I. OPTICAL WAVEGUIDE DIFFRACTION GRATINGS: COUPLING BETWEEN GUIDED MODES

by DENNIS G. HALL (ROCHESTER, NY, USA)

§ 1. INTRODUCTION	3
§ 2. Uses for Waveguide Gratings	5
2.1. General discussion	5
2.2. Interactions between guided waves	8
	3
§ 3. MODES SUPPORTED BY PLANAR OPTICAL WAVEGUIDES	4
	4
	22
· · · · · · · · · · · · · · · · · · ·	23
3.4. Radiation modes of the step-index waveguide	26
v	29
•	30
· · · · · · · · · · · · · · · · · · ·	32
· · · · · · · · · · · · · · · · · · ·	39
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	12
	16
5.5. Local normal mode expansion and coupled-mode equations (TM) 4	19
5.6. Summary of coupled-mode treatments	53
5.7. Perturbative treatment	54
5.8. TE-TM mode conversion	58
§ 6. SUMMARY	59
LIST OF SYMBOLS	60
References	52

II. ENHANCED BACKSCATTERING IN OPTICS

by YU.N. BARABANENKOV (MOSCOW, USSR), YU.A. KRAVTSOV (MOSCOW, USSR), V.D. OZRIN (MOSCOW, USSR) and A.I. SAICHEV (NIZHNI NOVGOROD, USSR)

§1.	INTRODUCTION	67
§ 2.	. Enhanced Backscatter from Solids Immersed in a Turbulent Medium	69
	2.1. Absolute effect of enhanced backscatter: A point transmitter and a point	
	scatterer in a turbulent medium	69
	2.1.1. Pure effect of enhanced backscatter	69
	2.1.2. A phase screen	72
	2.1.3. Spatial redistribution of the scattered intensity	72

	2.1.		74
	2.1.		74
	2.1.	.6. A lens interpretation of backscatter enhancement	75
	2.1.	in an and the second se	
		effects	76
	2.1.		79
	2.1.		
	2.1	tion of the intensity	82
	2.1.	10. Scattering from small inhomogeneities in a turbulent medium: A hybrid approach	84
	21	11. Polarization effects	87 87
	2.1. 2.7. 2.1.	tended transmitters, scatterers and receivers	87
-	2.2. EX		87
	2.2.		0/
		fluctuations of intensity	91
	2.2.	3. Effect of extended size of a reflector	92
	2.2.		95
	2.2.		- 95 - 98
	2.2.		101
	2.2.		101
	2.2.		110
	2.2.		110
2		lection from wavefront-reversing mirrors embedded in a random inhomo-	110
-		eous medium	111
	2.3.		111
	2101	reflected wave	111
	2.3.		
		focusing	113
	2.3.		115
		mirrors	117
	2.3.		
		inhomogeneities by a WFR mirror	119
§ 3. I	Enhang	CED BACKSCATTERING BY A RANDOM MEDIUM	123
3	3.1. Ove	erview	123
3	3.2. Gei	neral theory of multiple scattering: Ladder and maximally crossed diagrams	125
3	8.3. Tra	insfer equation and enhanced backscattering	135
3	3.4. Ang	gular distribution of backscattered intensity	139
3	3.5. Dif	fusion approximation	142
3	3.6. Pol	arization effects	148
3	3.7. Coł	herent backscattering in the presence of time-reversal noninvariant media	162
	3.7.		163
	3.7.		166
3	8.8. Coł	herent effects in the average field: Influence on backscatter intensity envelope	167
§4. 1	MULTIP	ATH COHERENT EFFECTS IN SCATTERING FROM A LIMITED CLUSTER OF	
5	SCATTE	RERS	168
4	1.1. Enh	nanced backscattering from a particle	168
	4.1.	1. Single particle near an interface	168
	4.1.	2. Combined action of a rough surface, turbulence and multipath coherent	
		effects	170
	4.1.	3. Existence of backscatter enhancement under time-varying conditions	171

XVI

4.1.4. Kettler effect	
4.1.5. Particle in a waveguide	
4.2. Enhanced backscattering by a system of two scatterers	
4.2.1. Watson equations (scalar problem)	
4.2.2. Polarization effects	i.
4.3. More involved scatterer system and geometries	
4.3.1. Cluster of N scatterers: Paired and single scattering channels 176	,
4.3.2. Scattering by bodies of intricate geometries	1
4.3.3. Coherent effects in diffraction by large bodies	
§ 5. Enhanced Backscattering from Rough Surfaces	i.
5.1. Trend to intensity peaking in the antispecular direction	i.
5.2. Backscatter enhancement involving surface waves	,
§ 6. Related Effects in Allied Fields of Physics	,
6.1. Enhanced backscattering in acoustics	,
6.2. Effects in the radio wave band	1
6.3. Other effects of double passage through random media	5
6.4. Coherent backscattering of particles from disordered media	\$
§ 7. CONCLUSION	,
Acknowledgment)
R EFERENCES	J

