
Index

- Abramowitz functions, 63, 64, 93, 108
 absorption event, 225
 absorption of radiation, 225
 accommodation coefficient for normal momentum, 35
 accommodation coefficient for tangential momentum, 35
 accommodation coefficients, 34, 35, 109
 activation energy, 221, 223, 224
 adsorption, 32, 33
 adsorption time, 32
 aerodynamic forces, 65
 aerosol, 66, 171
 aerosol particles, xv, 65, 66, 252
 aerosol reactors, 66
 aerosol science, 67
 aerospace, 65, 66
 analytic continuation, 138–140
 angle cutoff, 10
 angular momentum, 242, 243
 angular momentum
 conservation, 223
 angular velocity, 210
 Arrhenius formula, 221
 artificial satellites, 189
 atomic oxygen, 220
 attenuation coefficient (of a sound wave), 139
 attenuation parameter, 139
 attenuation rate (of a sound wave), 129
 Avogadro's number, 221

 bacteria, 66
 beam scattering, 36
 BGK model, 26–28, 48, 50, 82–85, 92, 95–97, 102, 105, 107, 109–114, 123, 133, 137–139, 151, 152, 169–173, 207, 211, 212, 235, 276, 278, 287, 289, 290, 292

 bifurcation, 246
 bimolecular reaction, 220, 222
 blunt bodies, 236
 body force, 46, 189, 244
 boiling temperature, 297
 Boltzmann constant, 20
 Boltzmann equation, 1, 2, 6, 7, 9–11, 15, 18, 20–22, 24–28, 30, 40, 41, 44, 45, 47–51, 65, 67, 68, 70, 71, 75, 82, 114–117, 122, 130, 141–143, 145, 147, 151, 152, 154, 162, 176, 180–184, 186, 187, 189, 211, 216, 222, 225, 230, 231, 233, 235, 237, 241, 244, 252, 254, 255, 259–261, 265, 273, 275–278, 281, 282
 Boltzmann gas, 56, 166, 186
 Boltzmann inequality, 15, 22, 26, 174
 Boltzmann, L. E., 2, 6, 25, 116, 204, 210, 214
 Boltzmann–Grad limit, 5, 7, 8, 114, 186
 bounce-back boundary condition, 41, 44
 boundary, 8, 18, 19, 23, 30, 84, 89, 92, 103, 131, 137, 138, 163, 174, 252, 254, 275, 281, 304
 boundary conditions, 8, 23, 24, 30, 40–43, 48, 50, 54, 57, 60, 61, 71, 72, 77, 79, 84, 85, 89, 90, 100, 101, 103, 104, 111, 112, 118, 119, 137, 152, 154, 163, 168, 171, 173–175, 190, 216, 225, 234, 252, 273, 274, 278, 280, 282, 283, 287, 290, 291, 297, 301, 302
 boundary data, 156
 boundary interactions, 231
 boundary layer reattachment, 238
 boundary layer separation, 238
 boundary layer theory, 55
 boundary source, 90
 boundary terms, 163
 boundary value problem, 76, 140

