

Index

- ab initio* calculations, 165, 304
- absence of backscattering, 20, 213
- AC transport, 9, 278, 284, 285, 290
- achiral nanotubes, 64
- acoustic phonons, 118
- adiabatic approximation, 280, 283
- adsorbates, 197, 201
- Aharonov–Bohm effect, 219, 222
- ambipolar behavior, 222
- amorphous graphene, 9, 311
- Anderson disorder, 9, 145–147, 149, 159, 165–167, 169, 170, 175, 183, 184, 229–231, 310
- Anderson localization, 173, 189, 191, 193, 305, 310, 345
- armchair edges, 30
- armchair nanotubes, 41, 44, 51, 52, 64, 112, 129, 131, 132, 148, 299, 314, 317
- arsenene, 70, 85
- ballistic motion, 112, 147, 159, 303
- ballistic regime, 107, 142, 147, 218, 258, 301
- bernal graphite, 25, 66
- Berry connection, 211, 213
- Berry curvature, 211, 212, 215, 233
- Berry phase, 116, 180, 210–213, 227, 235
- Bethe–Salpeter equation, 392
- bilayer graphene, 25–28, 30, 68, 69, 74, 125, 126, 128, 174, 208, 215, 249, 285, 288, 289, 350
- bipartite lattice, 16, 67
- Bloch states, 212, 253, 256, 393, 395
- Bloch theorem, 365, 394
- blocking factors, 96
- Boltzmann conductivity, 102, 162, 163, 165, 175, 305
- Boltzmann equation, 9, 92, 94, 99, 100, 149, 151, 159, 174, 305
- Born–Oppenheimer approximation, 355, 356
- boron-doped nanotubes, 293, 296
- borophene, 9, 70, 81–83, 85
- Bravais lattice, 13–15, 212, 364
- Brillouin zone, 7, 11, 13, 14, 16, 17, 19, 22, 23, 29, 32, 37, 39, 42, 44, 45, 49, 68, 73, 75–77, 79, 80, 82, 162, 176, 212, 213, 233, 280, 317, 332, 365, 367, 378
- Buckminsterfullerene, 4, 5
- carbon allotropes, 6
- carbon fibers, 5
- carbon nanofoams, 5
- carbon nanotubes (CNTs), 1, 5, 6, 10–12, 31, 35, 40, 41, 44, 45, 47, 48, 50, 54, 56, 63, 64, 66, 68, 93, 110, 118, 125, 128–132, 134, 144, 147, 151–153, 208–210, 213, 221, 222, 285, 291, 293–297, 299, 310, 314–320, 322–331, 334, 342, 343, 347, 352, 403, 412
- bundles, 51
- metallic, 120, 134, 137, 146, 147, 151, 154, 159, 208
- multi-wall (MWNTs), 5
- see* nanotube junction, 64
- single-wall (SWNTs), 6, 52, 53, 65, 68, 129, 134, 135, 137, 141, 144, 149, 150, 208
- carbon onions, 5
- carbon-based devices, 208, 284, 285
- carbon-based materials, 1, 6, 54, 92, 119, 286, 311, 342, 352
- carbon-based nanomaterials, 54, 352, 353
- carbyne, 3
- charge mobility, 157, 171, 199, 200, 202, 410
- charging energy, 94, 135, 203, 205–207
- chemical functionalization, 83, 201, 323, 324
- chemical impurities, 297, 303
- chemical substitutions, 229
- chemical vapor deposition (CVD), 8, 74, 88, 157, 194, 196, 202, 247, 322
- Chern number, 212, 232–234
- chiral nanotubes, 42, 44, 46
- chirality, 18–20, 41, 63, 66, 89, 161, 176, 253
- coherence time, 92–94, 177–179
- conductance peaks, 204–206

- conductivity, 2, 6, 7, 51, 54, 83, 86, 102, 103, 106, 107, 109–111, 116, 117, 142, 157–160, 163, 165, 168, 169, 173–176, 178, 183, 185, 189–193, 199, 225–227, 229–232, 262, 271, 273, 305–310, 328, 330, 392, 393, 410, 411
- constant interaction model, 205
- Cooperon, 114–116, 169, 175–178, 180, 392, 393
