Index

AB effect *see* Aharonov–Bohm effect
AB oscillation 5, 267, 350
AB rings 338, 344, 361, 365
AB square ring 356, 358, 361–363
Adams method 101
Aharonov–Bohm effect (AB effect) 5, 11, 13, 267–269, 291, 317, 337, 346, 361
amplitude 4, 5, 12, 14, 15, 19, 79, 80, 83, 84, 87, 176, 185, 186, 229, 230, 268, 267, 270, 288, 292, 327, 328
Anderson model 169, 190, 191
approximation 71, 105
  axial 295
  hard wall 370
  hydrodynamic 10
  relaxation time 43–45, 47, 49, 124

backscattering 28, 163, 166
ballistic conductor 28, 138
ballistic electron injection 22, 276
ballistic transport 28, 47, 277, 317, 355
band 116, 117, 129, 277
  quasi-continuous 129
barrier 9–11, 18, 19, 76, 80, 84, 85, 89, 92, 112, 116, 146, 150, 165, 166, 171, 177, 181
  double 87
  half infinite 10
  infinite 161
  quintuple 92
  source-side 224
barrier region 81, 82, 100, 101, 142
bias 17, 28, 50, 51, 92, 105, 109, 120, 138, 139, 184, 253, 254, 273
  backward 201, 202
  forward 201–203
  reverse 202, 203
bias voltage 17, 18, 89, 90, 97, 112, 119, 159, 165, 180, 181, 191, 192, 273, 274
Bloch frequency 51, 53, 54, 124, 129
Bloch function 131
Bloch oscillation 51, 75, 118, 123–127
Boltzmann distribution 10, 118
Boltzmann equation 3, 8, 9, 39, 44, 45, 60, 117
Boltzmann transport equation (BTE) 66
boundary conditions 27, 77, 78, 85, 286, 292, 297, 298, 321, 322, 330, 335, 336, 338, 345, 350, 352, 368, 370
  Griffith's 357
  periodic 27
Brillouin function 105
Brillouin zone (BZ) 51, 62, 63, 117, 118, 123
Broglie wavelengths 10, 310

BTE *see* Boltzmann transport equation
Büttiker formula 153–155, 157
Büttiker resistance 312
BZ *see* Brillouin zone

capacitance 32, 49, 92, 171, 176, 177, 179, 180, 183, 214–218, 229, 237, 246, 247
  gate-dot 210
  source-dot 211
carriers 22, 23, 31, 35, 39, 43, 145, 146, 149, 152, 154, 157, 161, 162, 164, 276–278, 317
  incident and reflected 146
  nonpolarized 110
cavity 306, 307
CB effect *see* Coulomb blockade effect
Coulomb blockade effect 14, 201, 204, 210, 239, 244, 258, 269, 270
Coulomb gap 240
Coulomb interaction energy 14, 269
Coulomb interactions 14, 188, 197, 206, 269
Coulomb oscillations 176, 177, 193–195, 197, 198, 213
Coulomb staircase 14, 180, 182, 269
coupled quantum dots 204–206
coupling 30, 86, 92, 97, 98, 100, 102, 169, 186, 188, 204, 205, 211, 231, 275, 375, 380
  spin-orbital 84, 86
current density 95, 105, 106, 119, 124, 286, 298, 321, 335, 363, 364, 369, 370, 372, 375, 381
current density operator 297, 369
current staircase 232

