An Antidamping Spin Orbit Torque Originating From The

One of the greatest revolutions in materials science in recent years has been the literal renaissance of age-old materials in new and unexpected guises and possessing correspondingly astounding properties. There was once a time, for instance, when textbooks declared that only metals could offer any progress in superconduction. Since then, familiar perovskites – and even humble magnesium boride – have been recognised as being so-called ‘room-temperature’ superconductors. Carbon in particular has benefited from this revolution and has now found application as routinely deposited diamond coatings and as C60 ‘buckyballs’. The most recent innovation has been the discovery and preparation of graphene; single-monolayer carbon having a remarkable strength. This success has naturally led researchers to ask whether other materials might also be prepared in an analogous monolayer form and offer similarly amazing properties. The present monograph summarizes all of the work carried out on such monolayer materials up to the beginning of 2017, with attention being restricted to those, like graphene, being composed of a single element. Most of the work done so far on these ‘elemental graphene analogues’ has been theoretical, but the existing experimental data suggest that they may well become as useful as graphene.
Nanomagnetic and spintronic computing devices are strong contenders for future replacements of CMOS. This is an important and rapidly evolving area with the semiconductor industry investing significantly in the study of nanomagnetic phenomena and in developing strategies to pinpoint and regulate nanomagnetic reliably with a high degree of energy efficiency. This timely book explores the recent and on-going research into nanomagnetic-based technology. Key features: Detailed background material and comprehensive descriptions of the current state-of-the-art research on each topic. Focuses on direct applications to devices that have potential to replace CMOS devices for computing applications such as memory, logic and higher order information processing. Discusses spin-based devices where the spin degree of freedom of charge carriers are exploited for device operation and ultimately information processing. Describes magnet switching methodologies to minimize energy dissipation. Comprehensive bibliographies included for each chapter enabling readers to conduct further research in this field. Written by internationally recognized experts, this book provides an overview of a rapidly burgeoning field for electronic device engineers, field-based applied physicists, material scientists and nanotechnologists. Furthermore, its clear and concise form equips readers with the basic understanding required to comprehend the present stage of development and to be able to contribute to future development. Nanomagnetic and Spintronic Devices for Energy-Efficient Memory and Computing is also an indispensable resource for students and researchers interested in computer hardware, device physics and circuits design.
Since the discovery of the giant magnetoresistance (GMR) effect in magnetic multilayers in 1988, a new branch of physics and technology, called spin-electronics or spintronics, has emerged, where the flow of electrical charge as well as the flow of electron spin, the so-called "spin current," are manipulated and controlled together. Recent progress in the physics of magnetism and the application of spin current has progressed in tandem with the nanofabrication technology of magnets and the engineering of interfaces and thin films. This book is intended to provide an introduction and guide to the new physics and applications of spin current. The emphasis is placed on the interaction between spin and charge currents in magnetic nanostructures.
Spintronics Handbook, 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.

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This book describes recent breakthroughs that promise major cost reductions in solar energy production in a clear and highly accessible manner. The author addresses the three key areas that have commonly resulted in criticism of solar energy in the past: cost, availability, and variability. Coverage includes cutting-edge information on recently developed 40? efficient solar cells, which can produce double the power of currently available commercial cells. The discussion also highlights the potentially transformative emergence of opportunities for integration of solar energy storage and natural gas combined heat and power systems. Solar energy production in the evening hours is also given fresh consideration via the convergence of low cost access to space and the growing number of large terrestrial solar electric power fields around the world. Dr. Fraas has been active in the development of Solar Cells and Solar Electric Power Systems for space and terrestrial applications since 1975. His research team at Boeing demonstrated the first GaAs/GaSb tandem concentrator solar cell in 1989 with a world record energy conversion efficiency of 35?, garnering awards from Boeing and NASA. He has over 30 years of experience at Hughes Research Labs, Chevron Research Co, and the Boeing High Technology Center working with advanced semiconductor devices. In a pioneering paper, he proposed the InGaP/GaInAs/Ge triple junction solar cell predicting a cell terrestrial conversion efficiency of 40? at 300 suns concentration. Having become today’s predominant cell for space satellites, that cell is now entering high volume production for terrestrial Concentrated Photovoltaic (CPV) systems. Since joining JX Crystals, Dr. Fraas has pioneered the development of various thermophotovoltaic (TPV) systems based on the new GaSb infrared sensitive PV cell. Dr. Fraas holds degrees from Caltech (B.Sc. Physics), Harvard (M. A. Applied Physics), and USC (Ph.D. EE).

