# I. THE STATISTICS OF SPECKLE PATTERNS

by J. C. DAINTY (London)

1. INTRODUCTION
2. NORMAL SPECKLE PATTERNS
2.1 First order statistics
2.2 Second order statistics
2.3 Statistics of the measured intensity
3. Partially Coherent Illumination
3.1 Spatial coherence – Fraunhofer plane
3.2 Spatial coherence – image plane
3.3 Temporal coherence
4. SURFACE-DEPENDENT FEATURES OF SPECKLE PATTERNS
4.1 Depolarising surfaces
4.2 A small number of scatterers
4.3 Slightly rough surfaces
5. Concluding Remarks
ACKNOWLEDGEMENTS
References

#### II. HIGH RESOLUTION TECHNIQUES IN OPTICAL ASTRONOMY by A. LABEYRIE (Meudon)

0.1 Introduction	49 50 51 51
0.2 History.	50 51 51
1. ATMOSPHERIC OPTICS	51 51
1.1 The atmospheric beterogeneity	51
1.2 Wave deformations and shadow patterns	53
1.3 The speckled structure of images	53
1.4 The MTF for short and long exposures	58
2. Direct Interferometry	59
2.1 Basic principles	59
2.2 Visibility modulus determination.	61
2.3 Quantum noise	63
3. Interferometer Designs and Results	64
3.1 The Fizeau and Michelson interferometers	64
3.2 Photoelectric Fizeau interferometers	66
3.3 The speckle interferometer	69
3.4 Interferometry with two telescopes	73

4.	THE IMAGE RECONSTRUCTION PROBLEM	. 76
	4.1 The visibility phase problem with direct interferometry	. 76
	4.2 The triple interferometer	. 78
	4.3 The seeing compensation approach	. 78
5.	CONSTRUCTION OF A SYNTHETIC-APERTURE ARRAY OF OPTICAL TELESCOPES	. 79
6.	INTENSITY INTERFEROMETRY.	. 82
7.	HETERODYNE INTERFEROMETRY	. 84
8.	Conclusions	. 84
Rı	EFERENCES.	. 85

## III. RELAXATION PHENOMENA IN RARE-EARTH LUMINESCENCE

by L. A. RISEBERG (Waltham, Massachusetts) and M. J. WEBER (Livermore California)

1. ]	NTRODUCTION																				91
2.	HISTORICAL DEVELOPMENTS.																				93
2	2.1 Spectra																				93
2	2.2 Relaxation																				95
3.	RARE-EARTH ENERGY LEVELS																				98
4.	Excitation and Decay in R.	AR	E-	E٨	AR]	гн	Sy	YST	ſEN	<b>4</b> S											102
5.	RADIATIVE DECAY																				106
	5.1 Theory																				106
	5.1.1 Electric-dipole trans	sit	io	ns	: J	ud	ld-	-0	fel	t t	he	or	y.								106
	5.1.2 Magnetic-dipole and	d (	ele	ect	ric	⊳q	ua	dr	up	ol	e t	ra	nsi	tic	ons	s.					109
:	5.2 Experimental results																				111
6.	MULTIPHONON RELAXATION.																				116
4	5.1 Introduction																				116
	5.2 Theory																				117
	5.3 Experimental results																				124
	6.3.1 Temperature depen	de	nc	e																	124
	6.3.2 Energy gap depende	en	ce																		127
	6.3.3 Host dependence.																				129
	6.3.4 5d $\rightarrow$ 4f relaxation																				132
7.	COOPERATIVE RELAXATION .																				133
	7.1 Ion-ion energy transfer.																				133
	7.1.1 Introduction																				133
	7.1.2 Theory																				135
	7.1.3 Energy migration.																				141
	7.2 Experimental results																				142
8.	SELECTED APPLICATIONS													•							150
	8.1 Upconversion phosphors																				151
	8.2 Lasers																				154
9.	CONCLUDING REMARKS																				155
RE	FERENCES																				156

