
Index

- AHNS theory 308–15
 α , α' , coefficients of mutual friction 88–9,
 230–1
 anisotropy of the vortex tangle 249–52
 axial mutual friction 108–11
 axial second sound attenuation 108–11,
 235
 B , B' , coefficients of mutual friction 89,
 92–7
 background fluid 45
 Baym–Chandler equations 196–9
 Bénard convection 35–6
 binding of ^3He to a vortex line 135–42
 binding of ^3He to the negative ion
 295–302
 Biot–Savart law 26–7
 Bose–Einstein gas 72
 condensate 72–3
 energy levels 74
 ideal 72
 imperfect 73–4
 bound excitation model of quantized
 vortices 118–21
 Brownian motion 38–41
 chemical potential gradient 156–60
 classification of turbulent superfluid flows
 244–5
 coherence length 46
 competing barrier nucleation theory 260,
 269–77
 complex pair response function 309
 condensate velocity 75, 81
 correlation length 46
 counterflow 55–6
 counterflow jet 240–2
 critical velocities 246, 255, 265, 268, 275,
 281, 291
 Crow instability 33–5
 cyclotron frequency 88, 286
 D , D' , D_1 , coefficients of mutual friction
 89
 d'Alembert's paradox 6
 decay of a superflow 266–7, 269, 270–1,
 273
 dielectric constant 305
 diffusion coefficient 261–2, 313
 dimensionless form of vortex dynamics
 217–18
 drag force on quantized vortices 88–9
 drift velocity of the tangle 224, 251–2
 dynamical healing length 79
 dynamical similarity 4, 218–24
 edge wave of vortex array 206
 effective mass 6
 Ekman layers 17
 Ekman number 17
 electromagnetic analogue 282–5
 elementary excitations 45–8
 encircling vortex ring 279
 energy flux density 6
 entry of vortices in a rotating annulus
 58–62, 149–54
 equations of motion
 Baym–Chandler 196–9
 Euler 2
 HVBK 92–195
 Landau 81
 Navier–Stokes 1
 two-fluid 44
 escape over barriers 38–41

344 *Index*

- Euler's equation 2
 evolution of a vortex tangle 227
- Feynman's rule 52
 Feynman vortices 50–2
 finite amplitude effects on a vortex
 plasma 310–13
 fluctuations in line density 252
 flux of vortex rings 262
 Fokker–Planck equation 261, 262, 309
 free energy
 minimization of 53
 saddle point 41, 262
 fugacity of vortices 307
- γ , γ_0 , γ'_0 coefficients of mutual friction
 88–9, 98–100, 105–8
 ghost of a vortex ring 115
 Ginzburg–Pitaevskii theory 79
 Gorter–Mellink mutual friction 55–6, 237
 Gross–Pitaevskii theory 78
 group velocity of helical waves 181
- Hamilton's equations 22–5
 Hasimoto solution 31–7
 healing length 79
 helical wave dispersion relation 29, 179
 helical waves 28–9, 179–87
³He condensation onto vortex cores
 135–42
³He trapping on ions 295–9
 Helmholtz's first theorem 4
 Helmholtz's second theorem 4
 Hills–Roberts theory 121–4
 homogeneous nucleation theory 260
 homogeneous turbulent state 246
 HVBK equations 92, 195
- ILF theory 260–3
 injected turbulence 244
 internal degrees of freedom 263
 intrinsic critical velocities 264–9
 intrinsic fluctuations 252
 ion measurements of vortex turbulence
 239–40
 ion mobility on vortex cores 132–5
 ions
 critical velocities 291–2
 escape of from vortices 131
 interaction with vortices 63, 127–32
 motion of 277–9
 positive and negative 63, 277
 ions (contd)
 trapped 63
 ³He on ions 295–302
 Iordanskii force 95, 101–2
- Kelvin waves 184–7
 Kelvin's theorem 5
 Kosterlitz–Thouless recursion relations
 306–8
 Kosterlitz–Thouless theory 303–8
- Landau critical velocity 46–7
 Langevin equation 308
 lattice sums 191–4
 lifetime and range of vortex rings 105–8
 line vortex 12
 linear dynamic theory 308–10
 localized induction approximation
 (Arms–Hama approximation) 25–8
 logarithmic decay of superflows 265–9,
 274–6
 low level dissipation 253–4
- Madelung transformation 75
 Magnus force
 classical 6
 on quantized vortices 88
 measurements of superfluid turbulence
 230–44
 mixing step in turbulence simulations 229
 modified mutual friction 253–4
 momentum space 261–2, 313
 mutual friction
 and vortex waves 212–214
 coefficients of 88–9
 equations of motion 44
 theory 95–102
 mutual friction approximation for
 turbulence 236
- Navier–Stokes equation 1
 neutron stars 160–4
 crust 163
 glitches 163
 normal fluid density 43
 normal jet 240–2
 nucleation
 by tunnelling 285–8
 of a vortex at the edge of a film 285
 of quantized vortices
 barrier to 256–60
 competing barrier model 269–77
 extrinsic and intrinsic 255–6