- cotunneling, 94, 207, 208
- Coulomb blockade, 94, 95, 134, 135, 145, 154, 203, 205, 206
- current–voltage characteristics, 141, 156
- curvature
- effects, 41, 47, 50, 131
- CVD-grown graphene, 347
- decoherence, 117, 118, 136, 150, 179, 183, 245, 248, 251, 313
- decoherent transport, 117
- defects
- edge, 152, 154, 155, 294, 334, 335, 337
 - extended, 57, 58
- Density Functional Theory (DFT), 12, 23, 24, 35, 38, 50, 61, 73, 77, 90, 239, 245, 253, 263, 266, 295, 304, 313, 330, 350, 354, 358–360, 364, 365, 370–374, 376, 377, 379, 397–399
- density of states (DOS), 20, 22, 37, 44–49, 51, 53, 57, 61, 64, 75, 82, 89, 90, 92, 96, 106, 109, 111, 113, 118, 119, 129, 133, 134, 139, 144, 146, 157, 160, 162, 166, 167, 170, 174, 187, 188, 191, 192, 198–200, 209, 219, 221, 230–232, 261, 275, 282, 287, 288, 292, 295, 296, 305, 308, 311, 312, 319–322, 327, 337, 340, 348, 379, 401, 403, 404, 407
- dephasing time, 262
- destructive interference, 94, 95
- diagrammatic theory, 175
- diamond, 1–3, 54
- dichalcogenide(s), 70, 76, 77, 259
- diffusive regime, 108, 109, 115, 147, 162, 180, 181, 184, 189, 192, 200, 271, 300, 330
- Dirac cone, 24, 176, 178, 213, 223, 249, 264
- Dirac equation, 7, 18, 32, 142, 239, 240
- Dirac fermions, 17, 18, 125, 142, 143, 173, 253
- massless, 7, 17, 20, 29, 120, 125, 142, 143, 148, 158, 175, 176, 238, 250
- Dirac point, 7, 17, 18, 21, 23, 24, 27, 57, 68, 112, 142, 146, 147, 157, 158, 160, 162, 165, 168–171, 173, 174, 181, 184–193, 199, 200, 202, 214, 229, 230, 233, 242–244, 250–253, 255, 259, 273, 286, 288, 305, 306, 311
- dislocation lines, 165
- disorder
- long range, 120, 164, 173
 - short range, 145, 157, 174, 184, 310
- dynamical gap, 289
- edge reconstruction, 148, 335, 336
- edge states, 32, 37–39, 67, 208, 215, 229, 234, 235, 285, 289, 290, 332, 335, 348
- electron(particle)-hole symmetry, 11, 16, 27, 67, 120, 199, 316
- electron–electron (interactions, effects), 20, 23, 35, 36, 39, 89, 92, 94, 106, 136, 183, 202, 225, 229, 313, 355, 359, 362, 379
- electron-phonon, 75, 92, 100, 148–152, 157, 183, 313, 379
- electronic confinement, 334, 352
- epoxide defects, 310
- Fabry–Pérot
- conductance oscillations, 136, 144
 - interference, 120, 128, 134
- Fermi surface, 16, 25, 46, 82, 177, 179, 213
- Fermi wavelength, 92, 93, 160, 165
- Field-effect transistors, 30, 140, 141, 151, 297
- flat bands, 37, 62, 68, 75, 203, 225, 326
- Floquet Hamiltonian, 281, 282, 284, 287, 291
- Floquet theory, 9, 278, 280, 281, 285, 287, 290
- fluctuations, 97, 102, 151, 154–156, 158, 162, 198, 205, 207, 298, 302, 339–341, 345
- flux quantum, 217, 219
- Fullerenes, 4–6, 11
- functionalization, 87, 229, 293, 309, 323, 324, 326–330, 340, 352
- covalent, 324
- functionalized
- carbon nanotubes, 323, 324
- gap graphene
- upper limit, 23
- Gaussian impurities, 174, 175
- Gaussian orthogonal ensemble (GOE), 205, 207
- Gaussian unitary ensemble (GUE), 205, 207
- geometric phase, 210, 211
- germanene, 9, 70, 79, 83–85
