Index

Numbers are page numbers. Letters f and t refer to a figure or table.

absorption coefficient, 214, 221
absorption cross section, 188
absorption line strength, 215
absorption lines, 214, 215, 218
ACE. See Aerosol Characterization Experiment
additive Gaussian noise approximation (AGNA), 351
ADEDIS. See Appareil de détection à distance
ADM. See Atmospheric Dynamics Mission
ADN. See Asian Dust Network
Advanced Remote Gaseous Oxides Sensor (ARGOS), 197, 198f
aerodynamical alignment, 36
Aerosol Characterization Experiment (ACE), 134
aerosols. See particles
AGNA. See additive Gaussian noise approximation
airborne lidar, 355–358, 360–368
DIAL and, 357–358
history of, 355–358
uses of, 360–363
wind measurement and, 344–347
Airborne Lidar and Observations of the Hawaiian Airglow (ALOHA), 363
Airborne Raman Ozone, Aerosol and Temperature Lidar (AROTEL), 364
Airborne Science Spacelab Experiments System Simulation (ASSESS), 361
aircraft safety, 348
ALEXIS. See Atmospheric Lidar Experiment in Space
ALISSA system, 380–381
ALOHA. See Airborne Lidar and Observations of the Hawaiian Airglow
ammonia (NH₃), 187, 204
amplified spontaneous emission (ASE), 411
AMPS payload. See Atmospheric, Magnetospheric and Plasmas in Space payload
analytic solutions, QSA and, 79–82
Ångström exponent, 106, 106t, 115, 192
angular scattering function, 50, 80
anti-Stokes Raman scattering, 244, 247, 248, 283
APDS. See avalanche photodiodes
Appareil de détection à distance (ADEDIS), 204
ARGOS. See Advanced Remote Gaseous Oxides Sensor
ARM. See Atmospheric Radiation Measurement Program
AROTEL. See Airborne Raman Ozone, Aerosol and Temperature Lidar
ASE. See amplified spontaneous emission
Asian Dust Network (ADN), 107
ASSESS. See Airborne Science Spacelab Experiments System Simulation
asymmetry factor, 80, 85
ATLID. See Atmospheric Lidar System
Atmospheric Dynamics Mission (ADM), 391
Atmospheric Lidar Experiment in Space (ALEXIS), 359
Atmospheric Lidar System (ATLID), 359
Atmospheric, Magnetospheric and Plasmas in Space (AMPS) payload, 358
Atmospheric Radiation Measurement Program (ARM), 226
atomic absorption filters, 149–151, 282
automotive lighting, 182
B-spline functions, 122
Ba, See barium
background mode, 130
backscatter, 8–10, 44, 105–141, 143, 188, 242
aerosols and, 116, 158f. See also particles
air molecules and, 10, 143
attenuated, 158f
coefficient, units of, 9
conversion factors, 131
depolarization and, 24, 30t, 50. See also depolarization
DIAL. See differential absorption lidar
Doppler shifts and, 17
efficiency, 89–90
efficient, 120
elastic, 12–13, 47, 107, 243, 292, 361
equation for, 109–112
extinction and, 45, 46, 89, 97, 131, 132f, 136f. See also extinction
inelastic. See Raman lidar
lidar equation and, 44. See also lidar equation
particulate matter and, 10. See also particles
polarization and, 23, 24, 30t, 50. See also polarization
ratio, 110, 131, 132f, 147, 192, 242, 282, 292
rotational Raman method, 281
See also scattering; specific systems, parameters
backward enhancement, 435f
ballistic trajectories, 436–437
barium (Ba), 149
base functions, 122, 123
beam expansion, 4
BELINDA. See broadband-emission lidar with narrow-band determination of absorption
Bernoulli equation, 45, 111
bioaerosol detection, 437–439
Boltzmann distribution, 276, 284, 319, 363
boundary layer flow, 108, 342f, 343
boundary value problem, 86
Brillouin scattering, 156, 274, 275f, 276, 402
broadband-emission lidar with narrow-band determination of absorption (BELINDA), 16, 399–414, 413f
broadening processes, 215, 216, 317, 401, 403–414
butane (C4H10), 203
Ca. See calcium
Cabannes line, 13, 15, 249, 274, 276, 402
Cai-Liou model, 66
calcium (Ca), 276, 308, 315f, 316
calibration, 155–157, 157f, 258, 286
CALIOP. See Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO mission, 380, 384, 385, 385f, 386, 389, 389f, 390
