
Index

- absorbing ball, 81, 131, 132, 133, 138, 142, 143
- Adams R.A., 208, 212
- angular
 momentum, 11
 velocity, 9, 10, 11
- attractor, 61, 64, 76, 170
 compact, 170
 definition of, 66
 global, 66, 80, 82, 83, 170, 182
 Lorenz, 81, 82, 83, 85, 86, 209
 universal, 66
- attractor dimension, 64, 83, 170, 172, 176, 179, 180
 definition of, 66, 67
 2d estimate, 62, 178, 201
 3d estimate, 62, 180
- Bartucci M. 210
- Babin A.V., 86, 180, 209
- background flow, 186, 187, 191, 196, 198, 199, 201, 204
- Bardos C., 22, 106, 209
- Beale T., 154, 156
- Beale, Kato, and Majda's theorem, 153, 154, 208, 210
- Beckenbach E., 208
- Bellman R., 208
- bifurcation, 37
 subcritical, 38
 supercritical, 38, 78
- Biot-Savart law, 154
- body force(s), 8, 23, 24, 51, 52, 169
- Boltzmann equation, 1, 21
- boundary conditions, 6, 7, 26, 33, 185, 187, 190, 191, 199
 Neumann, 6
 no-slip (Dirichlet), 16, 17, 19, 25, 185, 199, 200, 205
 periodic, 6, 7, 8, 12, 16, 17, 21, 23, 26, 38, 39, 49, 75, 111, 117, 131, 169, 183, 185, 187, 194
 rigid, 6, 7, 8, 12, 20, 26
 stress-free, 38, 75
 time-independent, 41
- boundary-driven flow, 201
 shear flow, 183
- boundary(ies)
 layer, 46, 57, 191, 192, 198, 200
 rigid, 200
 stress-free, 19
- Boussinesq equations, 18, 19, 20, 21, 27, 29, 74, 75, 76, 87, 193, 200, 205
- Brezis H., 208, 212
- buoyancy force, 18
- Busse 211
- calculus of variations, 33, 185
- Cantor set, 87
- Castaing B., 203, 211
- chaos, 70, 75
- classical determinism, 88, 89, 104
- classical solutions, 89, 106, 107
- compact set, 103
- concentric cylinder(s), 201, 202
- cone(s), 87
- conservation of mass, 3
- Constantin P., 86, 113, 134, 155, 173, 179, 181, 204, 209, 210
- Constantin and Foias' theorem, 74
- Constantin's theorem, 173, 181
- continuity equation, 3, 4, 19
- contraction mapping, 90, 113
- convection, 19, 21, 29
- convective derivative, 2, 3, 4, 5, 10
- convergence, 88
 uniform, 90, 94
- convergent subsequence, 103

