Index

Absorption 23–26, 58–59, 61–62, 92–94, 100, 118–121, 130–131, 181–184, 191, 196–198, 206, 242–243, 318–321, 325–326, 332
  Coefficient 23, 93, 120, 136, 151, 232, 319, 326, 394
  Edge 92, 100, 118–120, 182–183, 319
  Length 59, 61, 100, 394
Atomic distribution function 131
Atomic scattering factor *see* Form factor
Auger electron 130
Auto correlation function (ACF) 20–21, 236, 238, 387, 391, 399, 404

Babinet's principle 100
Background 91–94, 101, 103, 105, 108, 118–119, 146, 151, 180, 182, 196, 240, 330, 333
Beam
  Damage *see* Radiation damage
  Divergence 30–31, 35–36, 41–47, 67–68, 70, 73, 77
  Size 11, 30–31, 36–37, 42–43, 45–46, 61, 70–71, 73, 75–77, 79–81, 92–93, 96–98, 358–359, 389, 394
Beam hardening 317, 331–332
Beamline 29–31, 33, 36, 47–49, 51, 65–66, 72, 74, 91–93, 97, 147, 189–190, 270–272, 274, 395–397
  Magnetic scattering 189–190
  Optics 29, 47, 49, 51, 270, 398
Beamstop 72, 77, 91–92, 94–95, 115, 117
Bending magnet 32–38, 43
  Dipole 32
  Radiation 32–38
Betatron function (β-function) 42
Born approximation 1–26, 115, 231, 237–239, 346, 372, 388
Bragg
  Angle 9, 11, 24–25, 48, 139, 151, 189, 218–219, 317, 342, 351–352, 368, 406–407
  Reflection 10, 16, 22, 24–26, 48, 50–52, 82, 130, 132, 134, 138–139, 187, 209, 218–219, 243
  Nuclear 218
Brilliance 43, 45–47, 61, 93, 205–206, 210, 218, 243, 267, 287–288, 291–292, 296, 362, 396

Capillary waves 21, 234–236, 239, 245, 398, 400
Charge density wave (CDW) 158, 160, 406–407
Coherence length 30, 363, 365, 394
  Longitudinal 30, 363, 365, 394
  Transverse 30, 365, 394
Coherent fraction (XSW) 135–137

Coherent position (XSW) 134–136
Coherent scattering 2, 20, 200, 319, 345–359, 361, 363, 365, 370, 372
  Experiment 366
  Partial coherence 358–66
  Single pulse 374–77
Coherent X-ray diffractive imaging (CXDI) 341–345, 358, 366, 368–377
Compound refractive lens (CRL) 58–61, 75
Concentration effect 107
Contrast 18, 100
  Variation 89, 118–121
Convolution 13–14, 17, 41, 346–347, 364, 388
Critical angle 23–24, 49, 65–68, 70–71, 116–117, 219, 223, 232–233, 239–240, 246, 371–372, 398
Critical energy 35–38
Crystal truncation rod (CTR) 14, 353, 372

Darwin width 48, 50
Data correction 94–96
Debye formula 7, 98, 120
Debye–Waller factor 146, 148–150, 186
Delay unit *see* X-ray beam splitter
Diamond anvil cell (DAC) 147, 149, 255–257, 259–281, 285–289, 293–295
  Gasket 265, 275
  Laser heated 269–74
  Resistive heated 274–79
Dichroism 197, 212–213, 221
  Circular 197, 212
  Linear 213, 221
Differential cross section 103
Diffraction
  Powder 11–12, 75, 179, 255–256, 258, 260, 262–264, 266, 269, 275–278, 294
  Single crystal 130, 162, 255–256, 258, 260–263, 266–268, 275–281
Diffraction limit 57
Diffusion of atoms 403
Dispersion 232, 398
Distance distribution function 110–111
Domain walls 406, 409
DuMond diagram 47–51
Dynamic light scattering (DLS) 386
Dynamical heterogeneity 410
Dynamical matrix 148–150