- boundary values, 164
 bulk velocity, 1, 16, 17, 20, 26, 29, 44, 46, 48, 52, 53, 60, 61, 63, 69, 74, 76, 85, 101, 103–105, 111, 112, 119, 120, 135, 141, 145, 154, 155, 166–169, 175, 176, 178, 179, 181, 187, 190, 274–276, 284, 290, 297
 capillary, 98
 carbon whiskers, 66
 catalysts, 66
 cavity flow, 242, 254
 cell size, 242, 243, 263, 264
 cellular automata, 264
 center-of-mass system, 212, 221, 222
 central force, 9, 210
 central moments, 45, 46
 ceramics, 66
 Cercignani–Lampis (CL) model, 36, 213, 216, 234
 chaotic behavior, 245
 Chapman–Enskog expansion, 187, 284
 chemical bonds, 31
 chemical plants, 66
 chemical reactions, 1, 11, 205, 206, 220, 234, 239
 chemically reacting flows, 114, 115, 230, 231
 chemistry, 221, 273
 classical mechanics, 1, 23, 209, 214
 Clausius–Clapeyron equation, 288, 296
 CLL model, 234
 clouds, 66
 coaxial rotating cylinders, 168
 collision, 2–5, 9, 10, 107, 118, 206, 207, 209–212, 217–219, 222, 223, 232–234, 258, 259, 265, 287, 299
 collision energy, 221
 collision frequency, 26, 27, 82, 85, 109–111, 115, 135, 138, 145, 146
 collision integral, 11, 15, 26, 27, 72, 114, 211, 230
 collision invariants, 14, 18, 25, 52, 53, 76, 77, 90, 100, 143, 166, 177, 259
 collision iteration, 62, 68, 102
 collision mechanics, 231
 collision model, 26, 110, 211, 303
 collision operator, 11, 52, 54, 75, 143
 collision pair, 232
 collision term, 10, 11, 13, 21, 26, 44, 45, 47, 50, 62, 69, 110, 114, 116, 130, 131, 134, 135, 145, 152, 153, 166, 183, 186, 207, 209, 211, 258, 261
 collision-free dynamics, 116, 232
 comets, 277
 complex fluids, 265
 components of air, 204, 211, 220
 compressible flows, 79
 compressible fluid, 54, 65, 141
 compressible scaling, 180
 concentration, 221
 concentration gradient, 66
 condensation, 273, 275–277, 285, 286, 289, 290, 292, 293, 295–299, 306
 condensation coefficient, 274, 298
 condensed phase, 273, 290, 299
 condensing flow rate, 292
 connection layer, 255
 conservation equations, 52, 145, 147, 149, 185, 259, 260
 conservation form, 19, 186
 constitutive relation, 49, 64
 contact discontinuity, 236
 continuity equation, 168, 182
 continuous spectrum, 137, 138
 continuum, 204, 304
 continuum equations, 183, 184
 continuum gas dynamics, 16
 continuum limit, 123, 124, 139, 162, 169, 180, 181, 186, 189, 221, 293
 continuum mechanics, 18, 43, 57, 69, 129, 157, 167, 172, 173, 235, 236, 306
 continuum model, 65, 235, 236, 245
 continuum regime, 95, 98, 186
 convection, 187, 286, 295
 convective motion, 246
 correlations, 116
 Couette flow, 41–43, 50, 57, 58, 64, 67–70, 72, 75, 76, 85, 92, 96, 103, 111, 112, 117, 119, 122, 123, 130, 190
 cross section, 209, 231, 233, 239
 cutoff, 62, 64, 76
 cylindrical Couette flow, 171
 cylindrical Poiseuille flow, 169, 170
 deflection angle, 231
 degrees of freedom, 10
 delta function, 37, 40, 145, 163, 206, 217
 delta wing, 238
 dense gas, 186
 density, 1, 11, 16, 20, 26–28, 43, 45, 47, 48, 50, 54, 60, 61, 63, 65, 69, 71, 76, 82, 87, 91, 98, 99, 104, 114, 119, 120, 132, 141, 142, 145, 173, 178, 182, 187, 190, 243, 259, 274, 291, 305, 306
 density gradient, 98
 density parameter, 186
 density profile, 146, 151, 153, 154
 deposition techniques, 263
 detachment angle, 236
 detachment Mach number, 236
 detailed balance, 217, 219
 diatomic gases, 204, 211, 304, 305
 diatomic molecule, 204
 diatomic oxygen, 220