- Couette flow, 43, 190
 laminar, 43, 49, 186
 planar, 185
 profile, 47, 190, 191
 cylinder, 81, 82, 86
- degrees of freedom, 40, 61, 62, 64, 137, 152, 170, 179, 180
- density, 1, 3, 4, 5, 18, 19, 23
- dimension
 capacity, 65, 66, 73, 87, 180
 fractal, 65, 67
 Hausdorff, 65, 68, 74, 86, 171, 184
 Lyapunov, 68, 73, 74, 86, 179, 180
- dissipative dynamical system, 76
- dissipative system, 64
- divergence-free
 condition, 5, 7, 10, 17, 18, 22, 45, 129, 173, 185, 190, 194, 195
 vector field(s), 32, 33, 35, 37, 51, 97, 117, 185, 188, 196, 199, 200
- Divergence (Gauss) theorem, 7, 120
- Doering C. R., 168, 179, 204
- D -operator, 115
- drag, 44, 47, 48, 183, 186, 193, 201, 202
- Drazin P.G., 38, 86, 209
- eddy, 61, 125, 180
- eddy viscosity, 45
- Eden A., 86, 210
- eigenvalue(s), 25, 27, 30, 31, 34, 36, 37, 39, 71, 77, 78, 79, 86, 188, 202
- Einstein summation convention, 17
- ellipsoid, 67, 68
- energy, 12, 27, 57, 77, 129, 165
 cascade, 52, 53, 59, 150
 density, 27, 53
 dissipation rate, 55, 112, 158, 168, 179, 182, 184, 185, 186, 187, 192, 194, 200, 201
 evolution equation, 17, 22, 33, 99, 105, 109, 184
 kinetic, 7, 8, 12, 16, 31, 50, 51, 60, 184, 194
 method, 34
 spectrum, 52, 53, 55, 58, 59, 125, 126
- enstrophy, 11, 12, 52, 57, 58, 112, 121, 129
 cascade, 59
 dissipation rate, 58, 177
 spectrum, 55
- Euler-Lagrange equations, 33, 34, 185, 189, 196
- Euler's equations, 4, 5, 7, 8, 10, 12, 15, 22, 26, 137, 153, 156
- Euler singularities, 128, 148, 149, 153, 154
- existence, 88, 100, 184, 196, 199
- Farmer J.D., 86, 209
- Fineberg J., 203, 211
- fixed point(s), 66, 74, 76, 78, 79, 83, 87
- fluctuation field, 187
- Foias C., 86, 113, 134, 145, 155, 179, 181, 209, 210
- Fourier
 inverse transform, 49, 97
 modes, 50, 101, 158, 159, 168, 169, 199
 mode spectrum, 158, 168
 power spectrum, 166
 series, 162
 transform, 49, 51, 60, 65, 97, 98, 139, 157, 159
- frequency, 117
- friction coefficient, 60
- function(s)
 concave, 175
 L^2 , 11, 103, 114, 116, 117
 orthonormal, 36, 172, 173, 174, 175, 180, 181
 square integrable, 7, 103, 188, 200, 208
 square integrable periodic, 39, 159, 208
 fundamental theorem of calculus, 192
- Gagliardo, 108
- Galerkin
 approximation(s), 88, 96, 99, 100, 101, 102, 103, 104, 106, 107, 112, 117, 159, 164, 165, 199, 200
 equation(s), 164
 truncation, 76, 164
- Gallouet T., 208, 212
- Gibbon J.D., 179
- Ginzburg Landau equation 181
- Glimm J., 156, 210
- global
 existence, 96
 solution, 91, 92, 94
 weak solutions of Navier-Stokes, 103, 105, 111
- Golse F., 22, 106, 209
- Gramm-Schmidt procedure, 71
- Grashof number, 24, 37, 56, 59, 74, 130, 132, 133, 139, 144, 176
- Green's function, 6
- Gronwall's lemma, 31, 32, 33, 78, 80, 82, 91, 100, 102, 105, 109
- Guillopé C., 145, 155, 210
- Gunaratne G., 203, 210
- Hale J. 155, 210
- Hamiltonian, 62, 63, 64
- Henshaw W. D. 210
- Heslot F., 203, 210
- Hilbert space, 7
- Hopf E., 204, 210
- Howard L.N. 204, 210

