

Index

Symbols

2D charge-density wave, 210
 2D massless boson, 136
 2D quasifree electron system, 188
 2D superconductor, 105, 158
 3D superconductor, 105
g-factor, 166
k-*q* representation, 150, 267
k-vector, 34, 35, 37, 46, 57, 92
T-linear dependence of the heat capacity, 41
T-linear heat capacity, 40, 131
T-linear law, 131
T-linear phonon scattering rate, 249

A

activated-state temperature behavior, 92
 activation (or excitation) energy ε_3 , 94
 activation energies ($\varepsilon_1, \varepsilon_2$), 163
 activation energy, 85, 91, 94, 96, 244, 250
 activation energy ε_3 , 86, 88, 96, 98, 141
 addition law, 16
 Angle-Resolved Photoemission Spectroscopy (ARPES), 138, 139, 214
 angular frequency, 35, 178
 angular momentum, 166, 180
 anisotropic magnetoresistance, 189
 annihilation (creation) operator, 69, 259
 annihilation electron field operator, 70
 anticommutation rule, 211, 273
 antielectron, 158
 antisymmetric ket, 257
 antisymmetrizing operator, 257
 Arrhenius law, 88, 248
 Arrhenius plot, 96
 Arrhenius slope, 96
 Arrhenius-law Boltzmann factor, 216
 Arrhenius-type exponential, 244
 asymptotic expansion, 272
 azimuthal angle, 152

B

ballistic electron, 144
 ballistic electron model, 163
 ballistic transport, 141
 band edge, 31
 band index, 37, 46
 band theory of electrons, 37
 bare lattice potential, 36
 basic properties of superconductors, 99, 104
 bcc lattice, 6, 37
 BCS energy gap equation, 125
 BCS formula for the critical temperature, 138
 BCS ground state energy, 109
 BCS theory, 108, 109
 BCS theory of superconductivity, 208
 BCS-like Hamiltonian, 211
 BCS-like theory, 221
 BCS Hamiltonian, 108
 BEC in 2D, 214
 BEC of the pairons, 158
 BEC temperature, 137
 binding energy, 114
 Bloch electron, 37, 47, 48, 180
 Bloch electron dynamics, 57, 77, 87, 91, 93
 Bloch electron state, 46
 Bloch electron's wavelength, 46
 Bloch energy bands, 37
 Bloch state, 37
 Bloch system, 119
 Bloch wave, 93
 Bloch wavefunction, 29, 30, 35
 Bloch's theorem, 27, 33–37, 46, 80, 148
 Bohr magneton, 166
 Bohr–Sommerfeld quantization rule, 180
 Boltzmann distribution function, 97, 146, 243
 Boltzmann equation, 19, 21
 Boltzmann equation for a homogeneous stationary system, 199