- diffuse reflection, 60, 104, 171, 173, 234, 290
- diffusion, 187, 274, 290, 291
- diffusion coefficient, 221, 231
- discontinuity curves, 131
- discontinuity surfaces, 131
- discontinuous solutions, 131, 132
- discrete Boltzmann equation, 257
- discrete ordinate methods, 86, 235
- discrete spectrum, 139
- discrete velocities, 257
- discrete velocity models, 122, 230, 231, 256, 258–264
- discrete vibrational levels, 214
- dispersion relation, 137, 139, 140
- dissipation, 183
- dissociating molecule, 222
- dissociation, 222
- dissociation energy, 222
- dissociation-recombination reaction, 222
- distribution function, 2, 11, 24, 26, 31, 34, 35, 40, 45, 48, 50, 69–71, 79, 114, 132, 138, 155, 173, 177, 190, 205, 209, 216, 220, 221, 235, 274, 277, 278, 290, 291, 300, 301
- domain decomposition, 255
- drag, 30, 61, 88, 92, 96, 122, 123, 171, 190
- drag on a sphere, 171, 172
- dust, 66
- eigenfunctions, 36, 84
- eigensolutions, 84, 104, 105
- eigenvalues, 36, 44, 46
- elastic collisions, 212, 213
- elastic cross-section, 239
- electric field, 171
- electric power plants, 66
- electron, 171, 221
- electronic states, 225
- elementary mechanics, 1
- ellipse of the stresses, 122
- ellipsoidal distribution, 149
- ellipsoidal statistical (ES) model, 28, 151
- elliptic cylinders, 252
- emission coefficient, 225
- emission of radiation, 225
- endothermic reaction, 222
- energy, 18, 23, 24, 26, 41, 49, 114, 138, 141, 190, 221, 233, 259
- energy accommodation coefficient, 35
- energy balance, 209, 222
- energy conservation, 185, 206, 207, 217, 223, 233, 258, 259
- energy density, 17, 44
- energy equation, 53, 55, 168, 286, 295
- energy flow, 17, 18, 37, 55, 72, 141, 255
- energy release, 222
- energy states, 222
- energy transfer, 214
- enthalpies, 288
- entropy, 23, 37, 41, 236
- entropy balance, 150, 276
- entropy flow, 175, 176
- entropy inequality, 258
- entropy production, 41
- entropy source, 175
- environmental problems, 65
- equilibrium state, 24, 41, 220, 274
- Euler equations, 65, 79, 129, 180–183, 185–187, 236, 237, 254, 265, 276, 304
- Euler fluid, 129, 142
- Euler-Mascheroni constant, 63
- evaporating flow rate, 274, 291
- evaporating molecules, 290, 291, 297
- evaporating surface, 256, 277, 290
- evaporation, 273, 275–277, 280, 284–289, 293, 295–297, 299, 300, 304, 306
- evaporation coefficient, 274
- evaporation rates, 275
- evaporation–condensation, 276, 277
- evaporation–condensation coefficient, 278, 290, 292, 294, 298, 299
- profile, 299
- excited levels, 225
- exothermic reaction, 222
- fake collisions, 116, 217
- finite ordinate schemes, 88, 102
- Finite-Pointset method, 234, 246, 250
- flow domain, 234
- flow field, 231, 232, 238, 246, 254
- flow past a body, 171, 176, 179, 182, 190
- flow past a cylinder, 239
- flow past a sphere, 171
- flow past an axisymmetric body, 175
- flow rate, 35, 98, 99, 101, 102, 122, 123, 169, 170, 173, 281
- flow regimes, 40
- fluctuations, 119, 153, 154, 234, 235, 244–246
- fluorescence, 225
- flying vehicle, 65
- fog, 66
- Fokker–Planck equation, 28, 36
- Fourier transform, 164
- Fourier’s law, 176
- Fredholm alternative, 52, 177
- free jet expansions, 306
- free molecular conditions, 80, 101, 138
- free molecular flow, 35, 115, 131, 133, 162, 186, 189
- free molecular limit, 72, 95, 113, 123, 139, 171, 173
- free molecular regime, 37, 67
- free molecular solution, 62, 137
- frequency, 129, 136, 137

