

Index

- μARPES, 257
- 2D Fermi surface, 256
- 4GLS, 65

- Abbé theory, 233, 253, 264
- aberration-correction, 255
- absorption edge, 76, 117
- accelerators, 3
- achromat, double bend, 46
- achromat, multi-bend, 48
- adsorption site, 171
- amorphous materials, 145
- angle-resolved photoelectron spectroscopy, *see* ARPES
- anglesite, 203
- antiferromagnetic coupling, 207
- APPLE-II (Advanced Planar Polarised Light Emitter), 41
- archaeology, 203, 236
- ARPES, 194–200, 253, 256
- ARTEMIS, 166
- astigmatism, 78
- atomic force microscope (AFM), 238
- atomic structure factor, 104
- ATR, 236
- attenuated total reflection, *see* ATR
- Au(111), 196, 267
- Au₃Cu, 267
- Auger electron emission, 135, 168

- BaTiO₃, 259
- beam flux monitors, 99–101
- beam stop, 71
- beamlines, 70
- beamlines, front end components, 71
- bending magnet, 20
- bending magnet radiation, 12
- bending magnet radiation, angular distribution, 13
- bending magnet radiation, critical energy, 12
- bending magnet radiation, critical wavelength, 21
- BESSY, 85
- BESSY II, 87, 237
- beta function, 48
- betatron, 16
- betatron wavenumber, 47
- Bi₂Se₃, 169, 204
- black body infrared source, 226
- Bohr magnetons, 206
- Bragg CXDI, 267
- Bragg's law, 90, 105
- bremsstrahlung, 7, 103
- bremsstrahlung, gas, 70
- Brewster angle, 75
- bright-field images, 254
- brightness, spectral, 1, 46
- brilliance, 7, 45
- Brillouin zone, 195

- camera obscura, 251
- capillary condenser, 246
- CCD devices, 260
- CdO(100), 202
- CdSe nano particles, 148
- CH₃Cl, 230
- channel plate multiplier, 188
- characteristic radiation, 102
- charge-coupled device, 111
- chemical shifts, 178
- CHESS, 65
- chromatic aberration, 47
- cinnabar, 203
- circular dichroism, 204
- CO adsorption, 173, 232
- CO molecule, 225
- C–O stretching vibration, 231
- coherence, 2, 53–6, 263–71
- coherence, temporal, 55
- coherence, transverse, 55, 153
- coherent fraction, 55
- coherent X-ray diffraction imaging, *see* CXDI
- collagen, 236
- collimation, 71, 264
- compound refractive lenses, 80, 244
- Compton profile, 215
- Compton scattering, 68, 109, 194, 213–18
- computed tomography, 242
- concentric hemispherical analyser, 196, 253
- critical wavelength, 21

- cryo-electron microscopy, 120, 246
 cryo-soft X-ray tomography, 246
 Cu(110), 178
 Cu(111), 232
 Cu₃Au, 267
 CuB₂O₄, 213
 cultural heritage materials, 236
 curved wave effects, 165
 CXDI, 263–71
 CXDI, Bragg, 267
 CXDI, plane-wave (PCXDI), 265
 cyclotron, 3
 cyclotron radiation, 7
 Czerny-Turner monochromator, 83

 dark-field images, 254
 Darwin reflectivity curve, 131, 136, 240
 Debye-Scherrer cones, 124
 Debye-Waller effect, 175
 Debye-Waller factor, 163, 166, 201
 detector dead times, 109
 detectors, 2D imaging, 107
 detectors, 2D pixel, 111
 detectors, multiple analysing crystal, 113
 detectors, position-sensitive, 107
 detectors, X-ray diffraction, 107–13
 Diamond Light Source, 48, 124, 152, 162, 164, 166
 diffraction grating, lamellar multilayer, 99
 diffraction gratings, 82
 diffraction gratings, blaze angle, 83
 diffraction gratings, reflection, 82
 dipole selection rules, 171, 199
 Dirac cone, 196
 dislocations, 260, 263, 269
 dispersion function, 48
 Doppler effect, 10
 Doppler shift, 28
 double bend achromat, 46
 dynamic aperture, 43

