

Index

a

Abrikosov–Gor’kov (AAG) theorem 197, 223
 AC measurements 97
 aluminum-aluminum oxide-aluminum
 junction (Al-Al₂O₃-Al) 53
 Ambegaokar–Baratoff formula 54
 antiphase-slip 127
 antiphase-slip (APS) 116
 antiphase-slips 117, 119, 120, 125–127,
 136, 180
 antiproximity effect in nanowires 165
 arbitrary infinitesimal variation 38
 Arrhenius activation 177
 – exponent 106, 110
 – factor 68
 – law 8, 104, 109, 118, 164, 176, 189, 201,
 202, 211
 Arrhenius resistance 180
 attempt frequency XIV, XXI, XXIII–XXV,
 61, 67, 68, 72, 73, 107

b

Bardeen formula 136, 149, 157, 170, 171,
 213, 238, 239
 battery-operated preamplifier 98
 bell-shaped distributions 218
 black body radiation 94
 Bloch wave 75
 BNC cable 98
 bogoliubons 29, 44, 53, 55, 56, 67, 114, 116,
 121, 122, 155, 169
 Bogoliubov quasiparticles 7, 121
 Boltzmann constant 7
 bosons 2
 Brownian diffusion 124

c

calculus 11
 – of variations 40

Caldeira–Leggett

– damping effect 180
 – macroscopic quantum tunneling
 theory 208
 – mechanism 173
 – quantum dissipation model 205
 – theory 73

carbon nanotube 82, 86

– fluorinated 86

Carnot cycle 30

Catalan number 230

chip carrier 92

coefficient of viscosity 11

coherence length 47

condensation energy density 8, 18, 110

Cooper pair 2, 223

– density 2

coplanar waveguide resonator 49

cotton insulation 94

Coulomb

– blockade 87, 105, 202

– energy 59, 60

– island 3

– repulsion 1, 87, 112

Crick–Watson double-helix 86

critical current 213

cryostat

– cold finger 92, 93

cubic potential 53, 66, 71, 73

– thermal escape 67

current-conservation equation 62

current–phase relationship 233

current–phase relationship (CPR) 50, 65

– of the superconducting device 54

d

data acquisition (DAQ) cards 96

Dayem bridge 122, 123

- DC
 - measurements 96
 - transport setup 135
- de Gennes solution 118, 120
- deoxyribonucleic acid (DNA) 86
 - as a structural template 86
 - metal-coating 87
 - molecules 86
- depairing current 213
- dichloroethane 81
 - 1,2-dichloroethane 86
- dielectric constant 113
- digital analogue converter 98
- Dirac delta function 145
- dispersion 217
- dissipative Schmid–Bulgadaev transition 11
- distribution of the switching currents 139
- DNA
 - molecule 87
- Drude formula 51
- dry nitrogen gas 81
- dynamic equilibrium condition 116

- e**
 - Eddy current 93
 - electric current 44
 - Electrodag-1415M 84
 - electrode 28, 35, 49, 66, 79, 101
 - shunting effect 184
 - electromagnetic
 - quantity 226
 - electromagnetic (EM)
 - noise filter 93
 - wave 94
 - electron 2, 28
 - beam lithography 54, 79
 - macromolecule 2
 - uncondensed/unpaired 3
 - electron–electron
 - attraction 1
 - Coulomb repulsion 200
 - repulsion 13
 - electron–phonon interactions 1
 - electronic transport measurement 95
 - electrostatic charging energy 238
 - elementary diffusion theory 223
 - equilibrium state 25

- f**
 - Fabry–Pérot interferometer 49
 - Faraday cage 29, 92
 - Fermi
 - distribution energy 1
 - energy 51
 - velocity 51, 126, 223
 - fermion 2
 - flicker noise 220
 - fluorinated carbon nanotube 81, 86
 - fluorine atom 86
 - focused ion beam machine (FIB) 84
 - Fokker–Planck equation 68
 - Foucault current 93
 - free energy 17, 22, 24
 - density 17
 - minimization 38
 - function 38
 - functional 38

