

Index

Note: Page numbers in *italics* refers to figures and **bold** refers to tables.

a

Abbe diffraction limit 144
absorption cell 31, 94
absorption coefficient 83, 84
absorption spectrum 79, 81–92, 118–119
accelerator mass spectrometry
(AMS) 181–182
additivity of absorbance 84
adjacency effect 91
adsorption–desorption kinetics 34
aerosol mass spectrometry 182
airy disk criterion 144, 144
algae organic matter (AOM) in water 129–130
angle raster scan 156–157
anti-Raman scattering 58
anti-stokes Raman scattering 41, 44, 57
aqueous-phase analysis, SEM in 164–165
artificial wall-sticking method 153
atmospheric brown carbon 104–105
atmospheric pressure chemical ionization
(CI) source 171, 175
atomic force microscopes (AFMs) 143, 145,
151–153
characterizing interfacial processes
166–167
contact mode 159
instrument and working mode 159–160
in interface interactions 166–168
noncontact mode 159
sample preparation 160

tap mode 159
working mode and force pattern 159
attenuated total reflection Fourier transform
infrared spectroscopy (ATR-FTIR)
12–13, 15–17, 33–37
attenuated total reflection infrared
spectroscopy (ATR-IRS) 10
Auger electrons 150
auxochrome 87–89
effect 90

b

Beer–Lambert law 9, 14, 79, 82–84, 102
deviation and correction of 84
monochromatic light 84
solution concentration, deviation caused
by 86
Beer's law 83, 99
Boltzmann distribution 50
bond length 3
Born–Oppenheimer approximation 3
Brillouin scattering 43
Broglie wavelength 147
Brown carbon (BrC) 104–105, **106**

c

camera room 155
capillary electrophoresis-mass spectrometry
(CE-MS) 186–187
cartesian components 42

cathode ray tube (CRT) display 155
 cell culture samples 153
 charge-coupled device (CCD) detector
 63–64, 64, 69
 charge-transfer process 54
 chemical aging process 192
 chemical enhancement mechanism 56
 chemical factors, deviation caused by 86–87
 interfering substances 87
 pH 86–87
 uneven medium 87
 chemical oxygen demand (COD)
 monitoring 102–104, **103**
 chemical transfer effect 55
 chromophores 87–89
 absorption spectrum data **88**
 circularly polarized (CP) radiation 42
 cis-*trans* isomerism 91
 cleaning 158
 coherent anti-Stokes Raman spectroscopy/
 spectrum (CARS) 56, 58–59
 coherent Stokes Raman scattering
 (CSRS) 56–57
 coherent Stokes Raman spectrum 58–59
 collimator 94
 collision energy (CE) 191
 color intensity 79
 complex organic pollutants 190–191
 condenser 154
 conductive coating 152
 conductive treatment 158
 confocal laser scanning microscope (CLSM)
 145–147
 in environmental bioassay 160–161, 161
 in field of biology and nanotoxicology 160
 imaging principle 146–147, 146
 instrument 153–154
 light source 146
 sample preparation 153–154
 conjugation effect 2, 89–90
 constant energy synchronous fluorescence
 scanning method 116
 continental aerosol, characterization
 134–136
 cross-ring effect 92

d

Damen, Porto, Tell nomenclature 53, 53
 dark current 64
 de Broglie formula 144
 dehydration 158
 depolarization ratio 54
 derivative spectrophotometry 101–102
 differential spectrophotometry 99–100
 diffuse reflectance infrared Fourier transform
 spectroscopy (DRIFTS) 10–12
 diffuse reflection (rough surfaces) 12
 diode array detector 95
 diode array multichannel spectrophotometer
 96, 97
 dispersion elements 93, 123
 dispersive infrared spectrometer 18–19
 dispersive spectrometers 66–67, 67
 dissolved organic carbon (DOC) analysis
 105–106
 dissolved organic matter (DOM) 122, 189, 190
 COD removal in water 132
 in drinking water 131
 environmental quality assessment of water
 body 132
 in landfill leachate 131–132
 in natural water 131
 sewage treatment effect 132–133
 in water 130–134
 water quality indicators 133–134
 double-beam UV-vis spectrophotometer
 97–98, 97
 double harmonic approximation 8
 drift tube 183
 drying 158
 dual-wavelength UV-vis spectrophotometer
 98–99, 98

e

EEM deconvolution 122–123
 EEM fluorescence spectroscopy 189
 elastic scattering 43
 electrochemical deposition 73
 electromagnetic field 4
 and molecule 7–9
 in Raman spectroscopy 45–46