 EDAX, 208, 210, 250
 electric quadrupole cross-sections, 204
 electromagnetic spectrum, 2
 electron beam focusing, alternating gradient, 7, 44
 electron bunch, 6, 41
 electron density distribution, 114, 153, 207
 electron electrostatic dispersive analyser, 187
 electron emittance, 46
 electron emittance, normalised, 62
 electron inelastic scattering, 169, 174
 electron inelastic scattering, mean-free path, 185
 electron scattering cross-section, 175
 electron storage ring, 18
 electron-hole pair creation, 187
 electronic structure, 185–225
 electron-plasmon scattering, 187
 ELETTRA, 49, 58, 219

 emittance, 45
 emittance, diffraction-limited, 49
 emittance, electron, normalised, 62
 emittance, horizontal, 47
 emittance, vertical, 47
 Energy Dispersive EXAFS, 167
 Energy Dispersive X-Ray Analysis, *see* EDAX
 energy recovery linac, *see* ERL
 epitaxial films, 136
 ERL, 64–6
 ESRF, 95, 97, 122, 154, 240
 étendue, 228
 European XFEL, 59, 62
 evanescent wave, 126
 Ewald sphere construction, 105, 113
 EXAFS, 162–71, 199
 EXCURVE, 166
 extended X-ray fine structure, *see* EXAFS

 Fe₂O₃, 183
 FEF, 166
 FEL, 2, 56–64, 120
 FEL, seeding, 63
 FELIX, 58
 Fellgett's advantage, 227
 Fermi level, 197
 ferroelectric domain switching, 259
 ferromagnetic magnetisation rotations, 259
 ferromagnetic ordering, 207
 filled skutterudite, 206
 flipping ratio, 217
 fluorescent X-ray emission, 135
 focusing of incident beam, 243–6
 focusing, capillary, 243
 FODO lattice, 44
 form factor, 104
 formate, 172
 Fourier transform, 114, 145, 164, 177, 207, 264
 Fourier transform infrared spectroscopy, *see* FTIR
 FPAs (Focal Plane Arrays), 234
 fractional order diffraction beams, 127
 Fraunhofer diffraction, 248
 free-electron-like dispersion, 196
 Fresnel diffraction, 247
 Fresnel equations, 74
 Fresnel zone plates, *see* FZP
 Fresnel zones, 244
 FTIR, 227
 FTIR microscopic image, 233
 FTIR spectromicroscopy, 236
 full-field imaging, 243
 full-field imaging, XRF, 252
 furan, 172
 FZP, 244, 246, 271

