

QUANTUM MECHANICS USING COMPUTER ALGEBRA

Includes sample programs for
REDUCE, MAPLE, MATHEMATICA and C++

Willi-Hans Steeb

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World Scientific

Quantum Mechanics Using Computer Algebra

**Vladimir P. Gerdt, Wolfram Koepf, Ernst
W. Mayr, Evgenii V. Vorozhtsov**



Quantum Mechanics Using Computer Algebra:

Quantum Mechanics Using Computer Algebra Willi-Hans Steeb, 1994 Solving problems in quantum mechanics is an essential skill and research activity for scientists engineers and others Nowadays the labor of scientific computation has been greatly eased by the advent of computer algebra packages These do not merely perform number crunching tasks but enable users to manipulate algebraic expressions and equations symbolically For example differentiation and integration can now be carried out algebraically by the computer This book collects standard and advanced methods in quantum mechanics and implements them using REDUCE a popular computer algebra package Throughout sample programs and their output have been displayed alongside explanatory text making the book easy to follow Selected problems have also been implemented using two other popular packages MATHEMATICA and MAPLE and in the object oriented programming language C Besides standard quantum mechanical techniques modern developments in quantum theory are also covered These include Fermi and Bose Operators coherent states gauge theory and quantum groups All the special functions relevant to quantum mechanics Hermite Chebyshev Legendre and more are implemented The level of presentation is such that one can get a sound grasp of computational techniques early on in one's scientific education A careful balance is struck between practical computation and the underlying mathematical concepts making the book well suited for use with quantum mechanics courses

Quantum Mechanics Using Computer Algebra: Includes Sample Programs In C++, Symbolic++, Maxima, Maple, And Mathematica (2nd Edition) Willi-hans Steeb, Yorick Hardy, 2010-03-24 Solving problems in quantum mechanics is an essential skill and research activity for physicists mathematicians engineers and others Nowadays the labor of scientific computation has been greatly eased by the advent of computer algebra packages which do not merely perform number crunching but also enable users to manipulate algebraic expressions and equations symbolically For example the manipulations of noncommutative operators differentiation and integration can now be carried out algebraically by the computer algebra package This book collects standard and advanced methods in quantum mechanics and implements them using SymbolicC and Maxima two popular computer algebra packages Throughout the sample programs and their outputs are accompanied with explanatory text of the underlying mathematics and physics explained in detail Selected problems have also been implemented using two other popular packages Mathematica and Maple while some problems are implemented in C Modern developments in quantum theory are covered extensively beyond the standard quantum mechanical techniques The new research topics added to this second edition are entanglement teleportation Berry phase Morse oscillator Magnus expansion wavelets Pauli and Clifford groups coupled Bose Fermi systems super Lie algebras etc Quantum Mechanics Using Computer Algebra Willi-hans Steeb, 1994 **Quantum Mechanics Using Computer Algebra** W.-H. Steeb, Yorick Hardy, 2010 This book collects standard and advanced methods in quantum mechanics and implements them using SymbolicC and Maxima two popular computer algebra packages Throughout the sample programs and their outputs are

accompanied with explanatory text of the underlying mathematics and physics explained in detail Selected problems have also been implemented using two other popular packages Mathematica and Maple while some problems are implemented in C

Quantum Mechanics Using Computer Algebra: Includes Sample Programs In C++, Symbolic++, Maxima, Maple, And Mathematica (2nd Edition) Willi-hans Steeb,Yorick Hardy,2010-03-24 Solving problems in quantum mechanics is an essential skill and research activity for physicists mathematicians engineers and others Nowadays the labor of scientific computation has been greatly eased by the advent of computer algebra packages which do not merely perform number crunching but also enable users to manipulate algebraic expressions and equations symbolically For example the manipulations of noncommutative operators differentiation and integration can now be carried out algebraically by the computer algebra package This book collects standard and advanced methods in quantum mechanics and implements them using SymbolicC and Maxima two popular computer algebra packages Throughout the sample programs and their outputs are accompanied with explanatory text of the underlying mathematics and physics explained in detail Selected problems have also been implemented using two other popular packages Mathematica and Maple while some problems are implemented in C Modern developments in quantum theory are covered extensively beyond the standard quantum mechanical techniques The new research topics added to this second edition are entanglement teleportation Berry phase Morse oscillator Magnus expansion wavelets Pauli and Clifford groups coupled Bose Fermi systems super Lie algebras etc