- Galilei invariance, 260
Gamma function, 300
gas, 1, 8–10, 16–18, 22–24, 27, 30, 32, 37
gas constant, 20
gas–surface interaction, 1, 30, 34, 35, 67, 109, 115, 189, 213, 221, 225
gas–vapor mixture, 299
gaseous state, 288
Grad, H., 69, 70, 145
gravity, 1, 171, 245
grazing collisions, 10, 62
Green’s function, 163–165
- H-theorem, 22–24, 28, 210, 212, 216–219, 259
half-range completeness, 105
half-range polynomial expansion, 96, 123
half-space, 82, 83, 87, 103, 105, 131, 138, 139, 162, 275–278, 286, 297, 304, 306
half-space problem, 40, 139, 276, 289
Hamiltonian, 216
hard spheres, 2, 7, 9, 55, 56, 64, 95–97, 110, 114, 115, 122, 123, 138, 140, 148, 155, 204, 205, 217, 232, 233, 246, 263, 297
heat, 41, 50, 55
heat conductivity, 27, 54, 69, 82, 144, 187, 216, 231, 263, 284
heat diffusion, 48
heat flow, 1, 18, 20, 37, 45, 55, 61, 64, 69–71, 79, 92, 122, 149, 151, 166–168, 173, 176, 208
heat fluxes, 65
heat of reaction, 223
heat transfer, 30, 84, 92, 96, 122, 171, 173, 190, 250, 277
helium, 155, 235
Hertz–Knudsen formula, 274, 275, 294
high altitude flight, 67, 122, 220
high frequency sound waves, 140
high temperatures, 204, 205, 220
high-temperature air, 222
Hilbert expansion, 54, 67, 68, 103, 142, 151, 165, 176, 177, 183, 187, 195
Hilbert method, 75, 143
Hilbert solution, 103, 104, 107
Hilbert space, 30
homoenergetic affine flows, 44, 45, 68
hydrogen, 204
hypersonic flow, 235, 236, 239, 241, 245
hypersonic jet, 306
hypersonic speed, 220
hysteresis, 236
- ideal fluid, 79, 129, 141
impact parameter, 231
incomplete accommodation, 234
incompressible fluid, 178, 182, 265
incompressible viscous flows, 245
industrial emissions, 66
industrial processes, 263
inelastic collisions, 212, 213
inelastic scattering, 225
inertial motion, 232
initial chaos assumption, 8
initial conditions, 43, 75, 156, 182
initial data, 49, 129, 156, 233, 236
instability, 241, 243, 245
interaction potential, 31
interface conditions, 255
interfaces, 255, 265, 273, 297, 299
intermolecular force, 10, 47, 54, 64, 231
intermolecular potentials, 62
internal degrees of freedom, 211, 212, 214, 221
internal energy, 10, 18, 20, 23, 185, 187, 209, 212, 221, 223, 224, 300
internal state, 209, 231
internal variables, 209
inverse collision, 210
inverse Knudsen number, 94, 172
inverted temperature gradient, 275, 276, 289, 296, 297, 299
ionization, 205, 220, 221, 225, 226
ionization phenomena, 1
ionized flows, 115, 231
ions, 66, 221
isothermal surfaces, 252
isothermal waves, 138
isotope separation, 277
- jet boundary, 306
- kinematic viscosity, 183
kinetic boundary layers, 40
kinetic energy, 2, 10, 36, 209, 305
kinetic equation, 209
kinetic model, 26, 129, 207, 230
kinetic solvers, 265
kinetic theory, 1, 16, 20, 30, 65, 92, 113, 129, 142, 173, 204, 220–222, 235, 241, 265, 273
Knudsen gas, 59, 186
Knudsen layers, 40, 51, 54, 71, 72, 78–80, 93, 101, 103, 110–112, 133, 168, 256, 275–278, 285, 289, 293, 295–298, 300, 301, 304
Knudsen minimum effect, 99, 113
Knudsen number, 43, 51, 58, 62, 64, 68, 84, 96, 98, 101, 102, 112, 119, 122, 171, 189, 235, 237, 239, 243–247, 252, 263, 264, 293, 297, 299
Knudsen, M., 36, 51, 98, 99
Kramers’ problem, 104, 105, 107
Kronecker delta, 20
- laminar flow, 241, 245
laminar regime, 238
Larsen-Borgnakke model, 213–215