- Boltzmann equation for an electron–impurity system, 21
- Boltzmann equation method, 11
- Boltzmann–Arrhenius factor, 244
- Bose commutation rules, 67, 69, 133, 254
- Bose distribution function, 6, 97, 133, 155, 242
- Bose-condensed state, 144
- Bose–Einstein Condensation (BEC), 97, 98, 133, 136, 141, 146, 155, 203, 243
- boson, 5
- boson occupation number, 270
- boson speed, 214
- bosonic pairon model, 163
- bosonic second-quantized operator, 69
- bound electron pair, 114
- Bravais lattice vector, 34
- Bravais vector, 46, 78
- Bravais vector for the sq lattice, 79
- Brillouin boundary, 28, 35, 38, 56, 238, 239
- Brillouin zone, 38, 39, 57, 80, 148, 158
- Brillouin zone boundary, 241
- Brillouin zone of copper, 38
- bulk limit, 42, 45, 55, 156, 269
- C**
- canonical variables (Q_κ, P_κ), 54
- carbon, 1
- carbon hexagon, 92, 98
- carbon nanotube, 1, 77
- carrier charge, 86, 95
- carrier density, 86, 95
- carriers in the SdH oscillations, 221
- Cartesian axes, 48
- Cartesian coordinate system, 49
- Cartesian coordinates, 147
- Cartesian frame of coordinates, 34
- Cartesian unit cell, 146, 249
- cause of both QHE and superconductivity, 208
- cause of superconductivity, 56, 107
- cause of the QHE, 207, 208
- center of mass (CM) momentum, 112
- center of mass (CM) of any composite, 210
- center of oscillation, 170
- changing potential field, 65
- channeling electrons, 93
- charge current density, 15, 243
- charge distribution, 158
- charging energy, 144
- chemical potential, 134, 156, 172, 274
- C-hexagon, 84, 93
- classical electron, 15
- closed loop superconductor, 102
- closed orbit in k -space, 189
- closed k -orbit, 180
- closed r -orbit, 180
- CM momentum, 210
- CM of the holes (wavepacket), 147
- CM of the pairons, 163
- CM of the “electrons”, 147
- collision rate, 13
- collision term, 19
- collision time, 14, 97
- commutation relation in the k - q representation, 150
- commutation relations, 113, 267
- commutation relations for pair operators, 119
- commutators among B and B^\dagger , 267
- complex dynamical variable, 66
- composite (c-) boson, 208, 210, 211
- composite (c-) boson (fermion), 207
- composite (c-) fermion, 208, 210, 211
- composite boson excitation spectrum, 225
- composite particle, 6
- compound superconductor, 106, 107
- condensation energy, 142, 144
- condensation of massless bosons in 2D, 136
- condensed pairon, 137, 144
- conduction electron, 4, 93, 177, 216
- conduction electron density, 192
- conduction in graphene, 93
- conduction in the wall, 98
- conductivity, 97, 232
- conductivity of a SWNT, 85, 94
- conductivity of carbon NTs, 87
- constant-energy surface, 49
- Cooper Hamiltonian, 268
- Cooper pair, 75, 91, 96, 98, 107, 130, 180, 208, 211, 267
- Cooper pair (pairon), 85, 95, 96, 108, 110
- Cooper pair (pairon) carrier model, 141
- Cooper pair flux quantum, 102
- Cooper-like equation, 212
- Cooper’s equation, 116, 151, 267, 269
- coronet Fermi Surface, 250
- Coulomb (charging) energy, 142
- Coulomb field energy, 143
- Coulomb force between a pair of electrons, 72
- Coulomb interaction, 36, 72, 75
- creation (annihilation) operator, 69
- creation electron field operator, 70
- creation operator for “electron” (1) and “hole” (2) pairon, 149
- creation operator for zero-momentum pairon $B_{k_0}^\dagger \equiv b_k^\dagger$, 153
- creation operators for “electron” (1) and “hole” (2) pairon, 112

critical field, 107
 critical magnetic field, 105
 critical temperature, 86, 99, 105, 106, 109, 137, 157, 182, 206, 209, 214, 274
 cross section of the r -orbit, 180
 crystal's natural (triangular) axes, 147
 cuprate superconductor, 107
 current density, 17, 97, 204
 current density of patrons, 242
 current relaxation rate, 21
 curvature inversion, 56
 cyclotron frequency, 170, 181, 200
 cyclotron mass, 191, 196
 cyclotron motion, 170, 200
 cyclotron resonance, 171

D

DC Josephson effect, 102
 de Haas–van Alphen (dHvA) oscillations, 175, 177, 184, 200
 de Haas–van Alphen (dHvA) oscillations in silver, 179
 de Haas–van Alphen (dHvA) oscillations in susceptibility, 177
 Debye continuum model, 56
 Debye distribution, 56
 Debye energy, 139
 Debye frequency, 108, 114, 138, 211
 decay rate, 183, 200
 deformation potential approximation, 66
 delta-function replacement formula, 197
 density gradient, 236
 density of conduction electrons, 17
 density of excited bosons, 134, 156
 density of normal modes, 55, 56
 density of scatterers, 16
 density of state in the momentum space, 42
 density of states (DOS), 40, 41, 55, 148, 153, 172, 236
 density of states at the Fermi energy, 154, 237
 density of states for electrons with down-spins, 168
 density of states for electrons with up- and down-spins, 168
 density of states for electrons with up-spins, 168
 density of states in energy, 41
 density of states per spin at the Fermi energy, 109
 density of states per unit volume, 44
 density of zero-momentum bosons, 157
 density-wave mode, 65
 diamagnetic moment, 172, 174

diamagnetic susceptibility for a metal, 174
 diamond, 1
 differential conductance, 161
 differential cross section, 19
 diffusion coefficient, 11
 diffusion constant, 236
 Dingle temperature, 200
 Dirac delta function, 174
 Dirac fermion moving with a linear dispersion relation, 221
 Dirac picture (DP), 72
 Dirac's theory, 209
 directional cosine, 250
 dispersion relation, 30
 dissipationless flows, 137
 divalent metal, 39
 dominant carrier in graphene, 84
 down-spin, 267
 down-spin electron, 167
 dressed electron, 191, 197, 198
 drift velocity, 17, 215
 Drude formula, 85, 89, 95, 233, 235
 Dulong–Petit's law, 54
 dynamic response factor, 66