DBRTD *see* double-barrier resonant tunneling diode
DBS *see* double-barrier structure
DC *see* differential conductance
DC bias 50
DC bias voltage 127, 194
DC currents 52, 53
defects 4, 5, 251, 266, 267
dependence 32, 44, 60, 61, 193, 194, 197, 199, 253
  exponential 259, 260
  monotonic 173
  nonlinear 7
  periodic 355
  superlinear 121
device 11, 12, 14, 16, 19, 21, 22, 32, 57, 69, 171, 183–188, 221, 222, 245–247, 249, 255, 256, 268–270, 274–276
  carbon-based 26, 35, 36
  charge-sensing 236, 237
  double-dot 201, 202
  double quantum dot 198
  dual-gate 170
  electronic storage 21, 275
  high-frequency 115, 120
  high-mobility 36
  high-speed 54
  hot-electron 115
  MESFET 68
  microelectronic 21, 275
  multichannel 17, 273
  multi-terminal 18, 81, 151, 153, 273, 317
  nanoscale 32
  on/off switch 227
  quantum effect 115
  quantum-interference 296
  quantum wire 12
  silicon-based 26
  single-channel 17, 272
  single-electron 235
  slotted-gate 170
  spin-based 26

spin-polarized 336
submicron 54, 66
three-terminal 18, 211, 236, 273
two-terminal 14, 15, 80, 81, 160, 270, 308
ultra-narrow 256
ultra-small 9, 68
unipolar 31
differential conductance (DC) 50, 52, 53, 95, 124–126, 129, 191, 193, 226, 227
dilute magnetic semiconductor (DMS) 22, 104, 105, 107–111, 276, 277, 317, 318
Dirac distribution function 17
Dirac relativistic equation 27
Dirac relativistic wave equation 281
distribution function 9, 39, 43, 117, 139, 148
balance 9
collision 41
drift Fermi–Dirac 71
equilibrium 105
single-particle 39
DMS *see* dilute magnetic semiconductor
double-barrier resonant tunneling diode (DBRTD) 11, 94, 107
double-barrier structure (DBS) 75, 87, 88, 96–99, 107, 108, 195
double-dot memory 259–261
drain 19, 20, 30, 31, 33, 65, 66, 68, 190, 191, 211, 212, 214, 216, 222–225, 245, 246, 248–250, 253, 287, 292, 293
drain circuits 298
drain electrodes 31, 68
drain regions 59, 65, 251
drain voltage 66, 69, 217–221, 229, 232, 244
DRAM *see* memory, dynamic random access
Dresselhaus spin-orbit interaction (DSOI) 281, 282
DSOI *see* Dresselhaus spin-orbit interaction

effective mass 4, 32, 39, 51, 76, 77, 94, 97, 112, 117, 119, 121, 127, 132, 294, 297
effective mass Hamiltonian 98, 130, 280
effective mass parameter 295, 299
effect
base-push-out 49
degeneracy 71
electro-optic 279
even-odd 197
hot-electron 9, 59
mode-mixing 312
nonparabolicity 97
phase-coherent 11, 13, 268, 288, 292
turnstile 180
eigenenergies 16, 131, 132, 271, 289, 319, 341, 343–345, 352, 356, 362, 373, 379
eigenstates 132, 196, 281, 340, 344–346, 351, 352, 356, 357
Einstein relation 7
electron beam lithography 141, 159, 221, 252
electron density 10, 50, 67, 71, 89, 112, 118, 120, 139, 141, 170, 177, 184, 187, 307
electron energy 6, 42, 44, 52, 56, 62, 77, 87, 93, 127, 140, 340, 342, 344, 345, 350
electron energy distribution 65, 90
electron Fermi energy 144, 303
electron Hamiltonian 160