- laser-sputtering, 277
 latent heat, 286, 288, 289, 296, 297, 299
 lattice fluid, 264
 lattice gas, 264, 265
 law of interaction, 10
 leading edge, 235
 Lennard–Jones potential, 149
 lift, 30, 190
 lift-to-drag ratio, 37
 linearized Boltzmann equation, 75, 79, 82, 88, 90, 95, 97, 99, 101, 103, 109, 112, 122, 135, 162, 164, 168, 171, 174–176, 179, 284
 linearized Boltzmann operator, 177
 linearized collision operator, 29, 52, 54, 76, 84, 122, 143, 163
 linearized collision term, 29
 Liouville equation, 7
 liquid, 245, 264, 273
 liquid state, 288
 loaded-sphere model, 211
 local Maxwellian, 26
 logarithmic singularity, 64
 Lorentz, H. A., 210, 216, 217
- Mach angle, 305
 Mach number, 43, 119, 122, 144, 148, 153, 155, 173, 176, 182, 235, 236, 243, 245, 252, 275, 276, 279, 281, 283–285, 288–290, 292, 293, 295, 304–306
 Mach reflection, 236, 241
 Mach stem, 236, 237
 macroscopic slip, 105
 magnetic field, 209, 212
 mass, 18, 19, 23, 24, 26, 141, 259
 mass balance, 286, 291, 295
 mass conservation, 185, 258, 305
 mass density, 44, 104
 mass density in phase space, 16
 mass flow, 17, 60, 71, 92, 141, 255, 275, 291, 292, 294
 matched asymptotic expansions, 179
 Maxwell gas, 45, 47
 Maxwell molecules, 10, 45, 47, 48, 54, 56, 58, 62, 63, 68, 69, 73, 82, 84, 95–97, 118, 124, 140, 148
 Maxwell's boundary conditions, 60, 124, 290
 Maxwell's model, 35, 213, 234
 Maxwell, J. C., 2, 45, 69, 71, 107, 112, 204
 Maxwellian distribution, 21, 41, 43, 50, 54, 69–71, 75, 82, 83, 85, 89, 90, 99, 103, 104, 135–137, 142, 145, 146, 149, 151, 154, 162, 163, 171, 173, 177, 178, 183–187, 190, 207, 256, 259, 274–276, 278, 284, 290–292
 Maxwellians, 16, 25, 41, 60, 72, 75, 141, 147, 149, 221, 278, 288
- mean free path, 41–43, 51, 54, 58, 59, 64–67, 78–80, 86, 103, 107, 111, 112, 115, 117, 119, 133, 135, 140, 144, 146, 148, 165, 167, 169, 172, 189, 195, 239, 243, 245, 263, 264, 282, 298, 299, 304
 merged layer, 235
 micromachines, 66, 252, 263
 microscopic slip, 105
 Millikan's formula, 172
 Millikan's oil drop experiments, 171
 Milne problem, 104
 mixture, 10, 204–207, 209, 221, 231, 260–262, 265, 299
 model molecules, 231
 molar density, 221
 molecular chaos, 5, 7, 8
 molecular collisions, 59, 67, 101, 115, 189, 231
 molecular diameter, 66, 231, 243
 molecular dynamics, 241, 242, 274, 298
 molecular interaction, 9, 54, 55, 89, 148, 205, 217, 223, 290
 molecular levels, 239
 molecular mass, 20
 molecular model, 9, 95, 96, 116, 146, 234, 245, 246
 molecules, 1, 2, 7–10, 23, 30, 31, 35, 37, 40, 44, 46, 50, 54, 59, 61, 64–66, 71, 72, 76, 84, 99, 101, 105–107, 114–119, 130, 136, 138, 140, 152–154, 186, 190, 204–207, 209–212, 217–219, 221, 222, 231, 232, 235, 239, 243, 261, 264, 273, 274, 287, 290–292, 298–300, 304
 moment equations, 275–278, 282, 287, 299, 303
 moments, 45, 48, 50, 52, 61, 63, 64, 68–72, 79, 82, 110, 118–120, 122, 132, 135, 137, 139, 140, 148, 154, 166, 177, 184, 277, 278, 289
 momentum, 2, 17–19, 23, 26, 36, 141, 190, 233, 259, 265
 momentum balance, 46, 53, 167
 momentum conservation, 83, 107, 185, 206, 207, 217, 233, 258, 259
 momentum density, 17
 momentum equation, 52, 167, 286, 295
 momentum flow, 17, 18, 45, 71, 141, 255
 momentum transfer, 183
 monatomic, 43
 monatomic gas, 27, 43, 56, 110, 136, 153, 171, 204, 205, 210, 211, 230, 231, 246, 276, 301, 303, 305, 306
- Monte Carlo
 Direct Simulation (DSMC), 114, 117, 119, 154, 211, 230, 231, 234–236, 238, 241–243, 245, 246, 249, 263, 264, 290, 299
 quadrature method, 114, 153, 230
 simulation, 111, 117, 122, 149, 152–154, 156, 157, 230, 234, 276, 292, 300