- electromagnetic mechanism 55
 - electromagnetic spectrum 1, 2
 - electromagnetic wave 43
 - electron-absorbing groups 121
 - electron beams 145, 147, 152
 - electron bombardment ionization. *see* electron ionization
 - electron diffraction 148, 149
 - electron-donating group 120
 - electron gun 154
 - electronic spectrum 79
 - electronic transition 79
 - electron impact ionization. *see* electron ionization
 - electron ionization (EI) 174
 - electron microscope 143
 - and core components 145
 - electron volatility 144
 - intermediate mirror 147
 - projection mirror 147
 - electron transitions 81
 - electro-optical system 156–157
 - electrospray ionization (ESI) source 171, 173–174, 174
 - electrostatic analyzer 181
 - electrostatic sector mass analyzer 178–179
 - elemental analysis 28
 - elemental carbon (EC) 104
 - Enterobacter* sp. 165–166
 - environmental bioassay, CLSM in 160–161
 - equal absorption dual-wavelength elimination method 100
 - ESI-mass spectrometry (ESI-MS) 174
 - excitation–emission matrix (EEM)
 - fluorescence 189
 - spectrum 117
 - external factors 2
 - external optical path system 62
 - external reflection technique 11–12
- f**
- field of biology, CLSM in 160
 - fixed thickness liquid pool 25
 - fluorescence analysis methods, development of 112
 - fluorescence derivatization 128
 - fluorescence-dissolved organic matter (FDOM) sensor 106
 - fluorescence EEM method 132–133
 - fluorescence emission spectrum 115, 117–119
 - fluorescence excitation spectrum 115
 - fluorescence intensity 119–122
 - fluorescence microscopes 143
 - fluorescence polarization analysis 117, 118
 - fluorescence quenching method 122, 128
 - fluorescence spectrometer/
 - spectrophotometer 123–127, 124
 - fluorescence spectroscopy, application of 129–134
 - Fourier-transform infrared spectroscopy (FTIR) 1, 13–16
 - application in 30–32, 35
 - micro-FTIR 30
 - Fourier transform ion cyclotron resonance (FT-ICR) 176, 189, 190
 - Franck–Condon principle 69
 - FT-Raman spectrometers 61, 63, 66
 - fulvic acid-like substance-chelated calcium 161
- g**
- gas chromatography-mass spectrometry (GC-MS) 171, 186, 192
 - gas ionization detector 182
 - gas Raman spectroscopy technology 71
 - glass prism 93
 - gold nanoparticles (GNPs) 160
 - grand Raman spectrum 44
 - graphene oxide (GO) 167
 - grating ghosts 66
- h**
- hard ionization 173–174
 - harmonic approximation 4
 - harmonic potential 5
 - heavy metals in water 104
 - heteronuclear diatomic molecule 8–9
 - high-performance capillary electrophoresis (HPCE) 186

high-performance liquid chromatography (HPLC) 174
 high-performance liquid chromatography-inductively coupled plasma mass spectrometer (HPLC-ICP-MS) 188
 holographic gratings 66
 hotspot 54
 hydrogen bonds 31
 hydroxyapatite (HAp) 165
 hyperconjugation effect 89–90
 hyperpolarizability(ies) 8, **47**
 hyper-Raman effect 58

i

ideal fluorescence
 spectrophotometer 126–127
 imaging amplification system 154
 immobilized bacteria technique 161
 indium antimonide (InSb) detector 23
 inductively coupled plasma mass spectrometer (ICP-MS) 171–172, 180–181
 elemental analysis 187
 interface 181
 ion focusing system 181
 ion source 181
 sample introduction system 180
 steps for 180
 inelastic collision 44
 inelastic neutron scattering 4
 inelastic scattering 43
 infrared absorption 41
 infrared reflectance spectroscopy 10–11
 infrared reflection-absorption (IRRAS) 10, 12
 infrared (IR) spectroscopy 1, 70
 applications 28–37
 in atmospheric processes 30–31
 attenuated total reflection Fourier transform infrared spectroscopy. *see* attenuated total reflection Fourier transform infrared spectroscopy
 classification of 17
 detector 22, **23**
 diffuse reflection (rough surfaces) 12
 dispersive infrared spectrometer 18–19
 energy level 3–5
 in environmental analysis and testing 36–37
 experimental facility 17–28
 extractive measurements 31–32
 Fourier transform infrared spectroscopy (FTIR) 13–16
 gaseous sample preparation techniques in 24
 infrared radiation sources **21**
 infrared reflectance spectroscopy 10–11
 in interface characterization 33–34
 interferometer 22
 interferometric infrared spectrometer 19
 IR spectrum 9–10
 light source 19–20
 liquid sample preparation techniques in 24–26
 maintenance of 27–28
 molecule and electromagnetic field, interaction between 7–9
 monochromator 22
 OP-FTIR spectroscopy measurement method 32–33
 qualitative and quantitative analysis 28–30
 in reaction kinetics 34–35
 solid sample preparation techniques in 26
 specular reflection (smooth surfaces) 11–12
 structural overview 18–23
 techniques and principles 7–17
 vibrational mode 5–7
 vibration transition probability 2
 water and heavy aqueous solutions preparation techniques in 26
 infrared spectrum 1–2
 and Raman spectra 59–60
 intensities in 10
 InGaAs detectors 66
 injector magnet 181
 inlet system 183
 interferometer 22