electron motion 48, 76, 115, 170, 181
electrons 3–5, 14–18, 40–44, 54–59, 65, 66, 68–71, 169–174, 179–183, 189–192, 240–244, 249–251, 256–258, 272, 276–278, 317–322
  antiparallel spin 200
  ballistic 13, 65, 269
  capacitor 240
  conduction 72, 105
  conduction-band 318
  hot 7
  positive and negative *z*-polarized 280
  spinless 367, 373
  spin-polarized 22, 23, 109, 276
  spin-up and spin-down 25, 107–109, 190, 280, 320, 325, 329, 338
  unpaired 188
electron spin 14, 21, 24, 169, 186, 274, 337, 355
electron transport 17, 31, 39, 47, 58, 179, 180, 201, 202, 225, 232, 273, 285, 380
  diffusion-dominated 49
  spin-dependent 360
electron tunnels 181, 210, 238
electron velocity 48, 59, 118, 120
electron wave function 85, 160, 296, 297, 302, 319
electron waves 4, 5, 14, 15, 18, 19, 76, 77, 82, 266, 267, 270
  injected 292
  outgoing 302
electro-optic modulator 23, 24, 278–280
energy 4–6, 28, 29, 42–44, 51, 52, 66, 87, 88, 97, 98, 101–105, 116, 148, 150, 184, 190, 267, 280, 281
  carrier 29
  Coulomb 186, 189, 197, 210
  cyclotron 196
  electrostatic 177, 178, 210, 238
  ground state 177
  intervalley 56
  lateral and longitudinal 16, 271
  optical phonon 29, 56
  potential 108, 109, 212
  resonant 87, 88, 90, 92
  single-electron 189
energy bands 16, 27, 90, 129–131, 272
  bulk 117
  discrete 271
  lateral 271
energy barrier 31, 238, 259
energy dissipation 21, 28, 65, 275
EPROM *see* memory, erasable programmable read-only

FEL *see* free electron laser
Fermi–Dirac distribution function 17, 273
Fermi energy 4, 12, 13, 71, 90, 105, 152, 154, 177, 190, 193, 265
Fermi level 28, 112, 190, 191, 198, 225, 231, 232
Fermi sea 190
Fermi velocity 4, 27, 145, 266
Fermi wavelength 3, 4, 12, 140, 145, 265
ferromagnetic contact 320, 325, 326, 329–335, 375
FET *see* transistor, field-effect
field-effect transistor
  graphene nano-ribbon 26
  graphene spin 278
  metal-oxide semiconductor 171, 211, 237
  metal-oxide-silicon spin 23, 278
  single-electron 246
  spin-injected 367, 368, 381

floating gate 243, 244, 246, 247, 258
polysilicon 244
self-aligned 247
Fock–Darwin state 196, 199, 200
Fourier transform 11, 52, 171
free electron laser (FEL) 50, 51, 124

gate 11, 12, 19, 20, 30, 141, 165, 166, 174, 176, 177, 181, 210, 211, 291–293, 298, 326–328, 330–332, 335
gate bias 73, 250, 253, 254
gate electrodes 68, 159, 192
gate voltage 19, 23–25, 31–33, 36, 141, 142, 159, 160, 175–185, 191–193, 197, 196, 217–219, 224, 225, 255, 256, 326–328, 373, 379–381
bias 19
threshold 243
gate width 11–13, 159, 160, 269
Gauss theorem 289
giant magnetoresistance (GMR) 21, 22, 275
giant Zeeman splitting 22, 105, 107, 109, 110, 276, 277, 317, 318
GMR *see* giant magnetoresistance
GNRFET *see* transistor, graphene nano-ribbon field-effect
graphene 26, 27, 35, 36
graphene honeycomb lattice 27

Hall bars 164
Hall conductivity 27
Hamiltonian 16, 99, 100, 271, 281, 286, 295, 296, 318, 319, 339, 342, 356–358
dimensionless 356
transformed 99
heavy hole 86, 97, 98, 100–102, 279, 297–299
heavy hole resonance 104
heavy hole resonant peaks 97
heavy hole wave 298, 299
Heavyside step function 9
HEMT *see* transistor, high-electron-mobility
holes 27, 31–33, 97, 98, 100, 105, 109, 146, 151, 152, 295–298, 317, 321
hole tunneling 86, 100
hopping conduction 129, 131, 133
hot-electron regime 7, 8, 44
Hund's rule 197, 204

ideal conductor 15, 16, 145, 148, 165, 271, 272
impurities 4, 5, 57, 70, 117, 160–163, 171, 173, 190, 266, 267
charged 173
ionized 70
localized spin 190
magnetic 317
injected waves 79, 80, 83, 288, 345, 346
injection 22, 58, 201, 249, 276
injection energies 58–60
interference effect 18, 149, 292, 324, 325, 327, 328, 334, 334, 335

