

Index

a

aluminum nanoring 266
 amorphous 203, 244
 amplitude fluctuations 86, 91, 127, 159
 Andreev reflection 181, 278
 Andreev solution 187
 annihilation field operators 22, 82
 anticommutation relationships 5, 9
 antiproximity effect 219, 224, 248, 250
 antisymmetric tensor 131, 133
 approximation
 – parabolic band 40, 42
 Arrhenius–Little
 – formula 247
 Aslamazov–Larkin 139, 151
 attempt frequency 54, 64, 92, 195, 222

b

BCS
 – model 5, 10, 20, 36
 – theory 3–4, 20, 32
 BCS gap 7
 – equation 6, 26
 BdG equations 34, 41, 180, 255
 biasing current 97, 143, 164, 294, 297
 bilayer 175, 253, 279, 284, 287
 Bogoliubov 8
 Bogoliubov–de Gennes equations 8, 34, 40,
 180, 255
 Boltzmann
 – distribution 68
 – equations 4, 17
 Born approximation 16, 19
 Bose condensation 4–5
 boson modes 154–155
 Büchler, Geshkenbein and Blatter theory 100

c

Caldeira–Leggett approach 154

carbon nanotube 31, 48, 203, 226, 278

Chang and Altomare 208, 215
 confinement 76, 150, 159, 162
 contact resistance 175, 177, 285
 continuum limit 107, 113, 119, 139
 conversion resistance
 – electron 106, 109, 116
 – normal 108, 112, 120
 Cooper
 – instability 4
 – pair 3, 12, 31, 35, 49, 105, 241
 Cooper box 152–153, 156, 269
 core contribution (QPS action) 26, 88, 90
 Coulomb blockade 117, 230, 266, 281
 Coulomb gas 95, 110
 Coulomb repulsion 49, 151
 cryostat: copper powder 220
 crystal-momentum 163
 current–phase relationship 156–157,
 182, 290
 current–voltage characteristics 248, 250

d

dark count 292, 295, 297
 Debye
 – energy 13
 – frequency 5
 – phonon energy 37
 – window 43
 decay rate 93, 98
 deconfinement 102, 162
 depairing current XXVIII, 179, 243, 249
 differential conductance 177, 183, 288
 differential resistance 176, 227, 278, 285, 290
 diffusion propagator 83
 Dirichlet 104, 134, 161
 disorder 76, 126, 137, 151, 179, 272
 disorder averaging 80, 126
 Drude 26, 84

- duality 149, 152, 155–156, 263
 Duffing oscillator XXIX, 245–246
- e**
 e-beam resist 204, 213
 effective action 22, 79, 105, 113, 122, 140, 161
 effective action (Drude contribution, London contribution, Josephson contribution) 83, 86–88
 Eilenberger–Larkin–Ovchinnikov equations 12–13, 17–18, 169
 electrochemical potential 67, 108, 124
 electron–phonon coupling 13, 40, 45, 50
 electrostatic potential 109, 160, 173, 175
 envelope function 119
 etching 199, 251, 294
 Euclidean action 80, 92, 110, 124, 130, 152
 evaporation 198, 213
 – angled 213
 – quenched 34
 expansion coefficients 46
- f**
 fabrication
 – nanowire 195, 201, 246
 Fermi energy 7, 33, 180, 281
 Fermi surface 16, 36, 169, 171
 Fermi wavelength 31, 42, 115, 169, 256
 fermionic excitations 7, 31
 Fermi–Dirac occupation 7
 film resistance 227
 films 35, 47, 77, 151, 256
 filtering 219–220
 fluorinated carbon nanotube 204, 228, 248
 fluorocarbon nanotube *see* fluorinated carbon nanotube
 Fokker–Planck 64, 66, 68, 92
 free energy barrier 50, 59, 90, 130, 160, 195, 222
 free energy minima 55, 59, 122, 160
 frequency-momentum 23, 82–83, 86
- g**
 Galilean invariance 22, 122
 gauge invariant 21, 25
 Gaussian approximation 139–140
 Gaussian fluctuation 22, 139
 Ginzburg–Landau
 – approximation 55
 – coherence length 56
 – equation 12, 60, 68, 70, 139
 – free energy 10, 51, 55, 57, 60, 66, 90, 98, 222, 237
 – relaxation time 12, 66, 226
 – theory 10–11, 52
 Giordano 70, 196, 225, 233, 242
 GL free energy *see* Ginzburg–Landau, free energy
 Golubev–Zaikin theory 79, 247–248
 Gorkov equations 3, 15, 18
 grain Hamiltonian 108–109
 gravity *see* Yang–Mills duality
 Green’s functions 3–4, 12–14, 16–18, 21–23, 25, 81–83, 169–174
 – equations of motion 14
 – thermodynamic 14
- h**
 Hartree–Fock approximation 8
 Hermitian conjugate 14, 153
 Hertz–Millis–Moriya theory 139
 Hilbert space 67–68, 170
 hydrodynamic contribution 76, 91, 223
 hydrogen silsesquioxane (HSQ) 265, 294, 296
 hysteresis XXXVI, 237, 287, 290
- i**
 inelastic scattering 172
 infinite film 42
 infinite-randomness fixed point *see* IRFP
 interacting phase slips 159
 interface resistance 168, 177, 235, 287
 intrinsic superconductivity 277–278
 ion beam deposition 251
 ion-milling 212–213, 224, 266
 IRFP XV, 142
- j**
 Josephson energy 52–53, 109, 153, 269
 Josephson junction
 – 1D chain 105, 107, 116, 149
 – 2D array 78
 Josephson relation XXXV, 51, 67, 87, 161, 287
 junction capacitance 53
 junction resistance 114
- k**
 Keldysh
 – formulation 19, 80
 Keldysh Green’s function 170–171, 173
 Khlebnikov–Pryadko theory 121, 123
 kinetic inductance 98, 131, 265, 292
 Kosterlitz–Thouless–Berezinskii *see* KTB transition
 KTB transition 76, 96, 108, 118, 149