- g**
 - Gaussian
 - noise 77
 - normal distribution 70
 - unit 112, 169, 224, 226
 - Geiger counter 135
 - Giaever junction 53, 54
 - Gibbs energy 37, 59, 143, 155, 233
 - barrier 143, 145, 173
 - density 35
 - of superconducting wires 31
 - Gibbs energy barrier 235
 - Gibbs free energy 18, 21, 125
 - Gibbs functional 126
 - Gibbs potential 34, 156
 - barrier 233
 - Ginzburg–Landau (GL)
 - equation 30, 39, 46, 118
 - time-dependent 107
 - free energy 17
 - Ginzburg–Landau–Abrikosov–Gor’kov (GLAG) theory 15
 - Ginzburg–Landau (GL)
 - equation 225
 - Giordano model 149, 165, 169, 174, 210
 - experimental tests 175
 - Golubev–Zaikin
 - attempt frequency 128
 - microscopic theory of TAPS 125, 130
 - theory 173, 174, 183
 - Gor’kov–Josephson equation 5
 - Gor’kov phase equation 5, 28, 119, 128, 134
 - Gor’kov’s phase evolution 54
 - Green’s function 15

- h**
 - Hamiltonian operator 69
 - harmonic oscillator 11, 29, 69, 237

heat exchange gas 29
 Heisenberg uncertainty 9, 70, 74, 163, 166, 223

helium 92
 – cryostat 92
 – thermal conductivity 92

Helmholtz
 – free energy 174

Helmholtz energy 17, 37, 65, 154
 – barrier 173
 – density 35
 – Taylor series 154

Helmholtz free energy 4, 18, 21, 27, 31, 40, 65
 – density 16
 – functional 117

Hilbert space 163
 hyperbolic sine function 120

i

indium 92
 insulating 187
 integral differentiation rule 147
 inverse Kurkijärvi–Fulton–Dunkleberger (KFD) transformation 152
 ion 18
 isopropanol 81

j

Johnson–Nyquist thermal current noise 76
 Josephson
 – energy 157
 – equation 65, 68
 – junction 57, 59, 61, 76, 113, 190, 191, 210
 – macroscopic quantum tunneling (MQT) 165
 Josephson junction 53, 54
 – kinetic inductance 61
 Joule
 – heated normal state (JNS) 132
 – heating 27, 35, 48, 136
 – power 55

k

Keithley voltmeter 98
 Khlebnikov theory (K-theory) 185, 186
 kinetic energy 17, 58, 75, 136
 kinetic inductance 49, 60, 208
 Kirchhoff equation 76
 Kosterlitz–Thouless (KT) transition 12, 103
 Kramers escape rate theory 113
 Kramers theory 67, 157, 160

Kurkijärvi
 – critical current law 161
 – power law 160, 162, 187, 190
 – temperature law 152, 161
 – theory 143, 157

Kurkijärvi–Fulton–Dunkleberger (KFD) transformation 143, 147, 148, 191

Kurkijärvi–Garg (KG model) 236

Kurkijärvi–Garg model (KG model) 189, 190
 – derivation 195

Kurkijärvi theory 131

l

LabView program 97, 140, 147

LAMH
 – model 107, 114, 115, 122, 168
 – resistance 121

Langer–Ambegaokar (LA) theory 160

Laplace equation 225, 230

law

– of quantum mechanics 10, 62
 – of the energy conservation 74

Likharev current–phase relationship 234

linear resistance measurement 152

linear transport measurement 164

Little–Parks (LP)

