

1. Record Nr.	UNINA9911019734203321
Autore	Chattaraj Pratim Kumar
Titolo	Electron Density : Concepts, Computation and DFT Applications
Pubbl/distr/stampa	Newark : , : John Wiley & Sons, Incorporated, , 2024 ©2024
ISBN	9781394217656 139421765X 9781394217632 1394217633
Edizione	[1st ed.]
Descrizione fisica	1 online resource (611 pages)
Altri autori (Persone)	ChakrabortyDebdutta
Disciplina	539.72112
Soggetti	Density functionals Electron distribution
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Nota di contenuto	Cover -- Title Page -- Copyright -- Contents -- List of Contributors -- Preface -- Chapter 1 Levy-Perdew-Sahni Equation and the Kohn-Sham Inversion Problem -- 1.1 Introduction -- 1.2 One Equation & -- xrArr -- Several Methods -- Universal Nature of Different Density Based Kohn-Sham Inversion Algorithms -- 1.2.1 Generating Functional S[] of DensityBased Kohn-Sham Inversion -- 1.2.2 Condition on Generating Functional S[] -- 1.2.3 Examples of Different Generating Functionals -- 1.2.4 Application to Spherical Systems -- 1.2.5 Using Random Numbers to do DensitytoPotential Inversion -- 1.3 General Penalty Method for DensitytoPotential Inversion -- 1.4 Understanding Connection Between Density and WavefunctionBased Inversion Methods Using LPS Equation -- 1.5 Concluding Remarks -- Acknowledgments -- References -- Chapter 2 Electron Density, Density Functional Theory, and Chemical Concepts -- 2.1 Introduction -- 2.2 Viewing Chemical Concepts Through a DFT Window -- 2.3 Electron Fluid, Quantum Fluid Dynamics, Electronic Entropy, and a Local Thermodynamic Picture -- 2.4 Miscellaneous Offshoots from Electron Density Experience -- 2.5 Concluding Remarks -- Acknowledgments -- References -- Chapter 3 Local and Nonlocal Descriptors of the Site