interferometric infrared spectrometer 19
 intermediate lens 155
 internal coordinate 6
 internal displacement coordinate 6
 internal factors 2
 interval partial least squares (iPLS) 103
 ion detection system 184
 ion focusing system 181
 ion mobility-mass spectrometry (IM-MS) 186
 ion source 173–176
 AMS 181
 CI 175
 EI 174
 ESI sources 173–174, 174
 ICP-MS 181
 MALDI 175–176, 175
 PTR-MS 183

k

Kerr effect 56

l

Lambert law 83
 lighting system 154
 light internal reflection principle 13
 light microscopy 143, 145
 lightning rod effect 55
 light scattering 42–43
 light source 92–93
 linear low-density polyethylene/low-density polyethylene (LLDPE/LDPE) 34, 35
 liquid cell, types of 24–25
 liquid cell window piece material 24–25
 liquid chromatography-mass spectrometer (LC-MS) 171, 186
 liquid film methods 26
 liquid nitrogen cooling method 153
 localized surface plasmon resonance (LSPR) 73
 luminescence, mechanism of 112, 112

m

magnetic sector mass analyzer 178, 178
 MALDI time-of-flight mass spectrometry (MALDI-TOF MS) 184–185, 185

marine aerosol, matter transfer 136–137
 mass analyzer 176–180
 mass spectrometry (MS)
 in atmospheric research 187–192
 experimental facility 180–187
 principles of 172–180
 matrix-assisted laser desorption/ionization (MALDI) source 171, 175–176, 175
 mercury cadmium telluride (MCT)
 detectors 23
 metal-containing particles, microscopic observation of 162–163
 methanol-soluble organic carbon (MSOC) 105
 Michelson interferometer 62–63
 microcantilever 152
 micro-FTIR 30
 microplastics (MP) 36–37, 72–75, 73, 75, 191
 micro-Raman spectroscopy 71, 74
 microscopic imaging 144–145, 144
 microscopy
 atomic force microscope 151–153
 classification 145–153
 CLSM 145–147
 core of 143
 SEM 149–151
 TEM 147–149
 working principles 145–153
 mirror symmetry rules, with absorption spectrum 118–119, 118
 Mn (II) oxidation 164
 3D mobile piezoelectric actuators 159
 molecular absorption spectrum 117
 molecular fluorescence
 EEM deconvolution 122–123
 experimental facility 123–127
 factors affecting fluorescence intensity 120–122
 fluorescence parameters 119–122
 fluorescence spectrum 115–119
 generation 112–115
 molecular vibration rotation spectrum. *see* infrared spectrum
 monochromator 18, 22, 62–63, 93–94, 126
 montmorillonite (Mt.) 165

Morse potential 4, 5
 moving window partial least squares (mwPLS) 103
 multicomponent systems 30, 100, 128–129
 multi-elemental analysis, MS in 187–189
 multiplication subtraction method 100–101
 multispectroscopy 130

n

nanoparticles analysis, MS in 189
 nanoparticles detection, by SERS 75–76
 nanoSIMS 192
 nanotoxicology, CLSM in 160
 Nd:YAG lasers 61
 near-field Raman spectroscopy (NFRS) 55
 nitrate nitrogen in water 104, 105
 nonlinear Raman spectroscopy (NLRS) 47, 56–57, 57
 non-monochromaticity of incident light 84–86, 85

o

objective lens 155
 observation room 155
 one-dimensional neural network (1D-CNN) 74
 open-path Fourier transform infrared (OP-FTIR) spectroscopy measurement method 32–33
 optical microscope 145
 organic aerosol composition analysis 189–190
 organic carbon (OC) 104
 organic liquid sample 26
 organic mass spectrometry 172
 organophosphate esters (OPEs) 192
 organophosphorus precipitation 166