Quantum Mechanics Using Maple © Marko Horbatsch,2012-12-06 Quantum Mechanics Using Maple permits the study of quantum mechanics in a novel interactive way using the computer algebra and graphics system Maple V Usually the physics student is distracted from understanding the concepts of modern physics by the need to master unfamiliar mathematics at the same time In 39 guided Maple sessions the reader explores many standard quantum mechanics problems as well as some advanced topics that introduce approximation techniques A solid knowledge of Maple V is acquired as it applies to advanced mathematics relevant for engineering physics and applied mathematics The diskette contains 39 Maple V for Windows worksheet files to reproduce all the problems presented in the text The suggested exercises can be performed with a minimum of typing

SymbolicC++:An Introduction to Computer Algebra using Object-Oriented Programming Kiat Shi Tan,Willi-Hans Steeb,Yorick Hardy,2012-12-06 Symbolic C An Introduction to Computer Algebra Using Object Oriented Programming provides a concise introduction to C and object oriented programming using a step by step construction of a new object oriented designed computer algebra system Symbolic C It shows how object oriented programming can be used to implement a symbolic algebra system and how this can then be applied to different areas in mathematics and physics This second revised edition Explains the new powerful classes that have been added to Symbolic C Includes the Standard Template Library Extends the Java section Contains useful classes in scientific computation Contains extended coverage of Maple Mathematica Reduce and MuPAD

Computer Algebra With Symbolic++ Yorick Hardy,Willi-hans Steeb,Kiat Shi

Tan,2008-09-04 This book gives a comprehensive introduction to computer algebra together with advanced topics in this field It provides a detailed coverage of the mathematics of computer algebra as well as a step by step guide to implement a computer algebra system in the object oriented language C The used tools from C are introduced in detail Numerous examples from mathematics physics and engineering are presented to illustrate the system s capabilities Computer algebra implementations in LISP and Haskell are also included In addition gene expression programming and multiexpression programming with applications to computer algebra are introduced **Computer Algebra and Materials Physics** Akihito Kikuchi,2018-06-26 This book is intended as an introductory lecture in material physics in which the modern computational group theory and the electronic structure calculation are in collaboration The first part explains how to use computer algebra for applications in solid state simulation based on the GAP computer algebra package Computer algebra enables us to easily obtain various group theoretical properties such as the representations character tables and subgroups Furthermore it offers a new perspective on material design which could be executed in a mathematically rigorous and systematic way The second part then analyzes the relation between the structural symmetry and the electronic structure in C60 as an example of a system without periodicity The principal object of the study was to illustrate the hierarchical change in the quantum physical properties of the molecule which correlates to the reduction in the symmetry as it descends down in the ladder of subgroups The book also presents the computation of the vibrational modes of the C60 by means of the computer algebra In order to serve the common interests of researchers the details of the computations the required initial data and the small programs developed for the purpose are explained in as much detail as possible **Computerized Symbolic Manipulation in Mechanics** Edwin Kreuzer,2014-05-04 The aim of this book is to present important software tools basic concepts methods and highly sophisticated applications of computerized symbolic manipulation to mechanics problems An overview about general purpose symbolic software is followed by general guidelines how to develop and implement high quality computer algebra code The theoretical background including modeling techniques for mechanical systems is provided which allows for the computer aided generation of the symbolic equation of motion for multibody systems It is shown how the governing equations for different types of problems in structural mechanics can be automatically derived and how to implement finite element techniques via computer algebra software Perturbation methods as a very powerful approach for nonlinear problems are discussed in detail and are demonstrated for a number of applications The applications covered in this book represent some of the most advanced topics in the rapidly growing field of research on symbolic computation *Dynamical Systems and Applications* Ravi P. Agarwal,1995 World Scientific series in Applicable Analysis WSSIAA aims at reporting new developments of high mathematical standard and current interest Each volume in the series shall be devoted to the mathematical analysis that has been applied or potentially applicable to the solutions of scientific engineering and social problems For the past twenty five years there has been an explosion of interest in the study of nonlinear dynamical systems