Physics at Surfaces is a unique graduate-level introduction to the physics and chemical physics of solid surfaces, and atoms and molecules that interact with solid surfaces. A subject of keen scientific inquiry since the last century, surface physics emerged as an independent discipline only in the late 1960s as a result of the development of ultra-high vacuum technology and high speed digital computers. With these tools, reliable experimental measurements and theoretical calculations could at last be compared. Progress in the last decade has been truly striking. This volume provides a synthesis of the entire field of surface physics from the perspective of a modern condensed matter physicist with a healthy interest in chemical physics. The exposition intertwines experiment and theory whenever possible, although there is little detailed discussion of technique. This much-needed text will be invaluable to graduate students and researchers in condensed matter physics, physical chemistry and materials science working in, or taking graduate courses in, surface science.

This book offers an extensive introduction to the extremely rich and intriguing field of spin-related phenomena in semiconductors. In this second edition, all chapters have been updated

to include the latest experimental and theoretical research. Furthermore, it covers the entire field: bulk semiconductors, two-dimensional semiconductor structures, quantum dots, optical and electric effects, spin-related effects, electron-nuclei spin interactions, Spin Hall effect, spin torques, etc. Thanks to its self-contained style, the book is ideally suited for graduate students and researchers new to the field.

This book offers a balanced and comprehensive guide to the core principles, fundamental properties, experimental approaches, and state-of-the-art applications of two major groups of emerging non-volatile memory technologies, i.e. spintronics-based devices as well as resistive switching devices, also known as Resistive Random Access Memory (RRAM). The first section presents different types of spintronic-based devices, i.e. magnetic tunnel junction (MTJ), domain wall, and skyrmion memory devices. This section describes how their developments have led to various promising applications, such as microwave oscillators, detectors, magnetic logic, and neuromorphic engineered systems. In the second half of the book, the underlying device physics supported by different experimental observations and modelling of RRAM devices are presented with memory array level implementation. An insight into RRAM desired properties as synaptic element in neuromorphic computing platforms from material and algorithms viewpoint is also discussed with specific example in automatic sound classification framework.

Over two volumes and 1500 pages, the Handbook of Spintronics will cover all aspects of spintronics science and technology, including fundamental physics, materials properties and processing, established and emerging device technology and applications. Comprising 60 chapters from a large international team of leading researchers across academia and industry, the Handbook provides readers with an up-to-date and comprehensive review of this dynamic field of research. The opening chapters focus on the fundamental physical principles of spintronics in metals and semiconductors, including an introduction to spin quantum computing. Materials systems are then considered, with sections on metallic thin films and multilayers, magnetic tunnelling structures, hybrids, magnetic semiconductors and molecular spintronic materials. A separate section reviews the various characterisation methods appropriate to spintronics materials, including STM, spin-polarised photoemission, x-ray diffraction techniques and spin-polarised SEM. The third part of the Handbook contains chapters on the state of the art in device technology and applications, including spin valves, GMR and MTJ devices, MRAM technology, spin transistors and spin logic devices, spin torque devices, spin pumping and spin dynamics and other topics such as spin caloritronics. Each chapter considers the challenges faced by researchers in that area and contains some indications of the direction that future work in the field is likely to take. This reference work will be an essential and long-standing resource for the spintronics community.

The Frontiers in Materials Editorial Office team are delighted to present the second edition of the “Rising Stars” article collection, “Frontiers in Materials: Rising Stars 2020”, showcasing the high-quality work of internationally recognized researchers in the early stages of their independent careers. All Rising Star researchers featured within this collection were individually nominated by the Topic Editors in recognition of their potential to influence the future directions of their respective fields. The work presented here highlights the diversity of research performed across the entire breadth of the materials science and engineering field and presents advances in theory, experimentation, and methodology with applications for solving compelling problems.