 gas ionisation chamber, 100, 107
 gas-phase clusters, 219

- Geiger-Müller tube, 100
 geometrical structure factor, 159
 GIM, 87
 Global Warming Potential, 229
 Globar, 227
 glucose isomerise, 157
 gold nanocrystal, 268
 gold nanoparticles, 'magic' numbers, 148
 gold, reflectivity, 76
 graphene, 196, 256
 grazing incidence monochromator, *see* GIM
 guanine, 220
 Guinier plot, 156
 Guinier theory, 156
- haematite, 183
 hard X-ray photoelectron spectroscopy,
 see HAXPES
 harmonics, 13, 32
 HAXPES, 200–2
 heavy fermion behaviour, 207
 Helios, 67
 Helmholtz-Kirchoff formulae, 179
 Helmholtz-Lagrange law, 45
 high resolution electron energy loss spectroscopy
 (HREELS), 231
 high-resolution inelastic X-ray scattering, *see* IXS
 holography, photoelectron, 179
 holography, X-ray fluorescence, 181–4
- icosahedral Au particle, 148
 image plates, 108
 imaging, 242–71
 imaging, coherent X-ray diffraction, 263–71
 imaging, full-field, 243
 imaging, lensless, 264
 imaging, phase contrast, 248
 imaging, photoelectron, 253
 imaging, spectroscopic, 249–60
 imaging, transmission, 246
 imaging, X-ray absorption edge, 252
 InAs, 258
 inelastic neutron scattering (INS), 239
 infrared synchrotron radiation, 226
 inner potential, 163, 197
 InSb(001) surface, 130
 insertion devices, 21
 instrument function, 114
 inverse Compton scattering, 68
 inverse X-ray fluorescence holography, 183
 ion chambers, 166
 isomorphous replacement, 116
 IXS, 238
- Kirkpatrick-Baez focusing, 79, 243, 252
 KKR (Korringa-Kohn-Rostoker) method, 216
 Kossel structure, 162
- Kramers-Kronig relation, 116, 208
 Kronig oscillations, 162
- lasers, conventional, 1, 53
 lasers, free-electron, *see* FEL
 Laue conditions, 104
 Laue diffraction, 260
 LCLS, 59
 LCLS FEL, 63
 LEED, 130, 165
 LEEM, 253
 LEEM/PEEM instruments, 255
 lensless imaging, 264
 linac, 3, 7, 62
 Linear Coherent Light Source, *see* LCLS
 linear dichroism, 259
 linear muffin-tin orbital (LMTO) calculations, 217
 Liouville's theorem, 45
 liquid In, 241
 liquid structure, 145
 Lorentz transformation, 8
 low energy electron diffraction, *see* LEED
 low energy electron microscopy, *see* LEEM
 luminescence, photon-stimulated, 108
- macromolecular crystallography, 121, 253
 macromolecular X-ray diffraction, *see* MX
 MAD, 118
 magnet, bending, 7, 46
 magnet, dipole, 7
 magnet, quadrupole, 7, 44, 46
 magnet, sextupole, 47
 magnet, superconducting, 24
 Magnetic Circular Dichroism, *see* XMCD
 magnetic phase contrast, 271
 MAXIV, 48, 87
 metal-organic frameworks (MOFs), 154
 Michelson interferometer, 227
 microbunching, 57
 microscopy, scanning, 242
 Miller indices, 105
 MIR, 118
 mirror reflectivity, 73
 mirror reflectivity, polarisation, 74
 mirror, X-ray, 72
 mirrors, 72–9
 mirrors, as low-pass filters, 76
 mirrors, elliptical, 78
 mirrors, focusing, 77
 mirrors, sagittal focusing, 78
 mirrors, spherical, 77
 mirrors, tangential focusing, 78
 mirrors, toroidal, 78
 momentum conservation, 194
 monochromator, 70
 monochromator, Czerny-Turner, 83
 monochromator, Seya-Namioka, 84

