



# CONTENTS

CONTRIBUTORS	xi
FOREWORD	xiii
PREFACE	xv
CONTENTS OF VOLUME 15, PART A . . . . .	xvii
CONTRIBUTORS TO VOLUME 15, PART A . . . . .	xix
6. Color Center Lasers	
by LINN F. MOLLENAUER	
6.1. Introduction . . . . .	1
6.2. Some Pertinent Color Center Physics . . . . .	2
6.2.1. General. . . . .	2
6.2.2. The F Center . . . . .	3
6.2.3. $F_A$ (II) Centers. . . . .	4
6.2.4. $F_B$ (II) Centers . . . . .	7
6.2.5. $F_2^+$ Centers . . . . .	9
6.2.6. Systems with a Pair of Spins . . . . .	12
6.3. Processes for Color Center Formation . . . . .	13
6.3.1. Apologia . . . . .	13
6.3.2. Additive Coloration . . . . .	14
6.3.3. F Center Aggregation . . . . .	16
6.3.4. The U Center . . . . .	17
6.3.5. Dynamics of the Two-Photon Coloration Process	18
6.3.6. $F_2^+$ Formation. . . . .	20
6.4. Optical Gain	22
6.4.1. The Problem of Self-Absorption. . . . .	23
6.4.2. Some Useful Gain Formulas . . . . .	24

6.5. Laser Cavities with a Highly Concentrated Modal Beam	25
6.6. Construction and Performance of a cw Laser Using F <sub>A</sub> (II) Centers	28
6.6.1. Basic Configuration . . . . .	28
6.6.2. Tuning Elements . . . . .	30
6.6.3. Alignment	32
6.6.4. Crystal Preparation . . . . .	32
6.6.5. F <sub>A</sub> (II) Center Stability . . . . .	33
6.6.6. Performance	34
6.7. Generation and Performance of a Distributed-Feedback Laser Using F <sub>A</sub> (II) Centers . . . . .	37
6.7.1. General	37
6.7.2. Creation of the Grating. . . . .	38
6.7.3. Performance of the DFB Laser . . . . .	39
6.8. Recent Developments in F <sub>2</sub> <sup>+</sup> Center Lasers . . . . .	41
6.8.1. Enhanced Production of F <sub>2</sub> <sup>+</sup> Centers through Use of a Two-Step Photoionization and Extrinsic Electron Traps . . . . .	41
6.8.2. F <sub>2</sub> <sup>+</sup> Center Lasers in the Hosts KF and LiF . .	45
6.8.3. Mode-Locking of F <sub>2</sub> <sup>+</sup> Center Lasers . . . . .	48
6.8.4. Possible Future Developments . . . . .	50
6.A. Appendix: Technique for the Piecewise Interferometric Generation of Gratings . . . . .	51
<b>7. Molecular Lasers</b>	
<b>7.1. Molecular Infrared Lasers</b>	
by T. MANUCCIA	
7.1.1. Introduction . . . . .	55
7.1.2. Basic Physics . . . . .	58
7.1.3. Device Configurations . . . . .	75
7.1.4. New Transitions . . . . .	83
<b>7.2. Rare Gas Halide Lasers</b>	
by S. K. SEARLES	
7.2.1. Introduction . . . . .	86

7.2.2. Mechanism	87
7.2.3. Apparatus	88
7.2.4. Results	90
8. Chemically Pumped Lasers	
by TERRILL A. COOL	
8.1. Introduction . . . . .	95
8.2. Disequilibrium in Reaction Product Energy States . . .	97
8.3. Supersonic Chemical Lasers . . . . .	102
8.3.1. The HF (DF) and CO Chemical Lasers . . . . .	105
8.4. New Purely Chemical Lasers . . . . .	111
8.4.1. A Purely Chemical Electronic Transition Laser .	111
8.4.2. Purely Chemical HCl and HCl-CO <sub>2</sub> Lasers . .	114
8.4.3. A Candidate for a Purely Chemical Laser at Visible Wavelengths . . . . .	115
8.5. Rotational Chemical Lasers . . . . .	116
8.6. Problems in the Search for New Chemical Lasers . . .	120
8.6.1. Kinetic Considerations in Chemical Laser Operation at Short Wavelengths. . . . .	121
8.6.2. Rare Gas Monohalide Excimer Lasers . . . . .	125
8.6.3. Promising Reaction Systems . . . . .	126
8.6.4. Special Initiation Techniques . . . . .	135
8.6.5. An Ideal Reaction Mechanism for an Efficient Visible Chemical Laser. . . . .	139
8.7. Conclusion. . . . .	140
9. Nonlinear Optical Devices	
by F. ZERNIKE	
9.1. Introduction	143
9.2. General	144
9.2.1. The Nonlinear Polarization . . . . .	144
9.2.2. The Coupled Amplitude Equations . . . . .	148
9.2.3. Phase Matching . . . . .	151
9.2.4. Other Phase-Matching Methods . . . . .	156