Mathematical techniques developed during this period have been applied to important nonlinear problems ranging from physics and chemistry to ecology and economics All these developments have made dynamical systems theory an important and attractive branch of mathematics to scientists in many disciplines This rich mathematical subject has been partially represented in this collection of 45 papers by some of the leading researchers in the area This volume contains 45 state of art articles on the mathematical theory of dynamical systems by leading researchers It is hoped that this collection will lead new direction in this field Contributors B Abraham Shrauner V Afraimovich N U Ahmed B Aulbach E J Avila Vales F Battelli J M Blazquez L Block T A Burton R S Cantrell C Y Chan P Collet R Cushman M Denker F N Diacu Y H Ding N S A El Sharif J E Fornaess M Frankel R Galeeva A Galves V Gershkovich M Girardi L Gotusso J Graczyk Y Hino I Hoveijn V Hutson P B Kahn J Kato J Keesling S Keras V Kolmanovskii N V Minh V Mioc K Mischaikow M Misiurewicz J W Mooney M E Muldoon S Murakami M Muraskin A D Myshkis F Neuman J C Newby Y Nishiura Z Nitecki M Ohta G Osipenko N Ozalp M Pollicott Min Qu Donal O Regan E Romanenko V Roytburd L Shaikhet J Shidawara N Sibony W H Steeb C Stoica G Swiatek T Takaishi N D Thai Son R Triggiani A E Tuma E H Twizell M Urbanski T D Van A Vanderbauwhede A Veneziani G Vickers X Xiang T Young Y Zarmi

Computer Algebra in Quantum Field Theory Carsten Schneider, Johannes Blümlein, 2013-10-05 The book focuses on advanced computer algebra methods and special functions that have striking applications in the context of quantum field theory It presents the state of the art and new methods for infinite multiple sums multiple integrals in particular Feynman integrals difference and differential equations in the format of survey articles The presented techniques emerge from interdisciplinary fields mathematics computer science and theoretical physics the articles are written by mathematicians and physicists with the goal that both groups can learn from the other field including most recent developments Besides that the collection of articles also serves as an up to date handbook of available algorithms software that are commonly used or might be useful in the fields of mathematics physics or other sciences

Visual Quantum Mechanics Bernd Thaller, 2007-05-08 Visual Quantum Mechanics uses the computer generated animations found on the accompanying material on Springer Extras to introduce motivate and illustrate the concepts explained in the book While there are other books on the market that use Mathematica or Maple to teach quantum mechanics this book differs in that the text describes the mathematical and physical ideas of quantum mechanics in the conventional manner There is no special emphasis on computational physics or requirement that the reader know a symbolic computation package Despite the presentation of rather advanced topics the book requires only calculus making complicated results more comprehensible via visualization The material on Springer Extras provides easy access to more than 300 digital movies animated illustrations and interactive pictures This book along with its extra online materials forms a complete introductory course on spinless particles in one and two dimensions

Computer Algebra in Scientific Computing Vladimir P. Gerdt, Wolfram Koepf, Ernst W. Mayr, Evgenii V. Vorozhtsov, 2011-09-01 This book constitutes the refereed proceedings of the 13th International Workshop

on Computer Algebra in Scientific Computing CASC 2011 held in Kassel Germany in September 2011 The 26 full papers included in the book were carefully reviewed and selected from numerous submissions The articles are organized in topical sections on the development of object oriented computer algebra software for the modeling of algebraic structures as typed objects matrix algorithms the investigation with the aid of computer algebra the development of symbolic numerical algorithms and the application of symbolic computations in applied problems of physics mechanics social science and engineering

Problems And Solutions In Quantum Computing And Quantum Information (4th Edition) Willi-hans Steeb,Yorick Hardy,2018-02-13 This is a very useful book which helps to understand the concepts of quantum computing and quantum information by well presented problems and detailed solutions It is highly recommended for beginners as well as for advanced researchers zbMATHQuantum computing and quantum information are two of the fastest growing and most exciting research fields in physics Entanglement teleportation and the possibility of using the non local behavior of quantum mechanics to factor integers in random polynomial time have also added to this new interest This book presents a huge collection of problems in quantum computing and quantum information together with their detailed solutions which will prove to be invaluable to students as well as researchers in these fields Each chapter gives a comprehensive introduction to the topics All the important concepts and areas such as quantum gates and quantum circuits product Hilbert spaces entanglement and entanglement measures teleportation Bell states Bell measurement Bell inequality Schmidt decomposition quantum Fourier transform magic gate von Neumann entropy quantum cryptography quantum error corrections quantum games number states and Bose operators coherent states squeezed states Gaussian states coherent Bell states POVM measurement quantum optics networks beam splitter phase shifter and Kerr Hamilton operator are included A chapter on quantum channels has also been added Furthermore a chapter on boolean functions and quantum gates with mapping bits to qubits is included The topics range in difficulty from elementary to advanced Almost all problems are solved in detail and most of the problems are self contained Each chapter also contains supplementary problems to challenge the reader Programming problems with Maxima and SymbolicC implementations are also provided