CAMEX. See Convection And Moisture Experiment
carbon dioxide (CO2), 25, 203, 242
carbon monoxide (CO), 187, 203
CARL. See Cloud And Radiation Lidar
CART. See Clouds And Radiation Testbed
CAT. See clear-air turbulence
ceilometers, 175, 175f, 179, 180f
centrifugal distortion constant, 283, 285t
CERES system, 390
CH4. See methane
C2H4. See ethylene
C2H6. See propane
C3H8. See propane
C4H10. See butane
Chebyshev particles, 24
chirp, 422–424
chlorine (Cl2), 196
cirrus clouds. See clouds
Cl2. See chlorine
clear-air turbulence (CAT), 348
climate forcing, 122
climate modeling, 106
Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), 385–386, 388f
Cloud And Radiation Lidar (CARL) 226
clouds, 23, 27–28, 39, 107
average reflection, 87
ceiling, 179–181
cirrus, 29, 30, 34, 37f, 51, 90, 95
cumulus, 50
dense diffusion, 84–88
detection of, 177–182
droplets in, 29
ice crystals in, 19, 22, 24, 29–31, 35t
liquid water content, 99
LITE and. See Lidar In Space Technology Experiment
mesospheric, 363
mixed phase in, 31
noctilucent, 28
particles in. See particles
small optical depths, 91
stratospheric. See stratospheric clouds
subvisual, 34
temperature measurements in, 274, 292
virtual profiles, 63
visibility and, 165–186
water clouds, 28
Clouds And Radiation Testbed (CART), 226, 227f, 228, 230
CO. See carbon monoxide
CO2. See carbon dioxide
coherent Doppler lidar, 337
collision broadening, 216, 317, 401–414
collision parameters, 61, 216
continuous-wave Doppler lidar, 331
contrails, 29
Convection And Moisture Experiment (CAMEX), 234
convective boundary layer, 108
correction algorithms, 89, 192
cross sections, 245–252, 284, 310, 311f
cross-sensitivity, 190
cross-validation, 126–127
crosswinds, 329
DAS lidar. See differential absorption lidar
DBS. See Doppler beam swinging scan
Deirmendjian distribution, 96, 171
DEMP. See diethylmethylphosphonate
depolarization, 20, 26–33, 51–52, 361
backscatter and, 24, 30t, 50
causes of, 23
circular, 21, 159, 159f
cirrus, 37f
clouds, 22
linear, 20, 21, 30, 30t, 33, 50, 52
Lorenz-Mie theory, 28
measures of, 20–23
ratio, 34f, 49
rotational Raman signal, 284, 290
York University model, 52
See also polarization
desert dust, 27
di-isopropylmethylphosphonate (DIMP), 204
DIAL. See differential absorption lidar
differential absorption lidar (DIAL), 15–16, 39, 187–212, 219, 224, 236, 274
absorption lines, 218
airborne, 357, 364
backscattering and, 192
BELINDA and, 16, 399–441
broadening effects, 403–405
correction experiment, 234
corrections for, 190, 191, 206
data acquisition and, 224
differential absorption coefficient, 214
dual, 207
equation for, 188, 190, 221
extinction and, 190
far-infrared, 203–206
guidelines for, 210
LaRC and, 357, 362, 365–366
LASE and, 234
MDIAL, 208
mid-infrared, 202–203
model atmosphere, 192, 192f
multi-wavelength, 206–209
ozone and, 357
Raman lidar and, 16
scattering and, 407f
spectral distribution, 217, 406
temperature measurement, 236–238, 276, 399
types of, 196–206
differential absorption lidar (DIAL) (Continued)
ultraviolet, 196–200
visible-light, 200–202
water vapor and, 213, 227f, 234, 357, 358, 365, 391, 399, 407f
wavelengths in, 195, 206, 218. See also specific systems
white-light femtosecond lidar, 399–441
diffraction scattering, 96, 98
diffusion limit, 84–88, 99
DIMP. See di-isopropylmethylphosphonate
direct-detection Doppler lidar, 332–336, 334f, 335f, 343
direct-problem model, 90, 96, 98
discrete dipole approximation, 24
Doppler beam swinging (DBS) scan, 341
Doppler broadening, 156, 215, 276, 317, 401
Doppler-free saturated-absorption spectroscopy, 318
Doppler systems, 17, 18
DBS scan, 341
shift in, 243, 308, 325
wind lidar, 325–354
double-cavity etalon, 412
drag forces, 32
droplets, 29, 430–439
dust, 35, 181

