

Contents

1	INTRODUCTION	1
2	HIDDEN AND DYNAMICAL SYMMETRIES OF ATOMS AND MOLECULES	5
2.1	Rigid Rotator	8
2.2	Hydrogen atom and Runge-Lenz vector	10
2.3	Dynamical symmetries for spin systems	15
2.4	Hubbard atom and Fulde molecule	23
2.4.1	Three-fold way for Hubbard atom	29
2.5	Fock – Darwin atom	31
2.6	Dynamical symmetry and supersymmetry	35
2.6.1	Manifestations of supersymmetry in atomic models	39
2.7	Quasienergy spectrum for periodical time-dependent problems	45
3	NANOSTRUCTURES AS ARTIFICIAL ATOMS AND MOLECULES	49
3.1	Introductory remarks	49
3.2	Planar quantum dots	51
3.3	Vertical quantum dots	61
3.4	Self-assembled quantum dots	66
3.5	Complex quantum dots	70
3.5.1	Double quantum dots	72
3.5.2	Triple quantum dots	80
3.6	Molecules and molecular complexes	91
3.6.1	Fullerene molecules as quantum dots	93
3.6.2	Nanotubes as quantum dots	95
3.6.3	Single electron tunneling through metal organic complexes	96
3.6.4	Vibrational degrees of freedom in single molecular tunneling	101

4	DYNAMICAL SYMMETRIES IN THE KONDO EFFECT	107
4.1	Kondo mapping and beyond (surplus symmetries)	108
4.2	Kondo effect in quantum dots with even occupation	126
4.3	Kondo physics for short chains	136
4.3.1	Serial geometry	137
4.3.2	Side geometry, Fano – Kondo effect	147
4.3.3	Cross geometry	156
4.3.4	Parallel geometry	160
4.3.5	Multichannel Kondo tunneling	162
4.4	Kondo physics for small rings	179
4.4.1	Kondo tunneling and Aharonov – Bohm interference	190
5	DYNAMICAL SYMMETRIES IN MOLECULAR ELECTRONICS	197
5.1	Kondo effect in molecular environment	197
5.1.1	Chiral symmetry of orbitals and Kondo tunneling	199
5.1.2	Kondo effect in the presence of Thomas-Rashba precession	201
5.1.3	Scanning tunneling spectroscopy via Kondo impurities	206
5.2	Kondo effect in molecular magnets	211
5.3	Phonon assisted tunneling	217
5.3.1	Two-electron tunneling at strong electron-phonon coupling	227
6	DYNAMICAL SYMMETRIES AND SPECTROSCOPY OF QUANTUM DOTS	233
6.1	Kondo effect in the presence of electromagnetic field	234
6.2	Excitonic spectroscopy of quantum dots	240
7	DYNAMICAL SYMMETRIES AND NON-EQUILIBRIUM ELECTRON TRANSPORT	245
7.1	Dynamically induced finite bias anomalies in tunneling spectra	248
7.2	Dephasing and decoherence in quantum tunneling	258
7.2.1	Vector Keldysh model in the time domain	276
8	TUNNELING THROUGH MOVING NANOOBJECTS	283
8.1	Conversion of coherent charge input into the Kondo response	286
8.1.1	Single-electron shuttling	290
8.2	Time-dependent Landau-Zener effect	292
9	MATHEMATICAL INSTRUMENTATION	309
9.1	$SU(2)$ group for arbitrary spin	309
9.2	Kinematical constraints for systems with $SO(n)$ and $SU(n)$ symmetries	311
9.2.1	$SO(4)$ group	311
9.2.2	Noncompact groups $SO(p, n-p)$	313
9.2.3	Groups of conformal transformations	314
9.2.4	From $SU(2)$ to $SU(n)$	315
9.3	Bosonization and fermionization for arbitrary spins	320

9.3.1	Schwinger boson representation for the $SU(2)$ group	321
9.3.2	Holstein – Primakoff boson representation for the $SU(2)$ group	322
9.3.3	Dyson – Maleev representation for the $SU(2)$ group	323
9.3.4	Pomeranchuk – Abrikosov spin fermion representation for the $SU(2)$ group	323
9.3.5	Spin-fermion representations for the $SO(n)$ groups	325
9.3.6	Popov – Fedotov semi-fermion representation	326
9.3.7	Majorana fermionization	327
9.3.8	Mixed fermion-boson representations	327
10	CONCLUSIONS AND PROSPECTS	329
	Index	335
	References	341

Dynamical Symmetries for Nanostructures
Implicit Symmetries in Single-Electron Transport
Through Real and Artificial Molecules

Kikoin, K.; Kiselev, M.; Avishai, Y.

2012, XIII, 351 p. 129 illus., Hardcover

ISBN: 978-3-211-99723-9