

Second Quantization

- Second quantization is one of the most useful representations in many-body theory
- Creation and annihilation operators
 - Denote $|0\rangle$ as the state with no particles (the vacuum)
 - $a_i^\dagger$ creates a particle in state i : $a_i^\dagger|0\rangle = |i\rangle$, $a_i^\dagger|i\rangle = 0$
 - a_i annihilates a particle in state i : $a_i|i\rangle = |0\rangle$; $a_i|0\rangle = 0$
 - Anti-commutation relations:

$$\{a_i^\dagger, a_j^\dagger\} = \{a_i, a_j\} = 0$$

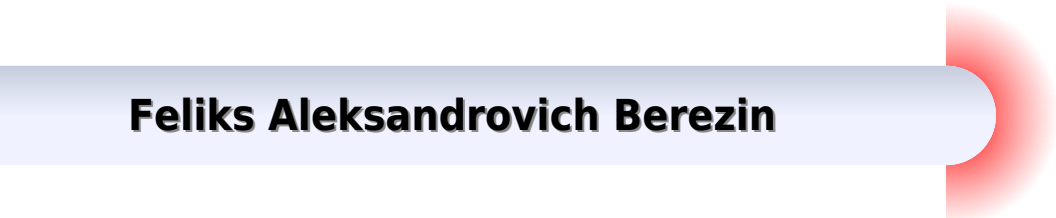
$$\{a_i, a_j^\dagger\} = \{a_j^\dagger, a_i\} = \delta_{ij}$$

- Many-body Slater determinant

$$\Phi = \frac{1}{\sqrt{A!}} \begin{vmatrix} \phi_i(\mathbf{r}_1) & \phi_i(\mathbf{r}_2) & \dots & \phi_i(\mathbf{r}_A) \\ \phi_j(\mathbf{r}_1) & \phi_j(\mathbf{r}_2) & & \phi_j(\mathbf{r}_A) \\ & \vdots & \ddots & \vdots \\ \phi_l(\mathbf{r}_1) & \phi_l(\mathbf{r}_2) & \dots & \phi_l(\mathbf{r}_A) \end{vmatrix} = \underbrace{a_i^\dagger \dots a_j^\dagger a_l^\dagger}_{l > \dots > j > i} |0\rangle$$

Method Of Second Quantization

Feliks Aleksandrovich Berezin



Method Of Second Quantization:

The Method of Second Quantization F.A. Berazin, 2012-12-02 The Method of Second Quantization deals with the method of second quantization and its use to solve problems of quantum mechanics involving an indefinite number of particles mainly in field theory and quantum statistics Topics covered include operations on generating functionals linear canonical transformations quadratic operators and Thirring's four fermion model State spaces and the simplest operators are also described This book is comprised of four chapters and begins with an overview of the method of second quantization and the relevant notations The first chapter focuses on the connections between vectors and functionals and between operators and functionals together with fundamental rules for operating on functionals The reader is then introduced to the so called quadratic operators and the linear canonical transformations closely connected with them Quadratic operators reduced and not reduced to normal form are considered The final chapter discusses the Thirring model the simplest relativistically invariant model in quantum field theory and explains why it includes infinities This monograph will be of value to students and practitioners of mathematical physics The Method of Second Quantization Feliks A. Berezin, 1966 *Second*

Quantization-Based Methods in Quantum Chemistry Poul Joergensen, 2012-12-02 Second Quantization Based Methods in Quantum Chemistry presents several modern quantum chemical tools that are being applied to electronic states of atoms and molecules Organized into six chapters the book emphasizes the quantum chemical methods whose developments and implementations have been presented in the language of second quantization The opening chapter of the book examines the representation of the electronic Hamiltonian other quantum mechanical operators and state vectors in the second quantization language This chapter also describes the unitary transformations among orthonormal orbitals in an especially convenient manner In subsequent chapters various tools of second quantization are used to describe many approximation techniques such as Hartree Fock perturbation theory configuration interaction multiconfigurational Hartree Fock cluster methods and Green's function This book is an invaluable source for researchers in quantum chemistry and for graduate level students who have already taken introductory courses that cover the fundamentals of quantum mechanics through the Hartree Fock method as applied to atoms and molecules *The Method of Second Quantization* Daniel J. Weintraub, 1966