EARLINET. See European Aerosol Research Lidar Network
Earth Observing System, 358–359, 368, 384, 391
eddy-correlation technique, 233
effective absorption coefficient, 221
effective cross section, 311f
effective extinction, 74, 89
effective medium theorem, 68–78, 92
El Chichón, 130
elastic backscatter, 12–13, 107, 361
  equation for, 188
  lidar system, 12–13, 107
  signal blocking, 299
  suppression of, 292
ELISE. See Experimental Lidar in Space Experiment
Eloranta model, 67
entrainment zone, 232

EOS. See Earth Observing System
equivalent radiance, 75–76
equivalent source profile, 76
error amplification, 124
error analysis, 124, 127–128
ESA. See European Space Agency
ethane (C2H6), 206
ethylene (C2H4), 204
European Aerosol Research Lidar Network (EARLINET), 107, 266
European Space Agency (ESA), 107, 218
Experimental Lidar in Space Experiment (ELISE), 359
extinction, 44, 45, 51, 63, 105, 167, 188
air molecules and, 11, 190
atmospheric, 143
backscatter ratio, 110, 131, 132f, 192, 242
coefficient, 105
correction factors, 131
DIAL and, 190. See also DIAL
effective, 74, 89
efficiencies, 120
lidar equation and, 10
lidar ratio, 242
particles and, 11. See also particles
rotational Raman and, 287f. See also rotational Raman systems
wavelength-dependent effects, 189
VOR and, 167
See also specific systems
extinction-to-backscatter ratio, 120

