

Index

a

adaptive optics (AO) 100, 107, 115,
 138, 173, 246
 integral field spectroscopy 127,
 239
 systems 102
 techniques 193
 telescope 186
 ADU-flux conversion 215
 airmass 199, 202, 210
 correction for 229
 Aladin Array 240
 anisotropic crystals 14
 anti-reflection coatings 42–43
 apochromatic corrections 121
 apodization 158
 ARCONS camera 145
 Arrayed Waveguide Gratings (AWG)
 devices 141
 assembly, integration and testing (AIT)
 51
 astrometric calibration 232
 astrometry 208
 astronomical data cubes *vs.*
 common-sense data cube 237
 astronomical efficiency 129
 astronomical nights 191
 astronomical seeing 167
 Astrophotonics 138–144
 astrophysical quantity image 238
 astrophysical spectral 98
 atmospheric curse 82
 atmospheric dispersion 226

atmospheric extinction 189
 atmospheric turbulence 1, 137, 155,
 169, 171, 181, 194
 Australian Astrophysical Observatory
 (AAO) 72, 124

b

bandpass 173
 basic spectroscopic principles 18–19
 BEAR instrument 90
 bias (subtraction) 221
 blaze angle 28
 Bragg grating 140
 bright time 200
 BTO telescope 103

c

calibrated flux values 218
 calibrations 207
 astrometric 230
 detector 215
 geometric 215, 225
 spectrophotometric 229
 wavelength 215, 224
 CALIFA survey 149, 241
 canonical plane grating long-slit
 spectrograph 28
 Cassegrain focus 47
 catadioptric systems 36
 cat's-eye mounting 90
 CFHT telescope 102
 Chandra X-ray Science Center (CXC)
 240

- Charge Coupling Device (CCD) 33, 48, 83, 101, 159
 - array 144
 - detector 122
 - pixels 226
- charge injection devices (CIDs) 35
- chart (pointing) 200
- classical 3-mirror derotator 47
- closed-loop control systems 89, 174
- coarse sampling 107
- coherence radius angle 171
- completeness 206
- cone effect 179, 184
- contiguous spaxels 130
- corner-cube 89
- coronagraphic grade optics 40
- coronagraphic system 116
- correlated noise, effect of 232
- cosmics rays 161
 - impact of 163, 201
- covariance (matrix) 218
- crowding effects 230
- cryogenics
 - digital detector, proper temperature 48, 75
 - NIR instruments 49
- current wide-field projects 117
- d**
- dark (subtraction) 222
- dark current 160
- dark exposures 222
- dark time 200, 202
- data analysis
 - definition 237
 - handling data cubes
 - spatial view 239
 - spectral view 238–239
 - 3D view 239
 - handling data cubes: 3D spectrographs 237
 - multi-object spectrography 237
 - viewing data cubes
 - CXC 240
 - data cube visualisation 240
 - monochromatic layers 241
- data cubes 81, 216, 217, 229, 232, 238
 - data cubes handling
 - spatial view
 - monochromatic images, data cubes 239
 - overlap, differential spectral information 239
 - spectral view
 - Doppler-Fizeau shift 238
 - integral field data cubes 238
 - non-linear process 238
 - 3D spectrographs 237
 - 3D view 239
 - data gathering 199
 - data reduction
 - schemes 216, 218
 - slitless MOS 216
 - software system testing 213
 - system 213
 - data reduction systems (DRS) 162
 - data sampling 153
 - data visualisation software 237
 - deformable mirror (DM) 173, 174, 176, 182
 - deployable multi-integral field systems (DMIFS) 126
 - detector calibrations 207, 215
 - detector noise 202
 - detector pixels 130, 154
 - diamond-turning 41
 - dichroic beamsplitters 19
 - differential atmospheric correction 226–228
 - differential image motion monitor (DIMM) 208
 - diffraction effects 154
 - diffraction limit 16, 169
 - digital detectors 62
 - digital multi-mirror device (DMD) 66, 67
 - digital signal processors 177
 - direct photonics coupling 141
 - dispersers
 - efficiency 28
 - grating principle 27–28
 - prisms 25–27
 - dispersion (atmospheric) 199
 - dithering 205