E

effective charge, 215
 effective electron density, 216
 effective lattice potential, 36
 effective mass, 31, 48, 86, 95, 183, 187
 effective mass m_3^* , 85, 94
 effective mass of an electron, 152
 effective masses (m_1, m_2), 149, 158, 163
 effective masses (m_1, m_2, m_3), 42
 effective phonon-exchange interaction, 75
 effective potential field, 36
 Ehrenfest–Oppenheimer–Bethe (EOB) rule, 6, 210
 eigenvalue equation, 261
 eigenvalue problem, 261
 Einstein relation, 237, 238
 electric conduction in SWNT, 141
 electric current, 17
 electric current density, 232
 electrical conduction in SWNTs, 3
 electrical conductivity, 15, 16
 electrical conductivity of NTs, 85, 86
 electron, 3, 7, 17, 84, 86, 91–94, 98, 158, 163, 177, 221
 electron (fluxon)–phonon interaction, 210
 electron (hole) wavepacket, 77, 147
 electron carrier model, 141
 electron density (field), 69

- electron density deviation, 66
 - electron density of states per spin at the Fermi energy, 114
 - electron effective mass, 148
 - electron energy, 210
 - electron energy gap, 157
 - electron flux quantum, 178, 180
 - electron in a Landau state, 171
 - electron mass, 75
 - electron pair (–pairon), 158
 - electron speed, 16
 - electron spin resonance, 167
 - electron variables, 259
 - electron-gas system, 74
 - electronic heat capacity, 40, 104
 - electron-pair operators (b_k, b_k^\dagger), 133
 - electrons moving in graphene walls, 85
 - electron's response, 66
 - electron–electron interaction, 207
 - electron–fluxon composite, 203, 211
 - electron–impurity scattering, 16
 - electron–phonon interaction, 57, 65, 163
 - electron–phonon scattering, 16
 - electron–transverse phonon interaction, 70
 - electrostatic potential shift, 145
 - elementary excitation, 126
 - ellipsoidal constant-energy surface, 49
 - ellipsoidal Fermi surface, 178, 179
 - ellipsoidal surface, 42
 - enclosed magnetic flux, 180
 - energy bands, 29
 - energy gap, 104, 123, 127
 - energy gap at 0 K, 109
 - energy gap between the moving and the stationary fc-bosons, 215
 - energy gap equation, 128
 - energy of the moving pairon, 146
 - energy of the pairon, 269
 - energy of zero-point motion, 5
 - energy-dependent current relaxation rate, 24
 - energy-dependent relaxation rate, 196
 - energy-eigenvalue equation for a harmonic oscillator, 170
 - energy-momentum (or dispersion) relation, 46
 - energy-state creation operator, 262
 - envelope of the oscillations, 183
 - equation of motion for a pairon, 97
 - equation-of-motion method, 128, 261
 - equations of motion for a Bloch electron, 46
 - equations of motion for a harmonic oscillator, 66
 - equipartition theorem, 54
 - exact pairon wavefunction, 151
 - excited electrons near the Fermi surface, 187
 - excited pairons, 269
 - exponential decay rate, 187
 - extremum condition for $|\Psi\rangle$, 122
- F**
- face-centered cubic (fcc) lattice, 38, 40
 - factorization approximation, 269
 - fc-boson, 214, 216
 - fc-boson condensed at a finite momentum, 216
 - fc-boson density, 216
 - fc-boson energy, 274
 - fc-boson number, 213
 - fc-boson, having the linear dispersion relation, 215
 - fcc lattice structure, 38
 - Fermi anticommutation rules, 70, 108, 112, 133, 211, 258, 259
 - Fermi degeneracy, 173, 185
 - Fermi distribution function, 6, 40, 41, 172, 196, 235, 269
 - Fermi distribution function for free electrons, 21
 - Fermi energy, 6, 40, 108, 147, 168, 181, 235
 - Fermi liquid model, 27, 36, 37, 46, 108, 131
 - Fermi sea, 114
 - Fermi speed, 146, 158, 213
 - Fermi sphere, 38, 41
 - Fermi statistics of electrons, 208
 - Fermi surface, 37, 39, 41, 117, 148, 152, 178
 - Fermi surface for a superconductor, 131
 - Fermi surface of Cu, 38
 - Fermi surface of Na, 38
 - Fermi velocity, 65, 96, 137, 242
 - Fermi-liquid state, 208
 - fermion, 5
 - fermion–antifermion symmetry, 158
 - Fermi–Dirac statistic, 72
 - Feynman diagram, 72
 - Fick's law, 11, 236
 - field effect (gate voltage) study, 84, 93
 - filling factor (Landau-level occupation ratio), 205
 - finite size effect, 85, 93
 - first Brillouin zone, 28, 38, 40
 - flux quanta, 102, 180
 - flux quanta (fluxons), 191, 207
 - flux quantization, 101, 209
 - flux quantization for the Cooper pair, 180
 - fluxon, 209
 - fluxon number operator $n_{k_s}^{(3)}$, 211
 - fluxon–phonon interaction strength, 210