Johnson spin switch 23, 278
junction 22, 109, 276, 277, 281, 313, 314
base-collector 48
emitter-base 48
magnetic tunnel 22, 275

Klein paradox 35

Koga's experiment 351, 352
Kondo effect 169, 188, 190–193, 206
Kondo resonance 190, 191, 193
Kondo temperature 189–192
Kondo valley 188, 191, 192

Landau energy levels 98, 111, 112
Landauer–Büttiker formula 14, 17, 270, 271, 273, 282, 285, 317
Landauer formula 17, 145, 147, 272, 273
Landau levels (LLs) 105, 107, 161, 166, 184, 186
large-scale integrated circuit (LSIC) 14, 25, 269
lateral confinement potential 16, 271
light holes 86, 96, 97, 100, 102, 103, 277, 297–299
LLs *see* Landau levels
logic circuit 115, 227, 229, 231
low-pressure chemical vapor deposition (LPCVD) 246
LPCVD *see* low-pressure chemical vapor deposition
LSIC *see* large-scale integrated circuit

magnetic field 98, 106–111, 160, 161, 166, 167, 171, 172, 183–187, 193, 197–199, 267, 287–289, 339, 345, 346, 348, 351, 352, 355, 356
magnetic flux 5, 13, 267, 269, 289, 339, 346, 353, 356, 357, 360, 361, 363, 364
magnetic tunnel junction (MTJ) 22, 237, 239, 240, 275
memory 182, 235, 238–241, 251
  dynamic random access (DRAM) 22, 182, 235, 276
  erasable programmable read-only (EPROM) 235
  few-carriers 235
  flash 235
  large-capacity 183
  magnetoresistive random access (MRAM) 22, 275
  nonvolatile 22, 276
  silicon 235
  single-dot 258, 260, 261
  static random access (SRAM) 22, 276
  ultra-narrow-channel 254
  ultra-narrow silicon floating gate 254
memory node 235–243
mesoscopic effects 11, 14, 268, 270
mesoscopic systems 147
metal-oxide semiconductor field-effect transistor (MOSFET) 30, 62, 64, 66, 171, 209, 211, 227, 237, 241–243, 269
miniband superlattices 50
miniband transport 51, 116, 117, 119, 121, 123, 129
modes 28, 137, 139, 140, 271, 285, 373, 375
  current-carrying 138
  propagating 305
  radial breathing 28, 29
momentum 4, 5, 9, 10, 27, 42, 43, 47, 49, 60, 71, 89, 130, 190, 266, 267, 281, 322
  orbital angle 295
  total angle 295
  transverse 143
Monte Carlo simulation 40, 43, 55, 58, 61

MOSFET *see* metal-oxide semiconductor field-effect transistor
MRAM *see* memory, magnetoresistive random access
MTJ *see* magnetic tunnel junction

NDC *see* negative differential conductance
NDR *see* negative differential resistance
NDV *see* negative differential velocity
negative bias 184, 253, 254
negative conductance 117, 118, 122
negative differential conductance (NDC) 50, 118, 120, 124, 129, 221–223, 226
negative differential resistance (NDR) 75
negative differential velocity (NDV) 120
negative effective mass (NEM) 121, 122
negative voltage 95, 141, 174, 176, 192, 240
neighboring quantum wells 129, 130
neighboring wells 92, 116, 129, 134
NEM *see* negative effective mass
NMS *see* non-magnetic semiconductor
non-magnetic semiconductor (NMS) 107, 109
Nyquist relation 7, 8