– effect 46
 – oscillation 49, 232

Little's

– fit (LF) 108–110, 115, 122, 201, 206

– Geiger counter 135

– helix 163

– phase slip (LPS) 7, 12, 23, 33, 40, 79, 95, 104, 105, 110, 166

– phase slip (PS) 187

London penetration depth 3

Lorentz force 157

low pressure chemical vapor deposition (LPCVD) process 79

m

macromolecule 105

macroscopic

– quantum tunneling (MQT) 9, 55, 131, 163, 164, 197

– solenoid 210

macrostate 25

magnetic

– field 40

– flux 228

– quantum 47, 162, 226, 232

– nanoparticle 10

master equation 146

Maxwell equation 42, 46

- McCumber
 - barrier 158
 - theory 173
- Meissner
 - current 7, 49, 230
 - effect 3, 232
- metallic nanowire 81
- microscopic effective action formalism 183
- microstate 25
- microwave radiation 70
- molecular templating 79
- molecule 86
- molybdenum-germanium (MoGe) 83, 86, 89, 215
 - alloy 215
 - film 82
 - nanowires 172, 184
 - optimized alloy 102
- monotonic function 144
- Mooij–Schön velocity 160, 185
- mounting procedure 91
- multiphase-slip switching 188
- multiple phase slips 151

- n**
- nanoloop 227, 228
- nanometer-scale wire 101
- nanoparticle 10
- nanoscale superconducting device 61
- nanowire 10, 37, 48, 65, 74, 101
 - antiproximity effect 165
 - fabrication 79
 - homogeneity 104
 - insulating 198
 - kinetic inductance 51, 172, 199, 209
 - made of superconducting materials 101
 - normal 198
 - resistance 169
 - S-type 198
 - superconducting
 - destruction of superconductivity 197
 - temperature-dependent coherence length 183
 - truly superconducting 198
 - uniformity 104
- National Instruments digitizer card 140
- negative-curvature Arrhenius-like activation 179
- net fluctuation effect 119
- net phase slippage rate 116, 149
- Newton equation 35, 63, 69
- Niemeyer–Dolan technique 54

- nonsuperconducting wire 187
- nucleation theory 23

- o**
- Ohm’s law 44, 98, 115, 202

- p**
- parabolic law 175
- parity effect 3, 6
- perfect superconductor 117
- phase-evolution equation 5
- phase fluctuation 71
- phase slip (PS) 180, 189
 - barrier 153
 - heating effects 129
 - overheating effect 138
- phase-slip (PS)
 - barrier 156
 - tunneling 186
- phase slippage
 - event 169
 - LAMH model 115
 - net rate 120
- photolithography 81–83
- photon 208
 - detector 53
- photoresist 82, 83
- pink noise 220
- Planck’s constant 3, 125, 136, 163
- Planck’s formula 74
- plasma
 - frequency 56, 61, 62
 - oscillation 62, 175
- positive
 - magnetic
 - flux 55
- potential energy 58
 - barrier 163
- probability
 - density 217
 - distribution 144, 148
- pseudo-four-probe geometry 102

- q**
- quantum
 - dissipation 11
 - fluctuation 24, 71, 105, 141, 177
 - mechanics theory 163
 - phase slip (QPS) 9, 128, 141, 142, 151, 164, 167, 183
 - fugacity 180
 - Giordano model 12, 149, 165
 - saturation behavior 194
 - ZGOZ theory 199