force term, 19
 Fourier's law, 12
 four-valence electron conduction, 93
 fractional charge, 208
 fractional LL occupation ratio (filling factor), 208
 fractional quantum Hall effect (QHE), 203, 205–207
 fractional ratio, 203
 free boson model, 214
 free electron model, 174, 181
 free electron model in 3D, 152
 free electrons in equilibrium, 168
 free energy, 181, 186
 free energy for a system of free electrons, 172
 free massless boson, 214
 free pairon model, 137
 free-electron Fermi sphere, 37
 frequency integral, 55
 Fröhlich interaction Hamiltonian, 65, 70, 71
 f-sum rule, 136, 214
 fugacity, 97, 134, 135, 156, 157, 242
 full-spin boson, 209
 fundamental (f) c-boson (fc-boson), 212
 fundamental composite (c-) boson, 212
 fundamental quantum nature, 208

G

galvanomagnetic phenomena, 171
 gapless semiconductor, 77, 87, 160
 gas constant, 135
 gate voltage effect, 92, 96
 gate voltage shift, 145
 generalized BCS Hamiltonian, 56, 113, 268
 generalized energy gap equation, 124
 Ginzburg–Landau theory, 105
 grand canonical ensemble average, 269
 grand ensemble trace, 268
 graphene, 2, 4, 77, 78, 87, 91, 93, 147, 148, 221, 240, 241
 graphene layer, 249
 graphene sheet, 91, 93, 141, 146, 158, 163
 graphene wall, 91, 94
 graphite, 1, 4, 231, 240
 gravitational mass, 6
 ground pairon, 109, 128
 ground state energy, 122, 127, 154, 212
 ground state energy of the system of fc-bosons, 213
 ground state of the Bloch system, 121
 ground state wave function, 122
 group velocity, 30, 47
 group velocity of the Bloch wavepacket, 30

H

half-spin fermion, 209
 Hall coefficient, 18, 86, 148, 205, 237
 Hall effect, 17
 Hall effect measurements, 204
 Hall field, 203
 Hall resistivity, 203, 207, 208, 225
 Hall resistivity in GaAs/AlGaAs, 206, 208
 Hall resistivity plateau, 205, 206, 209, 225
 Hall voltage, 18
 Hall's experiment, 17
 Hamiltonian for an electron gas system, 71
 Hamiltonian for an electron–phonon system, 71
 Hamiltonian for moving pairons, 150
 Hamiltonian of a free electron in B , 170
 Hamiltonian of a simple harmonic oscillator, 4
 Hamilton's equations of motion, 47
 harmonic approximation, 54, 55
 harmonic equation of motion, 66
 Harrison's model, 40
 heat capacity, 40, 53–55, 136, 233
 heat capacity per electron, 234
 heat capacity per unit volume, 234
 Heaviside step function, 185
 Heisenberg equation of motion, 260
 Heisenberg picture (HP), 259, 260
 Heisenberg uncertainty relation, 5
 Heisenberg's uncertainty principle, 38
 helical angle, 84, 93
 helical line, 84, 85, 93
 helicity, 84, 85, 93
 hexagonal close packed (hcp) crystal, 39, 250
 high-temperature superconductivity (HTSC), 107, 208
 Hohenberg's theorem, 136, 214
 hole, 3, 7, 17, 84–86, 91–94, 96, 98, 158, 163, 177, 221
 hole axial transport, 96
 hole channel current in a SWNT, 92
 hole current, 85
 hole mass, 85
 hole mass in the carbon wall, 85
 hole pair (+pairon), 158
 holes, 85
 holes moving in graphene walls, 85
 homogeneous superconductor, 104
 honeycomb lattice for graphene, 163
 honeycomb lattice structure, 2
 hyperboloidal Fermi surface, 179

