



Monte Carlo Methods in Quantum Problems

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Monte Carlo Methods In Quantum Problems

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Monte Carlo Methods In Quantum Problems:

Monte Carlo Methods in Quantum Problems M.H. Kalos, 2012-12-06 Monte Carlo methods have been a tool of theoretical and computational scientists for many years. In particular, the invention and percolation of the algorithm of Metropolis, Rosenbluth, Rosenbluth, Teller, and Teller sparked a rapid growth of applications to classical statistical mechanics. Although proposals for treatment of quantum systems had been made even earlier, only a few serious calculations had been carried out. Such calculations are generally more consuming of computer resources than for classical systems, and no universal algorithm had or indeed has yet emerged. However, with advances in techniques and in sheer computing power, Monte Carlo methods have been used with considerable success in treating quantum fluids and crystals, simple models of nuclear matter, and few-body nuclei. Research at several institutions suggests that they may offer a new approach to quantum chemistry, one that is independent of basis and yet capable of chemical accuracy. That Monte Carlo methods can attain the very great precision needed is itself a remarkable achievement. More recently, new interest in such methods has arisen in two new areas: as Particle theorists in particular, K. Wilson has drawn attention to the rich analogy between quantum field theory and statistical mechanics, and to the merits of Monte Carlo calculations for lattice gauge theories. This has become a rapidly growing sub-field. A related development is associated with lattice problems in quantum physics, particularly with models of solid-state systems. There is much ferment in the calculation of various one-dimensional problems such as the Hubbard model.

Quantum Monte Carlo Methods in Physics and Chemistry M.P. Nightingale, Cyrus J. Umrigar, 1998-12-31 This book contains lectures on the basic theory and applications of quantum Monte Carlo methods, with contributions written by authorities in the field. Although tutorial in nature, it includes current developments. Both continuum systems and lattice models are covered. The applications include atomic, molecular, and solid-state physics, statistical and low-temperature physics, and nuclear structure. Suitable for Ph.D. students and beyond.

Quantum Monte Carlo Methods In Condensed Matter Physics Masuo Suzuki, 1993-12-30 This book reviews recent developments of quantum Monte Carlo methods and some remarkable applications to interacting quantum spin systems and strongly correlated electron systems. It contains twenty-two papers by thirty authors. Some of the features are as follows: The first paper gives the foundations of the standard quantum Monte Carlo method, including some recent results on higher-order decompositions of exponential operators and ordered exponentials. The second paper presents a general review of quantum Monte Carlo methods used in the present book. One of the most challenging problems in the field of quantum Monte Carlo techniques, the negative sign problem, is also discussed, and new methods proposed to partially overcome it. In addition, low-dimensional quantum spin systems are studied. Some interesting applications of quantum Monte Carlo methods to fermion systems are also presented to investigate the role of strong correlations and fluctuations of electrons and to clarify the mechanism of high- T_c superconductivity. Not only thermal properties but also quantum mechanical ground-state properties have been studied by the projection technique using

auxiliary fields Further the Haldane gap is confirmed by numerical calculations Active researchers in the forefront of condensed matter physics as well as young graduate students who want to start learning the quantum Monte Carlo methods will find this book useful

Quantum Monte Carlo Methods James Gubernatis, Naoki Kawashima, Philipp Werner, 2016-06-02 The first textbook to provide a pedagogical examination of the major algorithms used in quantum Monte Carlo simulations

Recent Advances In Quantum Monte Carlo Methods William A Lester, 1997-05-02 The quantum Monte Carlo QMC method is gaining interest as a complement to basis set ab initio methods in cases where high accuracy computation of atomic and molecular properties is desired This volume focuses on recent advances in this area QMC as used here refers to methods that directly solve the Schrödinger equation for example diffusion and Green's function Monte Carlo as well as variational Monte Carlo The latter is an approach to computing atomic and molecular properties by the Monte Carlo method that has fundamental similarities to basis set methods with the exception that the limitation to one particle basis functions to facilitate integral evaluation is avoided This feature makes possible the consideration of many body wave functions containing explicitly interparticle distances a capability common to all variants of QMC