Fabry-Perot interferometer, 14, 113, 147–149, 148f, 282, 412
fallstreak, 35t
Faraday filter, 313
Fe. See iron
fiber amplifiers, 163
field-of-view range, 95, 98–99
filamentation, 416–417, 417f, 420
finite difference methods, 24
flux measurement, 85, 197, 204, 205f
fog, types of, 172f
forward propagation problem, 78
Fourier transforms, 74, 77, 86
fractal particles, 24
Fraunhofer formula, 94
Fredholm integral equation, 120
free path length, 61
freon, 133, 204
generalized cross-validation, 126, 127
geometrical-optical theory, 24, 96–98
Geoscience Laser Altimeter System
(GLAS), 355, 359, 380, 381, 384t, 386, 390
Glan prism, 19, 22
GLAS. See Geoscience Laser Altimeter System
Global Backscatter Experiment
(GLOBE), 362
Global Tropospheric Experiment
(GTE), 362
GLOBE. See Global Backscatter Experiment
GOES-8 image, 234, 235f
graupel, 32
gravity waves, 281, 308
Green’s function, 69, 72, 74, 77, 84
group velocity dispersion (GVD), 424
GTE. See Global Tropospheric Experiment
GVD. See group velocity dispersion
haze, 27
HCl. See hydrogen chloride
heliports, 183–185
heterodyne-detection lidars, 337, 338f
Hg. See mercury
high spectral resolution lidar (HSRL), 14, 39, 90, 108, 143–164, 274, 361
aerosols and, 113
backscattering and, 46
basic principle of, 145–147
component descriptions, 153t
Fabry-Perot systems, 147–149, 148f
implementations, 147–151
polarization and, 39
remote operation, 151–157
temperature measurements, 275t
UW Arctic HSRL, 151
H₂O. See water vapor
hollow-core fibers, 163
homogeneous scattering, 404, 407f
HSRL. See high spectral resolution lidar
hydrazine, 187
hydrogen chloride (HCl), 187, 203
hydrometeors, 20, 21
I₂. See iodine
ice, 25f, 29–31, 35t
Iceland spar, 19
ICESat, 355, 382f, 391
Imaging Infrared Radiometer (IIR), 385
INDOEX. See Indian Ocean Experiment
Indian Ocean Experiment (INDOEX), 132–135, 362
industrial emissions, 187–212
inelastic scattering. See Raman scattering
injection seeding, 224
iron (Fe), 276, 315t, 319, 363
integrated water vapor, 228, 229f
integration-lidar technique, 274, 277–281
interfering gas, 190, 193
internal scattering, 22
interropical convergence zone
(ITCZ), 372
inverse methods, inverse problems
algorithms for, 120, 192, 405
base functions, 123
ill-posed, 121, 122, 128
influence matrix, 127
iteration and, 96–98
multiple scattering and, 91–100
random search and, 96
regularization of, 121
variable windows, 123
window, 123
iodine (I₂) absorption cells, 150, 151
iron (Fe), 308, 319, 363
isosbestic point, 145–147, 252f
ITCZ. See interropical convergence zone
K. See potassium
kernel efficiencies, 120
kernel functions, 65, 120
kernel matrix, 127
Kerr effect, 17, 414–416, 415f
Klett method, 46, 93, 97, 112, 116, 133, 145, 169, 405
Lagrange multiplier, 126
Large Aperture Scanning Airborne Lidar
(LASAL), 374, 378f
LASA. See Lidar Atmospheric Sounder
and Altimeter
LASAL. See Large Aperture Scanning Airborne Lidar
LASE. See Lidar Atmospheric Sensing Experiment
Laser Atmospheric Sensing Experiment (LASE), 234, 235f, 366
Laser Atmospheric Wind Sounder (LAWS), 359
Laser Doppler Velocimetry (LDV), 330–331
laser guide star, 321
laser-induced breakdown (LIB), 435f
laser time-of-flight velocimetry (LTV), 330
latent heat flux, 233
LAWs. See Laser Atmospheric Wind Sounder
LDV. See Laser Doppler Velocimetry
Leonid shower, 363
Li. See lithium
LIB. See laser-induced breakdown
Lidar Atmospheric Sensing Experiment (LASE), 358, 366
Lidar Atmospheric Sounder and Altimeter (LASA), 358, 359, 366, 391
lidar bright band, 32
lidar dark band, 32, 37
lidar equation, 221
backscatter and, 44. See also backscatter
broadening and, 402–403
common form of, 11
extinction coefficient and, 10
four factors, 6–11
general, 219–221
geometric factor, 8
inversion of, 403–405. See inversion methods
monochromatic form, 219
ratio in, 110, 132f, 147, 242, 282, 292
rotational Raman, 284
systems factor, 6
transmission term, 10
Lidar In Space Technology Experiment (LITE), 57, 58f, 100, 355, 366, 370, 370f, 371f, 373f, 374f, 389
lidar ratio, 110
limit of detection, 189
Lindenberg Aerosol Characterization Experiment, 107
line-of-sight velocity, 327, 401
line shape, 215
line strength, 215
linear depolarization, 20, 21, 30, 33
liquid water content, 99
LITE. See Lidar In Space Technology Experiment
lithium (Li), 308, 315, 315t
local optical oscillator, 336
logarithmic-normal distribution, 117
Lorenz-Mie theory, 23, 24, 28, 432–435
LTV. See laser time-of-flight velocimetry
Mars Orbiting Laser Altimeter (MOLA), 380
maximum-entropy principle, 126
mass concentration, 181, 190
Maxwell-Boltzmann distribution. See Boltzmann distribution
Maxwell equations, 59, 417
mean free path, 57, 83, 87
melting region, 32
mercury (Hg), 187, 196, 197
mesopause region, 17, 274, 308–319, 358
mesosphere, 275t, 281, 301f, 321
metallic layers, 315–316
meteorological optical range (MOR), 167, 176, 178f
methane (CH₄), 203, 206, 242, 363
MFOV lidar. See multiple-field-of-view lidar
micropulse lidar, 209
microwave radar, 20, 21
Mie scattering, 13–14, 29, 49, 118, 130
miniaturized lidar, 183–185
minimization concept, 124
minimum discrepancy principle, 126, 127
minimum distance method, 124
minimum range resolution, 189
mixed-phase clouds, 31
mode radius, 171
MODIS system, 390
MOLA. See Mars Orbiting Laser Altimeter
molecular absorption filters, 149–151
molecular extinction, 192
molecular lidar ratio, 110
molecular scattering, 26–33. See also specific types
Monte Carlo simulations, 60–65, 68, 81, 88, 96
INDEX 451