I

impurity scattering rate, 86, 95

incompressible quantum fluid state, 205
 independent electron model, 37
 instantaneous Coulomb interaction, 72
 integer QHE, 206, 207, 212
 integer QHE plateau, 208
 integer quantum Hall effect (QHE), 203, 205
 integral number of carbon hexagons, 91
 interaction Hamiltonian, 70
 interboson distance, 214
 interelectronic Coulomb interaction, 36
 internal energy density, 135
 interpairon distance, 137
 interparticle interaction potential, 261
 inverse collision frequency, 243
 inversion (mirror) symmetry, 148
 inversion symmetry, 80
 ion contribution, 16

J

Jain's theory of fractional hierarchy, 203
 Josephson effects, 102
 Josephson interference, 103
 Josephson junction, 102
 Josephson tunneling, 102

K

kinetic momentum, 171, 184, 197, 198
 kinetic theory of gas dynamics, 11
 Kronig–Penney model, 30

L

Lagrangian in the harmonic approximation, 54
 Landau diamagnetism, 165, 171, 174, 186
 Landau energy, 172
 Landau Level (LL), 170, 171
 Landau Level (LL) degeneracy, 198
 Landau oscillator quantum number, 172
 Landau states, 170, 171, 184, 271
 Landau susceptibility, 174
 Landau-level occupation ratio (filling factor),
 205
 lattice, 4
 lattice axes, 34
 lattice dynamics, 53, 55, 57
 lattice force, 47
 lattice momentum, 46
 lattice periodic potential, 46
 lattice vibration, 55
 lattice-ion mass, 75
 Laughlin wavefunction, 206, 208
 linear dispersion relation, 96, 133, 138, 139,
 155, 163, 242
 linear dispersion relation for the 3D Cooper
 pair, 213

linear dispersion relation in two dimensions,
 146
 linear energy-momentum (dispersion)
 relation, 153
 linear energy-momentum (dispersion) relation
 for the center of mass motion, 146
 linear heat capacity, 177
 linear operators (η , η^\dagger), 258
 Liouville operator, 72
 LL degeneracy, 216
 localized Bloch wavepacket, 46
 longitudinal elastic wave, 56
 longitudinal phonon, 70
 longitudinal wave, 65
 longitudinal wave mode, 65
 long-range order, 105
 Lorentz force, 17, 48, 177
 lowest bound energy, 114

M

magnetic energy, 168
 magnetic flux, 101, 103, 215
 magnetic flux line, 100, 101, 107
 magnetic moment, 101, 165, 166, 180
 magnetic moment per unit area, 186
 magnetic oscillations, 186, 188, 196
 magnetic oscillations in bismuth (Bi), 251
 magnetic pressure, 100
 magnetic susceptibility, 177, 187
 magnetization, 169, 177, 182, 183, 186, 187
 magnetoconductivity, 187
 magnetogyric ratio, 165, 166
 magnetomechanical ratio, 166
 magnetoresistance (MR), 189
 magnetoresistivity, 225
 magnetotransport mass, 191, 196, 197, 200
 main characteristic of metallic conduction, 142
 major axes of the ellipsoid, 48
 majority carriers in graphite, 250
 majority carriers in nanotubes, 84
 many-body perturbation method, 71
 many-body trace, 262
 many-body-system density operator, 262
 Markovian approximation, 74, 75
 mass conservation law, 136
 massless boson, 214
 Matthiessen's rule, 15, 16
 mcl crystal, 81, 249
 mean free path, 14
 mean free time, 16
 Meissner effect, 100, 101, 107, 127, 158, 205,
 225
 metallic (semiconducting) SWNT, 141, 163