- Mott-Smith bimodal distribution, 149
 Mott-Smith method, 148, 149, 152, 275
 multimodal approximation, 152
 multiphase flows, 265
 multiple collisions, 3

 Navier–Stokes equations, 47–49, 54, 64, 65, 67, 70, 79, 80, 103, 112, 113, 129, 130, 137, 142, 144, 148, 151, 153, 156, 168, 171, 172, 178, 180, 182, 183, 187, 235, 239, 245, 249, 252, 254, 263–265, 276, 284–286, 293, 295, 300
 compressible, 27, 186, 187
 nearest neighbor interactions, 264
 nearly continuum regime, 162
 nearly free-molecular regime, 67
 neutron waves, 138
 nitrogen, 204, 220, 239
 no-time-counter DSMC, 116
 nonequilibrium, 113, 222, 299
 noncondensable gas, 299, 300
 nondegenerate levels, 209
 nondrifting Maxwellians, 16
 nonequilibrium state, 23
 nuclear reactor, 66
 null collision technique, 233, 239
 number density, 11, 221, 223, 246, 299

 oblique shock, 236
 one-particle probability density, 2
 optical fibers, 66
 orthogonality condition, 144
 outgassing, 31
 oxygen, 204

 parity operator, 89, 163
 partial pressure, 300
 perfect gas, 23, 180, 181, 185, 186
 periodicity conditions, 117, 182, 246
 perturbation methods, 64, 67, 162, 230
 perturbation of equilibria, 75, 144
 phase equilibrium, 276
 phase space, 2, 11, 16
 phase speed, 129, 136, 139, 140
 phase transitions, 265
 photon emission, 225
 photons, 221, 225
 Planck distribution, 225
 point masses, 3, 9, 204, 209, 217
 Poiseuille flow, 87, 98, 99, 111, 113, 123, 162, 169, 173
 pollen, 66
 polyatomic gases, 11, 28, 114, 204–207, 209, 212, 213, 216–218, 221, 230, 239, 280
 polyatomic molecules, 1, 209, 210, 216, 218, 231