- Doppler–Fizeau shift 140, 238
 Drizzle 232
 DS9 240
 DS9 data cube view 240
- e**
- earth remote sensing hyper-spectral
 data cubes 237
- Echelle spectroscopy 5
- effect non-telecentricity 38
- 8-m class telescopes 103
- electromagnetic field 141
- electromagnetic spectrum 167, 189
- electromagnetic wave 14
- ESO VLT Observatory 120
- etendue 15, 23, 26, 30, 53, 71, 88, 108,
 137, 143, 169
 concept 16
- etendue conservation
 infinitesimal surface element 15
 minimum beam etendue 16
 2D illustration 16
 two dimensions, plane section 17
- EUCLID NISP spectrograph 64
- European Southern Observatory (ESO)
 65
- evanescent field 141
- exoplanet
 direct detection of 115
 imagers 116
- exoplanets 116, 178
- exposure time calculator (ETC) 200,
 204
- extremely large telescopes (ELT) 194
- f**
- Fabry–Pérot (FP) 2, 4, 6, 20, 81, 83, 92,
 130, 184, 216, 238
 psf 172–173
- feasibility study 51
- fiber-based slicer approach 103
- fiber-based spectrograph
 MOS approach 75
 Schmidt collimator 75
- fiber slicer 103
- fiber systems performance 75
- field mounting 24
- field programmable arrays 177
- filter bandpass 84
- first order diffraction angle 28
- Fishermen pond type systems 73
- flat field (super) 215, 218, 222
- flat-field calibrations 222
- Fourier transform spectrometer (FTS)
 6, 81, 88, 92, 130, 153, 217, 238
- 4 m-class telescopes 103
- 4-m Mayall telescope 67
- FP cavity 20
- Fresnel equations 14
- full-width at half maximum (FWHM)
 21, 154, 170, 211
- g**
- γ rays 192
- Gaussian error propagation 226
- Gaussian fitting 238
- Gaussian function 172
- Gaussian model 204
- Gaussian noise propagation 232
- Gaussian PSF 97, 202
- general-use instruments 245
- geometrical calibrations 208, 215,
 225
- geometrical optics formulae 13
- GMACS 138
- grating 27, 140
- grating etendue
 optimum sensitivity 30
 shelf reflective gratings 30
 VPHG 30
- grating fundamental equation 27
- grating spectrograph
 holographic 29
 long-slit concept 28
 surface relief grating 29
- grey time 200
- grism 96
- ground-based multi-slit systems 68
- ground-based telescope 170, 173
- ground-layer adaptive optics (GLAO)
 approach 186
 technique 184, 194
- ground seeing 170

h

H-band 167
 HgCdTe 160
 high-altitude dry site 167
 high aperture ratio 103
 high-contrast integral field spectrometer 116
 High Energy Astrophysics Science Archive Center (HEASARC) 240
 high-order echelle grating 30
 high performance dioptric systems 37
 high reflectivity coatings 43–44
 high SNR spectra 208
 homogeneous data cubes 237
 Hubble flow 156
 Hubble Space Telescope (HST) 64, 192, 194, 216
 hydroxyl radical (OH) 139
 hyper-spectral imaging 95
 hysteresis effects 86, 188

i

IFU-type instrument 216
 image processing software 239
 incidence plane 13
 infrared detector pixels 131
 instrument grasp 129
 integral-field spectrographs (IFS) 8, 95, 115, 116, 129, 130, 137, 173, 185, 238
 fiber-based 130
 mirror slicer-based 107
 integral field technique 247
 integrating 3D detector 145
 integration time 201
 interference filter 22–24, 83, 86, 87
 interferogram 217
 IR arrays 35
 IRIS2 spectrograph 141

j

James Webb Space Telescope (JWST) 39, 63, 192, 194
 J-band 167
 JWST micro-shutter waffle-like array 68

k

K-band 167
 KMOS instrument 125
 KMOS kinematic survey (K2S) 135, 240
 Kolmogorov turbulence model 170, 171, 195

l

laser tomography adaptive optics (LTAO) 181, 186
 lenslet
 array 99
 fiber hybrid approach 103
 IFS SAURON 113, 238
 lenslet-based approach 103
 lenslet-based IFS 116, 119
 light beams 13
 light flux concentration 184
 line spread function (LSF) 157, 158, 228
 long-slit 2, 4, 25, 185
 spectrograph 63, 92, 98, 122
 low-resolution spectra 65
 lucky imaging 171

m

mask, properties of 225
 McDonald Observatory 144
 mechanical design
 alignments 48
 classical kinematic mounting 46
 NIR instruments 49
 optical components 45
 MEIFU 119
 meters-size telescopes 168
 microlens array 95, 96, 100
 micropupils 96
 micro-shutter array 68
 microwave kinetic inductance detectors (MKID) 144
 mini-lenses 95
 mirror-based image slicers 104, 119
 MOAO 187
 MOFFAT 156, 234
 monolithic poly-methyl-methacrylate lenses 100

