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Magnetic Nanostructures: Spin Dynamics and Spin Transport ...
The interconnection between the spin current and spin dynamics via the spin-dependent scattering and an accompanying by spin torque effect in ferromagnetic/normal metal based magnetic multilayer nanostructures is studied including a high fast out-of-equilibrium spin dynamics. Features of the spin transport through interfaces and its impact on spin dynamics are described on the base of the scattering matrix formalism for spin flows.

Spin Transport and Dynamics in Multilayer Magnetic ...
The elementary physical mechanisms involving the spin dynamics when exciting magnetic nanostructures with femtosecond optical pulses are considered. The variety of experimental methods and theoretical approaches used to study the magnetic properties of the materials on a broad range of temporal and spatial scales are examined.

Ultrafast magnetization dynamics of nanostructures - Bigot ...
The objective, invariably, is to control and study spin dynamics using charge and elastic degrees of freedom. In certain cases, an understanding of this coupling can be exploited reciprocally to employ magnetic fields in controlling the charge and/or elastic dynamics.

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Engineering and Physical Sciences Research Council (EPSRC) Date: 2 November 2020

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Magnetic Nanostructures: Spin Dynamics and Spin Transport ...
The field of spintronics is dynamic and evolving at a tremendous pace. This field is centered on the creation and manipulation of spin currents and their use in manipulating magnetic moments via the transfer of spin and orbital angular momenta. Just in the past 3 years the conversion of pure charge currents to pure spin currents has made major advances with unforeseen efficiencies in simple metals of up to 50% and perhaps even greater efficiencies in unconventional topological matter.

2017 Spin Dynamics in Nanostructures Conference GRC
In magnetic materials, both the dynamics and life-times of hot-electrons depend on their spin polarization [22{24]. These dierences lead to the concept of spin-dependent transport upon laser excitation and thus to the generation of ultrafast spin cur- rent pulses.

Nanomagnetism and spintronics is a rapidly expanding and increasingly important field of research with many applications already on the market and many more to be expected in the near future. This field started in the mid-1980s with the discovery of the GMR effect, recently awarded with the Nobel prize to Albert Fert and Peter Grünberg. The present volume covers the most important and most timely aspects of magnetic heterostructures, including spin torque effects, spin injection, spin transport, spin fluctuations, proximity effects, and electrical control of spin valves. The chapters are written by internationally recognized experts in their respective fields and provide an overview of the latest status.

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 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 Barnaś, P Balaz, A Dyrdał 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 Wysokiński, T Domański 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

The static and dynamic properties of spin distributions within domain walls(DWs) confined by Permalloy nanowire conduits are investigated by numerical simulations and high-speed magneto-optic polarimetry. Phase boundaries and critical points associated with DW spin distributions of various topologies are accurately determined using high-performance computing resources. Field-driven mobility curves that characterize DW propagation velocities in 20 nm thick nanowires are calculated with increasing the width of nanowires. Beyond the simple one-dimensional solution, the simulations reveal the four distinct dynamic modes. Oscillations of the field-driven DW velocity in Permalloy nanowires are observed above the Walker breakdown condition using high-speed magneto-optic polarimetry. A one-dimensional analytical model and numerical simulations of DW motion and spin dynamics are used to interpret the experimental data. Velocity oscillations are shown to be much more sensitive to properties of the DW guide structure (which also affect DW mobility) than the DW spin precessional frequency, which is a local property of the material. Transverse bias field effects on field-driven DW velocity are studied experimentally and numerically. DW velocities and spin configurations are determined as functions of longitudinal drive field, transverse bias field, and nanowire width. For a nanowire that supports vortex wall structures, factor of ten enhancements of the DW velocity are observed above the critical longitudinal drive-field (that marks the onset of oscillatory DW motion) when a transverse bias field is applied. The bias-field enhancement of DW velocity is explained by numerical simulations of the spin distribution and dynamics within a propagating DW that reveal dynamic stabilization of coupled vortex structures and suppression of oscillatory motion in the nanowire conduit resulting in uniform DW motion at high speed. Current-driven and current-assisted field-driven domain wall dynamics in ferromagnetic nanowires have thermal effects resulting from Joule heating, which make difficult to separate the spin-torque effects on DW displacements. To understand the thermal effects on DW dynamics, the temperature dependence of field-driven DW velocity is explored using high-bandwidth scanning Kerr polarimetry. Walker critical fields are decreased with increasing temperature and temperature-induced dynamic mode changes are observed. The results show that Joule heating effects are playing an important role in current-driven/current-assisted field-driven DW dynamics.