III. GENERATION AND PROPAGATION OF ULTRASHORT OPTICAL PULSES

by I.P. CHRISTOV (SOFIA, BULGARIA)

§1.	INTRODUCTION	201
§ 2.	Theoretical Background	202
	2.1. Propagation of optical pulses through a resonant medium	202
	2.2. Propagation in a transparent linear medium	209
	2.2.1. Regular pulses	209
	2.2.2. Partially coherent pulses	212
	2.3. Nonlinear propagation of optical pulses	213
	2.3.1. Regular pulses	213
	2.3.2. Partially coherent pulses	218
§ 3.	GENERATION OF FEMTOSECOND OPTICAL PULSES	220
	3.1. Broadband media	220
	3.2. Mode-locking techniques	221
	3.2.1. Passive mode-locking	222
	3.2.2. Synchronously pumped mode-locked (SPML) lasers	227
	3.2.3. Miscellaneous techniques	231
	3.3. Amplification of femtosecond pulses	235
	3.4. Pulse compression	239
§ 4.	PROPAGATION EFFECTS	244
	4.1. Free-space propagation	245
	4.1.1. Regular pulses	245
	4.1.2. Partially coherent pulses	247
	4.2. Transmission through optical components	249
	4.2.1. Ray-optics approach	250
	4.2.2. Wave-optics approach	253

XVII

4.3. Propagation through dispersive systems	256
4.3.1. Temporal modes representation of a propagating pulse	256
4.3.2. Propagation of a short pulse in a dispersive medium	257
4.3.3. Pulse shaping	261
4.4. Propagation in a nonlinear medium	269
4.4.1. Formation of bright solitons	269
4.4.2. Formation of dark solitons	271
4.4.3. The soliton self-frequency shift	274
4.4.4. Nonlinear propagation of chirped and noise pulses	275
4.5. Femtosecond pulses in information systems	276
4.5.1. Soliton-based communication systems	276
4.5.2. Image processing by optical pulses	279
§ 5. Conclusion	284
Acknowledgments	284
References	284

IV. TRIPLE-CORRELATION IMAGING IN OPTICAL ASTRONOMY

by G. Weigelt (Bonn, Fed. Rep. Germany)

§1.	INTRODUCTION	295
§ 2.	SPECKLE MASKING: BISPECTRUM OR TRIPLE CORRELATION PROCESSING	296
§ 3.	Objective Prism Speckle Spectroscopy	309
§4.	WIDEBAND PROJECTION SPECKLE SPECTROSCOPY	309
§ 5.	Optical Long-Baseline Interferometry and Aperture Synthesis	311
§6.	CONCLUDING REMARKS	315
ACK	NOWLEDGMENT	316
Appe	$\mathbf{MDIX} \mathbf{A} \dots \dots$	316
Refe	RENCES	317

V. NONLINEAR OPTICS IN COMPOSITE MATERIALS

1. Semiconductor and Metal Crystallites in Dielectrics

by C. FLYTZANIS, F. HACHE, M.C. KLEIN, D. RICARD and PH. ROUSSIGNOL (Palaiseau, France)

§ 1. INTRODUCTION	323
§ 2. FABRICATION AND CHARACTERIZATION TECHNIQUES	325
2.1. Fabrication techniques	325
2.1.1. Metal crystallites	325
2.1.2. Semiconductor crystallites	327
2.2. Characterization techniques	331
2.2.1. Structure and size determination	331
2.2.2. Optical techniques	334
§ 3. Confinement Effects	338
3.1. Basic model	338
3.2. Dielectric confinement	339
3.2.1. Linear regime: Effective-medium approach	339
3.2.2. Nonlinear regime	341

XVIII

3.3. Quantum confinement	345
3.3.1. Basic model	345
3.3.2. Quantum-confined states and wave functions	350
3.3.2.1. Metal crystallites	351
3.3.2.2. Semiconductor crystallites	353
3.3.3. Level broadening	356
3.3.3.1. Metal crystallites	356
3.3.3.2. Semiconductor crystallites	359
§ 4. Nonlinear Optical Properties of Metal Composites	368
§ 5. Nonlinear Optical Properties of Semiconductor Composites: Theory	375
§ 6. Nonlinear Optical Properties of Semiconductor Composites: Experimen-	
TAL STUDIES	383
6.1. Large semiconductor crystallites	384
6.1.1. Frequency and intensity dependence of optical nonlinearities	384
6.1.2. Temporal evolution of optical processes: Photodarkening	390
6.2. Quantum-confined crystallites	399
6.2.1. Enhancement of the optical Kerr effect	399
6.2.2. Electroabsorption: Static Stark shift and Franz-Keldysh effect	401
§ 7. Conclusions and Extensions	404
References	406
Author Index	413
Subject Index	427
CUMULATIVE INDEX, VOLUMES I-XXIX	431

xix