- mono-mode fiber 140, 142
 - moon 206
 - Moon's diffuse light 200
 - Moore's law 177
 - Mosaicing 206
 - MOS-type instrument 216
 - multi-aperture interferometry 143
 - multi-arm approach 19
 - multi-conjugate adaptive optics (MCAO) 182
 - multi fiber-based slicer 95
 - multi-fiber positioning systems
 - AAO 71
 - 2dF 71
 - multi-filter imager 83, 145
 - multi mirror-based slicer 95
 - multi-object spectrographic (MOS)
 - instruments 6, 61, 77, 132, 137, 185
 - history, digital age
 - digital detectors 62
 - NGT 62
 - history, pioneers
 - astronomical technique 61
 - 'slitless' approach 61
 - multi-slit based multi-object spectroscopy
 - multi-fiber concept 70–71
 - multi-slit concept 64–66
 - multi-slit holders 66–69
 - slitless based multi-object spectroscopy
 - slitless concept 62–64
 - multiple wavefront sensors 183
 - multi-pupil imaging 97
 - multi-slit based multi-object spectroscopy
 - multi-fiber spectrograph 70
 - multi-slit concept 64–66
 - multi-slit instruments
 - NIR multi-slit spectrographs 70
 - optical multi-slit spectrographs 70
 - multi-slit MOS 130
 - multi-slit selection softwares 66
 - multi-slit spectrograph 65
 - multi-slit systems 83
 - exchangeable zero-deviation gratings 69
 - kinematic mountings 69
 - multi-slit systems patrol field 66
 - multi-wavelength imaging 19
 - MUSE 119, 120, 155, 201, 215
 - e2v CCD detectors 222
 - IFU pipeline 219
 - instrument 186
 - integral field spectrograph 236
- n**
- narrow-band imaging 129
 - Nasmyth focus 47
 - Nasmyth platform 46
 - Near Infra-Red (NIR) Array 35, 48, 138
 - new generation telescope (NGT) 62
 - night-sky emission spectrum 139
 - nod and shuffle 205
 - noise (variance) 217
 - noise probability function 162
 - noise variance 204, 226
 - estimation 217
 - non-scanning 3D techniques 92
 - normal distribution 162, 204
 - numerical aperture (NA) 18
 - Nyquist 153
 - Nyquist sampling 186
 - Nyquist-Shannon sampling theorem 153, 154, 157
- o**
- OH software avoidance technique 139
 - OH-suppression fibers 138, 141, 143
 - one-step resampling scheme 226
 - optical computation
 - inherent chromatic aberrations 37
 - schmidt mounting 39
 - optical etendue 17
 - optical fabrication
 - diamond-turning 41
 - moulding techniques 41
 - substrate grinding 40
 - optical fibers principle 18
 - optical imaging systems 17
 - optical systems 116, 117

optical throughput 15
 optimal extraction 204
 optimum spectral resolution 31
 opto-mechanical slicer 105
 opto-mechanical systems 118
 orthogonal plane mirrors 89

p

packing efficiency 99, 130
 peak wavelength 21
 phase correction 216
 photometric conditions 230
 photometric night 189
 photon counting 3D detectors 144
 photon counting detector 87, 184
 photonics-based spectrograph 138, 146
 photonics Fourier transform spectrometer 141
 photon noise 202
 photoresist lenslet array 100
 pick-up noise 160
 piezo deformable mirrors 176
 piezo-driven technique 85
 pixels detector 129
 pixel table 226, 232
 Planck constant 202
 pointing chart 200
 point-spread function (PSF) 131, 154
 Poisson discrete probability distribution 159
 Poisson noise 226
 polychromatic light beam 27
 polynomial coefficients 234
 prescan/overscan pixels 215
 principle investigator (P.I.) 50
 prism-like effect 185
 prism's principle 25
 prism transmissions 26
 PSF (spatial) 188, 234
 pupil mounting 24

q

Qfitsview 241
 Quality control 234
 quantum efficiency 86, 141, 146, 202
 quasi-Gaussian 183

r

radial velocities, spectra 238
 Rayleigh scattering 180
 real-time computer (RTC) 174, 176, 177
 residual opto-mechanical errors 172
 residual wavefront distortions 175
 resolving power 157
 resonant cavity quality factor (Q) 21
 RITMOS instrument 68
 RVSAO IRAF packages 238

s

SALT telescope 88
 sampling 154, 155
 SAURON survey 113, 238
 Scanning Fabry–Pérot 238
 scanning filters
 Fabry–Pérot (FP) interferometer 20
 FWHM 21
 interference filters
 classical etalon 23
 pupil image 24
 sky field image 24
 zero photon flux 21
 scanning Fourier transform spectrograph 217
 scanning FP technique 87
 scanning interferometry 129
 scanning long-slit spectrometers 129
 spectroscopy 129
 technique 83
 scanning long-slit spectrograph (SLSS) 81
 scanning slit spectroscopy 157
 scanning technics 129
 scintillation effect 167
 seeing 206
 seeing effects 168, 172
 seeing principles 168
 seeing properties 170
 sensitivity curse 82
 SExtractor software 239
 Shack–Hartmann wavefront sensor 177
 Shannon 153