This Editorial features the corresponding author(s) of each paper published within this important collection, ordered by section alphabetically, highlighting them as the great researchers of the future. The Frontiers in Materials Editorial Office team would like to thank each researcher who contributed their work to this collection. We would also like to personally thank the Topic Editors for their exemplary leadership of this article collection; their strong support and passion for this important, community-driven collection has ensured its success and global impact. Emily Young Journal Development Manager

The Handbook of Materials Modeling, 2nd edition is a six-volume major reference serving a steadily growing community at the intersection of two mainstreams of global research: computational science and materials science and technology. This extensively expanded new edition reflects the significant developments in all aspects of computational materials research over the past decade, featuring progress in simulations at multiple scales and increasingly more realistic materials models. Thematically separated into two mutually dependent sets – “Methods: Theory and Modeling (MTM)” and “Applications: Current and Emerging Materials (ACE)” – the handbook runs the entire gamut from theory and methods to simulations and applications. Readers benefit from its in-depth coverage of a broad methodological spectrum extending from advanced atomistic simulations of rare events to data-driven artificial intelligence strategies for materials informatics in the set MTM, as well as forefront emphasis on materials of far-ranging societal importance such as photovoltaics and energy-relevant oxides, and cutting-edge applications to materials for spintronic devices, graphene, cement, and glasses in the set ACE. The thorough, interconnected coverage of methods and applications, together with a line-up of internationally acclaimed editors and authors, will ensure the Handbook of Material Modeling’s standing as an enduring source of learning and inspiration for a global community of computational materials scientists.

This book presents some of the latest achievements in nanotechnology and nanomaterials from leading researchers in Ukraine, Europe, and beyond. It features selected peer-reviewed contributions from participants in the 4th International Science and Practice Conference Nanotechnology and Nanomaterials (NANO2016) held in Lviv, Ukraine on August 24-27, 2016. The International Conference was organized jointly by the Institute of Physics of the National Academy of Sciences of Ukraine, Ivan Franko National University of Lviv (Ukraine), University of Tartu (Estonia), University of Turin (Italy), and Pierre and Marie Curie University (France). Internationally recognized experts from a wide range of universities and research institutions share their knowledge and key results on topics ranging from nanooptics, nanoplasmonics, and interface studies to energy storage and biomedical applications.

The history of information and communications technologies (ICT) has been paved by both evolutive paths and challenging alternatives, so-called emerging devices and architectures. Their introduction poses the issues of state variable definition, information processing, and process integration in 2D, above IC, and in 3D. This book reviews the capabilities of integrated nanosystems to match low power and high performance either by hybrid and heterogeneous CMOS in 2D/3D or by emerging devices for alternative sensing, actuating, data storage, and processing. The choice of future ICTs will need to take into account not only their energy efficiency but also their

sustainability in the global ecosystem.

Starting from quantum mechanical and condensed matter foundations, this book introduces into the necessary theory behind spin electronics (Spintronics). Equations of spin diffusion, -evolution and -tunelling are provided before an overview is given of simulation of spin transport at the atomic scale. Furthermore, applications are discussed with a focus on elementary spintronics devices such as spin valves, memory cells and hard disk heads.

STAY UP TO DATE ON THE STATE OF MRAM TECHNOLOGY AND ITS APPLICATIONS WITH THIS COMPREHENSIVE RESOURCE Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond delivers a combination of foundational and advanced treatments of the subjects necessary for students and professionals to fully understand MRAM and other non-volatile memories, like PCM, and ReRAM. The authors offer readers a thorough introduction to the fundamentals of magnetism and electron spin, as well as a comprehensive analysis of the physics of magnetic tunnel junction (MTJ) devices as it relates to memory applications. This book explores MRAM's unique ability to provide memory without requiring the atoms inside the device to move when switching states. The resulting power savings and reliability are what give MRAM its extraordinary potential. The authors describe the current state of academic research in MRAM technology, which focuses on the reduction of the amount of energy needed to reorient magnetization. Among other topics, readers will benefit from the book's discussions of: An introduction to basic electromagnetism, including the fundamentals of magnetic force and other concepts An thorough description of magnetism and magnetic materials, including the classification and properties of magnetic thin film properties and their material preparation and characterization A comprehensive description of Giant magnetoresistance (GMR) and tunneling magnetoresistance (TMR) devices and their equivalent electrical model Spin current and spin dynamics, including the properties of spin current, the Ordinary Hall Effect, the Anomalous Hall Effect, and the spin Hall effect Different categories of magnetic random-access memory, including field-write mode MRAM, Spin-Torque-Transfer (STT) MRAM, Spin-Orbit Torque (SOT) MRAM, and others Perfect for senior undergraduate and graduate students studying electrical engineering, similar programs, or courses on topics like spintronics, Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond also belongs on the bookshelves of engineers and other professionals involved in the design, development, and manufacture of MRAM technologies.

