



# Quantum Magnetism

**Chen Wu, Jiaying Jin**



## Quantum Magnetism:

**Quantum Magnetism** Ulrich Schollwöck, Johannes Richter, Damian J.J. Farnell, Raymond F. Bishop, 2008-05-14 The investigation of magnetic systems where quantum effects play a dominant role has become a very active branch of solid state physics research in its own right The first three chapters of the Quantum Magnetism survey conceptual problems and provide insights into the classes of systems considered namely one dimensional two dimensional and molecular magnets The following chapters introduce the methods used in the field of quantum magnetism including spin wave analysis exact diagonalization quantum field theory coupled cluster methods and the Bethe ansatz The book closes with a chapter on quantum phase transitions and a contribution that puts the wealth of phenomena into the context of experimental solid state physics Closing a gap in the literature this volume is intended both as an introductory text at postgraduate level and as a modern comprehensive reference for researchers in the field Interacting Electrons and Quantum Magnetism Assa Auerbach, 1998-09-11 In the excitement and rapid pace of developments writing pedagogical texts has low priority for most researchers However in transforming my lecture notes into this book I found a personal benefit the organization of what I understand in a hopefully simple logical sequence Very little in this text is my original contribution Most of the knowledge was collected from the research literature Some was acquired by conversations with colleagues a kind of physics oral tradition passed between disciples of a similar faith For many years diagrammatic perturbation theory has been the major theoretical tool for treating interactions in metals semiconductors itinerant magnets and superconductors It is in essence a weak coupling expansion about free quasiparticles Many experimental discoveries during the last decade including heavy fermions fractional quantum Hall effect high temperature superconductivity and quantum spin chains are not readily accessible from the weak coupling point of view Therefore recent years have seen vigorous development of alternative nonperturbative tools for handling strong electron-electron interactions I concentrate on two basic paradigms of strongly interacting or constrained quantum systems the Hubbard model and the Heisenberg model These models are vehicles for fundamental concepts such as effective Hamiltonians variational ground states spontaneous symmetry breaking and quantum disorder In addition they are used as test grounds for various nonperturbative approximation schemes that have found applications in diverse areas of theoretical physics *Quantum Theory of Magnetism* Robert M. White, 2007-01-23 Quantum Theory of Magnetism is the only book that deals with the phenomenon of magnetism from the point of view of linear response That is how does a magnetic material respond when excited by a magnetic field That field may be uniform or spatially varying static or time dependent Previous editions have dealt primarily with the magnetic response This edition incorporates the resistive response of magnetic materials as well It also includes problems to test the reader's or student's comprehension The rationale for a book on magnetism is as valid today as it was when the first two editions of Quantum Theory of Magnetism were published Magnetic phenomena continue to be discovered with deep scientific implications and

novel applications Since the Second Edition for example Giant Magneto Resistance GMR was discovered and the new field of spintronics is currently expanding Not only do these phenomena rely on the concepts presented in this book but magnetic properties are often an important clue to our understanding of new materials e g high temperature superconductors Their magnetic properties studied by susceptibility measurements nuclear magnetic resonance neutron scattering etc have provided insight to the superconductivity state This updated edition offers revised emphasis on some material as a result of recent developments and includes new material such as an entire chapter on thin film magnetic multilayers Researchers and students once again have access to an up to date classic reference on magnetism the key characteristic of many modern materials

**Quantum Magnetism, Spin Waves, and Optical Cavities** Silvia Viola Kusminskiy, 2019-02-28 This primer thoroughly covers the fundamentals needed to understand the interaction of light with magnetically ordered matter and it focuses on cavity optomagnonics which is a topic undergoing intense study in current research The book is unique in combining elements of electromagnetism quantum magnetism and quantum optics and it is intended for advanced undergraduate or graduate students

*Quantum Magnetism* Bernard Barbara, Yosef Imry, G. Sawatzky, P. C. E. Stamp, 2008-06-24 This book is based on some of the lectures during the Pacific Institute of Theoretical Physics PITP summer school on Quantum Magnetism held during June 2006 in Les Houches in the French Alps The school was funded jointly by NATO the CNRS and PITP and entirely organized by PITP Magnetism is a somewhat peculiar research field It clearly has a quantum mechanical basis the microscopic exchange interactions arise entirely from the exclusion principle in conjunction with repulsive interactions between electrons And yet until recently the vast majority of magnetism researchers and users of magnetic phenomena around the world paid no attention to these quantum mechanical roots Thus e g the huge 400 billion per annum industry which manufactures hard discs and other components in the information technology sector depends entirely on room temperature properties of magnets yet at the macroscopic or mesoscopic scales of interest to this industry room temperature magnets behave entirely classically