Electric dipole transition 212
Electron
  Bunch 31, 33–34, 39, 41, 43, 45
  Density 5–8, 13, 16–18, 23, 99–100, 110, 112–113, 136, 232, 234, 342–343, 346–351, 354–355, 372–374, 388
  Profile 16
  Volts 3
Emittance 42, 298, 377
Energy
  Bandwidth 30–31, 35, 37, 40–41, 43, 45, 47, 50, 151, 189, 196, 318
  Resolution 30–31, 35, 47, 50, 92, 119, 137, 146, 150–152, 159–160, 162, 166, 199–200, 206, 318
  Spectrum 35, 39–40, 47–48, 206, 331

Energy-time space 209
Equation of states (EOS) 258–60, 272–273, 281, 283–284, 289
Error function 18
Evanescent wave 232, 240
Exchange bias 217, 220–224
Exchange coupling 215
Exchange-spring effect 215

Far field limit 362–63
Fermi surface 146, 155–156, 158–159, 169
Fluctuation
  Domain wall 406, 408
  Equilibrium 387–389
Fluorescence 73, 91–93, 119, 130–131, 134, 139, 156, 182, 191, 196, 260, 274–275, 281–285
Flux 29–30, 35–51, 55–57, 64, 69, 72, 82–83, 90, 114, 318, 345, 386, 391, 395–397
  Density 35–38, 40, 46, 55–56, 69, 72, 82–83, 396
Focal length 57–61, 64–66
Focusing
  Capillary 68–69, 75
  Diffractive optics 62–64
  Reflective optics 65–67
  Refractive optics 58–62
  Waveguide 69–72, 75
Form factor 8, 106–108, 120, 136, 186, 239, 248, 376
Fourier transformation 4–7, 13, 17–18, 21, 23, 208–209
Fractal 101–102
  Dimension 101–102
  Roughness 101–102
  Surface 101–102
Fraunhofer limit 360
Free electron laser (FEL) 61, 374
Fresnel equations 232
Fresnel limit 360
Fresnel reflectivity 24, 231, 233–234, 239, 245, 248
Fresnel zone plate 62–64

Guinier approximation 104–105, 113
Guinier and Kratky plot 104

Heterogeneity 389, 391, 410–411, 415
Hydrostatic condition 259, 277
Hyperfine interaction 206, 211

Index of refraction *see* Refraction index
Inelastic X-ray scattering (IXS) 146–150, 155
  Powder, wide angle 164–168
  Setup 152
Intensity 5–26, 29, 94–97, 105–112, 130–131, 133–134, 155–157, 159–161, 191–199, 323–324, 347–354, 356–359, 361–365, 386–391, 411–414
  Absolute 5, 17, 94, 96–97, 103, 105, 111–112, 120, 389

K-parameter 40–42
Kinematical approximation *see* Born approximation
Kirkpatrick–Baez (KB) mirror 65–67, 71–72, 75, 325
Kohn anomaly 154, 156, 158–159
  Giant 158–159
Kratky plot 99, 104, 111–112

Lamb–Mössbauer factor 212

Lambert–Beer's law 318, 326
Large volume press (LVP) 256–257, 262, 266–267, 286–287
Laser heating 169, 268–274, 295–296
Laue
  Function 9
  Oscillation 10, 15
Lens 57–64, 156–158, 331
  Adiabatic 61
  Compound refractive 58–61, 75
  Nanofocussing 60–61
Liquid surface 21, 230, 234–235, 237–239, 241

Magnetic reversal 220–224
Magnetic spin profile 217
Magnetism 162, 178, 186, 199, 205, 225
  Atomic multipole 179
  Phase transitions 178
  Spin and orbital 178, 186
Microdiffraction experiment 56, 68, 71, 73–75
Miller index 9, 133, 187
Modulo-d ambiguity 134
Momentum transfer *see* Wave vector transfer
Monochromator 47–51, 137, 150–152, 190–191, 242–243, 317–318, 363, 375, 392, 394, 398
  Backscattering 152
  High resolution 137
Mössbauer isotope 213, 215
Multilayer 18–19, 64, 67, 72, 130, 132, 200, 217–219, 221, 317–318
  Magnetic 200, 218–222
Multiplicity 12
Multipole in resonant scattering 197–198
Mutual coherence function (MCF) 361, 388

