

Index

- added mass, 203
 advection term
 definition, 51
 discretization, 59, 61
 AMR (adaptive mesh refinement), 19, 22, 71, 72, 225, 227, 232
 analytical solutions, 1, 180, 181, 198, 201, 214, 285, 287, 292
 atomization, 3, 4, 19, 72, 204, 205, 211, 212, 214, 215, 219, 222, 226, 228
 co-flowing, 4, 215
 effect of nozzle, 214, 219, 222, 223

 bad elements
 in front tracking, 145
 Berenson's correlation, 252
 Bi-Conjugate Gradient STABilized method, 68
 BiCGSTAB method, 68
 boiling, 248
 pool, 251
 convection, 249
 film, 248, 249, 251, 252
 flow, 249
 nucleate, 254
 pool, 249
 Bond number, 43
 boundary condition, 29, 30, 37, 40, 50, 67, 69, 71, 141, 189
 for free surface, 40
 no slip, 37, 69
 outflow, 29, 30, 66, 70
 partial slip, 47
 periodic, 30, 71, 146, 189, 191, 195, 219
 boundary integral method, 8–11
 breakup of droplet
 in linear shear flow, 9, 10
 under impact or collision, 228, 230
 breakup of rim, 205, 210, 211
 breakup of thin threads, 158, 206–208
 bubble columns, 19, 187
 bubbles
 rising, 2, 4, 179, 189, 193, 196
 small, 203

 bubbly flows
 homogeneous, 189–191
 buoyancy, 203

 capillary number, 43
 CFL (Courant, Friedrichs, and Lewy) condition, 53, 54, 109
 CFL number in VOF method, 109, 123–125
 CIP (constrained interpolated propagation) method, 14, 75, 77, 91–93
 closure relations, 187, 203
 CLSVOF (coupled level-set volume-of-fluid) method, 128
 coalescence, 8, 158, 159, 230, 232, 233
 coherent structures, 223
 collocated grid, 56, 58, 73
 color function, 76–78, 80, 82, 95–98, 128, 129, 131, 161, 167, 184
 combustion, 4, 205, 228
 complex physics, 17, 19
 craters, 5, 229–231, 233–235
 crown splash, *see* droplet impact
 CSF (continuous surface force) method, 13, 14, 161, 162
 CSS (continuous surface stress) method, 161, 164–166, 169, 177–179, 181
 curvature
 computed from height function, 184–186, 271
 computing in front tracking, 169–171, 175, 176
 computing in VOF, 163, 164, 167, 168, 184–186
 definition, 32
 expression for, 34, 35, 276
 Gauss, 274
 in axisymmetric geometry, 275
 mean
 definition, 33, 34, 169, 273, 274, 277
 total, 274

 data structure
 in front tracking, 85, 86, 133, 134
 dendrites, 264, 265
 dendritic structure, 6, 264
 density ratio, 202

- disjoining pressure, 44, 45, 48
 DNS (direct numerical simulation), 2, 3, 18, 19, 188, 195, 201, 203, 251
 drafting, kissing, and tumbling, 18, 192
 drop, *see* droplet
 droplet formation, 213, 215, 225
 droplet impact
 corolla, 213, 235, 236, 238–242
 crown splash, 232, 235, 240–242
 jet formation, 236
 prompt splash, 240

 Eötvös number, 43, 188
 small, 203
 electrohydrodynamics, 244
 energy conservation, 25
 ENO (essentially non-oscillating) scheme, 60, 61, 88

 Fantasia (Disney animation), 229
 Faraday waves, 234
 Finite-volume method, 26, 50, 55, 86
 fishbone patterns, 226
 floatsam and jetsam, 12, 83, 116
 flux-corrected transport method, 80
 Fourier's law, 26
 free surface, 1, 8, 11
 boundary condition at, 40, 45
 bubble bursting at, 204, 234, 235
 front capturing method, 91
 front-grid communications, 145–148
 weighting functions, 148
 front-tracking volume-of-fluid method, 129
 Froude number, 44

 Galileo number, 43, 188
 gas–liquid flows, 1, 6, 189, 291
 Gerris code, 61
 Gibbs–Thompson condition, 263
 GMRES method, 68
 Godunov method, 80
 grid generation, 17

 H-mode, 219
 Hamaker's constant, 44, 45
 heat transfer, 243
 Heaviside or step function, 35, 41, 76, 77, 279
 height-function method, 179, 181, 184
 human aspect, 20
 hybrid methods, 128
 CLSVOF, *see* CLSVOF (coupled level-set volume-of-fluid) method
 front-tracking VOF, *see* front-tracking volume-of-fluid method

 immersed-boundary method, 14, 86, 149
 indicator function, 68, 76, 77
 industrial applications, 1, 3, 187
 inertia, 203
 interface
 geometrical description, 30, 31, 47, 270
 intermolecular forces, 21, 22, 44, 45, 48, 208
 jump conditions, 37, 39, 40
 jump notation, 38
 kinematic singularity, 213
 kinematic viscosity, 29
 Krylov method, 68

 Lagrangian grids, 17
 Laplace number, 43
 Laplace's law, 45, 163, 177
 large-scale structures
 in atomization, 214
 in bubbly flows, 192
 LBM (lattice–Boltzmann method), 18
 level-set method, 14, 15, 75, 86, 87, 89, 90, 96, 128, 175, 232, 264
 lift force, 193, 196, 197, 199
 linked list, 139–141, 143, 154
 liquid fuel, 205
 living systems, 1, 6
 low Reynolds numbers, 53, 190
 lubrication approximation, 206, 207, 210