MOR. See meteorological optical range
MPEF. See multiphoton-excited fluorescence
MPI. See multiphoton ionization
Mueller matrix, 60
multi-dimensional search, 96
multiangle lidar technique, 108
multiphoton-excited fluorescence (MPEF), 432
multiphoton ionization (MPI), 227f, 228, 416, 432
multiple-field-of-view (MFOV) lidar, 54, 54f, 95, 97, 99, 100
multiple scattering, 14, 26, 29, 48f
bulk properties, 99–100
correction factor, 51
defined, 43
depolarization, 51–56
diffusion limit, 84–88, 99–100
effective values, 91
equation for, 96
field-of-view and, 98
inverse problem, 91–100
lidar and, 43–103
models of, 58–89
MUSCLE and, 64, 79, 83
polarization and, 49
pulse stretching, 54, 56, 57
radiative transfer, 58–60
scattering and, 43. See also scattering visibility, 173–174
Multiple Scattering Lidar Experiments (MUSCLE), 64, 79, 83
multiwavelength lidar, 119, 131
MUSCLE. See Multiple Scattering Lidar Experiments

N2. See nitrogen
Na. See sodium
NASA. See National Aeronautics & Space Administration
NASDA. See National Space Development Agency of Japan
National Aeronautics & Space Administration (NASA), 107
National Oceanic and Atmospheric Administration (NOAA), 343–344
National Space Development Agency of Japan (NASDA), 107
Network for the Detection of Stratospheric Change (NDSC) 266

Neumann series, 78
NEXLASER system, 200
NH3. See ammonia
nitrogen dioxide (NO2), 187, 196–197, 201–202, 207, 209
nitrogen monoxide (NO), 201
nitrogen (N2), 216, 242, 245t, 251t, 282, 283
NO. See nitrogen monoxide
NO2. See nitrogen dioxide
NOAA. See National Oceanic and Atmospheric Administration