and Bond Chemical Reactivity of Molecules -- 3.1 Introduction -- 3.2 Local and Nonlocal Reactivity Indexes -- 3.3 Site and Bond Reactivities -- 3.4 Concluding Remarks -- Acknowledgment -- References -- Chapter 4 Relativistic Treatment of ManyElectron Systems Through DFT in CCG -- 4.1 Introduction -- 4.2 Theoretical Framework -- 4.2.1 Dirac Equation -- 4.2.2 Relativistic Density Functional Theory: Dirac-Kohn-Sham Method -- 4.2.3 Decoupling of Dirac Hamiltonian: DKH Methodology -- 4.2.4 DFT in Cartesian Grid -- 4.2.4.1 Basic Methodology -- 4.2.4.2 Hartree Potential in CCG. 4.2.4.3 Hartree Fock Exchange Through FCT in CCG -- 4.2.4.4 Orbital Dependent Hybrid Functionals via RSFCT -- 4.3 Computational Details -- 4.4 Results and Discussion -- 4.4.1 OneElectron Atoms -- 4.4.2 ManyElectron Systems -- 4.4.2.1 Grid Optimization -- 4.4.2.2 Ground State Energy of Atoms and Molecules -- 4.4.3 Application to Highly Charged Ions: He and Lilsoelectronic Series -- 4.5 Future and Outlook -- Acknowledgement -- References -- Chapter 5 Relativistic Reduced Density Matrices: Properties and Applications -- 5.1 Introduction -- 5.2 Relativistic OneBody Reduced Density Matrix -- 5.3 Properties of Relativistic 1RDM -- 5.3.1 Natural Spinors: An Efficient Framework for Lowcost Calculations -- 5.3.1.1 Correlation Energy -- 5.3.1.2 Bond Length and Harmonic Vibrational Frequency -- 5.3.2 Natural Spinors as an Interpretive Tool -- 5.4 Concluding Remarks -- Acknowledgments -- References -- Chapter 6 ManyBody MultiConfigurational Calculation Using Coulomb Green's Function -- 6.1 Introduction -- 6.2 Theoretical Development -- 6.2.1 Presence of Magnetic Field -- 6.2.1.1 3D Electron Gas Model -- 6.2.1.2 2D Electron Gas Model -- 6.2.1.3 3D Exciton Model -- 6.2.1.4 2D Exciton Model -- 6.2.2 Absence of Magnetic Field -- 6.2.2.1 3D Helsoelectronic Ions -- 6.2.2.2 2D He Isoelectronic Ions -- 6.2.2.3 Energy Calculation Through Perturbation -- 6.2.2.4 Current Density of 2e System -- 6.3 Results and Discussion -- 6.3.1 3D Interacting Electron Gas -- 6.3.2 2D Interacting Electron Gas -- 6.3.3 3D Exciton Complexes -- 6.3.4 2D Exciton Complexes -- 6.3.5 3D Helsoelectronic Species -- 6.3.5.1 Analysis of E0(2) of He Isoelectronic Ions -- 6.3.5.2 Analysis of E0(3) of Helsoelectronic Ions -- 6.3.6 2D Helsoelectronic Species -- 6.4 Concluding Remarks -- Acknowledgments -- References -- Chapter 7 Excited State Electronic Structure-Effect of Environment. 7.1 Introduction -- 7.2 Methodology -- 7.2.1 Quantum Mechanical Methods -- 7.2.1.1 TimeDependent Density Functional Theory -- 7.2.1.2 Active SpaceBased Methods -- 7.2.1.3 Configuration InteractionBased Approaches -- 7.2.1.4 Equation of Motion Coupled Cluster -- 7.2.2 Molecular Mechanical Methods -- 7.2.2.1 ONIOM -- 7.2.2.2 Mechanical Embedding -- 7.2.2.3 Electronic Embedding -- 7.2.2.4 Polarizable Embedding -- 7.3 Representative Examples -- 7.3.1 Photoisomerization of Rhodopsin -- 7.3.2 DNABase Excited States in Solution -- 7.3.3 Green Fluorescent Proteins -- 7.4 Conclusion -- Acknowledgement -- References -- Chapter 8 Electron Density in the Multiscale Treatment of Biomolecules -- 8.1 Introduction -- 8.2 Theoretical Background -- 8.2.1 Hybrid Quantum Mechanics-Molecular Mechanics Approach -- 8.3 Polarizable Density Embedding -- 8.4 MultiScale QM/MM with Extremely Localized Molecular Orbitals -- 8.5 Multiple Active Zones in QM/MM Modelling -- 8.6 Reactivity Descriptors with QM/MM Modeling -- 8.7 Treatment of Hydrogen Bonding with QM/MM -- 8.8 Quantum Refinement of Crystal Structure with QM/MM -- 8.9 Concluding Remarks -- Acknowledgments -- References -- Chapter 9 Subsystem Communications and Electron Correlation -- 9.1 Introduction -- 9.2 Discrete and Local Probability Networks in Molecular Bond Systems -- 9.3 Bond Descriptors of