Brillouin-Wigner Methods for Many-Body Systems Stephen Wilson, Ivan Hubac, 2009-12-01 Brillouin Wigner Methods for Many Body Systems gives an introduction to many body methods in electronic structure theory for the graduate student and post doctoral researcher It provides researchers in many body physics and theoretical chemistry with an account of Brillouin Wigner methodology as it has been developed in recent years to handle the multireference correlation problem Moreover the frontiers of this research field are defined This volume is of interest to atomic and molecular physicists physical chemists and chemical physicists quantum chemists and condensed matter theorists computational chemists and applied mathematicians Condensed Matter Field Theory Alexander Altland, Ben Simons, 2006-06 Primer including problems and

solutions for graduate level courses on theoretical quantum condensed matter physics *The method of second quantization*, tr Feliks Aleksandrovich Berezin, *A Course on Many-body Theory Applied to Solid-state Physics* Charles Paul Enz, 1992 The main aim of this book is to give a self contained and representative cross section through present day research in solid state physics This covers metallic and mesoscopic transport localization by disorder and superconductivity including questions related to high temperature superconductors and to heavy fermion systems An important part of the book is devoted to itinerant electron magnetism discussing paramagnons strong correlation magnetization fluctuations and spin density waves All the formal tools used in these chapters are developed in the first part of the book which contains a thorough discussion of second quantization and of perturbation theory for an arbitrary complex time path and also describes the functional approach to Feynman diagrams including general ward identities Each chapter contains an extensive list of the relevant literature and a series of problems with detailed solutions which complement the main text The book is meant both as a course and a research tool **Felix Berezin** Mikhail A. Shifman, 2007 Felix Berezin was an outstanding Soviet mathematician who in the 1960s and 70s was the driving force behind the emergence of the branch of mathematics now known as supermathematics The integral over the anticommuting Grassmann variables that he introduced in the 1960s laid the foundation for the path integral formulation of quantum field theory with fermions the heart of modern supersymmetric field theories and superstrings The Berezin integral is named for him as is the closely related construction of the Berezinian which may be regarded as the superanalog of the determinant This book features a masterfully written memoir by Berezin's widow Elena Karpel who narrates a remarkable account of Berezin's life and his struggle for survival under the totalitarian Soviet regime Supplemented with recollections by his close friends and colleagues Berezin's accomplishments in mathematics his novel ideas and breakthrough works are reviewed in two articles written by Andrei Losev and Robert Minlos [The Non-Equilibrium Green's Function Method for Nanoscale Device Simulation](#) Mahdi Pourfath, 2014-07-05 For modeling the transport of carriers in nanoscale devices a Green function formalism is the most accurate approach Due to the complexity of the formalism one should have a deep understanding of the underlying principles and use smart approximations and numerical methods for solving the kinetic equations at a reasonable computational time In this book the required concepts from quantum and statistical mechanics and numerical methods for calculating Green functions are presented The Green function is studied in detail for systems both under equilibrium and under nonequilibrium conditions Because the formalism enables rigorous modeling of different scattering mechanisms in terms of self energies but an exact evaluation of self energies for realistic systems is not possible their approximation and inclusion in the quantum kinetic equations of the Green functions are elaborated All the elements of the kinetic equations which are the device Hamiltonian contact self energies and scattering self energies are examined and efficient methods for their evaluation are explained Finally the application of these methods to study novel electronic devices such as nanotubes graphene Si

nanowires and low dimensional thermoelectric devices and photodetectors are discussed

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