 potential energy, 222–224
 potential flow, 235
 power-law potentials, 10, 55, 56
 Prandtl number, 27, 54, 55, 82, 110, 111
 pressure, 1, 5, 20, 28, 45, 48, 52, 54, 70, 97, 98, 101, 102, 139, 140, 145, 166, 168, 175, 176, 178, 185, 273, 276, 286, 291, 295, 298
 pressure gradient, 53, 66, 167
 probability density, 2, 3, 5, 7, 11, 16, 31, 33, 117, 120, 207, 209
 probability distribution, 232, 233
 probability of a collision, 118

 quantum mechanics, 10, 209, 210, 219, 222

 radiation, 66, 204, 205, 221, 225, 226
 radiation frequency, 225
 radiative transfer, 104, 225
 radioactivity, 66
 radius of curvature, 133
 random collision pairs, 117
 Rankine–Hugoniot conditions, 141, 147, 154
 rare gases, 204
 rarefied plasmas, 226
 rate coefficients, 221
 Rayleigh–Bénard instability, 241, 245, 246
 re-entry calculations, 115, 236
 reactants, 221
 reacting collision, 11
 reaction cross-section, 221, 222, 239
 reaction model, 221
 reaction rates, 225
 reactive collision, 209
 reciprocity, 33, 34, 89, 212, 217, 218
 recombination process, 222
 recombination reaction, 222
 recovery temperature, 58
 reduced mass, 206
 reflected shock wave, 236
 reflection, 225
 regular reflection, 236, 237
 relative speed, 10, 217, 223, 224, 231
 relative velocity, 2, 6
 relaxation time, 211, 214
 reverse reflection, 41, 50, 119, 173
 Reynolds number, 235
 Riemann–Hilbert problem, 111
 rotating cylinder, 173
 rotating spheres, 168
 rotational cross-section, 239
 rotational energy, 211
 rotational invariance, 166
 rough sphere model, 211

 s-particle distribution function, 7, 115
 saturated vapor, 289, 296

- saturated vapor density, 274
 saturated vapor pressure, 274, 282, 283, 291, 299
 saturation, 288
 scaled Boltzmann equation, 176, 183
 scales of turbulence, 245
 scalings, 180, 181
 scattering amplitude, 209
 scattering cross-section, 217
 scattering event, 32, 225
 scattering kernel, 32, 34–37, 290
 scattering law, 231
 scattering probability, 225
 second-order slip, 111
 Senftleben-Beenakker effects, 212
 separated flows, 238
 shear flow, 47, 48, 64, 84
 shear stress, 168
 shear waves, 129, 135, 137–139
 shock layers, 80
 shock profile, 145, 235
 shock thickness, 144, 146, 148, 149, 151, 234, 237
 shock wave structure, 141, 142, 146, 149, 151, 152, 154–156, 235, 275, 276, 278
 shock waves, 67, 79, 129, 141, 142, 144, 155, 235, 236, 255, 265
 Shuttle Orbiter, 37, 236
 silicon chips, 66
 simulation schemes, 116, 117, 230
 singular perturbation, 51, 176, 186
 slip boundary condition, 112, 246
 slip coefficient, 105, 107–109, 123
 slip regime, 40
 slipstream, 236
 solid, 273
 solid state physics, 30
 solid wall, 1, 23, 30
 solitary wave, 130
 Sone sublayer, 133
 sonic jet, 304
 sound propagation, 137–139
 sound waves, 129, 135, 137, 138
 source flow, 305
 space shuttle, 67, 117
 space-homogeneous, 45–47, 68, 118, 221
 space-homogeneous solutions, 22
 spacecraft, 65, 115
 special-purpose machines, 265
 species, 205–207, 220–223, 225
 specific heat, 27, 54, 56, 204, 305
 specular reflection, 2, 8, 20, 23, 24, 35, 41, 50, 117, 119, 139, 173, 290, 292
 speed of light, 225
 speed of sound, 43, 136, 182
 speed ratio, 43, 243, 279, 287–289, 292
 spherical source, 275, 306
 sphero-cylinder model, 211
 spin, 209, 212
 spontaneous emission, 225
 stability, 117
 statistical independence, 7
 statistics, 1
 stochastic process, 115
 stochastic system, 117
 Stokes equations, 171, 175, 176
 Stokes paradox, 173, 176, 182
 strain rate, 49
 strange attractor, 245, 246
 stress tensor, 18, 20, 45, 64, 70, 79, 93, 151, 166
 stresses, 1, 18, 37, 49, 119, 252
 stretched variable, 176
 sublimation, 273
 subsonic flow, 275, 276
 supersonic flow, 235, 289, 304
 surface layers, 30
 surface of discontinuity, 79, 236
 tangential stress, 48
 Taylor vortices, 241, 243
 Taylor–Couette flow, 243, 246
 temperature, 1, 5, 20, 26–28, 31, 33, 35, 41, 43, 45, 48, 50, 53–58, 60–63, 70–72, 75, 76, 82, 87, 91, 98, 99, 104, 112–114, 119, 141, 144, 146, 149, 153, 166–168, 173, 175, 176, 178, 182, 185, 190, 209, 213, 215, 216, 220, 221, 231, 244, 246, 252, 254, 273, 274, 276, 282, 288–291, 295, 297–299, 306
 temperature field, 246, 252
 temperature gradient, 66, 103, 111, 112, 168, 252, 254
 temperature jump, 72, 111, 112, 123, 168, 283, 289
 temperature overshoot, 149, 151–154
 temperature profile, 122, 146, 149, 283, 299
 termolecular reaction, 222
 thermal creep, 112, 123, 252
 thermal energy, 44, 45, 70, 208, 305
 thermal speed, 43, 75
 thermal stress slip flow, 252
 thermal stresses, 252
 thermal transpiration, 98
 thermal waves, 135, 138
 thermally insulated, 57
 thermally radiating flows, 114, 230
 thermodynamics, 23, 37
 thermophoresis, 252
 thirteen moment equations, 69, 71, 151, 168, 275
 time reversal, 218
 time reversibility, 217, 218
 time reversible, 23, 33
 torque coefficient, 244