metallic compound, 106
 metallic single-wall carbon nanotubes, 141
 metallic SWNT, 3, 142, 157
 metal–insulator transition (MIT), 247
 Miller indices, 147
 MIT in VO₂, 249
 mixed representation, 274
 mixed representation of one-body density operator, 263
 mixed state, 107
 mobility, 222
 mode index, 66
 molar heat capacity, 135, 136
 molar heat capacity at constant density (volume), 135
 molar heat capacity for a 2D massless boson, 136
 momentum distribution function, 19
 momentum-state annihilation operator, 262
 momentum-state electron operator, 70
 monoclinic phase, 247
 monovalent fcc metal, 131
 monovalent metal, 33, 36–38, 131
 motional diamagnetism, 171
 Mott’s vrh theory, 96
 Mott–Hubbard picture, 247
 moving (noncondensed) fc-boson, 213
 moving fc-boson, 216
 moving pairon, 149, 151, 154
 moving patron, 245
 multivalent metal, 38
 multiwalled carbon nanotube (MWNT), 1, 77, 85, 229, 230, 240, 242
 MWNT bundle, 244

N

nanotube, 87
 nearly free electron model (NFEM), 38
 neck and belly orbits, 179
 neck Fermi surface, 86, 221
 net (CM) momentum, 267
 net momentum of a pair of electrons, 72
 neutral supercondensate, 131
 new band model, 87
 Newton’s equation of motion, 15, 48
 NFEM (Nearly Free Electron Model), 38, 250
 noble metal, 38, 179
 noncondensed fc-boson, 216
 non-Ohmic behavior, 141, 142, 163
 normal coordinates, 54
 normal current, 104, 110, 145
 normal curvature, 48
 normal mode, 54

normal modes of oscillations, 54
 normal modes of oscillations for a solid, 65
 normal momenta, 54
 normal Ohmic conduction, 95
 normal-mode frequencies, 55
 number density, 15, 16, 147
 number density of zero-momentum bosons, 134, 156
 number of zero-momentum bosons, 134
 number operator, 211, 254, 270
 number operator for electron (1) (hole (2)), 150
 number operator for pairons having net momentum q , 154
 number operator for the pairons in the state (\mathbf{k}, \mathbf{q}) , 154
 number operators for electrons, 267
 number operators for electrons and holes, 112
 number representation, 253
 numbers of the electrons with up- and down-spins, 168

O

observable, 256
 occupation number, 253, 270
 occupation numbers of pairons having a CM momentum q , 155
 occupation-number representation, 253
 Ohmic behavior, 143
 Ohm’s law, 15, 97, 204, 242
 one-body density operator, 262, 263
 one-body Hamiltonian, 261
 one-body operator, 260
 one-body trace, 262
 one-electron-picture approximation, 37
 one-pairon states, 122
 one-phonon exchange process, 73
 Onsager’s flux quantization hypothesis, 191
 Onsager’s formula, 177, 178, 181, 209
 Onsager’s magnetic flux quantization, 180
 open orbits in the k -space, 189
 orthogonal unit cell, 79
 orthorhombic (orc) crystal, 82, 251
 oscillation period, 183, 187
 oscillatory density of states, 221
 oscillatory magnetization, 187
 oscillatory statistical weight, 181, 187
 oxide layer, 102

P

pair annihilation operator, 268
 pair energies, 268
 pair operators, 153, 211, 268
 pair wavefunction, 116, 151
 pair-annihilate hole-type c-boson pairs, 212