Nano-crystalline materials 285–287
Natural linewidth 211, 213
Navier–Stokes equation 235
Near field limit 360
Névot-Croce factor 233, 236
Nuclear resonance 206–207, 210–211, 213
Nuclear resonant scattering (NRS) 205–214
  Basics 207–14
Numerical aperture 57, 71, 326
Nyquist theorem 350

Ordering
  Antiferromagnetic 180
  Local 146, 404
  Long-range 162, 229
  Magnetic 218, 225
  Multipole 197
  Octapole 199
  Short-range 404
Oversampling 344, 349–350, 352

Pair distribution function (PDF) 6–7, 20, 164, 285–286, 393
Parratt algorithm 233
Phase retrieval 321, 342, 345–346, 349–350, 352, 355, 374, 376
Phase transition 158–161, 195, 198, 260–263, 268, 286, 293–296
Phonon dispersion surface 152–154
Plane wave 3, 130, 132, 236–237, 341, 399, 401

Plastic–elastic properties 263
Polarization 3, 12, 30, 50–51, 98, 177, 179–180, 182, 186, 188–192, 194–198, 205, 210–214, 244, 247
  Circular 189, 195–197, 212
  Vector 4, 177, 189, 195, 198, 212–213
Polarization vector 132, 212
Polydispersity 102–103, 107, 109
Polyelectrolyte effect 107
Porod 99, 102–103, 111–112
  Constant 102–103, 112
  Invariant 111–112
  Law 102–103, 111–112
Powder diffraction 10–12, 179, 260, 262–264, 266, 269, 275
Power-law 101–102, 113, 159, 161
  Exponent 101–102
Power-law (SAXS) 100–102
Power spectral density (PSD) 21, 235–237
  Dynamical 235
  Gaussian 22
  Lorentzian 363
Pressure determination 281–85
  Standards 283–84
Pulse length 30, 34, 291, 415
Pulse train 374–376
Pump-probe 200, 294–296
Pyrometry 269–270, 274, 276

Quantum beats 207–209

Radiation damage 44, 62, 83, 97, 114, 242–243, 374–375
Radius of gyration 105, 400
Reciprocal lattice 10, 134, 136, 139, 148, 189, 192, 347–350, 354, 356–357
  Point 348, 350–351, 354, 356–357
  Vector 10, 134, 136, 139, 148, 189, 348
Reconstruction
  Hybrid Input-Output (HIO) method 343, 367, 376
    Guided 344, 367
  Image 326–327, 329, 331–332, 343–345, 367–368, 376
Reflection coefficient 17
Reflectivity *see* X-ray reflectivity
Refraction index 23, 369
Relaxation time 399–401, 404, 407
Resolution 57, 238
  Rayleigh 63
  Tomography 317–318, 325–326, 370
Resonance line 211
Roughness 14, 17–18, 21, 65, 69–70, 101–102, 221–222, 230, 233–237, 239, 245, 248–249

S-matrix 150
Sample thickness 93, 394, 399
Scattering 1–26
  Amplitude 5–6, 13, 19, 39, 100, 106–107, 176, 180, 186, 195–197, 209–210, 342, 346–349, 355–356, 359–361
  Angle 4, 23–25, 71–72, 77, 89–92, 94–100, 106, 114–118, 189, 231–232, 242, 244, 370–371, 397–399, 404–405
  Dynamical 2, 6, 10, 22–26, 50, 130, 145, 148, 150, 159, 210, 346, 409–410