Since the discovery of the giant magnetoresistance (GMR) effect in magnetic multilayers in 1988, a new branch of physics and technology, called spin-electronics or spintronics, has emerged, where the flow of electrical charge as well as the flow of electron spin, the so-called "spin current", are manipulated and controlled together. Recent progress in the physics of magnetism and the application of spin current has progressed in tandem with the nanofabrication technology of magnets and the engineering of interfaces and thin films. This book is intended to provide an introduction and guide to the new physics and applications of spin current. The emphasis is placed on the interaction between spin and charge currents in magnetic nanostructures.

This book presents both experimental and theoretical aspects of topology in magnetism. It first discusses how the topology in real space is relevant for a variety of

magnetic spin structures, including domain walls, vortices, skyrmions, and dynamic excitations, and then focuses on the phenomena that are driven by distinct topology in reciprocal momentum space, such as anomalous and spin Hall effects, topological insulators, and Weyl semimetals. Lastly, it examines how topology influences dynamic phenomena and excitations (such as spin waves, magnons, localized dynamic solitons, and Majorana fermions). The book also shows how these developments promise to lead the transformative revolution of information technology.

Magnetic Domain Walls in Bubble Materials covers the physics of domain walls in bubble domain materials. The book describes the microscopic origins and characteristics of the material parameters; the principles of domain statics and the Landau-Lifshitz equation, which is the basic equation of magnetization dynamics; and its physical significance. The text then discusses the experimental techniques, both static and dynamic, used in studying domain walls; the static internal structure of bubble-domain walls; the Bloch-wall dynamics based on one-dimensional solutions of the Landau-Lifshitz equation; and the wall-motion theory. The theory to low velocity phenomena in domain walls containing vertical Bloch; high-velocity radial and quasi-planar wall motions; and nonlinear bubble translation including the implications of the theory for bubble motion in devices, are also considered. The book further surveys special phenomena involving vibrations and wave motions of walls, and the effects of microwave-frequency fields on walls. Engineers and materials researchers involved in the development of practical bubble devices will find the book invaluable.

This book serves as a brief introduction to topological insulator physics and device applications. Particular attention is paid to the indirect exchange interaction mediated by near surface Dirac fermions and the spin texture this interaction favors. Along with useful information on semiconductor material systems, the book provides a theoretical background for most common concepts of TI physics. Readers will benefit from up to date information and methods needed to start working in TI physics, theory, experiment and device applications. Discusses inter-spin interaction via massless and massive Dirac excitations; Includes coverage of near-surface spin texture of the magnetic atoms as related to their mutual positions as well to their positions with respect to top and bottom surfaces in thin TI film; Describes non-RKKY oscillating inter-spin interaction as a signature of the topological state; Explains the origin of the giant Rashba interaction at quantum phase transition in TI-conventional semiconductors.

This book provides a comprehensive overview of the latest developments in the field of spin dynamics and magnetic damping. It discusses the various ways to tune damping, specifically, dynamic and static control in a ferromagnetic layer/heavy metal layer. In addition, it addresses all optical detection techniques for the investigation of modulation of damping, for example, the time-resolved magneto-optical Kerr effect technique.

This book focuses on an increasingly important area of materials science and technology, namely, the fabrication and properties of artificial materials where slabs of magnetized materials are sandwiched between slabs of nonmagnetized materials. It includes reviews by experts on the theory and descriptions of the various experimental techniques such as those using nuclear or electron spin probes, as well as optical, X-ray or neutron probes. It also reviews potential applications such as the giant magnetoresistance, and one specialized preparation technique, the electrodeposition. The various chapters are tutorial in nature, making the subject accessible to

nonspecialists, as well as useful to researchers in the field. Contents: Application of Magnetic Multilayers (M Pardavi-Horvath)Magnetic Coupling in Metallic Multilayers (Y Yafet)First-Principles Calculations of Magnetic Interfaces and Multilayers (M Weinert ' S Blügel)Influence of Imperfections on the Magnetic Properties of Fe/Ag Films and Multilayers (J Pirnay et al.)NMR Studies on Magnetic Multilayers (H A M de Gronckel ' W J M de Jonge)Conversion Electron Mössbauer Spectroscopy of Magnetic Multilayers (Ch Sauer ' W Zinn)Resonance in Coupled Ferromagnetic Layer Structures (P E Wigen)Magnetic Circular X-Ray Dichroism (F Baudelet et al.)Magneto-Optical Spectra in Multilayers (K Sato)Neutron and X-Ray Diffraction Studies of Magnetic Multilayers (C F Majkrzak et al.)Giant Magnetoresistance (GMR) in Multilayers (M Pardavi-Horvath)Electrodeposited Magnetic Multilayers (M P Dariel et al.) Readership: Graduate students, professional researchers and well-educated others (eg. contract officers). keywords:Magnetic Multilayers;Circular Dichroism;Giant Magnetoresistance;Magnetic Interfaces;Magnetic Multilayers: Effect of Imperfections;Conversion Electron Mossbauer Spectroscopy;Multilayer Magnetic Coupling;Magneto-Optical Spectroscopy;Neutron Diffraction;Magnetic Xray Diffraction;Magnetic Multilayer Fabrication;Supermirrors;Magnetic Recording;RKKY Coupling;Nuclear Magnetic Resonance;Ferromagnetic Resonance