- pair-create electron-type c-boson pairs, 212
 - pairon, 97, 107, 130, 142, 155, 242
 - pairon (Cooper pair), 85, 95, 96, 108
 - pairon (Cooper pair) carrier model, 142
 - pairon annihilation operator, 112, 150
 - pairon carrier model, 242
 - pairon density, 97, 158
 - pairon density of states, 118
 - pairon energy, 242
 - pairon ground state energy, 109, 115, 157
 - pairon momentum, 243
 - pairon net momentum, 133, 155
 - pairon occupation-number states, 155
 - pairon operator, 112, 150, 267
 - pairon speed, 145
 - pairon wavefunction, 116, 269
 - pairon–phonon scattering cross section, 145
 - pair-state operators, 268
 - particle density, 243
 - partition function per electron, 171
 - patron, 242
 - Pauli exclusion principle, 5, 155
 - Pauli magnetization, 186, 187
 - Pauli paramagnetic susceptibility, 175
 - Pauli paramagnetism, 165, 167, 169, 174
 - Pauli's exclusion principle, 38, 207, 253
 - Peierls instability, 247
 - penetration depth, 101
 - periodic boundary condition, 57
 - periodic lattice potential, 34
 - periodic oscillation of the statistical weight, 187
 - permutation operator, 255
 - permutation-symmetry property of the quantum particle, 259
 - phase, 178, 180
 - phase change, 104, 105
 - phonon, 16, 53, 55
 - phonon energy, 75, 210
 - phonon exchange, 151, 158
 - phonon momentum, 75
 - phonon scattering, 97, 145
 - phonon scattering rate, 86, 95, 145
 - phonon-exchange attraction, 71, 85, 91, 95, 108, 110, 116, 208, 221
 - phonon-exchange attraction between the electron and the flux quantum (fluxon), 221
 - phonon-exchange effect, 73
 - phonon-exchange interaction, 74, 75
 - physical vacuum state, 119
 - pitch, 84, 91–93, 98, 141
 - pitch angle, 98, 142
 - pitch in a metallic SWNT, 157
 - Planck constant, 181
 - Planck distribution function, 55, 145, 146
 - plane wave, 35
 - plateau height, 205
 - plateau stability, 205
 - Poisson's sum formula, 173, 186, 271
 - position representation, 259
 - potential energy, 53
 - potential field energy of a magnetic dipole, 166
 - primitive vectors, 78
 - principal axes of curvatures, 49
 - principal axis, 49
 - principal mass, 49
 - principal-axis transformation, 54
- Q**
- QH state, 205
 - QHE at filling factor $\nu = 2$, 221
 - QHE in GaAs/AlGaAs, 225
 - QHE in graphene, 221, 225
 - QHE state, 217, 225
 - quadratic dispersion relation, 48, 183
 - quadrivalent metal, 148
 - quantization of cyclotron motion, 170
 - quantum Hall (QH) state, 205
 - Quantum Hall Effect (QHE), 188, 203
 - Quantum Hall Effect (QHE) oscillations, 221
 - quantum Liouville equation, 72, 262
 - quantum Liouville operator, 73
 - quantum number, 35
 - quantum postulate, 260
 - quantum statistical postulate, 5
 - quantum statistical theory, 110
 - quantum statistics of the particles, 261
 - quantum wavepacket, 47
 - quantum zero-point motion, 34
 - quasielectron, 109, 147
 - quasielectron energy gap, 109
 - quasifree electron, 184
 - quasifree electron Hamiltonian, 197
 - quasifree electron model, 6, 183, 187
 - quasiparticle dispersion relations, 138
 - quasiparticle energy, 127
 - quasiwavefunction, 262
- R**
- radius of a MWNT tube, 85
 - rectangular cell model, 91, 92
 - reduced density operator, 274
 - reduced generalized BCS Hamiltonian, 119
 - reduced Hamiltonian, 153, 154
 - reduced wavefunction for the stationary fc-bosons, 213

reflection (mirror) symmetry, 80
 relative and net momenta, 112, 150
 relative momentum, 267
 relaxation (collision) time, 86, 95
 relaxation rate, 16, 24, 86, 95
 relaxation time, 24, 97, 243
 resistance, 86
 resistivity, 204
 right-hand screw rule, 165
 rigidity (shear) modulus, 82
 ring supercurrent, 101
 room-temperature quantum Hall effect (QHE)
 in graphene, 221
 running wave, 30, 65

S

Sbunikov–de Haas (SdH) oscillation, 187
 Sbunikov–de Haas (SdH) oscillations in
 GaAs/AlGaAs, 187
 scanned probe microscopy (SPM), 142
 scattering angle, 196
 scattering cross section, 16, 196
 scattering rate, 16
 Schrödinger energy-eigenvalue equation, 262,
 263
 Schrödinger equation, 46, 170
 Schrödinger equation for an electron, 34
 Schrödinger picture (SP), 259
 SdH oscillation period, 200
 second quantization, 253, 259
 second-quantization formalism, 108, 253
 second-quantized operators for a pair of
 electrons, 267
 Seebeck coefficient, 86, 229, 233, 239, 244
 Seebeck coefficient (thermopower), 229
 Seebeck coefficient for 3D motion, 234
 Seebeck coefficient for a bundle of MWNTs,
 245
 Seebeck coefficient in multi-walled carbon
 nanotubes, 229
 Seebeck coefficient of highly oriented
 single-crystal pyrolytic graphite, 230
 Seebeck coefficient of MWNTs, 243
 Seebeck coefficient S in copper (Cu), 229
 Seebeck current, 236, 237
 Seebeck electromotive force, 233
 semiclassical (wavepacket) model of a
 conduction electron, 240
 semiclassical electron dynamics, 78
 semiclassical equation of motion, 78
 semiconducting SWNT, 3, 91, 93, 142
 semiconductor-like T -behavior, 87
 shear modulus, 83

