

## Table of Contents

---

<b>Glossary of Symbols</b>	<b>x</b>
<b>Atmospheric Structure</b>	<b>1</b>
Atmospheric Structure	1
Atmospheric Structure with Altitude	2
Absorption and Scattering	3
Transmittance, Optical Depth, and Visibility	4
Meteorological Phenomena	5
<b>Kolmogorov Theory of Turbulence</b>	<b>6</b>
Kolmogorov Theory of Turbulence	6
Classical Turbulence	7
Velocity Fluctuations	8
Temperature Fluctuations	9
Optical Turbulence	10
Structure Parameter and Inner Scale	11
$C_n^2$ Profile Models	12
Power Spectrum Models	13
<b>Optical Wave Models in Free Space</b>	<b>14</b>
Optical Wave Models in Free Space	14
Paraxial Wave Equation	15
Plane Wave and Spherical Wave Models	16
Gaussian-Beam Wave at Transmitter	17
Gaussian-Beam Wave at Receiver	18
Hermite-Gaussian Beam Wave	19
Laguerre-Gaussian Beam Wave	20
Example	21
<b>Atmospheric Propagation: Second-Order Statistics</b>	<b>22</b>
Atmospheric Propagation: Second-Order Statistics	22
Rytov Approximation	23
Extended Huygens-Fresnel Principle	24
Parabolic Equation Method	25
Mean Irradiance and Beam Spreading	26
Beam Wander	27
Spatial Coherence Radius: Plane Wave	28
Spatial Coherence Radius: Spherical Wave	29

---

## Table of Contents

---

Spatial Coherence Radius: Gaussian-Beam Wave	30
Fried's Parameter and the Phase Structure Function	31
Angle-of-Arrival and Image Jitter	32
Example	33
Example	34
<b>Atmospheric Propagation: Fourth-Order Statistics</b>	<b>35</b>
Atmospheric Propagation: Fourth-Order Statistics	35
Rytov Approximation: Fourth-Order Specializations	36
Scintillation Index: Theory	37
Scintillation Index: Plane Wave	38
Scintillation Index: Spherical Wave	39
Scintillation Index: Gaussian-Beam Wave	40
Covariance Function: Plane Wave	41
Temporal Power Spectrum: Plane Wave	42
Aperture Averaging: Plane Wave	43
Aperture Averaging: Spherical Wave	44
Example	45
<b>Imaging Systems and Adaptive Optics</b>	<b>46</b>
Imaging Systems and Adaptive Optics	46
Fried's Atmospheric Parameter and Greenwood's Time Constant	47
Point Spread Function and Modulation Transfer Function	48
Spatial Resolution	49
Strehl Ratio and Image Resolving Power	50
Isoplanatic Angle and Point-Ahead Angle	51
Zernike Polynomials and Wave Front Representation	52
Zernike Polynomials for Atmospheric Imaging	53
Modal Expansion and Aperture Filter Functions	54
Zernike Tilt, Piston, and Angle-of Arrival Jitter	55
<b>Free Space Optical Communication Systems</b>	<b>56</b>
Free Space Optical Communication Systems	56
Direct Detection System	57

---

## Table of Contents

---

Threshold Detection	58
Signal-to-Noise Ratio: Direct Detection	59
Bit Error Rate	60
Coherent Detection System	61
Signal-to-Noise Ratio: Coherent Detection	62
Probability of Fade: Lognormal Model	63
Probability of Fade: Gamma-Gamma Model	64
Lasersatcom: Mean Irradiance and Beam Spreading	65
Lasersatcom: Uplink Scintillation under Weak Fluctuations	66
Lasersatcom: Downlink Scintillation under Weak Fluctuations	67
Lasersatcom: General Theory for Uplink/Downlink Scintillation	68
Lasersatcom: General Theory for Downlink Covariance and Correlation Width	69
<b>Laser Radar and Optical Remote Sensing</b>	<b>70</b>
Laser Radar and Optical Remote Sensing	70
Basic Radar Principles	71
Statistical Characteristics of Echo Beam	72
Enhanced Backscatter: Spherical Wave	73
Enhanced Backscatter: Gaussian-Beam Wave	74
Spatial Coherence	75
Scintillation Index: Spherical Wave and Point Target	76
Scintillation Index: Gaussian-Beam Wave and Point Target	77
Scintillation Index: Smooth Target	78
Scintillation Index: Diffuse Target—I	79
Scintillation Index: Diffuse Target—II	80
<b>Appendix</b>	<b>81</b>
Equation Summary	81
Notes	87
<b>Bibliography</b>	<b>89</b>
<b>Index</b>	<b>91</b>

---