l

Lagrangian density 124, 131, 149
 LAMH model 224, 228, 231
 LAMH theory 135, 196, 223, 225, 228, 232
 Langevin term 66, 68, 92
 lattice
 – parameter 105
 linear approximation 18
 lithography 197, 211, 223, 253, 287
 logarithmic interaction 77, 88, 97, 115, 125
 London equations 7, 9
 London penetration length 11, 85
 long wire limit 135, 182, 247
 low-pass filter 220–221
 Luttinger liquid 49, 66, 76, 97, 127

m

magnetic flux
 – expulsion 11
 magnetic susceptibility XXXIII, 84, 282–283
 magnetoresistance 232, 254
 Majorana fermion 32, 184, 286
 Majorana mode 185, 275, 286
 Matsubara frequency 19, 83, 110,
 138–139, 181
 Maxwell fields 134
 Meissner effect 7
 – magnetic 286
 membrane templating
 – porous 210
 – track-etched 210
 metal deposition 198, 225, 287
 molecular templating 202, 208, 215, 228, 239
 momentum conservation 121–122, 126
 Mooij–Nazarov theory 152, 159, 165
 Mooij–Schön plasmon mode 26, 77, 88, 149

n

Nambu space 21, 82, 170, 186
 nanotube
 – carbon 31, 48, 203, 226, 278
 – fluorinated 204, 228, 248
 – single-wall 276, 278
 nanowire array 207, 237
 nanowire cross section 123, 154, 201, 231,
 254, 296
 nanowire resistance 116, 123, 222, 287
 nanowires
 – aluminum XXV, 33, 47, 92, 175, 211,
 235, 244, 247, 257, 268
 – coupled 34
 – polycrystalline 215
 – single-crystal 31–32