**Quantum Theory of Magnetism** Robert M. White, 1983

*Magnetism: A Very Short Introduction* Stephen Blundell, 2012-06-28 What is that strange and mysterious force that pulls one magnet towards another yet seems to operate through empty space This is the elusive force of magnetism Stephen J Blundell considers early theories of magnetism the discovery that Earth is a magnet and the importance of magnetism in modern technology

*Magnetism Unleashed* Eleanor Hawking, 2025-01-30 Magnetism Unleashed offers a comprehensive journey through one of nature's most powerful forces and its transformative impact on modern technology From the basic principles of quantum mechanics to cutting edge applications in data storage and electric vehicles this book masterfully connects the theoretical foundations of magnetism with its practical applications that shape our daily lives The text follows a carefully structured progression beginning with fundamental physics concepts before diving into the revolutionary applications of magnetic phenomena Readers will discover how electromagnetic induction led to the development of electric

motors and generators which became the backbone of industrial progress. Particularly fascinating is the exploration of magnetic storage technology's evolution from basic tape drives to sophisticated hard disk drives, highlighting how advances in understanding magnetic domains at the atomic level enabled exponential growth in storage capacity. What sets this book apart is its interdisciplinary approach, weaving together insights from electrical engineering, physics, and materials science to present a complete picture of magnetic innovation. Through clear explanations and practical examples, readers gain insight into groundbreaking developments like giant magnetoresistance and rare earth magnets, while also exploring emerging technologies such as magnetic refrigeration and quantum computing applications. The book maintains technical accuracy while remaining accessible, making it an invaluable resource for both students and professionals in the field.

**Magnetic Field Effects in Low-Dimensional Quantum Magnets** Adam Iaizzi, 2018-11-28. This thesis is a tour de force combination of analytic and computational results, clarifying and resolving important questions about the nature of quantum phase transitions in one and two dimensional magnetic systems. The author presents a comprehensive study of a low dimensional spin half quantum antiferromagnet, the J-Q model, in the presence of a magnetic field in both one and two dimensions, demonstrating the causes of metamagnetism in such systems and providing direct evidence of fractionalized excitations near the deconfined quantum critical point. In addition to describing significant new research results, this thesis also provides the non-expert with a clear understanding of the nature and importance of computational physics and its role in condensed matter physics, as well as the nature of phase transitions, both classical and quantum. It also contains an elegant and detailed but accessible summary of the methods used in the thesis: exact diagonalization, Monte Carlo, quantum Monte Carlo, and the stochastic series expansion, that will serve as a valuable pedagogical introduction to students beginning in this field.

**Aspects Of Modern Magnetism - Lecture Notes Of The Eighth Chinese International Summer School Of Physics** F C Pu, Y J Wang, Chang-he Shang, 1996-05-04. This book, a collection of works by leading figures in the field, is devoted to the latest developments of modern magnetism, including micromagnetism, nanomagnetic materials, magnetic multilayers, macroscopic quantum magnetism, rare earth intermetallic compounds, giant magnetoresistance, and their applications. Some new concepts and theories are also included for a better understanding of these novel phenomena. This book can be used as an advanced text book on magnetism and materials science for graduate students in physics and materials science departments. It is also useful as a research reference for condensed matter physicists and materials scientists.

**Spintronics Handbook, Second Edition: Spin Transport and Magnetism** Evgeny Y. Tsymbal, Igor Žutić, 2019-06-26. 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 Features Presents the most comprehensive reference text for the overlapping fields of spintronics spin transport and magnetism Covers the full spectrum of materials and structures from silicon and organic semiconductors to carbon nanotubes graphene and engineered nanostructures Extends coverage of two dimensional materials beyond graphene including molybdenum disulfide and study of their spin relaxation mechanisms Includes new dedicated chapters on cutting edge topics such as spin orbit torques topological insulators half metals complex oxide materials and skyrmions Discusses important emerging areas of spintronics with superconductors spin wave spintronics benchmarking of spintronics devices and theory and experimental approaches to molecular spintronics