- monochromators, multilayer films, 97
 monochromators, VUV, 81–90
 monochromators, X-ray, 90–9
 multiple analysing crystal, 124
 Multiple Isomorphous Replacements, *see* MIR
 multiple scattering, 165
 Multiple-Wavelength Anomalous Diffraction, *see* MAD
 MX, 119, 122
 myoglobin, 119
 MYTHEN, 111
- nano-ARPES, 253
 NbFe₂, 218
 Near-Edge X-Ray Absorption Fine Structure, *see* NEXAFS
 NEG (Non-Evaporable Getter), 49
 neutron emission, 71
 NEXAFS, 162, 171–4, 199, 212, 252
 NEXAFS, selection rules, 172
 NF₃, 230
 Ni(100)-N₂, 211
 NIM, 87
 NIM, Czerny-Turner, 87
 NIM, Seya-Namioka, 87
 NIXSW, 135
 normal incidence monochromator, *see* NIM
 normalised electron emittance, 62
- optical cavity, 57
 optical microscope, 253
 optics, contamination, 72
 optics, *in situ* cleaning, 72
- pair distribution functions, *see* PDFs
 partial densities of states (PDOS), 201
 Patterson function, 114, 145
 PDFs, 144–51, 157
 PEEM, 253
 PEPICO, 222
 PGM, 86
 phase contrast imaging, 248
 phase problem, 115, 137, 264
 phase space, 43, 45, 47, 57
 PhD, *see* photoelectron diffraction
 phonon band structure, 226
 photodiode detector, 110
 photoelectron diffraction, 161, 174–82, 256
 photoelectron emission microscopy, *see* PEEM
 photoelectron holography, 179
 photoelectron scattering, 159
 photoelectron-photoion coincidence, *see* PEPICO
 photoemission, 135, 185–202
 photoemission selection rules, 199
 photoemission, angular distribution, 135
 photoemission, atomic β factors, 224
 photoemission, core level, 189–93
 photoemission, gas phase, 219–25
 photoemission, valence level, 194–200
 photographic materials as detectors, 107
 photoionisation, 76
 photomultiplier, 109
 photon emittance, 46, 228
 photon-stimulated luminescence, 108
 Pierce parameter, 60
 PILATUS, 111, 265
 pinhole, 55, 152, 266
 pixel detectors, 111
 plane grating monochromator, *see* PGM
 plasmon creation, 187
 polarisation, circular, 36, 206, 216, 258, 271
 polarisation, elliptical, 14, 36
 polarisation, linear, 14, 31
 polycapillary optic, 243
 polypeptide backbones, 123
 Porod region, 157
 powder diffraction, 123, 158
 proportional counter, 100, 109
 Pt(111), 233
 ptychography, 270
 pumping, differential, 72
 pump-probe technique, 119, 168
- QEXAFS, 167
 Quick EXAFS, *see* QEXAFS
- radiation damage, 120
 radiation filters, 71
 radiation safety, 71
 radiation shield wall, 71
 radiofrequency, *see* RF
 radius of gyration, 156
 RAIRS, 229
 Raman type of process, 213
 Rayleigh scattering, 238
 real space images, 182
 reciprocal lattice vector, 195
 reflection absorption IR spectroscopy, *see* RAIRS
 refraction, 73
 refractive index, 72–3, 244
 refractive lenses, 79
 relativistic effects, 8
 relaxor ferroelectric, 184
 resolving power, 89, 95
 resonant inelastic X-ray scattering, *see* RIXS
 resonant magnetic scattering, 208
 RF cavity, 7, 20, 42, 46
 RF, travelling wave, 5
 Rietveld refinement, 125
 RIXS, 208–13
 rocking curve, 94
 ro-vibrational spectra, 230
 Rowland circle, 85, 87
 Rydberg states, 219