– superconducting 4, 99, 219, 292
 – titanium 213, 233, 267, 270

Natelson and Willet 205

Newmann boundary condition 103

non-equilibrium 4, 13, 15, 19, 51–52, 80,
 167–170, 172, 176–177, 179

nonlinear oscillator 246, 265

o

oscillations

– Friedel 41, 47

oscillatory modulation 35, 44

p

pair-breaking 78, 136, 179, 229, 249

pair-velocity 179

paramagnetic impurities 15, 137–138

particle–hole symmetry 23, 25, 187

partition function 81, 96, 112, 126, 160

path integral formulation 19, 79

Pauli exclusion 5

Peierls distortion 285

Peierls instability 282

periodic boundary condition 35, 41, 55,
 64, 104

phase slips 50, 75, 123, 221, 263

photon detectors 214, 275, 292

π -filter 220–221

plane waves 58

plasma frequency 54, 114, 157, 163

plasma oscillations 157

plasmon thermal wavelength 96, 223

Poisson statistics 34, 45

propagation impedance 77, 97, 120, 150

proximity effect 234, 250, 276, 286, 294

pseudospin 153

q

QPS 88, 95, 152, 156, 226, 239, 263, 269

QPS dipole proliferation 115, 119

QPS dipoles 113, 116, 121

QPS interaction 77, 98, 130, 150

QPS qubit 153, 157, 269

QPS rate 80, 92, 130, 157, 271

QPS saddle point 93, 103

QPS transistor 263–264

QPS–anti-QPS pair 104, 128, 150, 161

quantized supercurrent 169, 183

quantum criticality 76, 136, 141

quantum phase 126

– transition 4, 19, 75, 224

quantum phase-slip *see* QPS

quantum-mechanical tunneling 51, 54, 122,
 130, 136

- quark plasma 150, 162
quasiparticle diffusion length 237
quasiparticle distribution 4, 168, 173
quasiparticle energy 36
quasiparticle excitation 7–8, 180
- r**
random-transverse-field Ising model 78, 141–142
RC filters 220–221
Refael, Demler, Oreg, Fisher theory 105
renormalization 103, 113, 232
- s**
S-SCNW-S 179, 243
s-wave superconductor 5, 185
SC-1 phase 108, 110, 115
SC-2 phase 108, 113, 115
scaling behavior 31, 104, 129
Schmid transition 97, 103, 117, 122, 127
Schrödinger equation 35
self-energy 172
semiconducting stencil 205, 209
semiconducting templating 215
shape resonance 31, 35, 42, 219, 255
Shapiro current 150, 156
Shapiro steps XXXV, 164, 247, 287
Shapiro voltage 156, 302
short-wire limit 90, 92, 127, 141, 179
short-wire SIT 116
shunt resistance 106, 112, 120, 150
sine-Gordon 112, 118, 149, 162
single-charge transistor 263
single-wall nanotubes 276, 278
SIT 78, 100, 115, 117, 128, 151, 231, 271–272
size oscillation 31, 45, 48
SNAP detector 295
SNAP technique 206, 215, 225, 235
SNS bridge 8, 168
spin–orbit interaction 32, 184
sputter deposition 213, 227
stabilization of superconductivity 253
stencil technique 201, 208, 224
step-edge fabrication 201, 206, 225
subharmonic structure 183–184
superconducting atomic point contacts 179, 183
superconducting channel 108, 118
superconducting contacts 237, 276, 280–281, 289
superconducting film 78, 95, 151, 200, 207
superconducting gap 42, 67, 120, 176, 276
superconducting grains 34, 105, 107
superconducting loop 159, 267, 269
superconducting nanorings 263, 266
superconducting proximity 167
superconducting transition 48, 75, 195, 249, 277
superconductor–insulator transition *see* SIT
superconductor–semiconductor nanowire–superconductor junctions *see* S-SCNW-S
supercurrent density 16, 161
superfluid
– current 107
– density 11, 86, 122
switching current 142, 169, 177, 239, 243, 294
- t**
TAPS (TAP) 32, 64, 70, 222, 242
TAPS + QPS XXVII, 237–238
TDGL equation *see* time-dependent Ginzburg–Landau equation
template synthesis 209, 248, 251
thermal activation 67, 70, 196, 226, 240
thermal agitation 54, 64
thermal conductivity 141
thermally activated phase slip *see* TAPS (TAP)
Thomas–Fermi screening 22
threshold thickness 40
time-dependent Ginzburg–Landau equation 12, 66–68, 93
topological defects 20, 78, 88, 95, 151
topological insulator 179, 185, 290
toy-model 201, 206, 208–209, 211, 213
transition curve 232–233
transition rate 59, 69
transition region 35, 38–39
transport properties 155, 169, 227
tunnel junctions 8, 138
tunneling barrier 288
tunneling current 266–267
tunneling path 132, 150
tunneling rate 80, 128, 150, 301
- u**
Usadel equation 3–4, 12, 168, 180, 275
- v**
Villain transformation 112, 152
voltage
– finite 10, 51, 175, 179, 183
voltage–current relation 97, 100
vortex
– antivortex 78, 95, 125, 149, 285

vortex charge 131, 159
vortex current 131, 134

w

Ward identities 22, 25
wet-etching 199, 209–210
Wigner–Dyson
– statistics 34, 45
winding number 52, 65, 135, 222
wire capacitance 89
wire resistance 97, 225

y

Yang–Mills duality 76, 143, 301

z

Zaikin–Golubev theory *see* Golubev–Zaikin
theory
ZBA 230, 278, 281
Zeeman gap 186
zeolite 49, 281