- grain boundaries, 57, 58, 60, 61, 145, 160, 194, 197–199, 201, 202
- graphane, 307
- graphene
- corrugations(*see also ripples*), 92, 248
 - few-layer, 7, 21, 24–26, 28, 29
 - monolayer, 11, 26, 27, 121, 125, 128, 158, 222, 226, 246, 249
 - nanoribbons (GNRs), 5, 7, 8, 11, 12, 29–33, 35, 39, 40, 59, 61, 62, 68, 118, 132, 143, 145, 146, 148, 152–156, 159, 206, 208, 218, 288, 293, 307, 328, 331, 332, 334, 335, 338, 340–352
 - single layer, 28, 208, 214, 247, 258
 - suspended, 7, 23, 74, 93, 137, 247
- graphene networks, 13, 41, 66, 67, 167
- graphene quantum dots, 203, 207–209

- graphene-based devices, 83, 95
 graphene-based materials, 11, 108, 145, 152,
 210, 285
 disordered, 102, 110, 145
 graphene-related materials, 278, 280
 graphene-related systems, 148, 152, 160,
 278, 303
 graphite, 1–7, 11–13, 22, 25, 26, 28, 40, 53, 70, 74,
 76, 79, 185, 203
 graphitic onions, 4, 5
 Green's functions, 92, 96, 118, 135, 227, 282, 313,
 379, 393, 397, 399
 recursive methods for, 227
 techniques, 399
 GW approximation, 49, 50
- Haeckelite, 5, 65, 66, 311
 Haldane model, 234–236
 Hartree approximation, 356
 helicity (*see also* *chirality*), 18, 20, 63
 helicity (chirality) operator, 18
 hexagonal boron nitride, 70, 75
 hexagonal graphite, 25
 high-symmetry points, 23
 Hofstadter butterfly, 224
 hydrocarbons, 337
- insulating state, 113, 115, 156, 157, 160, 184, 231
 intervalley scattering (processes), 159, 160,
 171–173, 175, 177–181, 183, 250, 265–268
 intravalley scattering (processes), 159, 163, 171,
 172, 177–180, 183
 inversion symmetry, 45, 76, 116, 212, 233, 241, 242,
 248, 269, 283
 inversion symmetry breaking, 215, 285
- Klein tunneling, 9, 120–122, 126, 142, 143,
 157–160, 171, 180, 205, 213, 285
 knitting algorithm, 227
 Kohn–Sham equations, 362, 372, 399
 Kondo effect, 94, 95
 Kramers–Kronig relations, 378
 Kubo–Greenwood conductivity, 9, 109, 313,
 392, 405
- Lanczos method, 92, 110, 276, 401, 402, 405
 Landau levels, 210, 218, 222–224, 226, 227, 235
 Landauer formula, 99, 118
 Larmor frequency, 246
 laser-induced effects, 285, 286
 line defect, 61, 67, 195, 196, 209
 Lippmann–Schwinger equation, 379
 local density of states (LDOS), 59, 64, 65, 306, 326
 localization length, 112, 113, 152, 155, 184, 192,
 193, 230, 301, 302, 306, 313, 340
 Luttinger liquid, 137
- magic angle, 28, 225
 magnetic impurity, 319
 magnetism, 308
 magnetization, 56, 237, 238, 272, 273, 308, 318–320
 magnetofingerprints, 152
 magnetoresistance, 179, 218, 221, 222, 237,
 246, 261
 magnetoresistance oscillations, 218, 221
 magnetotransport, 23, 218, 224, 229
 magnetotransport measurements, 218
 many-body effects, 24, 379
 many-body perturbation theory, 12, 371, 373
 mean free path, 92, 93, 108, 109, 113, 129, 142,
 145–152, 157, 160, 168, 171, 173, 181, 189,
 190, 199, 200, 209, 247, 255, 294, 295, 299,
 302, 312, 313, 325, 328–330
 inelastic, 92, 151
 mechanical exfoliation, *see* micromechanical
 cleavage, *see* micromechanical cleavage,
