

INDICE

C. PELLEGRINI - Preface	pag. xi
F. A. HOPF - Introduction to high-energy lasers.	
0. Introduction	» 1
1. Overview	» 3
2. Basic theory	» 13
3. Pulsed operation	» 29
4. Flow lasers.	» 43
5. Molecular lasers and kinetics.	» 48
6. Electronic-transition fusion lasers.	» 69
Appendix A. - CW processes in laser oscillators	» 77
Appendix B. - Cross-relaxation in degenerate levels.	» 79
Appendix C.	» 81
Appendix D.	» 83
R. BADESCU - Laser-fusion and laser-plasma interactions.	
1. The laser-fusion process	» 86
2. Stimulated scattering processes.	» 90
3. Absorption mechanisms	» 98
S. SINGER, C. JAMES ELLIOTT, J. FIGUEIRA, I. LIBERMAN, J. V. PARKER and G. T. SCHAPPERT - High-power, short-pulse CO ₂ laser systems for inertial-confinement fusion.	
1. Introduction and basic concepts (S. SINGER)	» 115
1'1. Basic principles of laser operation	» 116
1'2. The amplification process; the Franz-Nodvik solution	» 119
1'3. The electron-beam-controlled CO ₂ laser	» 123
2. Short-pulse oscillators (J. FIGUEIRA)	» 126
2'1. Introduction	» 126
2'2. Oscillator design	» 126
2'3. High-speed switching techniques.	» 129
2'4. Electro-optic switches.	» 135
2'5. Oscillator performance	» 138

3.	Retropulse protection (J. V. PARKER)	pag. 142
3'1.	Introduction	» 142
3'2.	Optical breakdown and its application	» 146
3'3.	Passive retropulse protection by optical breakdown . .	» 156
3'4.	Active retropulse protection by optical breakdown . .	» 159
3'5.	Optical breakdown enhanced by spatial overlap.	» 160
4.	Suppression of small-signal gain (J. FIGUEIRA)	» 165
4'1.	Introduction	» 165
4'2.	Faraday rotators.	» 166
4'3.	Saturable absorbers.	» 169
5.	Power amplifiers (G. T. SCHAPPERT)	» 176
5'1.	Introduction	» 176
5'2.	Absorption and emission of the CO ₂ molecule.	» 176
5'2.1.	The dipole moment and transition probabilities	» 177
5'3.	Pulse propagation in a two-level system	» 179
5'3.1.	Schrödinger's equation	» 180
5'3.2.	Maxwell's equations	» 181
5'3.3.	Rate equation limit	» 181
5'4.	Pulse propagation equations for CO ₂ amplifiers	» 182
5'4.1.	Degeneracy	» 182
5'4.2.	Rate equations and rotational relaxation.	» 183
6.	Amplifiers: the electron-beam-controlled laser amplifier (S. SINGER)	» 185
6'1.	Electron guns	» 185
6'2.	Thermionic cathodes	» 186
6'3.	Plasma cathodes	» 188
6'4.	The recombination-limited plasma	» 194
7.	Amplifiers: molecular kinetics (S. SINGER).	» 196
7'1.	The electron distribution function	» 197
7'2.	The excitation cross-section	» 199
7'3.	De-excitation processes	» 200
7'4.	The «four-temperature» model	» 202
7'5.	Efficiency and gas mix considerations	» 207
8.	Parasitic oscillations in high-gain laser fusion systems (C. JAMES ELLIOTT).	» 211
8'1.	Nature of the problem	» 211
8'2.	Fast-rising gain	» 212
8'3.	Oscillation modes inside multipass amplifiers	» 216
8'4.	Target modes	» 223
9.	Alignment techniques (I. LIBERMAN)	» 226
9'1.	Visible-alignment techniques.	» 226
9'2.	Beam transport alignment systems.	» 229
9'3.	Collinear CO ₂ alignment laser	» 232
9'4.	Target alignment methods.	» 234
9'5.	<i>In situ</i> target location verification	» 240
9'6.	The transmitting IR microscope.	» 241