320

total cross-section, 217, 221
 total energy, 19, 212
 trailing edge, 235
 transition regime, 113, 139, 140
 transition to turbulence, 241, 244, 245
 translation invariance, 164
 translational degrees of freedom, 212, 301
 translational energy, 211, 221
 transpiration, 252
 transport coefficients, 54
 travelling waves, 129, 130, 141
 trimodal gain function model, 151
 turbulence, 122, 241, 245, 265

upper atmosphere, 65

vacuum, 23, 273, 275, 304–306
 vacuum distillation, 277
 vacuum vapor deposition, 277
 vapor, 273–276, 281, 282, 288, 289, 291, 298–300, 304
 variable hard-sphere (VHS) model, 10, 231
 variable soft sphere (VSS) model, 231
 variational method, 88, 92–96, 102, 169, 173
 variational principle, 88, 90, 97, 109
 vehicles, 66
 velocity, 91, 104

Index

velocity distribution, 122
 velocity field, 252
 velocity gradient, 43, 103, 111
 velocity profile, 93, 105, 106, 109–111, 119, 122, 123, 151
 velocity slip, 72, 111, 113, 168
 velocity space, 14, 16, 40, 47, 89, 120, 174, 260, 278, 282
 vibrational cross-section, 239
 vibrational energy, 214
 vibrational relaxation, 239
 viscosity, 27, 47, 48, 54, 64, 68, 73, 82, 140, 144, 153, 183, 187, 213, 231, 263, 282, 284, 286, 295
 viscous boundary layer, 67, 235
 viscous stresses, 175
 vortex formation, 245, 250
 vortex motion, 242
 vortex patterns, 243, 245
 vortex structure, 242, 249, 250

wake flows, 238, 239
 wall Maxwellian, 35, 37, 138
 wave fronts, 131
 wavelength, 129
 wavenumber, 129
 weak shock, 144, 146, 148, 149