p

paraformaldehyde fixation method 153
 parallel factor analysis (PARAFAC) 123, 129
 parallel factor framework clustering analysis (PFFCA) 123
 partially polarized band 54
 particle coupling effect 55

particulate organic carbon (POC) concentrations 106
 passive measurement techniques 33
 paste method 26
 percentage absorbance coefficient 84
 perpendicular scattering configuration 52, 52
 pH effect 92
 phosphate-solubilizing bacteria (PSB) 165
 photocells 94, 95
 photodetectors 64
 photometric titration 101
 photomultiplier tube 63, 63, 65, 146, 126
 phototube 94
 plasmonic nanoparticles 76
 plastic pollution 37
 Pockels effect 56
 polarizability 42, 45, 47, 51
 dependence of 46
 electron 51
 polyatomic molecule 50
 polycyclic aromatic hydrocarbons (PAHs) 136–137, 139
 polyethersulfone (PES) filters 36
 polyethylene (PE) 191
 polyvinyl chloride (PVC) microplastics 191
 powder-activated carbon (PAC) 164–165, 164
 power system 157–158
 principal components analysis (PCA) 123
 projection lens 155
 proton-transfer reaction mass spectrometry (PTR-MS) 182–183, 187, 188
 pulsed ionization method 176
 pyroelectric detectors 22

q

quadrupole mass analyzer 176, 177
 qualitative analysis 29–30
 Raman spectroscopy for 70–71
 UV-vis absorption spectrum for 79–80
 quantitative analysis, with UV-vis spectroscopy 99–102
 quantum efficiency 64
 quantum mechanics theory 43
 quartz prism 93

R

Raman bands 51, 54, 67
 Raman effect 41, 45, 49
 Raman optical activity (ROA),
 defined 42
 Raman scattering 41
 characterization 41–42
 coefficient 70
 electron transition diagram 44
 intensity of 44, 70
 luminous flux of 70
 to resonance Raman scattering 45
 Raman shift 44, 46, 48–49, 66
 Raman spectra 46–50, 69
 anti-Stokes transition 50, 50
 hyper-Raman spectra 47
 and infrared spectra 59–60
 intensities in 51
 Raman effect 49
 Stokes Raman line 50, 50
 Stokes side 48
 virtual state 49
 for water 49
 wavenumbers 48
 Raman spectral intensity ratio 70
 Raman spectrometer/spectroscopy
 in atmospheric research 70–76
 basic components 60–66, 61
 theories and principles 42–43
 types of 43–60
 Raster scanning method 156
 Rayleigh criterion 144
 Rayleigh line 44, 46, 48, 50, 67, 68
 Rayleigh line filters 68–69, 68, 69
 Rayleigh scattering 41–43, 48, 62
 electron transition diagram 44
 optical filter 62–63
 record display system 95
 recording system 154
 reflection ToF mass spectrometer 177
 refractive index 144, 145
 relativistic effects 144, 145
 resonance Raman scattering 44
 resonant Raman spectroscopy 61

S

sample cell. *see* absorption cell
 sample introduction system 180
 sample preparation
 AFM 160
 ATR-FTIR 16
 CLSM instrument and 153
 DRIFTS 12
 infrared spectroscopy 24–27
 SEM 158
 TEM 155
 sample room 154
 saturated hydrocarbons 88
 scanning electron microscope (SEM) 143,
 149–151
 in aqueous-phase analysis 164–165
 instrument 155–158
 morphology of atmospheric particulate
 matter, analysis of 163–164, 163
 sample preparation 155–158
 in soil 165–166, 166
 scanning monochromator 68
 scanning probe microscope (SPM) 144
 scanning probe modification
 technique 167–168
 scattering, 42–43. *see also specific types*
 sealing tablets 154
 secondary electron imaging (SEI) 150, 151
 secondary electrons 150
 second ion mass spectrometry (SIMS) 184,
 184, 192
 self-acting effect 56
 shell-isolated nanoparticle-enhanced Raman
 spectroscopy (SHINERS) 75
 sigma orbital 81
 sigma star orbital 81
 signal collection and display system 157
 silicon nanowire arrays (SiNWArS) 76
 silicon photocells 94
 simulated gain and loss Raman
 scattering 56
 single-beam UV-vis
 spectrophotometer 96, 96
 single-cell force spectroscopy with AFM 167

