### Index

**a**  
Abbe’s law 170, 185, 212, 328  
absorbance 43  
absorption 28, 306  
absorption coefficient 42, 220f  
absorption spectrometer 42  
absorption spectroscopy 5, 41ff  
absorption spectrum 24ff, 41  
– experimental determination 41ff  
absorption spectrum of haemoglobin 50  
acceptor 86ff, 93ff, 95, 96, 270f  
actin 210, 211  
avtivator 83  
active transport 222  
adaptor 289  
adenosine triphosphate (ATP) 206ff, 210f  
amino acids 45  
analyser 152, 156ff  
anisotropy 75ff, 80, 253  
antioxidative reagents 56  
aplications fields 5ff  
aminic acids  
– absorption spectra 46  
– fluorescence spectra 47  
assay development 323ff  
assay quality 323ff  
atomic force microscopy (AFM) 9, 240ff  
– application examples 242ff  
– principle 241  
atomic orbital 18  
ATPase 206ff  
– rotation 206ff  
– subunits 208  
ATP hydrolysis 207  
ATP synthase See ATPase 207  
autocorrelation analysis 214ff  
– important parameters 221  
– mathematical background 220ff  
autofluorescence 54, 62  
avalanche photodiode (APD) 174, 175, 205  
avidin-biotin techniques 65f  

**b**  
basics in molecular photophysics 13ff  
Beer-Lambert law 47, 108  
binding affinity 309  
biochemiluminescence 6, 99ff, 296  
biomolecular motor 209  
bimolecule  
– optical properties 41ff  
biophysical chemistry 1  
– advanced methods 11, 167  
– definition 1  
bioitin 66, 209, 237  
blueshift 47  
Bohr magneton 142  
bridged PCR 289ff  
butadiene 19  

**c**  
cantilever tip 241, 242ff  
β-carotene 56, 265, 278f  
– absorption spectrum 57  
carotenoids 56ff, 278ff  
cell-attached patch (CAP) 247  
charged coupled device (CCD) 175, 177, 205, 330  
chemical shifts 125, 134, 138  
chiroptical methods 105ff  
chlorophyll 54f, 276ff  
– absorption and fluorescence spectra 55  
chromophore 62  
circular dichroism (CD) 6, 105ff  
circular dichroism spectroscopy 105  
coelenterazine 100
cofactors 49ff
– optical properties 49
coherent anti-stokes Raman scattering (CARS) 258, 268f
competitive binding assay 3
competitive inhibition 83
complementary DNA (cDNA) 315
conduction band minimum (CBM) 305f
confocal fluorescence 170
confocal fluorescence microscopy 169ff
continuous wave (CW) 263
conversion dynode 153
coopetativity 51
correlated spectroscopy (COSY) 130ff
correlation amplitude 214
correlation effects 224ff
cross-correlation 228f
cylindrical lens 179, 191
detector 153, 330
delayed extraction 154
detection anode 154
dielectric polarization 267
diffusion time 221
digoxigenin 237
dipole moment 142
dissociation constant 78
DNA 45ff
– hybridization 48
– optical properties 45
DNA cluster generation 288ff
DNA fragmentation 289
DNA fragment alignment 292
DNA-hairpins, unfolding 243
DNA hypochromism 48
dNA microarrays 314f
dNA origami 310ff
dNA-polymerase 296, 297
dNA primer 286
dNA replication 287
dNA sequencing 9, 287
donor 86ff, 95, 270f
donor-acceptor distance 92
drug development 333
drug discovery 332f
drug screening 1, 332f
dye sequencing 289ff
dynamic light scattering 115
dynode 153
electromagnetic radiation 13, 14, 122
electronic structure 15ff, 20f, 29
electronic wave function 15
electron multiplier 154
electron paramagnetic resonance (EPR) 7, 141ff
electrospray ionization (ESI) 149, 156
electrospray ionization-mass spectrometry (ESI-MS) 156ff
eLLipticity 106, 108
emulsion PCR 292ff
energy gap law 29, 95
energy level 19
enzyme 80ff
enzyme activation 83f
enzyme function 80
enzyme inhibition 81
enzyme kinetics 80
enzyme regulation 83f
enzyme-substrate complex 81
evanescent field 177
excitation 21, 96f
excitation energy 15
excitation intensity function 220
excited state 36
exon 314
external magnetic field 31
flavin 53
flavin mononucleotide (FMN) 53
– absorption and fluorescence spectra 54
flow cytometry 10, 317f
fluorescein 62f
fluorescence 27ff, 33, 35, 44, 220, 306
fluorescence anisotropy 71f, 324f, 331, 334
fluorescence assay 326
fluorescence-assisted cell sorter (FACS) 317f
fluorescence correlation spectroscopy (FCS) 8, 214ff
fluorescence cross-correlational spectroscopy (FCCS) 226f
fluorescence fluctuation 214ff
fluorescence in situ hybridization (FISH) 10
fluorescence kinetics 6, 93f
fluorescence labelling 5, 61f
fluorescence lifetime 37, 61, 94
fluorescence lifetime imaging (FLIM) 94
fluorescence linking 61f
fluorescence marker 61, 86, 94, 186, 204, 212, 220, 222, 303
fluorescence microscopy 7, 169ff, 259f
– conventional fluorescence microscopy 169ff
fluorescence polarization 71, 97
fluorescence polarization anisotropy (FPA) 5, 70ff, 253
– principles 70, 70ff
fluorescence polarization assay 265
fluorescence quantum yield 34, 62, 219f
fluorescence reader 326ff
fluorescence recovery after photobleaching (FRAP) 98
fluorescence spectrometer 43, 44ff
fluorescence spectrum 28, 43ff, 44
fluorescence techniques 61ff
fluorescence transition dipole moment 72
fluorescent protein (FP) 67, 188
fluorescing nanoparticle 9, 303, 320
fluorescing particle 222
Fourier transformation 128f, 133
fragment library 289
Frank-Condon integral 27f, 42
Frank-Condon principle 24ff
free induction decay (FID) 129
Fürster distance 89
Fürster resonance energy transfer (FRET) 6, 22, 65, 69, 85ff, 226, 229
– application examples 90ff
– energy diagram 85
– principles 84ff
– theoretical background 84ff