This book is a collection of lecture notes which were presented by invited speakers at the Eleventh School on Theoretical Physics "Symmetry and Structural Properties of Condensed Matter SSPCM 2014" in Rzeszów (Poland) in September 2014. The main challenge for the lecturers was the objective to present their subject as a review as well as in the form of introduction for beginners. Topics considered in the volume concentrate on: spin dynamics and spin transport in magnetic and non-magnetic structures, spin-orbit interaction in two-dimensional systems and graphene, and new mathematical method used in the condensed matter physics. Contents: Lectures on Non-Abelian Bosonization (A M Tsvelick)Electrical and Thermal Control of Magnetic Moments (J Barna?, P Balaz, A Dyrda? and V K Dugaevk)Rigged String Configurations, Bethe Ansatz Qubits, and Conservation of Parity (T Lulek)Nonequilibrium Spin Dynamics: From Protons in Water to a Gauge Theory of Spin-Orbit Coupling (I V Tokatly and E Ya Sherman)Non-Markovian Effects in the Lindblad Master Equation Approach to Electronic Transport (P Ribeiro and V R Vieira)Quantum Transport in Hybrid Nanostructures (K I Wysoki?ski, T Doma?ski and B Szukiewicz)Resonant Scattering Off Magnetic Impurities in Graphene: Mechanism For Ultrafast Spin Relaxation (D Kochan, M Gmitra and J Fabian)Spin-Orbit Interaction and Related Transport Phenomena in 2D Electron and Hole Systems (A Khaetskii)Landau Weak Crystallization Theory and Its Applications (E I Kats)Coupled Polarization/Magnetization Dynamics in Composite Multiferroics: An Overview (A Sukhov, L Chotorlishvili, C L Jia and J Berakdar)Reservoir Approach to Two-Dimensional Electron Gas in a Magnetic Field (W Zawadzki, A Raymond and M Kubisa)From Graphene and Topological Insulators to Weyl Semimetals (R D Y Hills, M Brada, Yang Liu, M Pierpont, M B Sobnack, W M Wu and F V Kusmartsev) Readership: For graduate students and junior condensed matter theorists. Key Features:Intermediate level between students textbook and monographProminent contributorsVarious modern aspects of condensed matter theoryKeywords:Symmetry;Spin Dynamics;Graphene;Topological

Insulators;Nanostructures

Solid State Physics, Volume 68 provides the latest information on a branch of physics that is primarily devoted to the study of matter in its solid phase, especially at the atomic level. Chapters in this updated volume include new research in the use of phonon-polaritons in polar materials to do plasmonic like studies, but without the plasmons, along with a section on Polar oxide interfaces. This prestigious serial presents timely and state-of-the-art reviews pertaining to all aspects of solid state physics. Contains contributions from leading authorities in the study of solid state physics, especially at the atomic level Informs and updates on all the latest developments in the field Presents timely and state-of-the-art reviews pertaining to all aspects of solid state physics

This book first provides the basics of magnetism that electrical engineering students in the semiconductor curriculum can easily understand. Then, it goes one step forward to discuss electron spin. Following the above background discussion, readers are taught the physics of magnetic tunnel junction device (MTJ), the work horse of MRAM, for memory applications. At the end of this book, the author gives a comparison of emerging non-volatile memories (PCM, ReRAM, FeRAM and MRAM). The author also explores MRAM's unique quality among emerging memories, in that is the only one in which the atoms in the device do not move when switching states. This property makes it the most reliable and low power.

Heterostructures consist of combinations of different materials, which are in contact through at least one interface. Magnetic heterostructures combine different physical properties which do not exist in nature. This book provides the first comprehensive overview of an exciting and fast developing field of research, which has already resulted in numerous applications and is the basis for future spintronic devices.