Monte Carlo Methods in Chemical Physics David M. Ferguson, J. Ilja Siepmann, Donald G. Truhlar, 1999 In Monte Carlo Methods in Chemical Physics An Introduction to the Monte Carlo Method for Particle Simulations J Ilja Siepmann Random Number Generators for Parallel Applications Ashok Srinivasan David M Ceperley and Michael Mascagni Between Classical and Quantum Monte Carlo Methods Variational QMC Dario Bressanini and Peter J Reynolds Monte Carlo Eigenvalue Methods in Quantum Mechanics and Statistical Mechanics M P Nightingale and C J Umrigar Adaptive Path Integral Monte Carlo Methods for Accurate Computation of Molecular Thermodynamic Properties Robert Q Topper Monte Carlo Sampling for Classical Trajectory Simulations Gilles H Peslherbe Haobin Wang and William L Hase Monte Carlo Approaches to the Protein Folding Problem Jeffrey Skolnick and Andrzej Kolinski Entropy Sampling Monte Carlo for Polypeptides and Proteins Harold A Scheraga and Minh Hong Hao Macrostate Dissection of Thermodynamic Monte Carlo Integrals Bruce W Church Alex Ulitsky and David Shalloway Simulated Annealing Optimal Histogram Methods David M Ferguson and David G Garrett Monte Carlo Methods for Polymeric Systems Juan J de Pablo and Fernando A Escobedo Thermodynamic Scaling Methods in Monte Carlo and Their Application to Phase Equilibria John Valleau Semigrand Canonical Monte Carlo Simulation Integration Along Coexistence Lines David A Kofke Monte Carlo Methods for Simulating Phase Equilibria of Complex Fluids J Ilja Siepmann Reactive Canonical Monte Carlo J Karl Johnson New Monte Carlo Algorithms for Classical Spin Systems G T Barkema and M E J Newman

Monte Carlo Simulation in Statistical Physics Kurt Binder, Dieter W. Heermann, 2013-03-14 Monte Carlo Simulation in Statistical Physics deals with the computer simulation of many body systems in condensed matter physics and related fields of physics chemistry and beyond to traffic flows stock market fluctuations etc Using random numbers generated by a computer probability distributions are calculated allowing the estimation of the thermodynamic properties of

various systems This book describes the theoretical background to several variants of these Monte Carlo methods and gives a systematic presentation from which newcomers can learn to perform such simulations and to analyze their results This fourth edition has been updated and a new chapter on Monte Carlo simulation of quantum mechanical problems has been added To help students in their work a special web server has been installed to host programs and discussion groups <http://www.cptphys.uni-heidelberg.de> Prof Binder was the winner of the Berni J Alder CECAM Award for Computational Physics 2001

Monte Carlo Methods in Quantum Problems M.H. Kalos, 1984-04-30 Monte Carlo methods have been a tool of theoretical and computational scientists for many years In particular the invention and percolation of the algorithm of Metropolis Rosenbluth Rosenbluth Teller and Teller sparked a rapid growth of applications to classical statistical mechanics Although proposals for treatment of quantum systems had been made even earlier only a few serious calculations had been carried out Such calculations are generally more consuming of computer resources than for classical systems and no universal algorithm had or indeed has yet emerged However with advances in techniques and in sheer computing power Monte Carlo methods have been used with considerable success in treating quantum fluids and crystals simple models of nuclear matter and few body nuclei Research at several institutions suggest that they may offer a new approach to quantum chemistry one that is independent of basis and yet capable of chemical accuracy That Monte Carlo methods can attain the very great precision needed is itself a remarkable achievement More recently new interest in such methods has arisen in two new areas as Particle theorists in particular K Wilson have drawn attention to the rich analogy between quantum field theory and statistical mechanics and to the merits of Monte Carlo calculations for lattice gauge theories This has become a rapidly growing subfield A related development is associated with lattice problems in quantum physics particularly with models of solid state systems There is much ferment in the calculation of various one dimensional problems such as the Hubbard model

Methods in Computational Chemistry Stephen Wilson, 2013-11-11 When forty years ago as a student of Charles Coulson in Oxford I began work in theoretical chemistry I was provided with a Brunsviga calculator a small mechanical device with a handle for propulsion metal levers for setting the numbers and a bell that rang to indicate overflow What has since come to be known as computational chemistry was just beginning There followed a long period in which the fundamental theory of the golden age 1925-1935 was extended and refined and in which the dreams of the early practitioners were gradually turned into hard arithmetic reality As a still computing survivor from the early postwar days now enjoying the benefits of unbelievably improved hardware I am glad to contribute a foreword to this series and to have the opportunity of providing a little historical perspective After the Brunsviga came the electromechanical machines of the late 1940s and early 1950s and a great reduction in the burden of calculating molecular wavefunctions We were now happy At least for systems containing a few electrons it was possible to make fully ab initio calculations even though semiempirical models remained indispensable for most molecules of everyday interest The 1950 papers of Hall and of Roothaan represented an important

milestone along the road to larger scale non empirical calculations extending the prewar work of Hartree and Fock from many electron atoms to many electron molecules and thus into real chemistry

Computational Atomic And Nuclear Physics - Proceedings Of The Summer School C Bottcher, Michael Robert Strayer, Joseph Bennett Mcgrory, 1990-07-05