Ohm's law 7
orbits 13, 24, 161, 162, 269
  scattered 161
oscillations 5, 51, 95, 106, 107, 128, 145, 171, 173, 176, 177, 185, 217, 267
output waves 288, 292, 329, 338

parasitic resistance 92, 94, 230
Pauli effect 201
Pauli exclusion principle 6, 6, 201, 268
peaks 50, 51, 94, 95, 97, 103, 104, 124, 126, 171, 185–187, 197, 199, 201, 203–205, 231, 232, 294, 299, 300
  Coulomb 193
  Coulomb oscillation 203
  zero-bias 194
peak-valley current ratio (PVCR) 224
perfect conductor 149, 162, 163
phase 4, 5, 19, 20, 52, 84, 127, 182, 266, 267, 269, 321, 335, 368
phase difference 19, 25, 108, 181, 283
phase factor 5, 77, 287, 338
phase relaxation 5, 6, 267, 268
phase shift 23, 279
phonon 4–6, 129, 266, 267
  acoustic 6, 28, 268
  low-frequency 6, 268
  optical 6, 28, 29, 34, 268
polarization 23, 277–279, 360
  spin-down 109
probability 17, 145, 154, 158, 201, 251, 272, 324
  reflection 79, 82–84, 148–150, 152, 298, 327, 330, 335, 372
  self-scattering 42
  scattering 6, 14, 41, 42, 56, 268
  transmission 79, 83, 84, 87, 92, 93, 102–105, 112, 146, 148, 158, 164, 165, 298, 372, 373, 375, 377, 380
PVCR *see* peak-valley current ratio

QPC *see* quantum point contact
quantum bite 169
quantum dot 14, 171, 176, 177, 181, 183, 185–187, 190, 192, 195, 204, 209, 211–216, 221, 222, 247, 269
  harmonic 196
  single-electron 210, 211
  single-level 190, 191
  split-gate 174
  ultra-small 215
quantum effect 4, 9–11, 13, 72, 115, 215, 265, 268
quantum interference 12, 14, 35, 147, 270, 317
quantum point contact (QPC) 174
quantum well 116, 129, 132
quasi-confined state 76, 87, 88, 112, 380
quasi-Fermi energy 145

radial breathing mode (RBM) 28, 29
random fluctuation pattern 173
Rashba coefficient 24, 25, 280, 281, 318, 319, 324, 325, 327, 334, 340, 341, 343, 344, 356, 358, 369, 375, 380
Rashba effect 319, 334
Rashba interaction 24, 280, 282
Rashba spin-orbit interaction (RSOI) 278, 279, 281, 319, 320, 322, 337, 352, 355, 356, 358, 361, 364, 367, 368
Rashba strength 362–364
Rashba wave function 321, 334, 335
RBM *see* radial breathing mode
relaxation time 14, 44, 47, 119, 127, 270
  collision 123
  spin coherence 318
reservoir 10, 11, 149, 151, 152, 154, 157, 158, 160, 163, 177, 179, 231, 232
resistance 28, 92, 137, 142, 147, 154, 156, 158, 189, 190, 216
resonance 51, 97, 110, 111, 124, 169, 190, 346, 377
resonant tunneling (RT) 75, 76, 78, 80, 82, 84, 86–88, 90, 92, 94, 96, 98, 100, 102, 104–112, 223–225
resonant tunneling diode (RTD) 75, 76, 94, 108–112
retention time 241, 248, 251, 254, 256–258
RSOI *see* Rashba spin-orbit interaction
RT *see* resonant tunneling
RTD *see* resonant tunneling diode

scanning electron microscope (SEM) 174, 228
scanning tunneling microscopy (STM) 276
scattering 4–6, 11, 15, 58, 59, 147, 152, 161, 164, 266–268, 271, 276, 305, 309, 311, 314
  carrier 28
  elastic 5, 28, 267
  electron–electron 6, 268
  energy-dissipating 65
  excitation exciton 29
  inelastic 5, 14, 28, 267, 270
  intervalley 59
  static 267
scattering matrix 15, 20, 80, 81, 83–86, 154, 270, 282, 302, 308–311, 313, 314
scattering matrix method 80, 81, 301, 308–310
Schottky barrier 28, 31, 33
Schottky-gate-induced depletion region 195