- nucleation (contd)
 in an unbounded flow 260–6
 in porous media 274–7
 tunnelling model 277–89
 of vorticity by ions 288–9
 nucleation rates 262, 288, 294, 301
 nucleation theory 260–301
 nucleopore transducers 233
 numerical simulation of a vortex tangle 225–30
- onset temperature of superfluidity 276–7
 order parameter 83
- penetration depth for viscous waves 9, 89–90
 phase slip 83–5
 phonons 45
 photographs of vortex arrays 145–7
 point vortices 13–305
 polarizability of vortex pairs 305
 potential barrier for nucleation 256–60
 potential vortex 13
 production of superfluid turbulence
 in narrow channels 236
 in wide channels 231–5
 pulsed ion techniques 239–40
- quantized circulation 48–50, 58–62
 quantized vortex rings 63–4
 quantum mechanics for vortices 77–82
 quasi-particles (elementary excitations) 45
- Rankine vortex 12
 Rayleigh criterion 35–8, 154
 reconnecting vortex tangle 227
 remnant vortices in helium II 177–8
 Reynolds number 4
 Rossby number 17
 rotation induced vorticity in thin films 316–22
 roton drift velocity 88, 95–102
 roton line cross section 101
 rotors 45
- saddle point in free energy 41, 257, 262
 saturated persistent current 273
 Schrödinger equation 75
 second sound 55–8
 Shikin levels 297–9
 shock waves 238
 sideband instability 184–7
 and recurrence for a vortex line 185–7
- simulation studies of pinning 169–70
 single disk apparatus 70–1
 small quantum vortex rings 114–18
 Smoluchowski equation 39, 262
 solid rotating vortex core 23
 solitary kink waves 31–3
 spin-up
 classical 17
 in helium II 170–7
 stability of
 flow of helium II rotating cylinders 154
 Kelvin waves 184–7
 static friction of vortices on boundaries 171–7
 static Kosterlitz–Thouless transition 303–8
 substitution energy 128
 superfluid density 43
 superfluid gyroscope 266
 superfluid turbulence 215–53
 surface tension vortex core 23
 susceptibility of vortex pairs 305
- Taylor–Couette flow 36–8
 in helium II 153–6
 Taylor–Proudman column 18
 temperature gradient in turbulent flow 233, 237
 thermal conductivity of thin films 315–16
 thermal counterflow 231–6
 thermal counterflow apparatus 233–4
 thermally activated vortex pair 305–8
 thermally excited vortex waves 211–12
 thermomechanical force 44
 thermorotation effects 156–60
 Tkachenko–Kelvin mixed mode dispersion relations 199
 Tkachenko waves 189–204
 observation of 199–204
 triangular array of vortices 143
 turbulence, superfluid
 analysis of 236–8
 anisotropy of 249–59
 density of 247–9
 production of 230–6
 scaling 218–20
 two-dimensional superfluidity 302, 303
 two-fluid model 42–5
- ultrasonically generated turbulence 242–4
 universal decay curve of superflow 264–6

346 *Index*

- varicose vortex waves 31
- vortex-antivortex pairs 304
- vortex arrays in rotating helium II 143–54
- vortex boundary force 173
- vortex core parameter 47
- vortex diffusion length 308–9
- vortex diffusivity 261–2
 - in two dimensions 313–14
- vortex dynamics 217
- vortex filament 12
- vortex-free strip 54, 55–7, 108–11
- vortex instability 208–11, 184–7
- vortex line 12, 27
- vortex loop 279–80
- vortex normal modes 205–7
- vortex nucleation in porous media 269, 274–7
- vortex pair plasma 305
- vortex pinning 160–70
- vortex reconnections 225–30
- vortex rings
 - in a Bose condensate 80, 114–18
 - in helium II 63–4, 112–14
- vortex sheets in helium II 48–9
- vortex tube 12
- vortex tunnelling 285–9
- vortex wave dispersion relation 29
- vortex waves
 - collective 187
 - dispersion 182–4
 - helical 28–30, 182–7
 - Kelvin 31
- vortex waves (contd)
 - mutual friction on 212–14
 - solitary 31–3
 - Tkachenko 189–204
- vortices
 - classical
 - definitions 12
 - diffusion of 8, 9
 - hollow core 22–3
 - laboratory generation of 19–21
 - potential 13
 - Rankine 12
 - rings 14, 22–5
 - pair 15
 - solid core 22–3
 - superfluid
 - energy per unit length 69
 - Feynman 50–2
 - in thin films 302
 - tangle 52, 215
 - reconnection 225–7
 - remnant 177–8
 - rings 63–4, 114–17
 - photographs of 145–7
 - triangular array 143
 - ultrasonically generated 243
- vorticity 7
 - in viscous flows 8–11
 - in helium II 52
 - in superfluid 84
 - in superfluid turbulence 238, 245–9