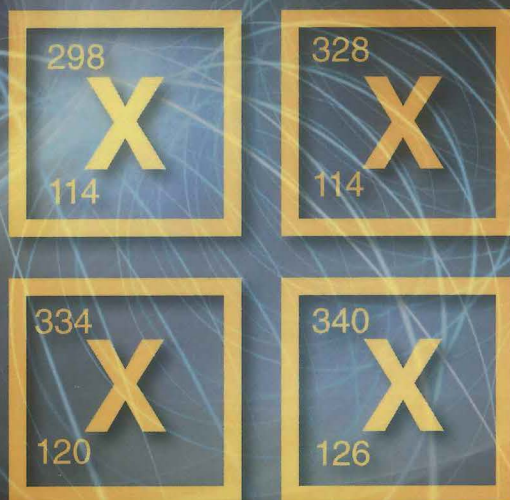


Arvydas Juozapas Janavičius • Donatas Jurgaitis



Quantum Mechanics in Potential Representation and Applications

สำนักหอสมุดมหาวิทยาลัยเชียงใหม่

fb4
3087

.b1648880
020622
122895672

Quantum Mechanics in Potential Representation and Applications



Arvydas Juozapas Janavičius
Donatas Jurgaitis
Šiauliai University, Lithuania

 **World Scientific**

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI • TOKYO

Contents

<i>Preface</i>	v
<i>Introduction</i>	vii
Chapter 1: Quantum Nature of the Matter	1
1.1 The Structure of Atoms	1
1.2 The Schrödinger Equation	4
1.3 The Fundamental Forces	7
References	13
Chapter 2: Quantum Waves and Particles	
Diffusion in Physical Vacuum	15
2.1 Introduction	15
2.2 Diffusion of Quantum Waves	16
2.3 The Quantum Diffusion of an Electron in the Hydrogen Atom	21
2.4 Solution of the Quantum Diffusion Equation for the Tunnel Effect for a Rectangular Barrier	24
2.5 Conclusions	27
References	28
Chapter 3: Nuclear Forces	29
3.1 The Interactions between Nucleons	29
3.2 The Shell Model and Mean Field Potentials	34
References	42

Chapter 4: Systems of Micro Particles	43
References	50
Chapter 5: The Scattering Theory and Nuclear Reactions	51
5.1 Introduction	51
5.2 Nuclear Reactions and the Optical Model	56
5.3 Inverse Tasks of Scattering	62
References	64
Chapter 6: The Schrödinger Equation in Potential Representation	65
6.1 Introduction	65
6.2 Solution in the Case of s-Waves	66
6.3 The Case of Large Nuclei	68
6.4 Numerical Results and Conclusions	71
References	73
Chapter 7: A General Solution of the Schrödinger Equation	75
7.1 Introduction	75
7.2 General Solution	77
7.3 Numerical Results and Conclusions	79
References	81
Chapter 8: The General Solutions for Positive and Negative Energies	83
8.1 Introduction	83
8.2 The Integral Equation for Positive Energies in the Potential Representation	85
8.3 The Integral Equation for Negative Energies in the Potential Representation	87
8.4 Numerical Results and Conclusions	89
References	91

Chapter 9: The Connection between Scattering Matrices for Different Potentials	93
9.1 Introduction	93
9.2 Integral Equations for Positive Energies	94
9.3 Connection of Potential Representation Method with Green's Functions	97
9.4 The Scattering Matrix	98
References	100
Chapter 10: The Separation of the Scattering Matrix from the Coulomb Field	101
10.1 Introduction	101
10.2 Obtaining Integral Equations	102
10.3 Obtaining the Scattering Matrix	106
References	107
Chapter 11: The General Solution for Bound States of the Woods–Saxon Potential	109
11.1 Introduction	109
11.2 The Derivation of Integral Equations	111
11.3 The Accuracy and Convergence of the Obtained Solutions	115
11.4 Conclusions	117
References	118
Chapter 12: The Perturbation Theory for Bound States	119
12.1 Introduction	119
12.2 Standard Green's Functions	123
References	124
Chapter 13: The Perturbation Method of Variation of Free Constants	125
13.1 Green's and Undefined Functions	125
References	128

Chapter 14: Green's Functions and Non-physical Solutions	129
14.1 Introduction	129
14.2 Non-physical Solutions of the Radial Schrödinger Equation	130
14.3 Derivation of the Integral Equation	132
14.4 Results and Conclusions	134
References	136
Chapter 15: The Potential Representation Method for Non-spherical Perturbations	139
15.1 Introduction	139
15.2 Integral Equations for Negative Energies in the Potential Representation	140
References	147
Chapter 16: Solutions with the Model Potential for the Potential Representation Method	149
16.1 Introduction	149
16.2 Modelling the Solutions of the Schrödinger Equation with the Harmonic Oscillator Potential	150
16.3 Green's Functions for the Potential Representation	152
16.4 The Accuracy of the Solutions Obtained	154
16.5 Conclusions	158
References	159
Chapter 17: Potential Representation for the Coulomb Interactions	161
17.1 Introduction	161
17.2 Bounded Systems: The Two-Body Task	162
17.3 The Many-Particles Task	168

17.4	Solution for the Ground State of the Helium Atom	169
17.5	Variation According to the Parameter Z	171
	References	173
Chapter 18: Transformations of the Hamiltonian for Jastrow's Correlation Method		175
18.1	Introduction	175
18.2	Transformation of the Hamiltonian for He Atom	177
18.3	Conclusions	180
	References	181
Chapter 19: Stability of Nuclei		183
	References	188
Chapter 20: Relativistic Corrections for Neutrons in the Harmonic Oscillator Well		189
20.1	Introduction	189
20.2	The Semi-relativistic Hamiltonian	190
20.3	Results and Conclusions	191
	References	192
Chapter 21: Relativistic Corrections to One-Nucleon Energy Levels for ^{208}Pb		193
21.1	Introduction	193
21.2	Semi-relativistic Equation	194
21.3	Methods and Results	196
21.4	Conclusions	199
	References	200
Chapter 22: Solutions for the Semi-relativistic Equations for the Heaviest Nuclei		201
22.1	Introduction	201

22.2	The Integral–Differential Semi-relativistic Equation	203
22.3	Results and Conclusions	206
	References	209
Chapter 23: Stability of the Shells of the Heaviest Atomic Nuclei in the Semi-relativistic Model		211
23.1	Introduction	211
23.2	The Integral–Differential Semi-relativistic Equation	213
23.3	Results and Conclusions	215
	References	220
Chapter 24: The Semi-relativistic Nuclear Shell Model for the Many-Particles Case		221
24.1	Introduction	221
24.2	The Solutions of Integral–Differential Semi-relativistic Equation for the Singular Potentials	224
24.3	The System of Integral Semi-relativistic Equations in the Hartree–Fock Approach	225
24.4	Conclusions	228
	References	228
Chapter 25: Relativistic Corrections for Different States of the Charmed and Bottom Mesons		229
25.1	Introduction	229
25.2	The Solutions of the Integral–Differential Semi-relativistic Equation	231
25.3	The Approximate System of Integral Semi-relativistic Equations	233

25.4	Semi-relativistic Model for Charmonium and Bottomonium	235
25.5	Conclusions	239
	References	241
	<i>Bibliography of the Authors</i>	243
	<i>Index</i>	247