- Ilyin A.A., 179, 211
incompressible fluid, 5, 7, 8, 17, 18
incompressibility condition, 5, 6, 15
inequality
 Arithmetic-mean-Geometric-mean, 206, 207
 calculus, 120, 128, 138, 142, 145, 146, 148, 151, 152, 154, 156, 208
 Cauchy's 36, 141, 162, 176, 179, 207
 Cauchy-Schwarz, 102, 112, 121, 130, 134, 141, 143, 145, 149, 173, 175, 207
 differential, 33, 82, 91, 95, 140, 144, 145, 158, 159, 163, 164, 188, 197, 200
 Gagliardo-Nirenberg, 208, 212
 Gronwall's, 31, 32, 33, 78, 80, 82, 91, 100, 102, 105, 109
 Hölder's, 109, 120, 124, 145, 149, 152, 154, 173, 179, 207, 208
 Jensen's, 141, 176
 Leray's, 104, 109, 131, 134, 144, 155
 Lieb-Thirring, 181, 208, 212
 $2d$ logarithmic, 141, 173, 208
 Minkowski's, 208
 Poincaré's 36, 39, 97, 102, 105, 112, 130, 163, 190
 Schwarz, 100, 122, 124, 173, 174, 190, 192, 207
 triangle, 159, 206
 Young's, 206
inertial range, 53, 54
inertia tensor, 14
intermittency, 150
inverse
 cascade, 58, 59
 squared lengths, 118, 126, 152, 180
Jaffe A., 156, 210
Jones D. 179, 211
John F., 115, 134, 210
Kadanoff L., 203, 211
Kaplan-Yorke formula, 67, 172, 179, 180
Kato, T., 154, 156
kinetic energy, 7, 8, 12, 16, 31, 50, 51, 60, 184, 194
Kolmogorov
 dissipation length, 54, 56, 57, 150, 151, 167, 179, 180
 picture, 57, 61
 scale, 55
 scaling theory, 49, 53, 54, 55, 192
 spectrum, 59
Kraichnan R.H., 59, 177, 209
Kraichnan length, 58, 61, 177
Kreiss H. 210
ladder
 bottom rung of, 142
 results, 129, 132, 135, 200
 theorem, 114, 118, 126, 128
Ladyzhenskaya O., 156, 210
Lagrange multiplier, 33, 34, 81, 185, 189
Laplacian, 5, 6, 24, 25, 26, 35, 36, 37, 108, 115, 119, 124, 130, 156, 159, 171, 173, 175, 180, 199, 200
Lathrop, D., 203, 211
length scale, 107, 118, 125, 137, 138, 144, 150, 151, 155, 156, 167, 168
 intensive, 146
Leray J., 103, 104, 109, 113, 144, 155, 200, 210
level sets, 22
Levermore C.D., 22, 106, 209
Libchaber A., 203, 211
Lieb E., 181, 208, 212
limit cycle, 66
linear conduction profile, 195, 197, 199
Lions J.L., 155, 210
Lipschitz condition, 63, 88, 89, 90, 91, 96, 104
 constant, 89
 global, 95, 96
 local, 95, 96, 99
local solution, 91, 92
logarithmic friction law, 47, 48, 201
Lorenz E.N., 86
Lorenz equations, 62, 74, 75, 76, 80, 86, 170
Lumley J., 59, 209
Lyapunov
 exponent, 67, 70, 73, 74, 86, 87,
 functional, 80, 85
 global exponent, 68, 70, 71, 83, 171, 172, 180
Magenes E., 155, 210
Majda A., 154, 156
Malham S. J. 210
manifold(s)
 unstable, 66, 74, 78, 79
Manley O.P., 86, 179, 210
mixing length, 45, 201
momentum, 1, 3, 15, 26
Montgomery D., 59, 209
Navier-Stokes equations, 23, 24, 25, 26, 27, 34, 37, 38, 41, 42, 43, 48, 51, 65, 74, 86, 158, 170, 182, 186, 200, 205
 $2d$, 57, 58, 62, 107, 111, 114, 138, 140, 169, 170, 171, 176, 178, 181, 182
 $3d$, 62, 107, 111, 113, 137, 144, 168, 170, 179
 incompressible, 1, 15, 16, 18, 21, 22, 88, 137, 144, 171, 184
 stationary, 29, 39, 60, 189
Newtonian fluid, 14, 17, 18, 42, 43, 183

- Newton's laws, 3, 4, 12
 Nickel G., 11
 Nirenberg L., 108, 208, 212
 norm, 8, 11, 31, 33, 36, 37, 114, 115, 116,
 159, 195, 196, 200, 208
 convergence, 113
 L^2 norm, 11, 103, 114, 116, 117
 seminorm, 115
 topology, 103
 Nusselt number, 29, 183, 194, 195, 198

 operator self-adjoint, 31, 36
 Ott E., 86, 209

 parabolic sheets, 82
 parallel plates, 183
 Parseval's theorem, 37, 50, 125
 phase space, 62, 63, 76, 170
 Picard iteration, 89, 90, 91, 96
 pipe flow, 183
 Poisson's equation, 5, 6
 power spectrum, 125
 Prandtl numbers, 27, 29, 75, 76, 133, 193,
 204, 205
 pressure, 1, 4, 5, 8, 12, 14, 15, 16, 20, 25, 34,
 41, 44, 121, 171, 180, 193
 projection, 70, 85, 101, 102, 172, 199, 200

 rate of strain tensor, 14, 42, 47, 155
 symmetric, antisymmetric, 15
 Rayleigh number, 27, 29, 37, 38, 59, 74, 75,
 76, 133, 183, 193, 194, 197, 203, 205
 regularity, 104, 107, 108, 110, 138, 144, 184,
 198, 199
 Reed M. 210
 Reid W.H., 38, 209
 Reyna L. 210
 Reynolds
 number, 26, 27, 35, 36, 37, 38, 39, 43, 44,
 46, 47, 48, 49, 51, 53, 55, 56, 57, 59,
 148, 183, 186, 190, 193, 201, 202
 stress, 42, 44, 45, 48
 Reynold's decomposition, 186, 204
 Reynold's equations, 42, 44, 201
 roll, 79, 83, 204
 Rudin W. 210