Abstract: We present our extensive research into magnetic anisotropy. We tuned the terrace width of Si(111) substrate by a novel method: varying the direction of heating current and consequently manipulating the magnetic anisotropy of magnetic structures on the stepped substrate by decorating its atomic steps. Laser-induced ultrafast demagnetization of a CoFeB/MgO/CoFeB magnetic tunneling junction was explored by the time-resolved magneto-optical Kerr effect (TR-MOKE) for both the parallel state (P state) and the antiparallel state (AP state) of the magnetizations between two magnetic layers. It was observed that the demagnetization time is shorter and the magnitude of demagnetization is larger in the AP state than those in the P state. These behaviors are attributed to the ultrafast spin transfer between two CoFeB layers via the tunneling of hot electrons through the MgO barrier. Our observation indicates that ultrafast demagnetization can be engineered by the hot electron tunneling current. This opens the door to manipulate the ultrafast spin current in magnetic tunneling junctions. Furthermore, an all-optical TR-MOKE technique provides the flexibility for exploring the nonlinear magnetization dynamics in ferromagnetic materials, especially with metallic materials.

In recent years, the physics community has experienced a revival of interest in spin effects in solid state systems. On one hand, the solid state systems, particularly, semiconductors and semiconductor nanosystems, allow us to perform benchtop studies of quantum and relativistic phenomena. On the other hand, this interest is supported by the prospects of realizing spin-based electronics, where the electron or nuclear spins may play a role of quantum or classical information carriers. This book looks in detail at the physics of interacting systems of electron and nuclear spins in semiconductors, with particular emphasis on low-dimensional structures. These two spin systems naturally appear in practically all widespread semiconductor compounds. The hyperfine interaction of the charge carriers and nuclear spins is particularly prominent in nanosystems due to the localization of the charge carriers, and gives rise to spin exchange between these two systems and a whole range of beautiful and complex physics of manybody and nonlinear systems. As a result, understanding of the intertwined spin systems of electrons and nuclei is crucial for in-depth studying and controlling the spin phenomena in semiconductors. The book addresses a number of the most prominent effects taking place in semiconductor nanosystems including hyperfine interaction, nuclear magnetic resonance, dynamical nuclear polarization, spin-Faraday and spin-Kerr effects, processes of electron spin decoherence and relaxation, effects of electron spin precession mode-locking and frequency focussing, as well as fluctuations of electron and nuclear spins.

The development of the spintronic-based data storage devices such as spin transfer torque magnetoresistive random access memory (STT-MRAM) is being driven by the surging data consumption and demand for faster data processing. The advantages of nonvolatility, higher data processing speed, lower power consumption and scalability hold the promise of the popularity of STT-MRAM in the future, of which spin transfer torque (STT) effect is the key. This thesis develops a spin diffusion model to study the spin dynamics in nanomagnetic structures and the corresponding STT effect acting on local magnetic moments. Chapter 2 provides an introduction to micromagnetic modeling, dominant magnetic interactions, and domain walls. Chapter 3 presents spin diffusion model, in which two approaches are discussed for handling the boundary conditions and we demonstrate their good performance in solving spin diffusion equation in finite element models. Chapter 3 also shows solutions for the spin accumulation in multi-layered magnetic structures at equilibrium and in dynamics. It also studies the case of spin transfer torque in magnetic nanostructures with the Néel wall, comparing it to the simplified Zhang & Li model. At the end of the chapter 3 we simulate the magnetization dynamics under STT effect using the FastMag micromagnetic simulation software coupled with the spin diffusion model.

Presenting recent scientific achievements in the investigation of magnetization dynamics in confined magnetic systems, this volume includes six chapters originating from different groups of experimentalists and theoreticians dominating the field since the discovery of the effect. Different chapters of the book reflect different facets of spin wave confinement, providing a comprehensive description of the effect and its place in modern magnetism. Valuable for scientists and engineers working on magnetic storage elements and magnetic logic, the guide is also suitable as an advanced textbook for graduate students.