normal visual range, 167
null profile, 201

O2. See oxygen
O3. See ozone
O branch, 245
off-axis lidar, 86
off-beam effects, 86, 100
OPAL. See Ozone Profiling Atmospheric Lidar
OPO. See optical parametric oscillator
optical depth, 44, 50, 144, 162f
optical displays, 36
optical Doppler effect, 326–328
optical parameters, 109–117. See specific types
optical parametric oscillator (OPO), 197, 203, 209
optical reciprocity principle, 70
optical thickness, 144, 292
overlap function, 5, 8, 9f
oxygen (O2), 203, 214, 216, 217, 236, 242, 244, 245t, 251t, 252t, 283, 429
Ozone Profiling Atmospheric Lidar (OPAL), 197–199
PARASOL system, 390
Parry arc, 36, 37f
Parseval equality, 73, 74
particles, 105–141, 161f
ACE and, 134
backscatter and, 116, 158f, 161f. See also backscatter
bioaerosol detection, 437–439
correction factor, 194f
particles (Continued)
effective radius, 117
effective scattering efficiency, 129
extinction profiles, 200f, 242
graupel, 32
inhomogeneous, 24
inversion methods, 192
mean radius, 117
MPEF and, 432
MPI and, 416, 432
nonlinear interactions, 430
nonspherical, 56
optical parameters, 109–117
perturbations by, 192
photons and, 156, 432
pollution and, 187–212. See also pollution
properties of, 106t, 171t
Raman lidar and. See Raman lidar
scattering and, 10, 27, 27. See scattering
shape of, 14
size of, 91, 95–99, 117, 436–437
spherical, 26, 432–437
stratospheric, 108, 120–132, 266. See also stratosphere
surface-area concentration, 117
tropospheric, 108, 119
types of, 27, 105–106, 112t
visibility and, 166, 170–173
volume concentration, 117
See also specific types, parameters, systems
pattern correlation, 329
PDL. See Polarization Diversity Lidar
penalty function, 124, 125
persistent elevated pollution episodes (PEPE), 365
phase function, 173f
phenomenological methods, 64–68
photocycles, 400
photons
crystal fibers and, 163
fluorescence and, 432
incident, 156
ionization and, 227f, 228, 416, 432
mean free path, 85
transport length, 87
Pinatubo, 30, 129–130
Placzek theory, 246
plasma generation, 416
plate crystals, 31
polar clouds, 27, 282, 360, 362
polar mesospheric clouds, 357, 363
PSCs. Polar Stratospheric Clouds. See stratospheric clouds
polarization, 14, 247, 248
backscatter and, 23. See also backscatter
circular, 19
diversity, 39
elliptical, 19
Glan prism and, 19, 22
lidar and, 19–42
linear, 19
multiple scattering and, 49
polarizability, 246, 250
refraction and, 19
rotational Raman. See rotational Raman lidar
Polarization Diversity Lidar (PDL), 33
pollution, 187–212, 365. See specific types, parameters
potassium (K), 308, 319
precipitation scattering, 31–33
pressure shift, 216
principle-component analysis, 131
projection techniques, 122
propane (C₃H₈), 203, 206
PRRS. See pure rotational Raman spectrum
pulse length, effective, 7
pulse stretching, 54, 56–57, 66
pulsed Doppler lidar, 321–322
pump-probe measurements, 436–437
pupil area, 75
pure rotational Raman spectrum (PRRS), 283–289, 285f
Q branch, 245
quarter-wave plate, 22
quasi-small-angle (QSA) approximation, 68–84
analytic solutions and, 79–82
Neumann series and, 78–79
radiative transfer and, 68–78
small-angle approximation, 71
two-stream model, 82
INDEX 453