- phase transition 74, 200
 - resistance 205
 - Schmid–Bulgadaev (SB) transition 175
 - temperature 173
 - theory 10
 - tunneling 95, 151, 163, 167, 201, 210
 - quantum-coherent 106
 - Zeno effect 11
 - quasiparticle 7, 53
 - qubit effect 55
- r**
- reactive ion etching (RIE) 79
 - renormalization group model 181, 206
 - reproducibility 90
 - resistively and capacitively shunted junction (RCSJ) model 57
 - retrapping current 133
 - return current 133
 - Riemann zeta function 126
- s**
- sample installation 91
 - scalar product 41
 - scanning electron microscope (SEM) 82, 84
 - Schmid–Bulgadaev (SB)
 - phase diagram 179, 180
 - transition 11, 55, 74, 175, 187, 205, 210
 - Schrödinger equation 5, 6, 16, 69
 - time-dependent 5, 6
 - time-independent 6
 - semiconductor 7
 - series resistor 96, 98
 - shunt capacitor 37
 - shunting
 - effect of the electrode 184
 - resistor 74, 213
 - silicon (Si) chip 84
 - silver paste 94
 - single-phase-slip switching 152
 - skewness 220
 - solenoid 17, 33, 60
 - Sommerfeld formula 239
 - sputtering 81, 88
 - standard resistor 98
 - Stewart–McCumber model 53, 57, 113, 205
 - macroscopic quantum phenomena 68
 - of normalized Variables 76
 - Stewart–McCumber model
 - mechanical analogy 62
 - stochastic
 - premature switching 131
 - quantity 217
 - streptavidin protein 87
 - superconducting
 - condensate
 - free energy 15
 - usable energy 15
 - electron 3
 - density 3
 - energy gap 166
 - flux quantum 159
 - loop 17, 49
 - macromolecule 105
 - nanaloop 227
 - nanowire 29, 204
 - order parameter 1, 15, 105, 126
 - parity effect 3, 4
 - quantum interference devices (SQUID) 53
 - qubit 53
 - wavefunction 163
 - wire 32, 103, 187
 - superconducting state (SS) 131
 - superconductivity 1, 215
 - energy gap Δ 2
 - suppression 112
 - superconductor 9
 - free energy 38
 - Helmholtz free energy 46
 - density 16
 - superconductor-insulator-superconductor (SIS) junction 53, 190
 - superconductor-insulator transition (SIT) 197
 - superconductor-insulator transition (SIT) 11, 90, 177, 181, 200, 202, 210, 237
 - superconductor-normal quantum transition 177, 200
 - superconductor-resistor transition (SRT) 187
 - superconductor-to-insulator transition (SIT) 187
 - supercurrent 2, 3, 28, 227
 - density 3, 43, 50
 - superfluid
 - density 4, 43
 - velocity 3, 36, 224, 230
 - superpair 2, 4, 18, 43, 225
 - switching
 - current 133, 143, 188, 191
 - distribution 139, 218
 - measurement 140
 - event 133
 - probability
 - density 139

- function 165
- statistic 139
- t**
- Taylor
 - expansion 56, 66, 233
 - theorem 71, 154, 162
- Taylor expansion 121
- TDGL equation 166
- thermal
 - energy 24
 - fluctuation 23, 74, 106, 141, 145, 155
 - phase slip 129
- thermal fluctuation 36
- thermally activated phase slip (TAPS) 8, 106, 118, 164, 187, 201, 238
 - Arrhenius model 149
 - Golubev and Zaikin theory 125, 130
 - high currents 157
 - LAMH model 107
 - TAPS-only model 151
- thermodynamic
 - critical field 158, 169
 - equilibrium 46
 - potential 39
 - system 18
- thermodynamic relation 30
- thermodynamics
 - definition of entropy 20
 - first law 19, 32
 - second law 20, 32, 33
- thermometer 94
- tilted washboard potential 64
- time-dependent Ginzburg–Landau equation (TDGL) 119
- time-evolution equation 5
- total entropy 25
- transmission electron microscope (TEM) 82, 84
- true superconductor 200, 205, 211
- tunneling 163
 - Caldeira–Leggett principle of dissipative suppression 184
 - event 180
- typical fluctuation 110
- u**
- usable energy 22, 23, 36, 58
- v**
- van der Waals forces 87
- variance 217
 - estimator 220
- vector potential 41, 47
- voltage 27
- voltmeter 9
- vortex-antivortex pair 20
- w**
- washboard potential 60
- wave number 231
- wavefunction 2, 10, 15, 69
 - collapse 10
- wavevector 4, 105
- white spots 88
- WKB expression 72
- z**
- Zeno effect 11
- zero-bias resistance 97
- zero-point fluctuation 72, 163, 166, 193
- zero-temperature coherence length 47
- ZGOZ theory 199