- single-component analysis 100
 - single-molecule fluorescence spectrum 117
 - slit 94
 - small Raman spectrum 44–45
 - soft ionization 173, 175
 - solid-state lasers 61, 69
 - solitary electron pairs 81
 - solution concentration, deviation
 - caused by 86
 - solvent effect 90–91, 90
 - spatial heterodyne technology 74
 - specific absorbance coefficient 84
 - spectral data acquisition 64
 - specular reflection (smooth surfaces)
 - 11–12
 - spray method 176
 - stacked interval partial least squares (siPLS) 103
 - standard addition method 99
 - standard curve method 99
 - stereoscopic effect 91–92
 - steric hindrance 91
 - stimulated Raman gain and anti-Raman scattering 58
 - stimulated Raman loss spectroscopy. *see* stimulated Raman gain and anti-Raman scattering
 - stimulated Raman scattering (SRS) 56–58
 - stokes displacement 119
 - stokes Raman line 50
 - stokes Raman scattering 41, 44
 - substrate effect 56
 - surface-enhanced Raman scattering 54
 - surface-enhanced Raman spectroscopy (SERS) 54–55, 71
 - chemical enhancement mechanism 56
 - hot pots 54
 - nanoparticles detection 75–76
 - pollutants and microplastics
 - detection 72–75, 73, 75
 - spatial resolution of 55
 - substrates 72
 - surface plasmon frequency/
 - resonance 54–55
 - switching magnets 181
 - synchronous fluorescence spectrum 115–116
 - synchronous scanning technology 115
- t**
- tablet pressing method 26
 - tandem accelerator 181
 - tandem mass spectrometry 185–186
 - tautomerism 89
 - Taylor expansion 8, 45
 - term diagram 4
 - thermogravimetry-Fourier transform
 - infrared reflection mass spectrometry (TG-FTIR-MS) 191
 - three-dimensional fluorescence
 - spectrum 117
 - three-dimensional (3D) shell-isolated
 - nanoparticle-enhanced Raman spectroscopy 76
 - time-of-flight (ToF) mass analyzer 176–177
 - time-of-flight-second ion mass spectrometry (ToF-SIMS) 192
 - tip-enhanced Raman spectroscopy (TERS) 55–56
 - tissue sample sections 153–154
 - total organic carbon (TOC) 106
 - tralopyril 191
 - transmission electron microscope (TEM) 143, 147–149
 - analysis of single particle
 - morphology 161–164
 - appearance of 154
 - imaging principle 147–149, 148
 - instrument 154–155
 - magnification 148, 149
 - metal-containing particles, microscopic
 - observation of 162–163
 - particle types and their mixing states 162
 - sample preparation 154–155
 - trapped-ion (or ion trap) mass
 - analyzers 179–180
 - trichloronitromethane (TCNM)
 - formation 190
 - trigonometric formula 48
 - tripyrindine 191

triple additive monochromator 67
triple subtractive instrument 67–68, 68

U

ultraviolet-visible (UV-vis) absorption
 spectroscopy 79–107
 absorption law and factors
 affecting 82–92
 applications 102–106
 atmospheric brown carbon,
 characterization 104–105
 B band and *E* band 89
 COD monitoring 102–104, **103**
 DOC analysis 105–106
 generation mechanism 81–82, 81
 heavy metals in water, determination 104
 K band 89
 nitrate nitrogen in water,
 determination 104, 105
 principle of 81–92
 R band 89
 shoulder peak 88
 strong band 88
 weak band 88
ultraviolet-visible (UV-vis)
 spectrophotometer/spectrophotometry/
 spectroscopy 69, 79, 92–95, 92, 95
 absorption cell 94
 classification 80, 92–102
 components of 92–95, 92, 95
 detector 94–95
 double-beam UV-vis
 spectrophotometer 97–98, 97
 dual-wavelength UV-vis
 spectrophotometer 98–99, 98
 light detector 94–95

light source 92–93
monochromator 93–94
photodiode array multichannel
 spectrophotometer 96–97, 97
quantitative analysis with 99–102
record display system 95
selective absorption of light 80, **80**
single-beam spectrophotometer 96

V

vacuum system 157–158, 184
vacuum ultraviolet (VUV) photolysis 190
variable-angle synchronous scanning
 method 116
variable thickness liquid pool 25
vibrational spectroscopy 4
vibration frequency 5
 vibration relaxation 113
vibration–rotation spectra 6
volatile organic compounds (VOCs) 30,
 182, 183
 detection in water and soil 191–192
 with higher proton affinity 183
 oxygenated 182
 proton-transfer reaction MS in 183

W

water-soluble organic carbon (WSOC) 105,
 134, 189
working curve method 30

X

X-ray(s) 43, 150

Y

Y-ray(s) 43