Thin Film Magnetoresistive Sensors presents a comprehensive review of thin film magnetoresistive (MR) sensors, including the theory of MR effects as well as the design, fabrication, properties, and applications of MR sensors. With over 1,000 references, the book fully reviews the theory, development, and use of these sensors. It provides essential information about the performance of various kinds of sensors, including permalloy magnetoresistors, spin valve sensors, multilayer sensors, colossal effect sensors, spin dependent tunneling sensors, and magnetoimpedance sensors. Divided into three independent parts, the book first concentrates on the most widely used sensors-anisotropic magnetoresistive sensors (AMR). The second part deals with giant magnetoresistive (GMR) sensors, including those still in development. In the third section, the book describes the applications of MR sensors, especially in data storage systems, industrial measurements, and nondestructive material testing systems.

The purpose of this collective book is to present a non-exhaustive survey of sp-related phenomena in semiconductors with a focus on recent research. In some sense it may be regarded as an updated version of theOpticalOrientation book, which was entirely devoted to spin physics in bulk semiconductors. During the 24 years that have elapsed, we have witnessed, on the one hand, an extraordinary development in the wonderful semiconductor physics in two dim- sions with the accompanying revolutionary applications. On the other hand, during the last maybe 15 years there was a strong revival in the interest in spin phen- ena, in

particular in low-dimensional semiconductor structures. While in the 1970s and 1980s the entire world population of researchers in the ?eld never exceeded 20 persons, now it can be counted by the hundreds and the number of publications by the thousands. This explosive growth is stimulated, to a large extent, by the hopes that the electron and/or nuclear spins in a semiconductor will help to accomplish the dream of factorizing large numbers by quantum computing and eventually to develop a new spin-based electronics, or “spintronics”. Whether any of this will happen or not, still remains to be seen. Anyway, these ideas have resulted in a large body of interesting and exciting research, which is a good thing by itself. The ?eld of spin physics in semiconductors is extremely rich and interesting with many spectacular effects in optics and transport.

This book reveals unique transport phenomena and functionalities in topological insulators coupled with magnetism and superconductivity. Topological insulators are a recently discovered class of materials that possess a spin-momentum-locked surface state. Their exotic spin texture makes them an exciting platform for investigating emergent phenomena, especially when coupled with magnetism or superconductivity. Focusing on the strong correlation between electricity and magnetism in magnetic topological insulators, the author presents original findings on current-direction-dependent nonreciprocal resistance, current-induced magnetization reversal and chiral edge conduction at the domain wall. In addition, he demonstrates how the coupling between superconductivity and topological surface state leads to substantial nonreciprocal resistance. The author also elucidates the origins of these phenomena and deepens readers’ understanding of the topologically nontrivial electronic state. The book includes several works which are published in top journals and were selected for the President’s Award by the University of Tokyo and for the Ikushi Prize, awarded to distinguished Ph.D. students in Japan.

The ability to understand and control the unique properties of interfaces has created an entirely new field of magnetism which already has a profound impact in technology and is providing the basis for a revolution in electronics. The last decade has seen dramatic progress in the development of magnetic devices for information technology but also in the basic understanding of the physics of magnetic nanostructures. This volume describes thin film magnetic properties and methods for characterising thin film structure topics that underpin the present 'spintronics' revolution in which devices are based on combined magnetic materials and semiconductors. Volume IV deals with the fundamentals of spintronics: magnetoelectronic materials, spin injection and detection, micromagnetics and the development of magnetic random access memory based on GMR and tunnel junction devices. Together these books provide readers with a comprehensive account of an exciting and rapidly developing field. The treatment is designed to be accessible both to newcomers and to experts already working in this field who would like to get a better understanding of this very diversified area of research.

Solid State Physics, Volume 71 provides the latest volume in this long-running series. This latest volume highlights new advances in the field, with this new volume presenting interesting chapters written by an international board of authors. Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Solid State Physics series Offers an updated release that includes the latest information in solid state physics

This book provides a comprehensive introduction to spintronics-based computing for the next generation of ultra-low power/highly reliable logic. It will cover aspects from device to system-level, including magnetic memory cells, device modeling, hybrid circuit structure, design methodology, CAD tools, and technological integration methods. This book is accessible to a variety of readers and little or no background in magnetism and spin electronics are required to understand its content. The multidisciplinary team of expert authors from circuits, devices, computer architecture, CAD and system design reveal to readers the potential of spintronics nanodevices to reduce power consumption, improve reliability and enable new functionality.