Computational power available to scientific researchers is increasing at such a rate in recent years that totally new numerical approaches to forefront problems are playing an increasingly important role in modern physics research At the Summer School current topics in atomic and nuclear physics where such computational approaches may be most fruitful were discussed by an internationally distinguished faculty Major topics discussed included Ultra relativistic Heavy Ion Collisions the importance of sub nucleon degrees of freedom to nuclear physics the importance of electromagnetic processes in collisions of high energy highly charged ions relativistic effects in atomic and nuclear structure current topics in quantum chemistry modern Monte Carlo techniques path integral methods and applications of static and time dependent Hartree Fock methods in atomic and nuclear physics

Mathematical Tools for Physicists Michael Grinfeld, 2015-01-12 The new edition is significantly updated and expanded This unique collection of review articles ranging from fundamental concepts up to latest applications contains individual contributions written by renowned experts in the relevant fields Much attention is paid to ensuring fast access to the information with each carefully reviewed article featuring cross referencing references to the most relevant publications in the field and suggestions for further reading both introductory as well as more specialized While the chapters on group theory integral transforms Monte Carlo methods numerical analysis perturbation theory and special functions are thoroughly rewritten completely new content includes sections on commutative algebra computational algebraic topology differential geometry dynamical systems functional analysis graph and network theory PDEs of mathematical physics probability theory stochastic differential equations and variational methods

Quantum Monte Carlo James B. Anderson, 2007-04-05 Monte Carlo methods are a class of computational algorithms for simulating the behavior of a wide range of various physical and mathematical systems with many variables Their utility has increased with general availability of fast computers and new applications are continually forthcoming The basic concepts of Monte Carlo are both simple and straightforward and rooted in statistics and probability theory their defining characteristic being that the methodology relies on random or pseudo random sequences of numbers It is a technique of numerical analysis based on the approximate solution of a problem using repeated sampling experiments and observing the proportion of times a given property is satisfied The term Monte Carlo was first used to describe calculational methods based on chance in the 1940s but the methods themselves preceded the term by as much as a century Quantum Monte Carlo QMC first appeared in 1982 and similarly was preceded by development of the related calculational methodology The success of QMC methods over the past few decades has been remarkable and this book will clearly demonstrate that success in its discussion of applications For isolated molecules the basic material of chemistry QMC methods have produced exact solutions of the Schroedinger equation

for very small systems and the most accurate solutions available for very large systems The range of applications is impressive folding of protein molecules interactions in liquids structure modeling in crystals and enzymes quantum dots designing heat shields and aerodynamic forms architecture design business and economics and even cinema and video games 3D modeling This book takes a similar approach to Henry Schaefer's classic book Quantum Chemistry OUP 1984 now a Dover edition collecting summaries of some of the most important papers in the quantum Monte Carlo literature tying everything together with analysis and discussion of applications Quantum Monte Carlo is a reference book for quantum Monte Carlo applications belonging near the desk of every quantum chemist physicist and a wide range of scientists and engineers across many disciplines destined to become a classic **Mathematical Tools for Physicists** George L.

Trigg, 2006-08-21 Mathematical Tools for Physicists is a unique collection of 18 carefully reviewed articles each one written by a renowned expert working in the relevant field The result is beneficial to both advanced students as well as scientists at work the former will appreciate it as a comprehensive introduction while the latter will use it as a ready reference The contributions range from fundamental methods right up to the latest applications including Algebraic analytic geometric methods Symmetries and conservation laws Mathematical modeling Quantum computation The emphasis throughout is ensuring quick access to the information sought and each article features an abstract a detailed table of contents continuous cross referencing references to the most relevant publications in the field and suggestions for further reading both introductory as well as highly specialized In addition a comprehensive index provides easy access to the vast number of key words extending beyond the range of the headlines *Few-Body Problems in Physics '93* Bernard Becker, R. van

Dantzig, 2012-12-06 It is apparent from the history of science that few body problems have an interdisciplinary character Newton after solving the two body problem so brilliantly tried his hand at the Sun Earth Moon system Here he failed in two respects neither was he able to compute the motion of the moon accurately nor did he understand the reason for that It took a long time to understand the fundamental importance of Newton's failure and only Poincaré realised what was the fundamental difficulty in Newton's programme Nowadays the term deterministic chaos is associated with this problem The deep insights of Poincaré were neglected by the founding fathers of Quantum Physics Thus history was repeated by Bohr and his students After quantising the hydrogen atom they soon found that the textbook case of a three body problem in atomic physics the ^3He atom did not yield to the Bohr Sommerfeld quantisation methods Only these days do people realise what precisely were the difficulties connected to this semi classical way of treating quantum systems Our field as we know it today began in principle in the early 1950s when Watson sketched the outlines of three body scattering theory Mathematical rigour was achieved by Faddeev and thereafter at the beginning of the 1960s the quantum three body problem at least as far as short range forces were concerned was tamed In the years that followed through the work of others who first applied Faddeev's methods but later added new techniques the three and four body problems became fully housebroken

