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Numerical Quantum Dynamics

Wolfgang Schweizer

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W. Schweizer



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From Quantum to Classical Molecular Dynamics Christian Lubich, 2008 Quantum dynamics of molecules poses a variety of computational challenges that are presently at the forefront of research efforts in numerical analysis in a number of application areas high dimensional partial differential equations multiple scales highly oscillatory solutions and geometric structures such as

symplecticity and reversibility that are favourably preserved in discretizations This text addresses such problems in quantum mechanics from the viewpoint of numerical analysis illustrating them to a large extent on intermediate models between the Schrodinger equation of full many body quantum dynamics and the Newtonian equations of classical molecular dynamics The fruitful interplay between quantum dynamics and numerical analysis is emphasized

Quantum Dynamics for Classical Systems Fabio Bagarello, 2012-10-11 Introduces number operators with a focus on the relationship between quantum mechanics and social science Mathematics is increasingly applied to classical problems in finance biology economics and elsewhere Quantum Dynamics for Classical Systems describes how quantum tools the number operator in particular can be used to create dynamical systems in which the variables are operator valued functions and whose results explain the presented model The book presents mathematical results and their applications to concrete systems and discusses the methods used results obtained and techniques developed for the proofs of the results The central ideas of number operators are illuminated while avoiding excessive technicalities that are unnecessary for understanding and learning the various mathematical applications The presented dynamical systems address a variety of contexts and offer clear analyses and explanations of concluded results Additional features in Quantum Dynamics for Classical Systems include Applications across diverse fields including stock markets and population migration as well as a unique quantum perspective on these classes of models Illustrations of the use of creation and annihilation operators for classical problems Examples of the recent increase in research and literature on the many applications of quantum tools in applied mathematics Clarification on numerous misunderstandings and misnomers while shedding light on new approaches in the field Quantum Dynamics for Classical Systems is an ideal reference for researchers professionals and academics in applied mathematics economics physics biology and sociology The book is also excellent for courses in dynamical systems quantum mechanics and mathematical models

Computational Strong-Field Quantum Dynamics Dieter Bauer, 2017-04-24 This graduate textbook introduces the computational techniques to study ultra fast quantum dynamics of matter exposed to strong laser fields Coverage includes methods to propagate wavefunctions according to the time dependent Schrödinger Klein Gordon or Dirac equation the calculation of typical observables time dependent density functional theory multi configurational time dependent Hartree Fock time dependent configuration interaction singles the strong field approximation and the microscopic particle in cell approach Contents How to propagate a wavefunction Calculation of typical strong field observables Time dependent relativistic wave equations Numerics of the Dirac and the Klein Gordon equation Time dependent density functional theory The multiconfiguration time dependent Hartree Fock method Time dependent configuration interaction singles Strong field approximation and quantum orbits Microscopic particle in cell approach

Numerical Quantum Dynamics, 2013

Numerical Methods for Complex Quantum Dynamics with Applications to Quantum Biology and Quantum Many-body Dynamics Robert Rosenbach, 2015 Quantum Dynamic Imaging Andre D Bandrauk, Misha Ivanov, 2011-07-12 Studying and

using light or photons to image and then to control and transmit molecular information is among the most challenging and significant research fields to emerge in recent years. One of the fastest growing areas involves research in the temporal imaging of quantum phenomena ranging from molecular dynamics in the femto to 10¹⁵s time regime for atomic motion to the atto to 10¹⁸s time scale of electron motion. In fact, the attosecond revolution is now recognized as one of the most important recent breakthroughs and innovations in the science of the 21st century. A major participant in the development of ultrafast femto and attosecond temporal imaging of molecular quantum phenomena has been theory and numerical simulation of the nonlinear non-perturbative response of atoms and molecules to ultrashort laser pulses. Therefore, imaging quantum dynamics is a new frontier of science requiring advanced mathematical approaches for analyzing and solving spatial and temporal multidimensional partial differential equations such as Time Dependent Schrödinger Equations (TDSE) and Time Dependent Dirac equations (TDDs) for relativistic phenomena. These equations are also coupled to the photons in Maxwell's equations for collective propagation effects. Inversion of the experimental imaging data of quantum dynamics presents new mathematical challenges in the imaging of quantum wave coherences on subatomic/subnanometer spatial dimensions and multiple timescales from atto to femto and even nanoseconds. In Quantum Dynamic Imaging: Theoretical and Numerical Methods, leading researchers discuss these exciting state-of-the-art developments and their implications for R&D in view of the promise of quantum dynamic imaging science as the essential tool for controlling matter at the molecular level.

Theoretical Femtosecond Physics Frank Grossmann, 2008-07-24. This volume offers theoretical investigations of atoms and molecules interacting with pulsed or continuous wave lasers. Theoretical background is included and the text incorporates several exercises. Additional calculations are performed in the appendices. **Photochemistry** Stefano Crespi, Stefano Protti, 2024-12-18. Reviewing photo-induced processes that have relevance to a wide number of academic and commercial disciplines, this volume reflects the current interests in chemistry, physics, biology, and technology. Section one covers organic and computational aspects of photochemistry, while Section two highlights topics like photomagnetism in organic dyes, *in silico* photochemistry, and delayed fluorescence in photosynthetic systems. The final section covers the SPR lectures on photochemistry on photoredox catalysis in synthesis, perfluoroalkylation of aliphatic substrates via photoinduced radical processes, and photocycloadditions of aromatic compounds with alkenes. The volume continues to provide essential reading for postgraduates, academics, and industrialists working in the field of photochemistry, enabling them to keep on top of the literature.

