

Dye Lasers: 25 Years

Edited by Michael Stuke

With 151 Figures

Springer-Verlag

Berlin Heidelberg New York London Paris

Tokyo Hong Kong Barcelona Budapest

Contents

1. Femtosecond Broadband Absorption Spectroscopy of Photodissociating Molecules	
By J. Glowonia, J. Misewich, R. Walkup, M. Kaschke and P. Sorokin (With 12 Figures)	1
1.1 Probing the Dissociation Process: TII Transient Spectra . . .	3
1.2 “Impact” and “Statistical” Transient Absorption Spectra. . .	6
1.3 Extracting the Difference Potential.	8
1.4 Examples of “Statistical” Spectra: Bi ₂	11
1.5 Conclusions	17
References.	17
2. Dye Lasers and Laser Dyes in Physical Chemistry	
By F.P. Schäfer (With 22 Figures).	19
2.1 The Wavelength Limits of Dye Lasers.	19
2.2 Limitations by Radiationless Transitions	23
2.3 The Smallest and Largest Dye Lasers	26
2.4 Increasing the Efficiency of Dye Lasers	30
2.5 Photodegradation of Laser Dyes	33
References.	36
3. Single-Atom Experiments and the Test of Fundamental Quantum Physics	
By H. Walther (With 10 Figures)	37
3.1 Overview	37
3.2 The One-Atom Maser	39
3.3 Dynamics of a Single Atom	41
3.4 A New Source of Nonclassical Light	42
3.5 Experimental Results – A Nonclassical Beam of Atoms . . .	44
3.6 A New Probe of Complementarity in Quantum Mechanics .	50
3.7 Summary and Conclusion	54
References.	55
4. Regioselective Photochemistry in Weakly Bonded Complexes	
By S. K. Shin, Y. Chen, E. Böhmer and C. Wittig (With 9 Figures)	57
4.1 Introduction	57

4.2 End-On CO_2 -HCl and Broadside CO_2 -HBr.	61
4.2.1 Product State Distributions	64
4.2.2 Time-Resolved Product Buildup.	65
4.2.3 Theoretical Considerations	65
4.3 N_2O -HI: OH + N_2 vs. NH + NO.	68
4.3.1 Product State Distributions	69
4.3.2 The Product Branching Ratio: OH + N_2 vs. NH + NO	71
4.4 Future Experiments.	72
4.5 Conclusion.	74
References.	74
5. Novel Resonator Design for Femtosecond Lasers	
By V. Magni, S. De Silvestri, A. Cybo-Ottone, M. Nisoli and O. Svelto (With 6 Figures)	77
5.1 Introduction	77
5.2 One-Folding Resonators.	78
5.3 Two-Folding Resonators.	82
5.4 Conclusions	85
References.	86
6. Distortion of Femtosecond Pulse Fronts in Lenses	
By Z. Bor and Z.L. Horváth (With 4 Figures)	87
6.1 Diffraction of a Femtosecond Pulse by a Dispersive Lens . .	87
6.2 Results of the Calculations	89
6.2.1 Distortion of the Pulse Front	89
6.2.2 Boundary Wave Pulse on the Optical Axis	90
6.2.3 Pulse Shape in the Focus.	91
6.2.4 Intensity Distribution in the Focal Plane	91
6.2.5 Intensity Distribution in a Plane Neighboring the Focal Plane.	92
6.3 Conclusions	93
References.	94
7. Infrared Dye Lasers for the Wavelength Range 1–2 μm	
By T. Elsaesser and W. Kaiser (With 8 Figures)	95
7.1 Photophysics of Infrared Dyes	95
7.2 Infrared Dye Lasers	98
7.2.1 Nanosecond Infrared Dye Lasers	99
7.2.2 Synchronously Pumped Picosecond and Subpicosecond Systems	99
7.2.3 Picosecond Dye Lasers Pumped in a Traveling-Wave Geometry	101
7.2.4 Nonlinear Frequency Conversion with Infrared Dye Lasers	106
References.	108