Molecular Communication Channels -- 9.4 Hartree-Fock
 Communications and Fermi Correlation -- 9.5 Communication
 Partitioning of TwoElectron Probabilities -- 9.6 Communications in
 Interacting Subsystems -- 9.7 Illustrative Application to Reaction HSAB
 Principle -- 9.8 Conclusion -- References -- Chapter 10 Impacts of
 External Electric Fields on Aromaticity and Acidity for Benzoic Acid and
 Derivatives: Directionality, Additivity, and More -- 10.1 Introduction --
 10.2 Methodology -- 10.3 Computational Details.
 10.4 Results and Discussion -- 10.5 Conclusions -- Acknowledgments
 -- References -- Chapter 11 A Divergence and Rotational Component
 in Chemical Potential During Reactions -- 11.1 Introduction -- 11.2
 Chemical Descriptors -- 11.3 Charge and Energy Exchange -- 11.4
 Fitness Landscape Diagrams -- 11.5 Chemical Reactions -- 11.6
 Examining the Charge Exchange -- 11.6.1 Path $p()$ and Charge
 Exchange -- 11.6.2 Systematic Changes Depending on the Starting
 Points on $p()$ -- 11.6.3 Specific Solutions Using a p Path -- 11.7
 Significance and Applications -- 11.8 Conclusions --
 Acknowledgments -- References -- Chapter 12 Deep Learning of
 Electron Density for Predicting Energies: The Case of Boron Clusters --
 12.1 Introduction -- 12.2 Deep Learning of Electron Density -- 12.3
 Neural Networks for Neutral Boron Clusters -- 12.4 Concluding
 Remarks -- Acknowledgements -- References -- Chapter 13 Density
 Based Description of Molecular Polarizability for Complex Systems --
 13.1 Introduction -- 13.2 Methodology and Computations -- 13.2.1
 InformationTheoretic Approach (ITA) Quantities -- 13.2.2 The GEBF
 Method -- 13.3 Results and Discussion -- 13.4 Conclusions and
 Perspectives -- Acknowledgment -- References -- Chapter 14
 Conceptual Density Functional TheoryBased Study of Pure and TMs
 Doped CdX (X & equals -- S, Se, Te -- TMs & equals --
 Cu, Ag, and Au) Nano Cluster for Water Splitting and Spintronic
 Applications -- 14.1 Introduction -- 14.2 Methodology -- 14.3 Results
 and Discussion -- 14.3.1 Electronic Properties and CDFTBased
 Descriptors -- 14.4 Conclusion -- Acknowledgments -- Funding --
 References -- Chapter 15 "Phylogenetic" Screening of External Potential
 Related Response Functions -- 15.1 Introduction -- 15.2 Alchemical
 Approach -- 15.3 The "Family Tree" -- 15.4 Firstorder Sensitivities --
 15.5 SecondOrder Sensitivities.
 15.5.1 Electric Dipole Polarizability -- 15.5.2 "Polarizability
 Potential" - Local Polarization -- 15.6 Alchemical Hardness -- 15.6.1
 Local Alchemical Hardness -- 15.7 Alchemical Characteristic Radius --
 15.8 Linear Response Function -- 15.9 Conclusions -- References --
 Chapter 16 On the Nature of Catastrophe Unfoldings Along the Diels-
 Alder Cycloaddition Pathway -- 16.1 Introduction -- 16.2 Molecular
 Symmetry and Elementary Catastrophe Unfoldings -- 16.2.1 The Case
 of Normal and InverseElectronDemand Diels-Alder Reactions --
 16.2.2 The C C Bond Breaking in a High Symmetry Environment --
 16.2.3 The Photochemical Ring Opening of 1,3Cyclohexadiene -- 16.3
 Concluding Remarks -- Acknowledgments -- References -- Chapter 17
 Designing Principles for Ultrashort HH Nonbonded Contacts and
 Ultralong C C Bonds -- 17.1 Introduction -- 17.1.1 The Art of the
 Chemical Bond -- 17.1.2 Designing and Decoding Chemical Bond --
 17.2 Governing Factors for Ultrashort HH Nonbonded Contacts --
 17.2.1 London Dispersion Interaction -- 17.2.2 Polarity and Charge
 Separation -- 17.2.3 Conformations and Orientations -- 17.2.4 Iron
 Maiden Effect -- 17.3 Elongation Strategies for C C Bonds -- 17.3.1
 Steric Crowding Effect -- 17.3.2 Core-Shell Strategy and Scissor Effect
 -- 17.3.3 Negative Hyperconjugation Effect -- 17.4 Concluding
 Remarks -- Acknowledgments -- References -- Chapter 18 Accurate

Determination of Materials Properties: Role of Electron Density -- 18.1
Introduction -- 18.2 Materials Properties: Structure and Electronic
Properties -- 18.2.1 Classification of Materials -- 18.2.2 Electronic
Properties of Materials -- 18.3 Molecules to Materials, Essential Role of
Electron Density -- 18.3.1 The Density Functional Theory (DFT) --
18.3.2 The Hohenberg-Kohn Theorems -- 18.3.3 The Hohenberg-
Kohn Variational Theorems -- 18.3.4 The Kohn-Sham (KS) Method.
18.3.5 Local Density Approximation.

Sommario/riassunto

This book delves into the advanced concepts of electron density and its applications in Density Functional Theory (DFT). It covers various aspects of DFT, including computational techniques, chemical reactivity descriptors, and the impact of electron density on molecular properties. The text is a collaborative work by experts from the Birla Institute of Technology and other institutions, providing insights into the role of electron density in chemical processes and material properties. It is intended for researchers and students in chemistry and material science, offering both theoretical and practical knowledge in the field.