Evgeny Tsymbal's research is focused on computational materials science aiming at the understanding of fundamental properties of advanced ferromagnetic and ferroelectric nanostructures and materials relevant to nanoelectronics and spintronics He is a George Holmes University Distinguished Professor at the Department of Physics and Astronomy of the University of Nebraska Lincoln UNL Director of the UNL's Materials Research Science and Engineering Center MRSEC and Director of the multi institutional Center for NanoFerroic Devices CNFD Igor Utii received his Ph D in theoretical physics at the University of Minnesota His work spans a range of topics from high temperature superconductors and ferromagnetism that can get stronger as the temperature is increased to prediction of various spin based devices He is a recipient of 2006 National Science Foundation CAREER Award 2005 National Research Council American Society for Engineering Education Postdoctoral Research Award and the National Research Council Fellowship 2003 2005 His research is supported by the National Science Foundation the Office of Naval Research the Department of Energy and the Airforce Office of Scientific Research

**Introduction to Frustrated Magnetism** Claudine Lacroix, Philippe Mendels, Frédéric Mila, 2011-01-12 The field of highly frustrated magnetism has developed considerably and expanded over the last 15 years Issuing from canonical geometric frustration of interactions it now extends over other aspects with many degrees of freedom such as magneto elastic couplings orbital degrees of freedom dilution effects and electron doping It is thus shown here that the concept of frustration impacts on many other fields in physics than magnetism This book represents a state of the art review aimed at a broad audience with tutorial chapters and more topical ones encompassing solid state chemistry experimental and theoretical physics

*Nanomagnetism* Georgia C. Papaefthymiou, 2022-04-18 *Nanomagnetism An Interdisciplinary Approach* provides a core foundation for understanding magnetic quantum size effects at the nanoscale and their many applications across the disciplines This textbook will be a valuable guide for students in new interdisciplinary courses in nanomagnetism and magnetic nanomaterials an area that has experienced immense growth in the last two decades due to advancements in sample preparation nanopatterning techniques and magnetic measurement instrumentation The interdisciplinary nature of nanoscience also makes this book an ideal resource for scientists working in industrial

laboratories and pharmaceutical and medical researchers looking to expand their understanding of the physics of magnetic probes Key Features Discusses physical chemical and nanotemplating synthesis techniques for the production of magnetic nanoparticles Covers experimental techniques for the determination of the macroscopic and microscopic magnetization of nanoparticles Discusses the role of nanomagnetism in high density magnetic recording media nanostructured permanent magnets MRI imaging enhancement and magnetically guided drug delivery      **Molecular Magnets** Maria

Balanda, Magdalena Fitta, 2019-03-19 Molecular magnets show many properties not met in conventional metallic magnetic materials i e low density transparency to electromagnetic radiation sensitivity to external stimuli such as light pressure temperature chemical modification or magnetic electric fields and others They can serve as functional materials in sensors of different types or be applied in high density magnetic storage or nanoscale devices Research into molecule based materials became more intense at the end of the 20th century and is now an important branch of modern science The articles in this Special Issue written by physicists and chemists reflect the current work on molecular magnets being carried out in several research centers Theoretical papers in the issue concern the influence of spin anisotropy in the low dimensional lattice of the resulting type of magnet as well as thermodynamics and magnetic excitations in spin trimers The impact of external pressure on structural and magnetic properties and its underlying mechanisms is described using the example of Prussian blue analogue data The other functionality discussed is the magnetocaloric effect investigated in coordination polymers and high spin clusters In this issue new molecular magnets are presented i ferromagnetic high spin Mn<sub>6</sub> single molecule magnets ii solvatomagnetic compounds changing their structure and magnetism dependent on water content and iii a family of purely organic magnetic materials Finally an advanced calorimetric study of anisotropy in magnetic molecular superconductors is reviewed      **Molecular Cluster Magnets** Richard Winpenny, 2012 This work covers new developments in the field of molecular nanomagnetism complementing previous books in this area for example the volume by Gatteschi Sessoli and Villain on Single Molecule Magnets The book is written by experts in the field and is intended as a compilation of critical reviews of new areas rather than a comprehensive text      *NMR-MRI,  $\mu$ SR and Mössbauer Spectroscopies in Molecular Magnets* Pietro Carretta, Alessandro Lascialfari, 2007-12-15 In this book an extensive overview on the results obtained during the last decade and on recent achievements in the study of molecular magnets by means of Nuclear Magnetic Resonance Muon Spin Rotation Magnetic Resonance Imaging and Mossbauer techniques is presented The aim is to introduce the reader to these techniques and to give a general background on their application to molecular spin systems      Artificial