 see micromechanical cleavage
 metallic state, 160, 309
 micromechanical cleavage, 6
 microtubules, 40
 minimum conductivity, 120, 143, 158–160, 163, 305
 mobility gaps, 63, 159, 307
 mode decomposition, 34, 35, 132, 143, 144, 288
 Moiré pattern, 74, 75, 194, 224
 momentum relaxation, 146, 178, 180, 248
 multiscale approaches, 293
 multiscale quantum transport, 293
- nanocones, 5, 6
 nanohorns, 5, 6
 nanotoroids, 5
 Nitrogen-doped nanotubes, 303
 nitrogen-doped nanotubes, 293
 noise, 97, 118, 119, 136, 144, 145, 162, 178,
 282, 291
 Non-reciprocal, 289
- optical phonon scattering, 130
 optoelectronics, 70, 71, 78, 85
 order-N transport methods, 10, 147, 230, 243, 401,
 405, 411
- Pauli matrices, 16, 18, 19, 176, 264
 Pauli principle, 97
 Peierls distortion, 50, 151
 Peierls substitution, 216, 222, 233, 235
 percolation transport, 157, 160
 phase shift, 121, 162, 167, 168, 291
 phosphorene, 9, 70, 79–81, 83, 85, 88, 89
 photonic crystals, 290
 plasmons, 23, 90, 378
 polarizability, 375, 376

- polycrystalline graphene, 160, 196–202
 probability amplitude, 97, 114, 195, 390
 pseudopotentials, 364, 368–372, 399
 pseudospin, 7, 18–20, 22, 115, 120, 125, 128, 143, 159, 162, 176, 183, 213, 228, 235, 239, 241–243, 250, 255, 256, 258, 264, 287
 pseudospin conservation, 120, 128, 143
- quantized conductance, 12, 107, 129, 156
 quantum (charge) pumping, 278
 quantum dynamics, 113, 256
 quantum Hall effect, 9, 210, 213, 218, 225–227, 232
 fractional, 225
 integer, 7, 225, 226, 289
 quantum interference(s), 94, 99, 108, 112, 114, 117, 147, 169, 175, 177, 178, 180, 184, 189, 222, 248, 278, 296, 297, 305, 306, 309, 313, 392
 quantum regime, 110
 quantum resistance, 99, 114
 quantum well, 116
 quasi-bound states, 316, 321, 322, 342
 quasicrystals, 406
 quasienergies (quasienergy spectrum), 280
 quasiperiodic systems, 110
- Raman (spectroscopy), 47, 335, 372
 random matrix theory, 205, 302
 random-phase approximation (RPA), 163, 376
 reciprocal
 lattice vectors, 13
 basis vectors, 68
 lattice, 13, 14, 365, 378
 space, 42, 77, 365, 367
 recursion method, 57, 187, 198, 199, 401, 412
 recursion methods, 119
 reflection matrix, 97
 relaxation time, 100–102, 161, 174, 178, 180, 246, 248, 250, 251, 253, 262, 267, 273
 relaxation time approximation, 100
 residence time, 94
 resistivity, 74, 168, 189, 201, 227, 229, 305
 rhombohedral graphite, 25
 ripples, 157, 247, 248, 253
- saturation regime, 106, 169, 173, 190, 192, 309
 scanning tunneling microscopy (STM), 46–48, 52, 59, 194, 304, 335, 347
 scattering centers, 159, 163, 194
 scattering events, 92, 99, 100, 102, 146, 150, 159, 160, 162, 163, 167, 177, 180, 248, 249, 251, 254, 389, 390
 scattering matrix, 97, 135, 136, 144, 279, 303, 379
 scattering potential, 146, 161, 167, 168, 183, 248, 253, 254, 297, 342, 396
 scattering theory, 167, 282, 395
- Schottky barriers, 64, 140, 141, 222
 Schwarzt crystals, 5
Scotch Tape method, *see* micromechanical cleavage
 screening, 78, 141, 157, 163–165, 174, 183, 185, 203, 293, 298, 314, 374, 376, 378