## IV. THE ULTRAFAST OPTICAL KERR SHUTTER by M. A.DUGUAY (Murray Hill, New Jersey)

1.	INTRODUCTION										163
2.	THE ULTRAFAST OPTICAL KERR SHUTTER										165
	2.1 Gating in $CS_2$ .									•	165
	2.2 Gating in nitrobenzene										169
	2.3 Gating with subpicosecond pulses .										170

XIV

	2.4 Gating in glass	3
	2.5 Time response	1
	2.6 Collinear gating	4
	2.7 Self-focusing	5
	2.8 Transverse gating	5
3.	Ultrahigh Speed Photography	7
	3.1 Light photographed in flight	7
	3.2 Gated picture ranging	)
	3.3 Ultrahigh speed framing photography	2
4.	SAMPLING OPTICAL SIGNALS	3
	4.1 Fluorescence lifetime measurements	3
	4.2 The echelon technique	5
	4.3 The optical sampling oscilloscope (OSO)	5
	4.4 Multichannel sampling with detector arrays	8
5.	CONCLUDING REMARKS	1
A	CKNOWLEDGEMENTS	2
RI	EFERENCES	2

# V. HOLOGRAPHIC DIFFRACTION GRATINGS

by G. SCHMAHL and D. RUDOLPH (Göttingen)

1. INTRODUCTION	197
2. THEORETICAL CHARACTERISTICS OF SPECTROSCOPIC DIFFRACTION GRATINGS	198
3. BASIC PRINCIPLES OF HOLOGRAPHIC DIFFRACTION GRATINGS	200
3.1 Interference fringe system.	201
3.1.1 Accuracy of the interference fringe system	201
3.1.2 Interference arrangements	207
3.1.3 Improvement of the ruling accuracy by superposition of identical recon-	
structed wavefronts.	207
3.1.4 Frequency and wavelength stability of the laser light	213
3.2 Photoresist layers	214
4 PRODUCTION OF HOLOGRAPHIC GRATINGS.	216
4.1 Gratings with symmetrical groove profiles	217
4.2 Gratings with asymmetrical groove profiles	219
5. PROPERTIES OF HOLOGRAPHIC GRATINGS AND COMPARISON WITH CLASSICAL GRATINGS	223
5.1 Wavefront interferogram, resolution and instrumental profile of plane gratings	224
5.2 Scattered light	226
5.3 Efficiency	228
5.4 X-ray gratings.	232
5.5 Gratings with imaging properties	235
6. FURTHER IMPROVEMENTS OF HOLOGRAPHIC GRATINGS.	242
Acknowledgments	242
References	242

# VI. PHOTOEMISSION

by P. J. Vernier (Dijon)

1.	INTRODUCTION	247
	1.1 The 3-step model	248
2.	THEORETICAL BASIS OF THE PE	250
	2.1 Calculation of the density of absorbed photons (DAP) from the bulk dielectric	
	constant	250