radar bright band, 32
radiance, 59
cconservation and, 59
definition for, 59
effective, 75, 77
equation for, 59, 71, 78, 84
multiple scattering, 58–60
QSA approximation, 68–84
radiant intensity, 85
radio acoustic sounding system (RASS), 233
Radio Science Center for Space and Atmosphere (RASC), 297, 298f, 299f, 302f
rain, 32, 37, 39
c aerosol properties, 112, 112t
c backscatter and, 90, 247–248, 249, 274, 290. See also backscatter
calibration, 258
DIAL and, 262–265. See differential absorption lidar
equation for, 256
Mie scattering and, 12
overview of, 242, 243t
c ozone and, 262–265, 266
c rotational. See rotational Raman systems
c scattering and, 12, 13, 26, 47, 144–147, 156, 242, 243, 249, 283
c simulation, 242
c stratospheric, 266
temperature and, 15, 275, 281
water vapor and, 256–261, 264, 266
Raman scattering, 4, 15, 191, 242–244, 251, 283–289, 363–364. See also scattering
random walk, 65
randomized-minimization method, 121
range resolution, 189
RASC. See Radio Science Center for Space and Atmosphere
RASS. See radio acoustic sounding system
Rayleigh band, 274
ray-tracing, 24, 29
Rayleigh-Gans theory, 24
Rayleigh lidar, 12, 13, 109, 113, 144, 242, 249–250, 275t, 277–282
receiver field of view (RFOV), 254
receiver footprint, 58
refractive index, 18, 19, 25, 118, 127, 128
regularization, 93, 121, 124, 126, 127
relative humidity, 267, 300
c resonance fluorescence lidar, 197, 274, 275t, 276, 307, 309f, 317–320, 363
c resonance scattering lidar. See resonance fluorescence lidar
retrieval algorithms, 90–91
return signals equation, 109–112
RFOV. See receiver field of view
Riccati equation, 45
rotational distortion constant 283, 285f
rotational Ramon quantum number, 250, 283
rotational Raman methods, 287f, 296f
bandwidth and, 294–297
calibration and, 286, 288
center wavelengths, 294–297, 295f
cross-section for, 247, 248
depolarization and, 284
extinction, 300
leakage error, 293f
line splitting, 286
polarization and, 284
pressure broadening, 286
spectrum, 283, 285f
technical implementation, 297–300
temperature lidar, 274, 275t, 281, 301f
troposphere and, 303
See also specific systems, parameters
trunway visual range (RVR), 168
S branch, 245
safety, lidar and, 33, 348
SAGE Ozone Loss and Validation Experiment (SOLVE), 363
SAGE. See Stratospheric Aerosol and Gas Experiment
SAM II. See Stratospheric Aerosol Measurement
Samoilova model, 67
satellite lidar systems. See spaceborne lidar
scaling laws, 90
scan techniques, 332, 338
scanning interferometer, 147–148
scanning lidar technique, 108
scattering
aerosol particles, 10
geosmetrical optics and, 24, 96–98
homogeneous, 404
inelastic. See Raman scattering
inhomogeneous, 404
mean free path, 83
Mie. See Mie scattering
multiple scattering, 43. See multiple
scattering
phase function, 49, 59
Raman. See Raman scattering
small-angle, 57, 80, 71. See also QSA
approximation
Schrodinger equation, 417–418
sea-salt particles, 105
self-calibration, 188
self-focusing, 414
self-guided propagation, 416
self-phase modulation (SPM), 319, 419
single-scattering albedo, 106t, 122,
134, 134f
size parameter, 24
slant optical range (SOR), 168, 177,
177f, 178f
slant visual range (SVR), 168
small-angle scattering, 57, 80, 71. See also QSA
approximation
smoothing, 125, 126f
smoothness, 135
snowflakes, 32
SO2. See sulphur dioxide
sodium (Na), 308–315, 311f, 312f, 314t,
315f, 317, 319, 319f
SOLVE-2. See SAGE Ozone Loss and
Validation Experiment
soot, 105, 106
SOR. See slant optical range
Space Laser Applications and
Technology (SPLAT), 358
Space Shuttle, 2
spaceborne lidar, 358–360, 368–391
spectral impurity, 223. See also amplified spontaneous emission (ASE)
specular reflection, 26
spherical particles, 53, 432–439
SPLAT. See Space Laser Applications
and Technology
SPM. See self-phase modulation, 319
sporadic layers, 314f
SRS. See stimulated Raman scattering
standardization methods, 352
stimulated Raman scattering (SRS), 191
stochastic methods, 64–68. See also
Monte Carlo methods
Stokes parameters, 22, 40, 60, 247, 250
Stokes vibration-rotation lines, 243, 247,
250, 283
storms, 39
stratiform clouds, 88
stratopause region, 282
Stratospheric Aerosol and Gas
Experiment (SAGE), 356–357,
361, 363
stratospheric aerosol, 107
stratospheric aerosol model, 130
Stratospheric Aerosol Measurement-II
(SAM II), 356–357, 361
stratospheric clouds, 27, 129–132, 266,
274, 275t, 282, 357–362
sulfur dioxide (SO2), 187, 191, 193, 196,
197, 202, 207, 208, 242
sulfuric acid, 130
sun photometer, 118
supercontinuum, 419, 428, 431
surface-area concentration, 117
surface tension, 32
SVR. See slant visual range
T-matrix approach, 24, 25
TARFOX. See Tropospheric Aerosol
Radiative Forcing Observational
Experiment
temperature measurements, 236–238,
273–305, 399, 429
Boltzmann distribution, 284, 319,
363, 429
integration technique, 274, 277, 301f
esosphere, 275t, 317–320
mesosphere, 275t, 277, 301f
Raman lidar and, 15, 274, 275t
rotational Raman and, 274,
281–297, 295f
stratosphere, 275t, 277, 301f
troposphere, 275t, 281, 301f
temporal focusing, 424
Teramobile system, 421–430, 432f
terawatt measurements, 423–430
thermosphere, 274, 276
thunderstorms, 33
trichloroethane, 204
trichloroethylene, 204
INDEX 455

triethylphosphate, 204

troposphere, 119–129, 266, 275t, 282
Tropospheric Aerosol Radiative Forcing Observational Experiment (TARFOX), 362, 366
truncated singular value decomposition, 126
turbulence, 83, 226, 230–233, 342
two-flux model, 82
two-laser system, 201