 Saffmann P., 134, 210
 Serrin J., 155, 210
 shear stress, 1, 12, 43, 45, 186
 shear stress tensor, 15
 Simon B. 210
 singularities
 spatial, 117
 temporal, 106, 139, 144, 147, 153
 Sparrow C., 86, 209
 spectral
 condition, 190, 192, 202
 constraint, 189, 191, 197, 202
 spectrum/spectra, 31, 34, 36, 49, 54, 55,
 118, 139, 150, 169, 188, 200, 205
 sphere, 80, 81, 86
 stability
 linear, 30, 31, 34, 37, 38, 39, 78
 nonlinear, 31, 32, 33, 34, 35, 38, 39, 78,
 189, 195, 198
 Stokes'
 equations, 185, 205
 operator, 199
 Straughan B., 38, 209
 stream function, 22, 75
 stress tensor, 12, 13, 14, 42
 strong solutions, 88, 104, 138, 139, 184
 subsequence, 104
 Swinney H., 203, 211

 Taylor microscale, 56, 57
 Temam R., 86, 113, 134, 145, 155, 179, 210
 temperature, 5, 18, 19, 21, 27, 29, 75, 134,
 193, 195, 196, 204
 Tennekes H., 59, 209
 theorem
 Constantin and Foias', 74
 Constantin's, 173, 181
 contraction mapping, 113
 divergence (Gauss), 7, 120
 fundamental theorem of calculus, 192
 ladder, 114, 118, 126, 128
 Parseval's, 37, 50, 125
 thermal
 conductivity, 22, 193
 convection, 18, 21, 27, 62, 75, 132, 183
 diffusion coefficient, 18, 27
 expansion coefficient, 18, 27, 193
 Thirring W., 181, 212
 Thomae S., 203, 210
 time-average(s), 40, 41, 118, 137, 140, 143,
 144, 147, 150, 176, 182, 184, 195, 197
 Titi E., 38, 167, 179, 209
 trace operation, 70, 172
 Trève Y., 86
 trial profile, 189, 190, 201
 Tritton D., 21, 209
 turbulence, 10, 40, 51, 178
 2d, 57, 58, 59, 61, 170, 184
 3d, 61, 184
 homogeneous, 54, 55
 isotropic, 57
 statistical theory of, 40, 184, 203
 turbulent
 closure problem, 42
 eddies, 17
 energy diffusion, 192
 energy spectrum, 56

- flow, 40, 44, 57, 183, 202
- fluctuations, 42, 46
- shear flow, 44
- uniqueness, 88, 96, 100, 104, 110, 198, 199
- variational
 - constrained problem, 188, 197
 - method, 195, 196, 202, 204
 - principle, 183, 195
- velocity, 2, 9, 18, 22, 25, 26, 27, 53, 182, 193
 - evolution equation, 17, 19
 - vector field, 1, 3, 6, 10, 14, 15, 16, 18, 41, 49, 61, 113, 144, 153, 172
- viscosity, 12, 15, 22, 23, 26, 27, 42, 52, 53, 110, 150, 151, 186, 192, 193
- viscous energy dissipation, 16, 17, 18, 43, 52, 151, 152, 182
- Vishik M.I., 86, 155, 180, 209
- volume element(s), 64, 67, 71, 73, 74, 171, 172, 176, 177, 179
- von Karman constant, 46, 201
- vortex stretching, 10, 11, 12, 17, 18, 52, 144, 182
- vortices, 10, 113
- vorticity, 9, 10, 11, 17, 18, 22, 58, 131, 134
 - bursts, 150
 - evolution equation, 10, 17, 112, 171
- wavenumber, 50, 51, 52, 54, 57, 58, 97, 126, 127, 137, 150, 160, 167
- weak
 - solutions, 88, 96, 97, 103, 104, 105, 111, 113, 138, 139, 182, 200, 201
 - topology, 102, 103
- Wu X-Z., 203, 210
- Yorke J., 86, 209
- Zaleski S., 203, 210
- Zanetti G., 203, 210