E. E. FILL – The high-power iodine laser.

1. Introduction	pag. 245
2. Fundamentals of the iodine laser.	» 246
2'1. Basic pumping mechanism	» 246
2'2. Spectroscopy of the iodine atom.	» 248
2'3. Iodine laser kinetics	» 251
3. Pulse propagation in iodine laser amplifiers	» 255
4. A description of the 1 TW iodine laser Asterix III	» 264
5. Conclusion	» 271

K. L. KOMPA – High-power tunable lasers and their applications to photochemistry and isotope separation.

1. Introduction: chemical applications of high-power lasers	» 274
2. High-power infra-red lasers	» 277
3. Tunable infra-red lasers	» 280
4. Laser-induced vibrational photochemistry: what are the new possibilities?	» 280
5. Isotope separation by lasers	» 297
6. UV lasers and UV laser photochemistry	» 301
7. Some practical considerations	» 302

S. DE SILVESTRI, O. SVELTO and F. ZARAGA – Photophysical and photochemical properties of gaseous UF₆.

1. Introduction	» 310
2. Vibrational modes of UF ₆	» 310
3. Rotational modes of UF ₆	» 315
4. The ν ₃ spectrum of UF ₆	» 318
5. Laser isotope separation schemes of UF ₆	» 321
6. Electronic absorption spectrum of gaseous UF ₆	» 323
7. Fluorescence properties of the electronic states	» 326
8. Conclusions.	» 334

S. MARTELLUCCI and S. SOLIMENO – High-power 16 micro-metre lasers for uranium isotope separation.

1. Introduction	» 337
2. Physical principles	» 339
3. 16 μm laser approaches	» 341
4. Recent results and perspectives	» 344

S. SOLIMENO and S. MARTELLUCCI – High-power chemical lasers.

1. Introduction	pag. 349
2. Physical principles	» 351
3. Chemical-reaction systems	» 354
4. High-energy and high-power chemical lasers.	» 358
5. Continuous-flow combustion lasers	» 359
6. Laser modelling	» 360
6'1. Electric dipoles for diatomic molecules	» 361
6'2. Line width and resonance broadening	» 362
6'3. Information-theoretical approach.	» 365
6'4. Laser theory: cascade and relaxation effects	» 365

S. STENHOLM – Single-particle theory of the free-electron laser.

1. Introduction	» 370
2. The model	» 373
3. Some physical properties	» 376
Appendix A	» 382
Appendix B	» 383

G. T. MOORE, M. O. SCULLY, F. A. HOPF and P. MEYSTRE – Coherent dynamics of the free-electron laser.

1. Introduction	» 385
2. Single-mode theory and linear gain.	» 390
3. Recoil, spread and saturation in the single-mode laser	» 393
4. The pulsed FEL	» 397
5. Free-electron echoes.	» 405

A. RENIERI – The free-electron laser: the storage ring operation.

I. Introduction	» 414
II. Single-particle dynamics in storage ring—An overview	» 416
2.1. Introduction	» 416
2.2. Storage ring layout.	» 416
2.3. Transverse electron motion for a monoenergetic beam	» 418
2.4. Off-energy transverse motion	» 422
2.5. Longitudinal motion	» 423
2.6. The damping—General formulation	» 428
2.7. Synchrotron radiation excitation.	» 429
2.8. Transverse beam dimension	» 432

III.	Single-particle free-electron laser theory	pag. 435
3.1.	Introduction	» 435
3.2.	Spontaneous Thomson scattering.	» 436
3.3.	Inhomogeneous broadening of the backscattered radiation	» 438
3.4.	Stimulated Thomson scattering—Single-particle theory	» 443
3.5.	Stimulated Thomson scattering—Laboratory frame representation	» 449
3.6.	Small-signal gain for a FEL operating in a SR.	» 455
IV.	The free-electron laser. The storage ring operation	» 457
4.1.	Introduction	» 457
4.2.	Longitudinal-motion equations.	» 458
4.3.	Laser rate equations	» 460
4.4.	Steady-state operation mode	» 460
4.5.	Average FEL power and efficiency	» 467
4.6.	Conclusions	» 470
Appendix A.	- Magnetic-field pattern in the transverse plane	» 470
Appendix B.	» 471
Appendix C.	- Small-signal approximation	» 471
Appendix D.	- Emittance generated by the FEL interaction	» 473
Appendix E.	- Small-signal regime operation mode	» 475