Computational Physics - Proceedings Of The 9th Physics Summer School At The Australian National Univ

Henry J Gardner, Craig M Savage, 1997-03-18 This volume presents the latest advancements and future perspectives of atomic molecular and optical AMO physics and its vital role in modern sciences and technologies The chapters are devoted to a wide range of quantum systems with an emphasis on the understanding of ionization high harmonic generation molecular orbital imaging and coherent control phenomena originating from light matter interactions The book overviews current research landscape and highlight major scientific trends in AMO physics interfacing with interdisciplinary sciences It may be particularly interesting for young researchers working on establishing their scientific interests and goals

Computer Simulation Studies in Condensed-Matter Physics IV David P. Landau, K.K. Mon, Heinz-Bernd Schüttler, 2012-12-06 The contribution of computer simulation studies to our understanding of proper ties of a wide range of condensed matter systems is now well established The Center for Simulational Physics has been hosting annual workshops with the in tent of bringing together some of the experienced practitioners in the field as well as relative newcomers in the field to provide a forum for the exchange of ideas and recent results This year s workshop the fourth in the series was held at the University of Georgia February 18 22 1991 These proceedings are a record of the workshop and are published with the goal of timely dissemination of the papers to a wider audience The proceedings are divided into three parts The first part contains invited papers which deal with simulational studies of classical systems and includes an introduction to some new simulation techniques and special purpose comput ers as well A separate section of the proceedings is devoted to invited papers on quantum systems including new results for strongly correlated electron and quantum spin models believed to be important for the description of high T c superconductors The contributed presentations comprise the final chapter

Supercomputer Simulations in Chemistry Michel Dupuis, 2012-12-06 Awareness of the need and potential of supercomputers for scientific and engineering research has grown tremendously in the past few years It has culminated in the Super computer Initiative undertaken two years ago by the National Science Foundation and presently under full development in the United States Similar initiatives are under way in several European countries and in Japan too Thus the organization of a symposium on Supercomputer Simulations in Chemistry appeared timely and such a meeting was held in Montreal Canada in August 1985 sponsored by IBM Kingston and IBM Canada and organized by Dr Enrico Clementi and Dr Michel Dupuis In connection with this IBM s support of the Cornell University Supercomputer Center several projects in the IBM Research Division the experimental parallel engine ICAP assembled at IBM Kingston and the announcement Fall 1985 of an add on vector feature to the 3090 IBM mainframe underscore IBM s commitment to high end scientific engineering computing The papers presented in this volume discuss topics in quantum mechanical and statis tical mechanical simulations both of which test the limits of computer hardware and soft ware Already a great deal of effort has been put into using vector supercomputers in these two areae Much more is needed and without doubt ie bound to happen To start an historical perspective of

computational quantum chemistry is provided by Professor Lwdin The contribution by Ohno and co workers gives an indication of the present status of Japanese supercomputers Kutzelnigg et al Bauschlicher et al and Guest et al **Essential Computational Modeling in Chemistry** Philippe G. Ciarlet,2010-12-07 Essential Computational Modeling in Chemistry presents key contributions selected from the volume in the Handbook of Numerical Analysis Computational Modeling in Chemistry Vol 10 2005 Computational Modeling is an active field of scientific computing at the crossroads between Physics Chemistry Applied Mathematics and Computer Science Sophisticated mathematical models are increasingly complex and extensive computer simulations are on the rise Numerical Analysis and scientific software have emerged as essential steps for validating mathematical models and simulations based on these models This guide provides a quick reference of computational methods for use in understanding chemical reactions and how to control them By demonstrating various computational methods in research scientists can predict such things as molecular properties The reference offers a number of techniques and the numerical analysis needed to perform rigorously founded computations Various viewpoints of methods and applications are available for researchers to chose and experiment with Numerical analysis and open problems is useful for experimentation Most commonly used models and techniques for the molecular case is quickly accessible

Computational Physics Joseph Marie Thijssen,1999-06-17 This book describes computational methods used in theoretical physics with emphasis on condensed matter applications Parallel Processing and Applied Mathematics, Part II Roman Wyrzykowski,Jack Dongarra,Konrad Karczewski,Jerzy Wasniewski,2010-07-12 This book constitutes the proceedings of the 8th International Conference on Parallel Processing and Applied Mathematics PPAM 2009 held in Wroclaw Poland in September 2009

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