gene expression 316
Giga-seal 246ff
gold surface 67
green fluorescent protein (GFP) 204, 317
– structure 68
ground state bleaching 270f

haemoglobin 50ff
– oxygen binding 51
haeme 49ff
highest occupied molecular orbital (HOMO) 19, 30f, 304f
high-resolution fluorescence microscopy 13, 184
high-throughput screening (HTS) 2, 4, 249, 323, 327, 329, 332ff
His-Tag 66
Hooke’s law 235, 241
hypermass 163

i
immunolabelling 64
infrared spectroscopy 116
inhibitor 83
inside out patch (IOP) 248f
internal conversion 30f
intersystem crossing 32, 89
intrinsic absorption 45f
intrinsic fluorescence spectroscopy 5
ion channel 245f
– classes 245f
ion detection 158ff
ionization 156ff
ion semiconductor sequencing 297ff
ion trap 161
iPALM 191
isoSTED 191
isosurface 17

Jablonski diagram 33

K
Karplus relation 126
Kasha’s rule 30
kinesin 210
Kramers-Kronig transformation 109

laboratory frame 127
Laporte’s rule 24
Larmor frequency 124f
laser scanning microscopy 174
lead structure 333
light 14
– interaction with molecules 20
light-harvesting complex (LHC) 277
light intensity 111, 119, 170, 172, 271
light scattering 7, 109ff
light-sheet microscopy 178ff
Lineweaver-Burk plot 82ff
lowest unoccupied molecular orbital (LUMO) 19, 304
luciferase 99, 296
luciferin 99
luminescence 33

macroscopic magnetization 124, 127f
magnetic dipole moment 123
magnetic moment 31
magnetic resonance techniques 121ff
magnetogyric ratio 123
Index

MALDI spectra 156
MALDI-TOF mass spectrum 156
mass spectrometer 149, 153, 156, 160
mass spectrometry 7, 149ff
Mathieu equation 160
matrix-assisted laser desorption ionization (MALDI) 149, 157
matrix-assisted laser desorption ionization time-of-flight detection (MALDI-TOF) 149ff
matrix compound 151
maximum tolerated dose (MTD) 335
messenger RNA (mRNA) 315
Michaelis–Menten constant 82
micro-ESI 158
microscope 171
microscope objective 169, 232f
microspheres 303, 320f
microtitre plate 326ff
microtitre plate formats 327
minimum effective dose (MED) 335
molar circular birefringence 108
molar extinction coefficient 43
molecular orbital 17f
molecular weight 149
– estimation 79
momentum 230ff
MS-MS techniques 163
multifocal detection reader 332
multiphoton excitation 9, 258f
muscle function 210
myoglobin 51f
myosin 209f, 213, 251

n
nano-ESI 158
nanoparticle 306
near infrared (NIR) region 14
negative ionization mode 151, 157
next generation sequencing 287ff
nicotinamide adenine dinucleotide 52ff
– absorption spectrum 53
– fluorescence spectrum 53
NMR-based structural analysis 138ff
noncompetitive inhibition 83
nonlinear microscopy 258ff
nonlinear optical signal 262
nonlinear optical techniques 266ff
nonlinear spectroscopy 257ff
nonradiative relaxation 30
nonradiative transition 27ff
nuclear magnetic resonance (NMR) 7, 121ff
– primary information deduced from NMR spectra 125
– principles 121
nuclear Overhauser effect (NOE) 135f
nuclear Overhauser effect spectroscopy (NOESY) 135
nucleotides 47
– absorption spectra 47
numerical aperture 171