- sample magnetisation, 216
 SASE, 59
 SASE amplification, 62
 SASE lasing, 61
 SAXS, 144, 151–9
 scanning microscopy, 242
 scanning near-field optical microscopy (SNOM), 238
 Scanning photoelectron microscopy, *see* SPEM
 scattering phase shift, 163
 Schwarzschild reflecting optics, 233
 scintillation detectors, 108
 scintillator materials, 109
 self-amplified spontaneous emission, *see* SASE
 self-convolution, 114
 SEXAFS, 169
 SGM, 86
 SiC(0001), 196
 single bunch, 42
 single-slit diffraction, 49
 small angle X-ray scattering, *see* SAXS
 Snell's law, 73
 space charge effects, 254
 spectral brightness, 227
 spectrograph, 112
 SPEM, 253
 spherical grating monochromator, *see* SGM
 spin moment, 206
 spin-orbit coupling, 196
 SRS, 19
 SrTiO₃, 183
 Stokes parameters, 36
 storage ring beam lifetime, 43
 storage ring optimisation, 51
 strain fields, 267
 superconductivity, 207
 Surface EXAFS, *see* SEXAFS
 surface layer, 195
 surface reconstruction, 127
 surface science, 72
 surface structure, 161, 170, 174
 surface X-ray diffraction, *see* SXRD
 surfaces, 2D periodicity, 127
 SXRD, 126–31
 SXRD, crystal truncation rods, 129
 SXRD, fractional order beams, 127
 synchrotron, 6
 synchronism, 20
 synchrotron radiation, angular spread, 9
 synchrotron, history, 17
- Tantalus, 19
 tautomers, 220
 TEM, 246, 254, 260
 terahertz radiation, 53
 TESLA, 59
 TGM, 85
- threshold photoelectron spectroscopy, *see* TPES
 thymine, 178
 THz radiation, 228
 time dilation, 10
 time structure of synchrotron radiation, 42
 time-of-flight – TOF- detectors, 221
 TiO₂(110), 138
 top up, 20
 topological insulator, 169
 Toroidal grating monochromator, *see* TGM
 Touschek effect, 43
 Townsend avalanche, 100
 TPES, 221
 TPES coincidence (TPESCO), 221
 transmission electron microscopy, *see* TEM
 transmission radiograph, 246, 263
 transverse coherence, 153, 264
 two slit interference, 54
- UCoGe, 216
 UHV, 70, 72
 ultra-high vacuum, *see* UHV
 Ultraviolet Photoelectron Spectroscopy, *see* UPS
 undulator, 24
 undulator parameter, 25
 undulator radiation, circular polarisation, 40
 undulator radiation, polarisation, 38
 undulator, coherence condition, 27
 undulator, planar, 24
 undulator, spectral output, 23
 UPS, 185
- vacuum ultraviolet, *see* VUV
 valence band mapping, 256
 valence band photoemission, 188
 vibrational modes of molecules, 226
 Victoreen formula, 201
 VUV, 101
- water ice, amorphous phases, 150
 wavelength shifter, 22
 WAXS, 152, 154
 wide angle X-ray scattering, *see* WAXS
 wiggler, 22
 wiggler, multipole, 24, 32
 Wolter optics, 252
 work function, 197
 WSe₂, 198
- XAFS, 160–74
 XANES, 162, 174, 199, 203, 208, 252
 XANES image, 253, 258
 XES, 208–13
 XES, resonant, 212
 XMCD, 204, 270
 XMCD image, 271
 XMCD-PEEM, 259, 271

- XPD (X-ray photoelectron diffraction), 175
 XPEEM, 256
 XPS, 185, 189–94
 X-Ray Absorption Fine Structure, *see* XAFS
 X-ray Absorption Near-Edge Structure, *see* XANES
 X-ray diffraction topography, *see* XRT
 X-ray diffraction, basics, 102–6
 X-ray diffraction, cryo-cooling, 120
 X-ray diffraction, heavy atom method, 115
 X-ray diffraction, Laue method, 119
 X-ray diffraction, phase problem, 114
 X-ray diffraction, phase recovery, 115
 X-ray diffraction, rotation method, 120
 X-ray diffraction, rotation patterns, 119
 X-ray diffraction, standard methods, 118–25
 X-ray diffraction, structure determination, 113
 X-ray emission spectroscopy, *see* XES
 X-ray fluorescence, 168, *see* XRF
 X-ray inelastic scattering, 226
 X-ray lithography, 67
 X-ray monochromator, double crystal, 92
 X-ray monochromator, high resolution, 96
 X-ray monochromators, channel-cut crystal, 92
 X-ray photoelectron spectroscopy, *see* XPS
 X-ray ptychography, 270
 X-ray scattering from non-crystalline materials, 143–4
 X-ray sources, laboratory, 102
 X-ray standing wave, 95
 X-ray standing wave technique, *see* XSW
 XRF, 249
 XRF full-field imaging, 252
 XRF tomograph, 251
 XRT, 260–3
 XSW, 95, 131–6, 199
 XSW, Argand diagram representation, 140
 XSW, coherent fraction, 137
 XSW, coherent position, 137
 XSW, normal incidence, *see* NIXSW
 XSW, site triangulation, 139
 XSW, structure imaging, 137
 XSW, surface structure determination, 104–36
 Young's slits experiment, 54