This handbook presents a comprehensive survey of magnetism and magnetic materials. The dramatic advances in information technology and electromagnetic engineering make it necessary to systematically review the approved key knowledge and summarize the state of the art in this vast field within one seminal reference work. The book thus delivers up-to-date and well-structured information on a wealth of topics encompassing all fundamental aspects of the underlying physics and materials science, as well as advanced experimental methodology and applications. It features coverage of the host of fascinating and complex phenomena that arise from the use of magnetic fields in e.g. chemistry and biology. Edited by two internationally renowned scholars and featuring authored chapters from leading experts in the field, Springer's Handbook of Magnetism and Magnetic Materials is an invaluable source of essential reference information for a broad audience of students, researchers, and magnetism professionals.

During the last six decades, Yang–Mills theory has increasingly become the cornerstone of theoretical physics. It is seemingly the only fully consistent relativistic quantum many-body theory in four space-time dimensions. As such it is the underlying theoretical framework for the Standard Model of Particle Physics, which has been shown to be the correct theory at the energies we now can measure. It has been investigated also from many other perspectives, and many new and unexpected features have been uncovered from this theory. In recent decades, apart from high energy physics, the theory has been actively applied in other branches of physics, such as statistical physics, condensed matter physics, nonlinear systems, etc. This makes the theory an indispensable topic for all who are involved in physics. The conference celebrated the exceptional achievements using Yang–Mills theory over the years but also many other truly remarkable contributions to different branches of physics from Prof C

N Yang. This volume collects the invaluable talks by Prof C N Yang and the invited speakers reviewing these remarkable contributions and their importance for the future of physics. Contents:The Future of Physics — Revisited (C N Yang)Quantum Chromodynamics — The Perfect Yang–Mills Gauge Field Theory (David Gross)Maximally Supersymmetric Yang–Mills Theory: The Story of N = 4 Yang–Mills Theory (Lars Brink)The Lattice and Quantized Yang–Mills Theory (Michael Creutz)Yang–Mills Theories at High Energy Accelerators (George Sterman)Yang–Mills Theory at 60: Milestones, Landmarks and Interesting Questions (Ling-Lie Chau)Discovery of the First Yang–Mills Gauge Particle — The Gluon (Sau Lan Wu)Yang–Mills Gauge Theory and Higgs Particle (Tai Tsun Wu & Sau Lan Wu)Scenario for the Renormalization in the 4D Yang–Mills Theory (L D Faddeev)Statistical Physics in the Oeuvre of Chen Ning Yang (Michael E Fisher)Quantum Vorticity in Nature (Kerson Huang)Yang–Mills Theory and Fermionic Path Integrals (Kazuo Fujikawa)Yang–Mills Gauge Theory and the Higgs Boson Family (Ngee-Pong Chang)On the Physics of the Minimal Length: The Questions of Gauge Invariance (Lay Nam Chang, Djordje Minic, Ahmed Roman, Chen Sun & Tatsu Takeuchi)Generalization of the Yang–Mills Theory (G Savvidy)Some Thoughts about Yang–Mills Theory (A Zee)Gauging Quantum Groups: Yang–Baxter Joining Yang–Mills (Yong-Shi Wu)The Framed Standard Model (I) — A Physics Case for Framing the Yang–Mills Theory? (Chan Hong-Mo & Tsou Sheung Tsun)The Framed Standard Model (II) — A First Test Against Experiment (Chan Hong-Mo & Tsou Sheung Tsun)On the Study of the Higgs Properties at a Muon Collider (Mario Greco)Aharonov–Bohm Types of Phases in Maxwell and Yang–Mills Field Theories (Bruce H J McKellar)Yang–Mills for Historians and Philosophers (R P Crease)Gauge Concepts in Theoretical Applied Physics (Seng Ghee Tan & Mansoor B A Jalil)Yang–Yang Equilibrium Statistical Mechanics: A Brilliant Method (Xi-Wen Guan & Yang-Yang Chen)Chern–Simons Theory, Vassiliev Invariants, Loop Quantum Gravity and Functional Integration Without Integration (Louis H Kauffman)The Scattering Equations and Their Off-Shell Extension (York-Peng Yao)Feynman Geometries (Sen Hu & Andrey Losev)Particle Accelerator Development: Selected Examples (Jie Wei)A New Storage-Ring Light Source (Alex Chao)New Contributions to Physics by Prof C N Yang: 2009–2011 (Zhong-Qi Ma)Brief Overview of C N Yang's 13 Important Contributions to Physics (Yu Shi) Readership: Graduate students and scientists working in high energy physics, statistical physics and condensed matter physics.
Spin CurrentOUP Oxford