o
one-dimensional (1D) NMR spectra 131
one-photon excitation (OPE) 258, 260
one-photon microscopy 259
optical density (OD) 43
optical rotatory dispersion 108
optical single-molecule detection 203ff
optical trap 231, 235
optical tweezer 230ff
– application examples 236ff
– theoretical background 230ff
orbital 15f, 24
oscillating dipole 110f
outside out patch (OOP) 249

p
patch clamp configurations 245
patch clamping 9, 245ff
patch pipette 247ff
Pauli’s rule 31
peptide 45f
peptide ladder sequencing 164
phase-matching condition 267
phenylisocyanate (PIC) 164
phenylisothiocyanate (PITC) 164
phosphorescence 33, 35
photoactivated localization microscopy (PALM) 187ff
photoactivatable fluorescent proteins 187
photoactivation 187
photoconversion 187
photomultiplier tube (PMT) 174, 205
photon 13, 230ff, 252
photoselection 71
photoswitching 187
photosynthesis 54, 56, 274ff, 280
photosynthetic energy conversion 274ff
photosynthetic energy flow 276ff
photosynthetic energy funnel 274
photosystem 275
pigment–protein complex 279
pinhole 173, 220
polarizability 95, 111
polarization 2, 14, 21, 220
polarization filter 3, 70
polarization ratio 265
polarization vector 14, 21, 23, 281
polymerase chain reaction (PCR) 286
positive ionization mode 151, 157
primary amino group reactive label 63f
probability density 15
protein 41ff
– isotope distribution 157
– optical properties 45
– relationship between volume and molecular mass 222f
protein sequence analysis 163
protein unfolding 244
pulsed NMR spectroscopy 126
pump beam 270
pump-probe spectroscopy 270ff, 276f
pyrosequencing 296ff
q
quadrupole mass analyser 159
quadrupole mass spectrometer 159
quantum confinement 304
quantum dots 304, 305
quantum efficiency 34
quantum yield 34, 35, 204
quencher 95
r
radiative transitions 27f
radiofrequency pulse 127f
radius of gyration 113
Raman spectroscopy 116
rate constant 34
ratiometric methods 69
Rayleigh ratio 112
reaction centre 277
reactive label 61
receptor-ligand binding forces 244
receptor-ligand complex 216
receptor-ligand interactions 78f, 90
redshift 47
retinal 56
RNA 41
RNA hairpins, unfolding 238
RNA polymerase 238f
rotating frame 127
rotational correlation time 73, 76, 145
rotational fluctuation 70
Russell–Saunders coupling 142
s
sanger sequencing 285ff
scalar coupling 125, 126
scattering methods 105ff
second-harmonic generation (SHG) 258, 266, 267
sequencing library 289
sequencing by ligation 294ff
single-biomolecule techniques 203ff
single-molecule real-time sequencing 299ff
singlet oxygen 56
Snell’s law 176, 233
spin angular momentum 123
spin labelling 145
spin orbit coupling 32
spin quantum number 123
spin state 124
stimulated emission depletion microscopy (STED) 183, 184ff
– principle 185
Stochastic Optical Reconstruction Microscopy (STORM) 187ff
Stokes-Einstein equation 222
Stokes shift 29
streptavidin 65, 238
structural analysis 138
structured illumination microscopy (SIM) 195ff
suction pulse 249f
sulphurylase 296
super-resolution optical fluctuation imaging (SOFI) 197ff
surface plasmon resonance (SPR) 308f
susceptibility 267
t
tandem mass spectrometer 163
2,2,6,6-tetramethylpiperidin-1-oxyl (TEMPO) 142f
thiol group reactive labels 64f
thiolinker 67
third-harmonic generation (THG) 668f
three dimensional (3D) super-resolution fluorescence microscopy 190f
time-of-flight (TOF) 149
titin 244f
TOF analyser 149
TOF reflectron 154
total internal reflection fluorescence (TIRF) microscopy 176ff, 188, 204, 206, 211, 213
transient absorption 273
transition 15
transition density 20
transition dipole moment 20ff, 23, 35, 73
transmission 41
trap stiffness 235
triplet state 27f, 32
triplet-state dynamics 224
two-dimensional diffusion 222
two-dimensional (2D) NMR spectroscopy 130
  – principle 134
two-photon excitation (TPE) 258, 260, 264, 279
  – advantages 259ff, 263ff
  – disadvantages 259ff
  – properties 263ff
two-photon microscopy 259

u
ultrafast laser system 262
ultrafast light-harvesting 274ff
ultrafast spectroscopy 9, 257ff, 270ff
ultra high-throughput screening (uHTS) 327
ultraviolet (UV) 14
uncompetitive inhibition 83

v
valence band maximum (VBM) 304ff
vector 1
vibrational energy 27
vibrational relaxation 27
vibrational spectroscopy 7
vibrational spectrum 115ff
vibrational transition 117, 118
vibronic transition 26, 42

w
wave function 15
wavelength 14
wavemixing 266ff
wave vector 231, 268
whole cell (WC) 249f
wide-field fluorescence microscopy 174

z
zero mode waveguide 300
Z’-factor 114
Zimm plots 326f, 331