Intelligence and Knowledge Processing Hemachandran K, Raul Villamarin Rodriguez, Manjeet Rege, Abejide Ade-Ibijola, Kok-Leong Ong, Vincenzo Piuri, 2024-12-26 This book constitutes the 4th International Conference on Artificial Intelligence and Knowledge Processing AIKP 2024 held in Johannesburg Business School Johannesburg South Africa during August 22-24 2024 The 18 full papers included in this book were carefully reviewed and selected from 76 submissions This

AIKP 2024 topics covered in these proceedings including machine learning natural language processing computer vision robotics data mining quantum AI and cognitive computing

**Frontiers in Magnetic Materials** Chen Wu, Jiaying Jin, 2022-08-12 The book aims to provide comprehensive and practical guidance on magnetism and magnetic materials. It involves four parts focusing on fundamental magnetism, hard magnetic materials, soft magnetic materials, and other functional magnetic materials. Part I highlights the ubiquity of magnetism and the close relationships between magnetic materials and our daily life. Perspectives on magnetism from Engineering and Physics are provided to introduce the two unit systems followed by the origin and categories of magnetisms. An introduction of important parameters during magnetization and magnetic measurement techniques are then provided to lay a solid foundation for the readers for better understandings of the design and development of different magnetic materials. Important magnetic materials are then introduced in the subsequent parts, delivering an overview of design principles, production technologies, research developments, and real world applications. For instance, rare earth free and rare earth based hard magnetic materials as well as soft magnetic materials such as Fe based alloys, composites, and ferrites are discussed. Other functional magnetic materials span a wide range involving smart materials with magneto X effects together with magnetic materials for applications including electromagnetic wave absorption, biomedicine, and catalysis etc. For these magnetic materials, more emphasis is placed on the latest advances and interdisciplinary perspectives.

**Tunneling in Complex Systems** Steven Tomsovic, 1998 The influential political philosopher Leo Strauss has been credited by conservatives with the recovery of the great tradition of political philosophy stretching back to Plato. Among Strauss's most enduring legacies is a strongly negative assessment of Nietzsche as the modern philosopher most at odds with that tradition and most responsible for the sins of twentieth century culture: relativism, godlessness, nihilism, and the breakdown of family values. In fact, this apparent denunciation has become so closely associated with Strauss that it is often seen as the very core of his thought. In *Leo Strauss and Nietzsche*, the eminent Nietzsche scholar Laurence Lampert offers a controversial new assessment of the Strauss-Nietzsche connection. Lampert undertakes a searching examination of the key Straussian essay, *Note on the Plan of Nietzsche's Beyond Good and Evil*. He shows that this essay, written toward the end of Strauss's life and placed at the center of his final work, reveals an affinity for and debt to Nietzsche greater than Strauss's followers allow. Lampert argues that the essay comprises the most important interpretation of Nietzsche ever published, one that clarifies Nietzsche's conception of nature and of human spiritual history and demonstrates the logical relationship between the essential themes in Nietzsche's thought: the will to power and the eternal return.

**Theory of the Nuclear Magnetic 1/T1 Relaxation Rate in Conventional and Unconventional Magnets** Andrew Smerald, 2013-08-13 One of the best ways to lift the lid on what is happening inside a given material is to study it using nuclear magnetic resonance (NMR). Of particular interest are NMR 1/T1 relaxation rates, which measure how fast energy stored in magnetic nuclei is transferred to surrounding electrons. This thesis develops a detailed quantitative theory of NMR



1 T1 relaxation rates and shows for the first time how they could be used to measure the speed at which energy travels in a wide range of magnetic materials This theory is used to make predictions for Quantum Spin Nematics an exotic form of quantum order analogous to a liquid crystal In order to do so it is first necessary to unravel how spin nematics transport energy This thesis proposes a new way to do this based on the description of quarks in high energy physics Experiments to test the ideas presented are now underway in laboratories across the world

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