Handbook of Magnetic Materials, Volume 29, highlights new advances in the field, with this new volume presenting interesting chapters written by an international board of authors on topics such as spin-orbit torque. Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in the Handbook of Magnetic Materials series

This book offers detailed insights into spin transfer torque (STT) based devices, circuits and memories. Starting with the basic concepts and device physics, it then addresses advanced

STT applications and discusses the outlook for this cutting-edge technology. It also describes the architectures, performance parameters, fabrication, and the prospects of STT based devices. Further, moving from the device to the system perspective it presents a non-volatile computing architecture composed of STT based magneto-resistive and all-spin logic devices and demonstrates that efficient STT based magneto-resistive and all-spin logic devices can turn the dream of instant on/off non-volatile computing into reality.

Fundamentals of Magnonics is a textbook for beginning graduate students in the areas of magnetism and spintronics. The level of presentation assumes only basic knowledge of the origin of magnetism and electromagnetism, and quantum mechanics. The book utilizes elementary mathematical derivations, aimed mainly at explaining the physical concepts involved in the phenomena studied and enabling a deeper understanding of the experiments presented. Key topics include the basic phenomena of ferromagnetic resonance in bulk materials and thin films, semi-classical theory of spin waves, quantum theory of spin waves and magnons, magnons in antiferromagnets, parametric excitation of magnons, nonlinear and chaotic phenomena, Bose-Einstein condensation of magnons, and magnon spintronics. Featuring end-of-chapter problem sets accompanied by extensive contemporary and historical references, this book provides the essential tools for any graduate or advanced undergraduate-level course of studies on the emerging field of magnonics.

Spintronic 2D Materials: Fundamentals and Applications provides an overview of the fundamental theory of 2D electronic systems that includes a selection of the most intensively investigated 2D materials. The book tells the story of 2D spintronics in a systematic and comprehensive way, providing the growing community of spintronics researchers with a key reference. Part One addresses the fundamental theoretical aspects of 2D materials and spin transport, while Parts Two through Four explore 2D material systems, including graphene, topological insulators, and transition metal dichalcogenides. Each section discusses properties, key issues and recent developments. In addition, the material growth method (from lab to mass production), device fabrication and characterization techniques are included throughout the book. Discusses the fundamentals and applications of spintronics of 2D materials, such as graphene, topological insulators and transition metal dichalcogenides Includes an in-depth look at each materials system, from material growth, device fabrication and characterization techniques Presents the latest solutions on key challenges, such as the spin lifetime of 2D materials, spin-injection efficiency, the potential proximity effects, and much more

Written by two well-known researchers in the field, this useful reference takes an applied approach to high frequency processes including oscillations and waves in ferromagnets, antiferromagnets, and ferrimagnets. Problems evaluated include ferromagnetic and antiferromagnetic resonances, spin waves, nonlinear processes, and high frequency manifestations of interactions between the magnetic system and other systems of magnetically ordered substances as elastic waves and charge carriers. Unlike previous monographs on this subject, which are highly theoretical and written for very advanced readers, this book requires only an average college background in mathematics and experimental physics. It will be a valuable addition to the library of engineers and scientists in research and development for communications applications, and scientists interested in nonlinear magnetic phenomena. It also serves as an excellent introduction to the topic for newcomers in the field. Magnetization Oscillations and Waves not only presents results but also shows readers how to obtain them; most formulas are derived with so many details that readers can reproduce them. The book includes many summaries and tables and detailed references to significant work in the area by European researchers.

This book presents recent and important developments in the field of Photonics and Optoelectronics, with a particular focus on Laser Technology, Optical Communications, Optoelectronic Devices and Image Processing. At present, Photonics and Optoelectronics

Technologies are pivotal to the future of laser, displays, sensors and communication technologies, and currently being developed at an extraordinary rate. This book details the theories underlying the mechanisms involved in the relevant Photonics and Optoelectronics. Devices such as laser diodes, photodetectors, and integrated optoelectronic circuits are investigated. The reviews by leading experts are of interest to researchers and engineers as well as advanced students.