- Shannon's theorem 131
 - signal to noise ratio (SNR) 88, 141, 153, 162, 200, 201, 215
 - SILFID 9, 102, 247
 - single conjugate adaptive optics (SCAO) 175, 182
 - single-mode laser beam 89
 - SITELLE 91
 - sky spaxels 130
 - sky spectrum 93, 238
 - sky subtraction 228–229
 - slit effect 97, 157
 - 'slitless' approach 61
 - slitless spectroscopy concept 62–64
 - slitless technique 62
 - sloan digital sky survey 59, 236
 - SNR spectra 241
 - solar light 191
 - solar system 115, 117
 - spatial dimensions 238
 - spatial pixels 82, 87, 125, 154, 186
 - spatial point spread function (PSF) 154, 172
 - spatial resolution 154
 - spatial sampling 107
 - spatio-spectral data cube 96
 - spaxel 99, 154
 - spectel 155
 - spectral flux distribution 200
 - Spectral Hole Burning Device (SHBD) 145
 - spectral pixels 82, 116, 155
 - spectral resolution 18, 157, 230
 - spectral sampling 156
 - spectrographic technique 83
 - spectrophotometry 130, 208
 - spectroscopic instruments 13
 - spectroscopic redshift survey 79, 237
 - spectroscopic toolbox
 - basic spectroscopic principles, spectroscopic case 18–19
 - etendue conservation
 - infinitesimal surface element 15
 - geometrical optics 13–15
 - optical computation 37
 - scanning filters
 - Fabry–Pérot Filter 24
 - Fabry–Pérot (FP) interferometer 20
 - interference filters 22–24
 - SPIFFI 9, 104
 - SpIOMM instrument 91
 - splitting exposures 204
 - Stationary Wave Integrated Fourier Transform Spectroscopy (SWIFTS) 141
 - STIS instrument 64
 - Strehl ratio 193
 - Subaru telescope 188
 - superconducting tunnel Junctions (STJ) 144
 - super-flatfieldind 218
 - SWIFTS principle 141
 - systematics 162, 203, 218
- t**
- team-use instrument 250–251
 - telecentric image 101
 - telescope
 - aperture 171
 - polishing errors 172
 - primary mirror 16
 - telluric correction spectrum 229
 - thermal expansion coefficient 20
 - 3D data set 120
 - 3D data visualization 240
 - 3D de-blending software 239
 - 3D detector 144
 - 3D instrumental approaches 245
 - 3D scanning techniques 91
 - 3D spectrographs 240
 - 3D visualization 241
 - three mirror anastigmat (TMA) 40
 - TIGER 9, 101, 247
 - Tiger-type spectrographs 101
 - tip/tilt isoplanetic field 181
 - total light flux 92
 - trace mask 223
 - transition edge sensors (TES) 144
 - tuneable filter 86, 88

- 2D detectors 92
 - optical detectors 32–35
 - photographic plate 32
 - spectro-imagers 31
 - 2D infrared arrays 35
- 2D etendue conservation 16
- 2dF (2-degree field) robotic system 72
- 2D spatial field 117, 119

V

- vacuum deposition 22
- variance 241
- variance data cube 241
- VIMOS 202
 - exposure, multi-object mode 65
 - ultra deep survey, spectra 79, 237
- VIRUS/MUSE approach 117
- visibility 206
 - curve 206
 - source 199
- VLT Observatory 181

- volume phase holographic gratings (VPHG) 30
- volume pixels 129
- voxel 239

W

- wavefront sensing 36
- wavefront sensor (WFS) 173, 176, 187
- waveguide arrays 143
- wavelength calibration errors 162
- wavelength calibrations 208
- WFOS-MOBIE 138
- wide-band interference filter 90
- wide-field
 - integral field spectroscopy 117
 - MOS systems 76
- wide-field: NIR MOS survey 77
- William Hershell Telescope 113, 238

Z

- zero-field mode 143