Bragg case 24–25
Laue case 24–25
Factor 99–100, 118–119, 148, 347
Function *see* Structure factor
Length 3, 6, 74, 77, 94–95, 97, 99–100, 102–106, 111, 113, 209–214, 238, 240, 363–364, 394
Length density 99–100, 105–106, 111
Magnetic 2, 6, 23, 175–200, 206, 211–216, 218, 221–225, 386
Coherent 200
Introduction 175–176
Non-resonant 176, 182–189
Resonant 175
Multiple 2, 6, 22, 51–52, 93, 115, 192–194, 210, 346, 386
Off-specular 19, 21, 117, 398
Specular 16, 19, 21, 115–118, 231–232, 236–238, 240, 244, 398
Scattering vector *see* Wave vector transfer
Scherrer formula 10, 99
Shape function 16, 346–348, 350–351, 356, 361, 363–364
Shapes in SAXS 98, 111
Shockwave experiments 281, 288
Siegert relation 388–389, 392, 410
Signal-to-noise ratio (SNR) 331, 389
Single exposure 268, 292–293, 296
Small angle scattering
μSAXS 77–78
Anomalous ASAXS 89–90, 118–121
Conventional SAXS 89–121
Grazing incidence GISAXS 90, 118
Speckle 200, 386, 389, 391–392, 395, 407, 413, 415
Contrast 389, 391–392
Size 389, 395
Strain 76–77, 81–82, 167, 178, 259, 290, 292, 345, 355, 357–358, 364, 368, 377, 411
Structure factor 8, 12, 17, 19, 23, 26, 106–109, 120, 131–134, 136–137, 347–350, 356, 385–387, 413–414
(XSW) 136
Magnetic 182
Liquid 240
Surface scattering 12–22, 78, 240
Surface tension 230, 234–235, 238–239, 247, 400
Susceptibility 23, 390
Synchrotron radiation source 31, 72–74, 243, 293

Thermal diffuse scattering (TDS) 146, 155
Time resolved experiment 255, 291, 298, 389, 395
Time spectrum 214, 219–220, 223
Tomography 2, 315–326, 328–330, 332, 334, 370–371
Absorption 318–321, 323, 325–326, 332, 370
Artefacts 329–332
Magnifying optics 325–326
Phase contrast 320–325, 370
Indirect 321–323
Principle 316–317
Reconstruction 316, 326–327, 329, 332
Resolution limit 370

Transmission coefficient 232
Two time correlation function 389–391, 410–411

Undulator 38–49, 59–61, 114, 137, 151, 189, 291, 293, 317, 394, 396–397
  Gap 39–40, 47
  Harmonic 42, 48, 291, 293, 397
  Spectrum 39–40, 47–49, 397
Unit cell 7–8, 132, 134, 137–140, 149–150, 184–187, 218, 257–258, 260, 283–284, 294, 346–350, 354–355, 375–377, 406

Vibrational density-of-states (VDOS) 165, 167, 169
Viscoelasticity 230, 398, 401
Viscosity 230, 234, 286, 400

Wave
  Length 3, 23, 25, 132, 213, 325
  Number 3, 44, 132, 236
  Vector 3–4, 8, 10, 23, 155–156, 158, 213, 216, 219, 231–233, 236, 371, 389–390, 399, 401
  Transfer 4, 10, 15, 78, 148, 231–233, 236, 239, 247, 346, 385, 389, 399, 411
Waveguide *see* Focusing waveguide
Wide angle scattering (WAXS) 71, 91, 97–98, 101, 113
Wiggler 37–39, 43, 317

X-ray
  Beam splitter 391–392
  Mirror 67
  Slit 37, 43, 93, 106, 395
  Wavefield 67–68, 129–132, 134, 344, 359
  Window 92–93
X-ray cross correlation analysis (XCCA) 387, 392–393, 413, 415
X-ray free electron laser (XFEL) 43–44, 257, 268, 386, 391
X-ray photon correlation spectroscopy (XPCS) 385–415
  Beamline 395–98
  Experiment and setup 394–98
X-ray reflectivity 118, 231, 245–248
  Fresnel 231–237, 245–246, 248
  Mercury 247
  Nuclear 218
  Water 245–246
X-ray standing wave (XSW) 129–141
  Formation 132–33
  Wavefield 129
  Yield 134