Nuclear Science Abstracts, 1976. Theoretical Chemistry Accounts Christopher Cramer, D.G. Truhlar, 2013-11-11. For the New Century Issue of the journal *Theoretical Chemistry Accounts*, the advisory editors identified papers from the first century of theoretical chemistry and discussed their importance for the twentieth century with an eye towards the twenty-first century. Sixty-six such perspectives are published in the New Century Issue. To make this unique collection available to younger scientists for entertaining reading and re-reading of the original publications, the publisher

decided to reprint a special edition of the issue **Physics Of Clusters** Gennady N Chuev,V D Lakhno,1998-08-25 The monograph is devoted to the relatively new and fast developing field of cluster physics It is based on talks given at the Cluster Workshops which were held in Pushchino in 1995 and 1996 The reports focus not only on the fundamental physical properties of clusters such as their geometric and electronic structure as well as optical thermal and magnetic properties but also on a broad spectrum of their potential applications These include nucleation and growth of small particles fabrication of new materials with predefined properties cluster assembled and nanostructures Some aspects of simulations and calculations of small particles and clusters are also discussed We hope that our monograph will be of interest to a broad range of readers who will be able to sense the excitement of the talks Quantum Dynamics with Trajectories Robert E. Wyatt,2005-05-20 This is a rapidly developing field to which the author is a leading contributor New methods in quantum dynamics and computational techniques with applications to interesting physical problems are brought together in this book Useful to both students and researchers **Third International Conference on Mathematical and Numerical Aspects of Wave Propagation** Gary C. Cohen,1995-01-01 This volume contains the papers presented at the title conference Speakers from 13 different countries were represented at the meeting A broad range of topics in theoretical and applied wave propagation is covered **Quantum Dynamic Imaging** Andre D. Bandrauk,Misha Ivanov,2011-07-12 Studying and using light or photons to image and then to control and transmit molecular information is among the most challenging and significant research fields to emerge in recent years One of the fastest growing areas involves research in the temporal imaging of quantum phenomena ranging from molecular dynamics in the femto 10¹⁵s time regime for atomic motion to the atto 10¹⁸s time scale of electron motion In fact the attosecond revolution is now recognized as one of the most important recent breakthroughs and innovations in the science of the 21st century A major participant in the development of ultrafast femto and attosecond temporal imaging of molecular quantum phenomena has been theory and numerical simulation of the nonlinear non perturbative response of atoms and molecules to ultrashort laser pulses Therefore imaging quantum dynamics is a new frontier of science requiring advanced mathematical approaches for analyzing and solving spatial and temporal multidimensional partial differential equations such as Time Dependent Schroedinger Equations TDSE and Time Dependent Dirac equations TDDEs for relativistic phenomena These equations are also coupled to the photons in Maxwell s equations for collective propagation effects Inversion of the experimental imaging data of quantum dynamics presents new mathematical challenges in the imaging of quantum wave coherences on subatomic subnanometer spatial dimensions and multiple timescales from atto to femto and even nanoseconds In Quantum Dynamic Imaging Theoretical and Numerical Methods leading researchers discuss these exciting state of the art developments and their implications for R D in view of the promise of quantum dynamic imaging science as the essential tool for controlling matter at the molecular level *Numerical Methods for Hyperbolic and Kinetic Problems* Stéphane Cordier,2005 Hyperbolic and kinetic equations arise in a large

variety of industrial problems For this reason the Summer Mathematical Research Center on Scientific Computing and its Applications CEMRACS held at the Center of International Research in Mathematics CIRM in Luminy was devoted to this topic During a six week period junior and senior researchers worked full time on several projects proposed by industry and academia Most of this work was completed later on and the present book reflects these results The articles address modelling issues as well as the development and comparisons of numerical methods in different situations The applications include multi phase flows plasma physics quantum particle dynamics radiative transfer sprays and aeroacoustics The text is aimed at researchers and engineers interested in applications arising from modelling and numerical simulation of hyperbolic and kinetic problems

The New Quantum Mechanics George Birtwistle,1928 **Numerical Grid Methods and Their Application to Schrödinger's Equation** C. Cerjan,1993-07-31 This book offers a unique perspective on the rapidly growing field of numerical grid methods applied to the solution of the Schrödinger equation Several articles provide comprehensive reviews of the discrete variable and pseudo spectral operator representation The applications include sophisticated refinements of the basic approaches with emphasis on successful parallel implementation The range of problems considered is broad including reactive scattering photoexcitation processes mixed quantum classical methodology and density functional electronic structure calculations The book thus serves as a direct introduction to numerical grid methods and as a guide to future research

Wave Mechanics and the New Quantum Theory Arthur Erich Haas,1928

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