

## CONTENTS

Translator's preface . . . . .	iii
Author's preface . . . . .	v

### Part I

#### SOME TOPICS FROM THE THEORY OF RANDOM FIELDS

#### AND TURBULENCE THEORY

INTRODUCTORY REMARKS . . . . .	1
Chapter 1. METHODS FOR STATISTICAL DESCRIPTION OF CONTINUOUS RANDOM FIELDS . . .	3
1.1 Stationary random functions . . . . .	3
1.2 Random functions with stationary increments . . . . .	8
1.3 Homogeneous and isotropic random fields . . . . .	15
1.4 Locally homogeneous and isotropic random fields . . . . .	19
Chapter 2. THE MICROSTRUCTURE OF TURBULENT FLOW . . . . .	27
Introductory Remarks . . . . .	27
2.1 Onset and development of turbulence . . . . .	27
2.2 Structure functions of the velocity field in developed turbulent flow .	29
2.3 Spectrum of the velocity field in turbulent flow . . . . .	34
Chapter 3. MICROSTRUCTURE OF THE CONCENTRATION OF A CONSERVATIVE PASSIVE ADDITIVE IN A TURBULENT FLOW . . . . .	40
3.1 Turbulent mixing of conservative passive additives . . . . .	40
3.2 Structure functions and spectral functions of the field of a conservative passive additive in a turbulent flow . . . . .	44

3.3	Locally isotropic turbulence with smoothly varying mean characteristics . . .	51
3.4	Microstructure of the refractive index in a turbulent flow . . . . .	55

## Part II

### SCATTERING OF ELECTROMAGNETIC AND ACOUSTIC WAVES

#### IN THE TURBULENT ATMOSPHERE

Chapter 4.	SCATTERING OF ELECTROMAGNETIC WAVES IN THE TURBULENT ATMOSPHERE . . . .	59
	Introductory Remarks . . . . .	59
4.1	Solution of Maxwell's equations . . . . .	59
4.2	The mean intensity of scattering . . . . .	64
4.3	Scattering by inhomogeneous turbulence . . . . .	69
4.4	Analysis of various scattering theories . . . . .	70
4.5	Evaluation of the size of refractive index fluctuations from data on the scattering of radio waves in the troposphere . . . . .	77
Chapter 5.	THE SCATTERING OF SOUND WAVES IN A LOCALLY ISOTROPIC TURBULENT FLOW . .	81

## Part III

### PARAMETER FLUCTUATIONS OF ELECTROMAGNETIC AND ACOUSTIC WAVES

#### PROPAGATING IN A TURBULENT ATMOSPHERE

INTRODUCTORY REMARKS . . . . .	91
Chapter 6. SOLUTION OF THE PROBLEM OF AMPLITUDE AND PHASE FLUCTUATIONS OF A PLANE MONOCHROMATIC WAVE BY USING THE EQUATIONS OF GEOMETRICAL OPTICS . . . .	93
6.1 Derivation and solution of the equations of geometrical optics . . . . .	93
6.2 The structure function and the spectrum of the phase fluctuations of the wave	97
6.3 Solution of the equations of geometrical optics by using spectral expansions	102
6.4 Amplitude and phase fluctuations of a wave propagating in a locally isotropic turbulent flow . . . . .	110

6.5	A consequence of the law of conservation of energy . . . . .	113
6.6	Amplitude and phase fluctuations of sound waves . . . . .	115
6.7	Limits of applicability of geometrical optics . . . . .	120
Chapter 7. CALCULATION OF AMPLITUDE AND PHASE FLUCTUATIONS OF A PLANE MONOCHROMATIC		
WAVE FROM THE WAVE EQUATION USING THE METHODS OF "SMALL" AND "SMOOTH"		
	PERTURBATIONS . . . . .	122
7.1	Solution of the wave equation by the method of small perturbations . . . .	122
7.2	The equations of the method of smooth perturbations . . . . .	124
7.3	Solution of the equations of the method of "smooth" perturbations by using spectral expansions . . . . .	128
7.4	Qualitative analysis of the solutions . . . . .	137
7.5	Amplitude and phase fluctuations of a wave propagating in a locally isotropic turbulent medium . . . . .	150
7.6	Relation between amplitude and phase fluctuations and wave scattering . .	156
Chapter 8. PARAMETER FLUCTUATIONS OF A WAVE PROPAGATING IN A TURBULENT MEDIUM WITH		
	SMOOTHLY VARYING CHARACTERISTICS . . . . .	164
Chapter 9. AMPLITUDE FLUCTUATIONS OF A SPHERICAL WAVE . . . . .		
		173

#### Part IV

#### EXPERIMENTAL DATA ON PARAMETER FLUCTUATIONS OF LIGHT AND SOUND WAVES PROPAGATING IN THE ATMOSPHERE

Chapter 10. EMPIRICAL DATA ON FLUCTUATIONS OF TEMPERATURE AND WIND VELOCITY IN THE		
	LAYER OF THE ATMOSPHERE NEAR THE EARTH AND IN THE LOWER TROPOSPHERE . .	189
Chapter 11. EXPERIMENTAL DATA ON THE AMPLITUDE AND PHASE FLUCTUATIONS OF SOUND WAVES		
	PROPAGATING IN THE LAYER OF THE ATMOSPHERE NEAR THE EARTH . . . . .	198

Chapter 12. EXPERIMENTAL INVESTIGATION OF THE SCINTILLATION OF TERRESTRIAL LIGHT	
SOURCES . . . . .	206
Introductory Remarks . . . . .	206
12.1 The probability distribution function of the fluctuations of light intensity	208
12.2 Dependence of the amount of scintillation on the distance and on the meteorological conditions . . . . .	210
12.3 The correlation function of the fluctuations of light intensity in the plane perpendicular to the ray . . . . .	212
12.4 Frequency spectra of the fluctuations of the logarithm of the light intensity (theory) . . . . .	215
12.5 Frequency spectrum of fluctuations of light intensity (experimental results)	219
Chapter 13. TWINKLING AND QUIVERING OF STELLAR IMAGES IN TELESCOPES . . . . .	224
APPENDIX . . . . .	258
NOTES AND REMARKS . . . . .	260
REFERENCES . . . . .	280