 second-nearest neighbors, 233, 236
 secondary Dirac cones, 74, 75
 self-consistent Born approximation, 157, 166, 169, 170, 200, 305
 semiclassical conductivity, 108, 115, 162, 164, 169, 170, 175, 183, 184, 192, 200, 201, 305, 306
 semiempirical models, 24
 semimetal, 16, 48
 sequential picture, 93, 94
 sequential tunneling, 94
 sextet, 335–337, 342
 spin Hall effect, 239, 259, 269
 spin polarization, 243, 251, 253, 255, 256, 260, 261, 269, 273–275, 308, 309
 spin relaxation, 9, 79, 239, 243, 245–251, 254, 255, 257–259, 262–264, 266
 spin relaxation times, 249, 252, 262
 spin–orbit coupling, 76, 78, 79, 115, 116, 145, 203, 226, 238, 239, 245, 251, 308
 spin-polarized calculations, 39, 348
 spintronics, 9, 71, 237, 238, 260, 332, 341
 stanene, 9, 70, 79, 84
 Stone–Wales defect, 209
 strong localization, 9, 145, 154, 160, 303, 306, 313, 325
 structural defects, 12, 56, 160, 165, 194, 202, 310, 311, 316, 390
 structural parameters, 68
 superconducting phase, 75
 superconducting transition, 75
 superconductivity, 50, 75
 symmetry breaking disorder, 231
- third-nearest neighbors, 21, 67, 295
 Thomas–Fermi model, 359
 Thouless relationship, 192, 294, 303
 time-dependent perturbation, 103
 time-reversal symmetry (TRS), 96, 111, 114, 154, 176, 179, 205, 207, 212, 213, 233, 303
 Tonomaga–Luttinger liquid, *see* Luttinger liquid
 topological defects, 56, 57, 194, 285, 311, 316, 337, 341, 352
 topological insulator, 226, 285, 288
 topological superconductivity, 75
 trajectory, 114, 116, 159, 177, 178, 252, 269
 transmission electron microscopy (TEM), 5, 56, 335, 347
 transmission matrix, 97

- transmission probability, 96, 109, 117, 121, 124, 125, 128, 130, 140, 142, 143, 196, 291, 333, 347, 348, 352
- transport gaps, 58, 154
- trigonal warping, 11, 17, 24, 26, 27, 44, 45, 68, 69, 176–179, 288
- trilayer graphene, 7, 26–28
- twisted bilayer graphene, 28, 74, 75, 225
- twisted graphene, 28
- two-dimensional quasicrystal, 74
- vacancies, 54–56, 61, 63, 152, 160, 167, 178, 185–193, 208, 209, 310, 316–320, 332, 333
 - monovacancies, 9, 55, 56, 145, 160, 185, 186, 309, 311, 316–320
- valley filter, 209
- valley Hall effect, 210, 215, 216
- valley mixing, 160, 162, 181, 228
- valleytronics, 78, 235
- van der Waals (vdW) heterostructure, 74, 90, 91
- van der Waals interaction, 9, 12, 70, 72, 76, 79, 85, 87, 90, 259, 260
- van Hove singularities (VHs), 21, 28, 45, 47, 64, 138, 166, 187, 198, 199, 219–221, 340
- vector potential, 103, 214, 216, 218, 222, 228, 235, 279, 286, 288
- wavepacket propagation, 267
- weak antilocalization, 116, 152, 157, 159, 160, 171, 175, 179–181, 183, 213, 239, 255, 259
- weak localization, 114, 116, 152, 159, 173, 179–181, 183, 190, 296, 306, 307, 392
- Wigner–Dyson distribution, 205
- zero-energy states, 37, 224
- zigzag direction, 60
- zigzag edge states, 66
- zigzag edges, 31, 37, 62, 332, 334, 341
- zigzag nanotubes, 44–46, 48, 315
- zone-folding approximation, 68, 294