into a vibrant field that is generating new scientific research and a burgeoning range of commercial applications with an annual market already at the trillion dollar threshold The means of fabricating and controlling matter on the nanoscale afford striking and unprecedented opportunities to exploit a variety of exotic phenomena such as quantum nanophotonic and nanoelectromechanical effects Moreover researchers are elucidating new perspectives on the electronic and optical properties of matter because of the way that nanoscale materials bridge the disparate theories describing molecules and bulk matter Surface phenomena also gain a greatly increased significance even the well known link

between chemical reactivity and surface to volume ratio becomes a major determinant of physical properties when it operates over nanoscale dimensions Against this background this comprehensive work is designed to address the need for a dynamic authoritative and readily accessible source of information capturing the full breadth of the subject Its six volumes covering a broad spectrum of disciplines including material sciences chemistry physics and life sciences have been written and edited by an outstanding team of international experts Addressing an extensive cross disciplinary audience each chapter aims to cover key developments in a scholarly readable and critical style providing an indispensable first point of entry to the literature for scientists and technologists from interdisciplinary fields The work focuses on the major classes of nanomaterials in terms of their synthesis structure and applications reviewing nanomaterials and their respective technologies in well structured and comprehensive articles with extensive cross references It has been a constant surprise and delight to have found amongst the rapidly escalating number who work in nanoscience and technology so many highly esteemed authors willing to contribute Sharing our anticipation of a major addition to the literature they have also captured the excitement of the field itself in each carefully crafted chapter Along with our painstaking and meticulous volume editors full credit for the success of this enterprise must go to these individuals together with our thanks for largely adhering to the given deadlines Lastly we record our sincere thanks and appreciation for the skills and professionalism of the numerous Elsevier staff who have been involved in this project notably Fiona Geraghty Megan Palmer and Greg Harris and especially Donna De Weerd Wilson who has steered it through from its inception We have greatly enjoyed working with them all as we have with each other

Nanodevices. Principle and Applications Jaysukh Markna,Tulshi Shiyani,2019-08-21 Academic Paper from the year 2018 in the subject Physics Nuclear Physics language English abstract This book can be useful for an academic course on nanoscience and nanotechnology This book is very useful for the beginner in nanotechnology and nanoelectronics The book is divided into seven chapters The first chapter contains the introduction of nanodevices definition and classification of nanostructures materials and nanodevices The second chapter contains the detailed summary of the semiconductors and various semiconductor nanodevices This will be helpful to study the changes occur at the nanoscale in bulk materials or bulk devices when they approach the nanoscale The third chapter contains the introduction principles and applications of various quantum confined structures and devices The fourth chapter gives the idea about the molecular junction single molecular devices and their applications in other devices as an incorporated structures or hybrid applications It contains the overview of natural and artificial nanodevices It has given the knowledge of molecular nanoelectronics The fifth chapter contains the overview and advanced knowledge of natural and artificial nanosensors It explains the various nanosensors and their applications

Advances in Solid State Physics Bernhard Kramer,2003-07-01 The 2001 Spring Meeting of the 65th Deutsche Physikalische Gesellschaft was held together with the 65 Physikertagung in Hamburg during the period March 26 30 2001 With more than 3500 conference attendees a record has again been achieved after several years of stabilisation in

participation This proves the continuing and now even increasing attraction of solid state physics especially for young colleagues who often discuss for the first time their scientific results in public at this meeting More than 2600 scientific papers were presented orally as well as posters among them about 120 invited lectures from Germany and from abroad This Volume 41 of *Advances in Solid State Physics* contains the written versions of half of the latter We nevertheless hope that the book truly reflects the current state of the field Amazingly enough the majority of the papers as well as the discussions at the meeting concentrated on the nanostructured solid state This reflects the currently extremely intensive quest for developing the electronic and magnetic device generations of the future which stimulates science besides the challenge of the unknown as has always been the case since the very beginning of Solid State Physics about 100 years ago

Zinc Oxide Hadis Morkoç, Ümit Özgür, 2008-12-03 This first systematic authoritative and thorough treatment in one comprehensive volume presents the fundamentals and technologies of the topic elucidating all aspects of ZnO materials and devices Following an introduction the authors look at the general properties of ZnO as well as its growth optical processes doping and ZnO based dilute magnetic semiconductors Concluding sections treat bandgap engineering processing and ZnO nanostructures and nanodevices Of interest to device engineers physicists and semiconductor and solid state scientists in general

Theory of Semiconductor Quantum Devices Fausto Rossi, 2011-01-13 Primary goal of this book is to provide a cohesive description of the vast field of semiconductor quantum devices with special emphasis on basic quantum mechanical phenomena governing the electro optical response of new generation nanomaterials The book will cover within a common language different types of optoelectronic nanodevices including quantum cascade laser sources and detectors few electron exciton quantum devices and semiconductor based quantum logic gates The distinguishing feature of the present volume is a unified microscopic treatment of quantum transport and coherent optics phenomena on ultrasmall space and time scales as well as of their semiclassical counterparts

Handbook of Spin Transport and Magnetism Evgeny Y. Tsymbal, Igor Zutic, 2011-08-25 In the past several decades the research on spin transport and magnetism has led to remarkable scientific and technological breakthroughs including Albert Fert and Peter Gruber's Nobel Prize winning discovery of giant magnetoresistance GMR in magnetic metallic multilayers *Handbook of Spin Transport and Magnetism* provides a comprehensive balanced account of the state of the art in the field known as spin electronics or spintronics It reveals how key phenomena first discovered in one class of materials such as spin injection in metals have been revisited decades later in other materials systems including silicon organic semiconductors carbon nanotubes graphene and carefully engineered nanostructures The first section of the book offers a historical and personal perspective of the field written by Nobel Prize laureate Albert Fert The second section addresses physical phenomena such as GMR in hybrid structures of ferromagnetic and normal metals The third section discusses recent developments in spin dependent tunneling including magnetic tunnel junctions with ferroelectric barriers In the fourth section the contributors look at how to control spin and magnetism in semiconductors In the fifth section they

examine phenomena typically found in nanostructures made from metals superconductors molecular magnets carbon nanotubes quantum dots and graphene The final section covers novel spin based applications including advanced magnetic sensors nonvolatile magnetoresistive random access memory and semiconductor spin lasers The techniques and materials of spintronics have rapidly evolved in recent years leading to vast improvements in hard drive storage and magnetic sensing With extensive cross references between chapters this seminal handbook provides a complete guide to spin transport and magnetism across various classes of materials and structures

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Magnetic Interactions And Spin Transport Introduction

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