Schrödinger equation 84, 86, 130, 288, 289, 342, 344, 352
SED *see* single-electron device
SEM *see* scanning electron microscope
semiconductor 4, 22, 23, 39, 43–45, 104, 116, 117, 266, 276–278, 317, 318
  bandgap 62
  bulk 29
  complementary metal-oxide 276
  compound 209
  ferromagnetic 276
  high-mobility 6, 25, 281
  low-mobility 6
  narrow-gap 367
  non-magnetic 107
  semimagnetic 111
  wide-gap 70
  zinc-blende 318
series resistance 159
  parasitic 230, 231
SFET *see* transistor, spin field-effect
SHT *see* transistor, single-hole
single-electron device (SED) 235, 236
single-electron memory 235–237, 239, 241, 242
SOI *see* spin-orbit interaction
spin device 362
spin-down state 21, 25, 274, 280, 322, 342, 344, 359
spin effect 201, 206
spin-orbit interaction (SOI) 224, 239 281, 286, 318, 355
spin orientation 21, 104, 105, 109, 111, 112, 275, 320, 324, 334, 342, 344, 351, 375
spin polarization 21, 23, 25, 35, 105–108, 276, 277, 280, 355, 356, 358–360, 362–365, 375, 380
spin transistor 22–24, 276, 278–280, 355, 367
  unipolar 23
spin transport 35, 337, 339, 344, 356, 359–362, 364
SRAM *see* memory, static random access
STM *see* scanning tunneling microscopy
stub 294, 298, 310, 326, 373, 375–377, 381
superlattice 51, 99, 115–117, 123, 124, 126, 128, 129, 132

technology
  electronic-optoelectronic 35
  lithography 171, 195, 247
  micro-lithography 170
  microprocessing 209
  molecular beam epitaxy 75
  nanoprocessing 21, 275
thermal energy 29, 44, 46, 68, 71, 127, 210, 214, 221, 222, 225
thermal equilibrium 7, 43
thermal oxidation 219, 244
Thomas term 281
threshold shift 244, 245, 250
threshold voltage 242–246, 249, 251
threshold voltage shift 245, 246, 248, 250, 254
TMR *see* tunneling magnetoresistance
transconductance 33, 69, 70, 73
transfer matrix 77, 78, 84, 86, 87, 99, 101, 102, 308, 309, 338–341, 343, 345, 348, 350, 352, 356–358, 370, 371, 380, 381
transfer matrix method 80, 81, 92, 302, 303, 305–307, 310, 340, 343, 344, 352, 359, 368

transistor 35, 47–49, 57, 115, 236
carbon nanotube field-effect 30
Datta–Das 23, 278
Datta–Das spin field-effect 337
field-effect (FET) 26, 31, 32, 57, 246, 248, 249, 252, 291
graphene nano-ribbon field-effect (GNRFET) 26, 33–35
high-electron-mobility (HEMT) 57, 70
high-frequency 47
metal-semiconductor field-effect 67
modulation doping field-effect 319
n-type 229
p-type 32, 33
silicon metal-oxide semiconductor field-effect 62
single-electron 14, 169–171, 173, 175, 177, 179, 181, 182, 209–211, 213, 215, 236, 270
single-hole (SHT) 223, 225, 226
spin field-effect (SFET) 23, 278
thin-base-region 47
transport 28, 57, 59, 61–63, 65, 115, 117, 182, 183, 185–187, 201, 203, 285, 301, 338, 340
diffusive 276
hole 31, 225, 298
hopping 121
longitudinal 115
mescoscopic 15
quantum waveguide 367, 373
spin-polarized 337
spin waveguide 352
transverse modes 15, 137, 139, 270, 271, 301, 303, 306, 313
tunneling barriers 79, 158, 176, 216, 217, 223, 276
tunneling magnetoresistance (TMR) 22, 106–108, 275
tunneling probability 90, 92, 97, 108, 201

valence band 31, 98, 105, 277, 295
valleys 56, 59, 94, 188, 191, 192, 215, 294, 299, 365, 377
very large scale integration (VLSI) 209, 227
VLSI *see* very large scale integration