Computer Algebra in Scientific Computing CASC'99 Victor G. Ganzha,Ernst W. Mayr,Evgenii V. Vorozhtsov,2012-12-06 The development of powerful computer algebra systems has considerably extended the scope of problems of scientific computing which can now be solved successfully with the aid of computers However as the field of applications of computer algebra in scientific computing becomes broader and more complex there is a danger of separation between theory systems and applications For this reason we felt the need to bring together the researchers who now apply the tools of computer algebra for the solution of problems in scientific computing in order to foster new and closer interactions CASC 99 is the second conference devoted to applications of computer algebra in scientific computing The first conference in this sequence CASC 98 was held 20-24 April 1998 in St Petersburg Russia This volume contains revised versions of the papers submitted by the participants and

accepted by the program committee after a thorough reviewing process The collection of papers included in the proceedings covers various topics of computer algebra methods algorithms and software applied to scientific computing symbolic numeric analysis and solving differential equations efficient computations with polynomials groups matrices and other related objects special purpose programming environments application to physics mechanics optics and to other areas In particular a significant group of papers deals with applications of computer algebra methods for the solution of current problems in group theory which mostly arise in mathematical physics

Applications of Computer Algebra Richard Pavelle, 2012-12-06 Today certain computer software systems exist which surpass the computational ability of researchers when their mathematical techniques are applied to many areas of science and engineering These computer systems can perform a large portion of the calculations seen in mathematical analysis Despite this massive power thousands of people use these systems as a routine resource for everyday calculations These software programs are commonly called Computer Algebra systems They have names such as MACSYMA MAPLE muMATH REDUCE and SMP They are receiving credit as a computational aid with increasing regularity in articles in the scientific and engineering literature When most people think about computers and scientific research these days they imagine a machine grinding away processing numbers arithmetically It is not generally realized that for a number of years computers have been performing non numeric computations This means for example that one inputs an equation and obtains a closed form analytic answer It is these Computer Algebra systems their capabilities and applications which are the subject of the papers in this volume

REDUCE for Physicists N MacDonald, 1994-01-01 The use of computer algebra systems in science and engineering has grown rapidly as more people realize their potential to solve tedious and extensive mathematical problems REDUCE for Physicists provides a comprehensive introduction to one of the most widely available and simple to use computer algebra systems focusing primarily on the needs of physicists As a means of performing symbolic computation REDUCE reduces tedious manual algebraic calculations and the dangers of casual errors Each chapter introduces some aspects of REDUCE and illustrates them with applications from various branches of physics including mechanics dynamics dimensional analysis quantum mechanics and plasma physics Emphasizing hands on work with REDUCE to tackle real physical problems the book includes exercises to test understanding throughout Students and researchers in the physical sciences and engineering using REDUCE for the first time will find this book an invaluable aid to learning

Hilbert Spaces, Wavelets, Generalised Functions and Modern Quantum Mechanics W.-H. Steeb, 2013-03-07 This book gives a comprehensive introduction to modern quantum mechanics emphasising the underlying Hilbert space theory and generalised function theory All the major modern techniques and approaches used in quantum mechanics are introduced such as Berry phase coherent and squeezed states quantum computing solitons and quantum mechanics Audience The book is suitable for graduate students in physics and mathematics

Clifford Algebras with Numeric and Symbolic Computations Rafal Ablamowicz, Joseph Parra, Pertti

Lounesto, 2012-12-06 Clifford algebras are at a crossing point in a variety of research areas including abstract algebra crystallography projective geometry quantum mechanics differential geometry and analysis For many researchers working in this field in mathematics and physics computer algebra software systems have become indispensable tools in theory and applications This edited survey book consists of 20 chapters showing application of Clifford algebra in quantum mechanics field theory spinor calculations projective geometry Hypercomplex algebra function theory and crystallography Many examples of computations performed with a variety of readily available software programs are presented in detail i.e. Maple Mathematica Axiom etc A key feature of the book is that it shows how scientific knowledge can advance with the use of computational tools and software

Reviewing **Quantum Mechanics Using Computer Algebra**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is actually astonishing. Within the pages of "**Quantum Mechanics Using Computer Algebra**," an enthralling opus penned by a highly acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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