## CONTENTS ·

	2.2 Dielectric constant and microscopic processes in a solid	252
	2.2.1 Collective motion of the electrons	253
	2.2.2 Collective motion of the ions	253
	2.2.3 One-electron excitations (direct transitions)	253
	2.2.4 One-electron excitations (non-direct transitions)	255
	2.3 Photoexcitation coefficient	255
	2.4 Fresnel equations and the DAP	256
	2.4.1 Validity of the Fresnel equations and spatial dispersion	258
	2.4.2 Validity of the Fresnel equations, surface roughness and plasma oscillations	260
	2.5 Surface photoexcitation.	261
	2.5.1 Surface photoexcitation from bulk states (SPBS)	261
	2.5.2 Photoexcitation from surface states	262
	2.5.3 Surface absorption, Fresnel equations and DAP	263
	2.6 The electron escape probability	263
	2.6.1 Coulomb repulsion between electrons	264
	2.6.2 Phonon scattering	267
	2.6.3 Electron-hole recombination.	268
	2.6.4 Transmission by the surface	268
	2.7 Theoretical determination of the escape probability	270
	2.7.1 Electron–electron interaction and the ballistic approximation.	270
	2.7.2 Diffusion equation and electron-hole recombination in negative electron	
	affinity (NEA) photocathodes	272
	2.7.3 De-excitation of photoelectrons by phonon scattering only.	273
	2.7.4 De-excitation of photoelectrons by both phonon and electron-electron	
		274
	2.7.5 The escape probability and analysis of the experimental data	275
	2.8 Photoemission and many-body effects	2/5
2	2.9 One-step theories of photoemission	211
3.	EXPERIMENTAL DETERMINATION OF THE ESCAPE DEPTH OF THE PHOTOELECTRONS	2/9
	5.1 Estimation of the escape depth from the variation of the ratio of from $X^+$ to have	280
	5.2 Estimation of the escape depin from the variation of the ratio of front $T$ to back	201
	I yield versus the thickness $z_0$ of thin films $\ldots$ $\ldots$ $\ldots$ $\ldots$ $\ldots$	201
	5.5 Estimation of the escape depth from the variation of the photoyield of thin films	701
	2.4 Estimation of the accord doubth from the healt and front nhotoxialds of one thin	204
	5.4 Estimation of the escape depth from the back and from photoyleids of one thin film	206
	25 Estimation of the essence denth from the variation of the photoviald with the	200
	angle of incidence	288
	3.6 Estimation of the escape depth from the PE of substrate through a coating layer	200
	3.7 Non-photoelectric methods	290
	3.8 Escape depth in negative electron affinity (NEA) photocathodes	295
	3.9 Estimation of the escape denth from hand bending considerations	299
	3.10 Estimation of the elastic escape depth for high energy electrons	302
4	SURFACE PHOTOFXCITATION	305
	4.1 Detection of a surface effect from the thickness dependence of the photovield	505
	of thin films	306
	4.2 Detection of a surface effect from the polarization dependence of the photovield	307
	4.3 Evidence for a surface photoemission from the spectral yield distribution	312
	4.4 Evidence for the photoemission from surface states obtained from photoelectron	
	energy distributions.	314
5.	Conclusion	319
Ac	KNOWLEDGEMENT	321
RE	FERENCES.	321

XVI

## VII. OPTICAL FIBRE WAVEGUIDES – A REVIEW by P. J. B. Clarricoats (London)

1.	INTR	ODUCTION	329
2.	Fibr	es with Core and Cladding Possessing Uniform Refractive Index	331
	2.1	Introduction	331
	2.2	Characteristic equation	333
	2.3	Approximate solutions of the characteristic equation	334
	2.4	Ray interpretation	338
	2.5	Validity of core and cladding mode approximations.	339
	2.6	Group delay and pulse dispersion in the absence of mode coupling	342
	2.7	Fields	350
	2.8	Power flow	352
	2.9	Attenuation due to a lossy layer	354
	2.10	Leaky modes.	357
	2.11	Attenuation due to bends	363
	2.12	Mode coupling due to perturbations	366
	2.13	Coupling due to bends	366
	2.14	Mode coupling and pulse dispersion.	369
	2.15	Reduction of pulse dispersion by intentional inhomogeneities.	374
	2.16	Excitation	375
		2.16.1 Incoherent.	375
		2.16.2 Coherent	376
3	Fibr	ES WITH NON-UNIFORM REFRACTIVE INDEX	381
5.	31	Introduction	381
	3.2	The W-fibre	382
	33	Graded index fibres	383
	5.5	3 3 1 General remarks	383
		3.3.2 Fibres with parabolic index variation	384
		3.3.3 Impulse response of graded index fibres	389
	34	Fibres with ring-shaped refractive index profiles	306
	3.5	Conclusions	300
Δ	2.5 ~VNO		400
R	EDEDE	WEEDOLMENTS	400
IU	SPERD	NCE3	400
A	UTH	OR INDEX	403
SU	JBJE	CT INDEX	412
CI	UMU	JLATIVE INDEX VOLUMES I-XIV	420

XVII