8. Propagation of Femtosecond Light Pulses Through Dye Amplifiers	
By B. Wilhelmi (With 13 Figures)	111
8.1 Introduction	111
8.2 Interaction in the Rate-Equation Approximation	116
8.3 Interaction of Very Short Light Pulses with Dye Solutions	117
8.4 Chirped and Stretched Pulse Amplification.	121
8.5 Conclusions	125
References.	126
9. Terawatt-Class Hybrid Dye/Excimer Lasers	
By S. Szatmári (With 5 Figures).	129
9.1 Input Pulse Generation by Pulsed Lasers.	130
9.2 Short-Pulse Amplification Properties of Excimers	132
9.3 Critical Issues for a TW Excimer Amplifier.	133
9.4 Spatially Evolving Chirped-Pulse Amplification	134
9.5 Off-Axis Amplification and Phase-Locked Multiplexing	136
References.	140
10. Blue-Green Dye Laser Seeded Operation of a Terawatt Excimer Amplifier	
By F.K. Tittel, T. Hofmann, T.E. Sharp, P.J. Wisoff, W.L. Wilson and G. Szabó (With 5 Figures)	141
10.1 Introduction	141
10.2 Dye Laser System	142
10.2.1 Oscillator Section	142
10.2.2 High-Performance Subpicosecond Dye Amplifier System	144
10.3 XeF(C-A) Experiments	146
10.3.1 Experimental Arrangement	146
10.3.2 Gain Measurements.	146
10.3.3 Energy Extraction.	148
10.4 Conclusions.	150
References.	151
11. Atomic Optics with Tunable Dye Lasers	
By V.S. Letokhov (With 9 Figures)	153
11.1 Introduction and History.	153
11.2 Radiation Force Acting on Atoms in a Resonant Light Field	155
a) Plane Wave	155
b) Gaussian Laser Beam	156
c) Plane Standing Light Wave.	157
11.3 Collimation.	157
11.4 Focusing an Atomic Beam; Imaging an Atomic Source.	159
11.5 Atomic Beam Reflection	162

11.6 Conclusion and Prospects	165
References.	166
12. Laser Spectroscopy of Small Molecules	
By V. Beutel, G. Bhale, W. Demtröder, H.-A. Eckel, J. Gress and M. Kuhn (With 10 Figures)	169
12.1 Introduction	169
12.2 Determination of Singlet-Triplet Potentials of Alkali Molecules	170
12.3 Isotope-Selective Spectroscopy of Ag ₂ Dimers	172
12.4 Sub-Doppler Spectroscopy of the Sodium Cluster	176
References.	180
13. In Situ Gas-Phase Diagnostics	
by Coherent Anti-Stokes Raman Scattering	
By W. Richter (With 9 Figures)	183
13.1 Introduction	183
13.2 Coherent Anti-Stokes Raman Scattering.	184
13.3 Experimental Considerations	185
13.4 Experimental Results	189
13.5 Summary and Conclusions.	192
References.	194
14. High-Resolution Spectroscopy at Short Wavelengths	
Using Pulsed Dye Lasers	
By S. Svanberg (With 5 Figures)	195
14.1 Generation of UV/VUV Radiation	196
14.1.1 Sum-Frequency Generation in Crystals	196
14.1.2 Frequency Conversion in Gases.	196
14.2 High-Resolution Laser Spectroscopy Using Pulsed Dye Lasers	197
14.2.1 Optical Double Resonance Experiments.	197
14.2.2 Level-Crossing Measurements.	197
14.2.3 Quantum-Beat Measurements.	199
14.2.4 Time-Resolved Studies on Atoms Formed by Short-Wavelength Dissociation	200
14.3 Conclusion	201
References.	202
15. Doppler-Free Spectroscopy of Large Polyatomic Molecules	
and van der Waals Complexes	
By H.J. Neusser, E. Riedle, T. Weber and E.W. Schlag (With 5 Figures)	205
15.1 Introduction	205
15.2 Doppler-Free Two-Photon Spectroscopy of Benzene	205

15.3 Doppler-Free UV Spectroscopy of Benzene–Noble-Gas van der Waals Clusters	209
15.4 Summary and Conclusion	211
References.	212
16. Electro-optic and Photoconductive Sampling of Ultrafast Photodiodes with Femtosecond Laser Pulses	
By J. Kuhl, M. Klingenstein, M. Lambsdorff, J. Rosenzweig, C. Moglestue and A. Axmann (With 8 Figures).	213
16.1 Introduction	213
16.2 Photoconductive Switches	213
16.3 Electro-optical Sampling	217
16.4 Characterization of MSM Photodiodes	218
16.4.1 MSM Schottky Photodetectors	218
16.4.2 Monte Carlo Simulation of the Transport.	219
16.4.3 Experimental Results	221
16.5 Conclusion	223
References.	223
17. Ultrafast Spectroscopy of Plasmas Generated by Very Intense Femtosecond Dye Laser Pulses	
By D. von der Linde (With 6 Figures)	225
17.1 Experimental.	226
17.2 Characteristics of the Reflected Light	228
17.3 Collinear Pump–Probe Experiments	230
17.4 Non-collinear Pump–Probe Experiments	231
17.5 Conclusions.	234
References.	234
18. Dye Laser Spectroscopy of Isolated Atoms and Ions in Liquid Helium	
By G. zu Putlitz and M. R. Beau (With 5 Figures).	237
18.1 Effects of Pressure on Spectral Lines.	237
18.2 Impurities in Liquid Helium.	239
18.3 Experiments	242
18.4 Spectroscopic Results.	244
18.5 Conclusions and Outlook	246
References.	246