9.2.5.	Large-Signal Conversion . . . . .	159
9.2.6.	Focused Beams . . . . .	161
9.2.7.	Interactions with Short Pulses . . . . .	164
9.2.8.	Output Angle . . . . .	165
9.2.9.	Intracavity Generation . . . . .	166
9.2.10.	Effects That Reduce the Efficiency . . . . .	167
9.3.	Parametric Oscillators . . . . .	168
9.3.1.	Introduction . . . . .	168
9.3.2.	Threshold . . . . .	168
9.3.3.	Risetime . . . . .	169
9.3.4.	Pump Power and Damage Threshold . . . . .	170
9.3.5.	Conversion Efficiency . . . . .	170
9.3.6.	Tuning and Linewidth . . . . .	172
9.4.	Generation by Mixing of Two Inputs . . . . .	174
9.4.1.	UV and Near IR . . . . .	174
9.4.2.	Mid- and Far-Infrared . . . . .	181
9.5.	Upconversion . . . . .	183
10.	Examples of Laser Techniques and Applications	
10.1.	Picosecond Spectroscopy by E. P. IPPEN and C. V. SHANK	
10.1.1.	Introduction . . . . .	185
10.1.2.	Picosecond Pulse Sources . . . . .	185
10.1.3.	Pulse Measurement Techniques . . . . .	198
10.1.4.	Applications . . . . .	201
10.2.	VUV Spectroscopy by J. J. WYNNE	
10.2.1.	Introduction . . . . .	210
10.2.2.	Multiphoton Processes and Resonant Enhancement . . . . .	211
10.2.3.	VUV Generation . . . . .	216
10.2.4.	Spectroscopic Studies Using VUV Generation . . . . .	222

10.2.5.	Multiphoton Absorption and Ionization Spectroscopy . . . . .	226
10.2.6.	Conclusion . . . . .	229
10.2.7.	Further Developments . . . . .	230
10.3. Doppler-Free Laser Spectroscopy by P. F. LIAO and J. E. BJORKHOLM		
10.3.1.	Introduction . . . . .	232
10.3.2.	Saturation Spectroscopy . . . . .	233
10.3.3.	Two-Photon Absorption without Doppler Broadening . . . . .	238
10.3.4.	Laser-Induced Line Narrowing . . . . .	243
10.3.5.	Conclusion . . . . .	248
10.4. Nonlinear Optical Effects by Y. R. SHEN		
10.4.1.	Introduction . . . . .	249
10.4.2.	Fundamentals of Nonlinear Optics . . . . .	250
10.4.3.	Nonlinear Susceptibilities . . . . .	252
10.4.4.	Nonlinear Optical Processes . . . . .	255
10.5. Laser-Selective Chemistry by JAMES T. YARDLEY		
10.5.1.	Introduction . . . . .	269
10.5.2.	Chemistry, Spectroscopy, and Laser Excitation . . . . .	270
10.5.3.	Chemical Kinetics . . . . .	278
10.5.4.	Relaxation Processes . . . . .	283
10.5.5.	Selective Chemistry by Electronic Excitation .	288
10.5.6.	Selective Chemistry by Vibrational Excitation	294
	Bibliography . . . . .	297
AUTHOR INDEX FOR PART A . . . . .		299
AUTHOR INDEX FOR PART B . . . . .		311
SUBJECT INDEX FOR PART A . . . . .		325
SUBJECT INDEX FOR PART B . . . . .		333