unscattered radiance, 79
urban areas, 193
UW HSRL, 151, 157

VAD. See velocity-azimuth display variance spectrum, 62, 227, 227f
velocity-azimuth display (VAD), 339, 339f, 340f
vertical optical range (VOR), 167
vibration-rotation Raman backscattering, 247, 248, 275t
virga, 31, 36
virtual experiments, 63–64. See Monte Carlo methods
virtual instrument, 350
visibility
aerosol distributions and, 166, 170–173
cloud lidar and, 165–186
multiple scattering and, 173–174
visual range, 166–167
Voigt function, 215, 217
volcanic eruptions, 2, 135, 361
volume concentrations, 30, 117, 130, 135–138
VOR. See vertical optical range

wake vortices, 347–348, 347f
water vapor (H2O), 204, 207, 217, 231f, 235f, 242, 251, 252t, 357, 360, 365, 399, 407, 429
airborne profiling, 234–236
clouds and, 28–29, 264
DIAL and, 213, 227f, 234, 357, 358, 365, 391
droplets in, 32
ice, 29–31
integrated, 228, 229f
measurement of, 256–261
mixing ratio, 257
pressure, 216
probability distribution, 232t
rain, 32
Raman lidar and, 252, 261f, 266
rotational Raman methods, 300
variance spectrum, 227f
weather forecasting, 352
weather modification, 31
weight factors, 124
Weinman model, 78–79
white-light lidar, 16, 414–430
wide-field camera, 385
Wind Infrared Doppler (WIND) system, 344, 346f
wind lidar
airborne systems, 344–347
crosswind determination, 329
Doppler systems, 325–354
double-edge technique, 335
scan techniques, 332
WIND system, 344, 346f
wind power stations, 349

York University model, 52
Springer Series in

OPTICAL SCIENCES

94 Photonic Crystals
Physics, Fabrication and Applications
By K. Inoue, K. Ohtaka (Eds.), 2004, 209 figs., XV, 320 pages

95 Ultrafast Optics IV
Selected Contributions to the 4th International Conference
on Ultrafast Optics, Vienna, Austria
By F. Krausz, G. Korn, P. Corkum, I.A. Walmsley (Eds.), 2004, 281 figs., XIV, 506 pages

96 Progress in Nano-Electro Optics III
Industrial Applications and Dynamics of the Nano-Optical System
By M. Ohtsu (Ed.), 2004, 186 figs., 8 tabs., XIV, 224 pages

97 Microoptics
From Technology to Applications
By J. Jahns, K.-H. Brenner, 2004, 303 figs., XI, 335 pages

98 X-Ray Optics
High-Energy-Resolution Applications
By Y. Shvyd'ko, 2004, 181 figs., XIV, 404 pages

99 Few-Cycle Photonics and Optical Scanning Tunneling Microscopy
Route to Femtosecond Ångstrom Technology
By M. Yamashita, H. Shigekawa, R. Morita (Eds.) 2005, 241 figs., XX, 393 pages

100 Quantum Interference and Coherence
Theory and Experiments
By Z. Ficek and S. Swain, 2005, 178 figs., approx. 432 pages

101 Polarization Optics in Telecommunications
By J. Damask, 2005, 110 figs, XVI, 528 pages

102 Lidar
Range-Resolved Optical Remote Sensing of the Atmosphere
By C. Weitkamp (Ed.), 161 figs., approx. 416 pages

103 Optical Fiber Fusion Splicing
By A. D. Yablon, 2005, 100 figs., approx. 300 pages

104 Optoelectronics of Molecules and Polymers
By A. Moliton, 2005, 200 figs., approx. 460 pages

105 Solid-State Random Lasers
By M. Noginov, 2005, 149 figs., approx. 380 pages

106 Coherent Sources of XUV Radiation
Soft X-Ray Lasers and High-Order Harmonic Generation
By P. Jaegle, 2005, 150 figs., approx. 264 pages

107 Optical Frequency-Modulated Continuous-Wave (FMCW) Interferometry
By J. Zheng, 2005, 137 figs., approx. 250 pages

108 Laser Resonators and Beam Propagation
Fundamentals, Advanced Concepts and Applications
By N. Hodgson and H. Weber, 2005, 497 figs., approx. 790 pages