Wannier–Stark ladder formula 131
Wannier–Stark state 129, 130, 132, 134
Wannier–Stark wave function 135
wave 77, 80–83, 143, 145, 148, 266, 268, 292, 302, 305, 307, 308, 323, 324, 338, 344, 345, 348
wave functions 77, 78, 83–86, 101, 102, 131–133, 143, 286–292, 296–298, 319–321, 325, 326, 329–331, 335, 336, 338, 339, 345, 357, 358, 368–370
harmonic-oscillator 163
hole 100, 101, 295–297
incident 323, 375
plane 190, 286
reflected 323, 338
tight binding 116
transmitted 323
transverse 161, 370
waveguide 305, 307, 309, 311, 313, 334, 336, 367, 372, 373, 376–379
wave vector 16, 25, 116, 118, 286, 287, 289, 290, 296–299, 318, 320, 322, 326, 334, 335, 338, 339, 341, 344
Wigner distribution function 10, 11
Wigner function 11, 67

Integrated circuits were developed following Moore's law, which predicted that the degree of microprocessor integration would double every 18 months in dynamic random-access memory (DRAM). However, as the size of circuit elements approaches its physical limit, the optical method used in manufacturing 16 nm-node chips is also approaching a limit. Although the scaling of microelectronic circuit elements still follows Moore's law, the unit density of power consumption will become unacceptable. Therefore, on the one hand, while the microelectronic technology is being developed continuously, on the other, the feasibility of overcoming Moore's law is also being considered—that is, the More than Moore strategy.

Physically, when the scale of the circuit elements decreases to 10 nm or even less, the quantum effect appears and plays a more and more important role. The electron transport becomes non-classical and non-linear. Even electron motion is like waveguide motion. This book introduces some interesting theories and experiments related to quantum transport. It consists of two parts: (i) Non-classical, Non-linear Transport, and (ii) Quantum Waveguide Theory in Mesoscopic Systems. It provides solid foundations for semiconductor micro- and nanoelectronics for the after-Moore age, develops the transfer matrix method and uses it to study the Rashba electron transport in the Aharonov–Bohm circular ring and square ring, and discusses theories in view of their applications in next-generation semiconductor electronics and industry.

Jian-Bai Xia is a professor at the Institute of Semiconductors, Chinese Academy of Sciences, Beijing. He has many firsts to his credit. Prof. Xia was the first to propose the plane wave expansion method, the tensor model of quantum spheres, the effective-mass theory of (11N)-oriented superlattices, and hole tunneling theory. He developed a systematic method in the framework of the effective-mass theory to study the electronic structures of quantum dots and wires in a magnetic or electric field, especially spin-related properties, besides predicting a series of new phenomena relating to quantum dots, quantum wires, and nanofilms. A recipient of many awards and honors, Prof. Xia has published more than 105 articles, authored or coauthored 2 monographs, and served in important capacities in several universities.

Duan-Yang Liu was born in Hunan, China, in 1985. He received his BS in applied physics from the the College of Science, Tsinghua University, Beijing, in 2006 and a PhD in condensed matter physics from the Institute of Semiconductors, Chinese Academy of Sciences, Beijing, in 2011. Since 2011, he has been a lecturer in the Physics Department, College of Science, Beijing University of Chemical Technology, Beijing. He is currently engaged in research on semiconductor physics, especially carrier transport in low-dimensional semiconductor devices.

Wei-Dong Sheng is a professor in the Department of Physics, Fudan University, Shanghai. From 1996 to 1999, he developed systematic transfer-matrix and scattering-matrix approaches to ballistic transport in quantum waveguides and investigated electron waveguide couplers, magneto-transport through edge states, and quantum coherent networks. From 2000 to 2008, he developed a comprehensive framework of numerical approaches to strain distribution, electronic structure, and optical properties of self-assembled quantum dots and is currently engaged in developing an efficient configuration-interaction method for strongly correlated electron systems. Prof. Sheng has held significant positions in many universities.

PAN STANFORD PUBLISHING
www.panstanford.com

V516
ISBN 978-981-4669-85-6
9 789814 669856