 MAC (marker-and-cell) method, 11–14, 51, 56, 59, 85, 109, 114, 121, 122, 125, 163, 229
 marker function, 12–16, 34, 68, 74–77, 80–82, 84, 86–88, 92–94, 97, 115, 133, 139, 150, 152–158, 161, 162, 174, 175
 marker particle (in front tracking), 14, 85, 86, 133, 151, 152
 marker particle (in volume), 12, 229
 mass conservation, 14, 22–24, 26, 28, 37, 41, 89, 90, 97, 112, 123, 136, 143, 206, 249
 in VOF, 97, 112, 123
 mean curvature, *see* curvature
 microstructure, 6, 20, 188, 262–265
 mixing layer, 205, 215, 216, 220, 291
 stability theory, 216
 Kelvin–Helmholtz, 216, 288
 Orr–Sommerfeld, 218
 transient-growth theory, 224
 momentum conservation, 24
 with interfaces, 39
 moon craters, 228
 central peak, 229
 Morton number, 43, 188
 multigrid methods, 67
 multigrid solvers, 67

 Navier–Stokes equations, 11, 21
 definition, 25
 Newtonian fluids, 22, 26, 28, 29, 40, 42
 definition, 24
 non-Newtonian fluids, 20
 nonuniform surface tension, 244
 nucleate boiling, 253
 Nusselt number, 252

 oceans, 1, 3, 5, 204
 Ohnesorge number, 43, 210, 231
 one-fluid approach, 15–17, 21, 41, 42, 54, 161

- PDF (probability distribution functions), 226
 phase change, 5, 19, 37–39, 41, 91, 248
 phase-field method, 15, 48, 90, 91, 264, 265
 Plateau–Rayleigh jet instability (capillary instability),
 4, 205, 206, 213, 214, 242
 Poisson equation, 52, 64
 potential flow
 in droplet impact, 237
 potential flow simulations
 in bubbly flows, 188, 190, 192
 pressure equation, 52, 64
 pressure solver, 66
 projection method, 12, 38, 51–53, 59
 PROST (proper representation of surface tension)
 method, 165, 166, 179, 181, 183, 184
- QUICK (quadratic upstream interpolation for
 convective kinematics) scheme, 60, 61
- rain, 1, 4, 5, 228
 Rayleigh–Taylor instability, 8, 11, 12, 85, 91
 in atomization, 224
 redistribution
 in VOF, 120, 122, 130
 of markers in front tracking, 137
 reinitialization
 in level-set method, 14, 88, 89
 Reynolds number, 42
 Richtmyer–Meshkov instability
 in droplet impact, 241, 242
 rim, 205, 209, 210, 212–214
- Saffman–Taylor instability, 10
 self-similar solutions, 48, 208, 234, 235
 sharp interface limit, 15, 16, 21, 22, 34, 37, 42, 44, 73,
 80, 81, 91, 93
 singular terms, 41
 SLIC (simple line interface calculation) method,
 82–84, 96, 116
 SOR (successive over-relaxation) method, 66–68
 spheres
 falling, 18
 splash, 4, 5, 11, 13, 210, 211, 213, 228, 230, 231, 240
 prompt, 240
 spray formation, 204
 staggered grid (MAC grid), 12, 54, 56–58, 65, 69, 74,
 114, 121, 125, 146, 153, 174
 step function
 approximation in front tracking, 84, 166
 surface geometry
 curvature, *see* curvature
 principal directions, 274
 surface tension, 203
 axisymmetry, 168
 computed from marker functions, 161–167, 184,
 185
 computed in front tracking, 168, 169, 171–177
 definition, 22, 38
 force (definition), 42
 surface tension tensor, 38, 39, 164
 surfactants
 in bubble dynamics, 189
 suspensions, 6, 8, 10
- Taylor–Culick rim, *see* rim
 thermocapillary motion, 244
 thin films, 19, 31, 44, 48, 206–208, 228
 splashing on, 235
 time integration, 51, 53
 topology change, 8, 44, 158, 159, 230, 232, 236
 in front tracking, 87, 134, 158, 159
 in VOF, 96
- unit normal
 definition, 31–33
 unstructured grids, 18, 85
 in front-tracking method, 135, 143
 in VOF, 131
- viscous terms
 discretization, 61, 64
 harmonic mean, 63, 64, 221
- VOF (volume-of-fluid) method, 12–15, 72, 81, 83, 84,
 88–90, 94–98, 103, 124, 128, 129, 150, 161, 163,
 165, 166, 169, 175, 182–184, 236, 242, 249
 advection, 108
 Eulerian implicit, 115, 116
 Lagrangian explicit, 115, 116
 unsplit, 116
 normal evaluation
 centered columns method, 100
 ELVIRA, 101–104, 107, 108, 123–125, 127, 128
 least-squares fit method, 103
 Youngs’ method, 99, 103, 104, 107, 108
 reconstruction, 12, 83, 84, 95–99, 101, 103, 104,
 106–108, 112, 116, 122–129, 183
 wisps, 116
 volume change, 248, 262, 263
 volume expansion, 250, 251
 volume fraction
 in front tracking, 155
 volume source at the interface, 41
 vortex-in-a-box test, 123, 125–127, 131, 132, 151,
 152
- wall layer
 in bubbly flow, 196, 201
 Weber number, 43
 weighted ENO scheme, 128
 wetting, 46, 48, 229, 230
 wisps, 116
 Worthington jet, 229