Shockley's formula, 250
 Shubnikov–de Haas (SdH) oscillations, 196,
 221
 simple cubic (sc) lattice, 46, 65
 single-wall carbon nanotube (SWCN), 1, 91
 single-wall nanotube (SWNT), 1, 77, 84, 91,
 93, 98, 141, 240
 sinusoidal oscillations to the free energy, 183
 six basic properties of superconductors, 111
 solid angle, 19
 speed of sound, 65
 spherical Fermi surface, 109
 spin angular momentum, 166
 spin anomaly, 166
 spin degeneracy, 38, 41, 44, 167, 172
 spin degeneracy factor, 116
 spin-statistics theorem, 5
 stationary density operator, 262
 stationary pairon, 151
 statistical weight, 172, 184, 186, 271
 supercondensate, 110, 130, 131, 215
 superconducting energy gap, 139
 superconducting ground state, 142
 superconducting properties, 208
 Superconducting Quantum Interference
 Device (SQUID), 103
 superconducting state, 86, 97, 110, 141, 142
 superconducting state of HTSC, 107
 superconducting temperature, 144, 243, 245
 superconducting transition, 104, 110
 superconductivity, 158
 superconductivity energy gap in the composite
 boson (c-boson) excitation spectrum, 225
 superconductors, 100
 supercurrent, 101–104, 107, 110, 142, 144,
 158, 215, 244
 supercurrent density, 158, 215
 supercurrent ring experiment, 99
 superfluid phase, 111
 superposable plane waves, 247
 susceptibility, 169, 177, 179, 187
 symmetric ket, 255
 symmetrizing operator, 255

T

tcl crystal, 81, 83
 temperature gradient, 236
 tet crystal, 249
 thermal activation, 77
 thermal conduction, 11, 12
 thermal diffusion of the MWNT bundle, 245
 thermal electromotive force (emf), 229
 thermal speed, 14

- thermally activated electron density, 80, 149, 241
 - thermally activated process, 77
 - thermally excited electron, 40
 - thermoelectric power, 229, 230
 - third-order phase transition, 136
 - time-dependent perturbation theory, 73
 - total magnetic susceptibility, 175
 - total number of pairons, 109
 - transition between the hole-type c-fermion states, 212
 - transverse elastic wave, 56
 - transverse lattice normal mode, 70
 - transverse wave mode, 65
 - traveling normal mode, 66
 - traveling wave, 66
 - tunneling experiment, 104
 - two-body density operator, 72
 - two-electron density matrix, 74
 - two-pairon states, 122
 - type I elemental superconductor, 107
 - type II magnetic behavior, 107, 110
- U**
- unit hexagon, 147
 - up-spin, 267
 - up-spin electron, 167
- V**
- vacuum ket, 69, 254
 - vacuum-state ket for phonons, 73
 - van Hove singularities, 56, 57
 - van Leeuwen's theorem, 171
 - vanadium dioxide (VO₂), 247
 - variable range hopping (vrh) theoretical formula, 96
 - variation, 123
 - vector potential, 170
 - vertices, 107
 - virtual electron pair, 132
 - virtual exchange of phonon, 108
 - virtual phonon, 73
- W**
- wave train, 30, 35
 - wavefunction, 170
 - wavelength, 65
 - wavepacket, 93, 247
 - wave-particle duality, 47
 - weak-coupling approximation, 73
 - Wigner–Seitz (WS) cell model, 77, 87, 93
 - Wigner–Seitz (WS) cell model for graphene, 3
 - WS model, 149
 - WS unit cell for graphene, 78
- Y**
- Young modulus, 82, 83
- Z**
- zero resistance, 99
 - zero resistivity, 206
 - zero-bias anomaly, 161
 - zero-momentum boson, 156
 - zero-momentum pairon, 118, 152, 154
 - zero-momentum pairon operator, 128
 - zero-pairon state, 122
 - zero-point energy, 55
 - zero-temperature BCS pairon size, 137
 - zero-temperature electron energy gap, 157
 - zero-temperature energy gap, 244
 - zone number, 29, 35