

# Solutions Manual Principles Of Lasers Orazio Svelto

Principles of Lasers Principles of Lasers Principles of Lasers Springer Handbook of Lasers and Optics Problems in Laser Physics Experimentelle Realisierung von neuen Konzepten für Hochleistungs-Nd:YVO<sub>4</sub>-Laser bei 1342 nm Lasers and Their Applications Beam Weapons Laser und Optoelektronik Frontiers in Guided Wave Optics and Optoelectronics The Laser Guidebook Journal of Bioenergetics and Biomembranes Laser Focus National Union Catalog Laser Focus with Fiberoptic Technology Conference on Lasers and Electro-optics Europe Infrared Technology Lasers & Applications Journal of the Optical Society of America National Union Catalog, 1982 Orazio Svelto Orazio Svelto Orazio Svelto Frank Trüger Giulio Cerullo Florian Lenhardt Phoenix Walsh Jeff Hecht Bishnu Pal Jeff Hecht Optical Society of America Principles of Lasers Principles of Lasers Principles of Lasers Springer Handbook of Lasers and Optics Problems in Laser Physics Experimentelle Realisierung von neuen Konzepten für Hochleistungs-Nd:YVO<sub>4</sub>-Laser bei 1342 nm Lasers and Their Applications Beam Weapons Laser und Optoelektronik Frontiers in Guided Wave Optics and Optoelectronics The Laser Guidebook Journal of Bioenergetics and Biomembranes Laser Focus National Union Catalog Laser Focus with Fiberoptic Technology Conference on Lasers and Electro-optics Europe Infrared Technology Lasers & Applications Journal of the Optical Society of America National Union Catalog, 1982 *Orazio Svelto Orazio Svelto Orazio Svelto Frank Trüger Giulio Cerullo Florian Lenhardt Phoenix Walsh Jeff Hecht Bishnu Pal Jeff Hecht Optical Society of America*

this fifth edition of principles of lasers includes corrections to the previous edition as well as being the first available as an ebook its mission remains to provide a broad unified description of laser behavior physics technology and applications

this book is the result of more than ten years of research and teaching in the field of quantum electronics the purpose of the book is to introduce the principles of lasers starting from elementary notions of quantum mechanics and electromagnetism because it is an introductory book an effort has been made to make it self contained to minimize the need for reference to other works for the same reason the references have been limited whenever possible either to review papers or to papers of seminal importance the organization of the book is based on the fact that a laser can be thought of as consisting of three elements i an active material ii a pumping system and iii a suitable resonator accordingly after an introductory chapter the next three chapters deal respectively with the interaction of radiation with matter pumping processes and the theory of passive optical resonators

this new edition features numerous updates and additions especially 4 new chapters on fiber optics integrated optics frequency combs and interferometry reflect the changes since the first edition in addition major complete updates for the chapters optical materials and their properties optical detectors

nanooptics and optics far beyond the diffraction limit features contains over 1000 two color illustrations includes over 120 comprehensive tables with properties of optical materials and light sources emphasizes physical concepts over extensive mathematical derivations chapters with summaries detailed index delivers a wealth of up to date references

this book presents the first comprehensive collection of solved problems in laser physics covering both fundamental and applied aspects of laser science and technology the framework of the book including structuring of topics and notations closely follows that adopted in the principles of laser book by professor o svelto the collection of problems presented in this book appears therefore a natural complement to svelto s textbook for testing and developing the skills acquired in the reading of the theory however it may also be a useful support to any general textbook on laser physics wherein problems are usually not solved in detail we remark that this is to our knowledge the first book to provide a complete and satisfactory set of solved problems in such a highly developing field of science and technology the problems fall mainly into three distinct categories i numerical applied problems which help the reader to become confident and familiar with the basic concepts and methods of laser physics and to acquire a feeling for numerical parameters entering in real world laser systems ii complementary problems that present in detail demonstrations of some analytical parts not given in the textbook and iii advanced problems aimed either to provide a deeper understanding of the subject or to cover more recent developments in the field audience this book is primarily intended for undergraduate and graduate students in physics engineering and chemistry however it may also be a useful tool for industrial professionals working in the field of laser technologies and laser applications as well as for researchers interested in basic aspects of real world lasers and related fields

inhalt dieser arbeit ist die entwicklung und charakterisierung von leistungsstarken kontinuierlich emittierenden nanosekunden und pikosekunden 1342 nm lasern basierend auf dem festkörperlaser nd:yvo<sub>4</sub> für solche kompakte und effiziente diodenlaser gepumpte festkörperlaser bei 1342 nm finden sich eine vielzahl von anwendungen wie zum beispiel in der faseroptik oder in der medizin vor allem die zweite und dritte harmonische der 1342 nm strahlung die bei 671 nm und 447 nm und damit im roten und blauen spektralbereich liegen eröffnen weitere große anwendungsfelder speziell für wellenlängen sensitive prozesse im sichtbaren für die erzeugung der 1342 nm laserstrahlung wird der  $4f3\ 2\ 4i13\ 2$  übergang in nd:yvo<sub>4</sub> ausgenutzt dieser weist einen geringeren wirkungsquerschnitt für die stimulierte emission auf als der stärkste übergang bei einer wellenlänge von 1064 nm die ausgangsleistung von 1342 nm lasern war bisher durch den sehr hohen wärmeeintrag bei 1342 nm emission in den laserkristall begrenzt aufgrund des hohen quantendefekts und der zusätzlich auftretenden excited state absorption tragen 40 der absorbierten pumpleistung direkt zur erwärmung des kristalls bei dies führt zu sehr starken thermisch induzierten linsen und im extremfall zur zerstörung des laserkristalls durch die optische anregung bei 888 nm und das verwenden eines niedrig dotierten 30 mm langen nd:yvo<sub>4</sub> kristalls kann die wärmelast auf ein großes volumen verteilt werden dadurch wird die verwendung hoher pumpleistungen von bis zu 110 w ohne zerstörung des kristalls möglich und die thermisch induzierte linse wird erheblich reduziert durch eine numerische simulation der thermo optischen und thermo mechanischen eigenschaften des laserkristalls und die experimentelle bestimmung der brennweite der thermischen linsen ist es möglich einen resonator zu entwickeln der stabilen modenangepassten laserbetrieb erlaubt

mit Hilfe dieses Pumpkonzepts kann ein Laser realisiert werden, der kontinuierlich eine beugungsbegrenzte Strahlung bei einer maximalen Ausgangsleistung von 24 W emittiert. Bisher gibt es keine leistungsstarken Dauerstrich-Strahlquellen im roten Spektralbereich, die auf der Frequenzverdopplung der Strahlung eines Festkörperlaser bei 1,3  $\mu\text{m}$  basieren. Dies ist auf das Fehlen geeigneter Laser bei 1,3  $\mu\text{m}$  zurückzuführen. Aufbauend auf dieser Dauerstrich-Strahlquelle bei 1342 nm kann mittels externer Frequenzverdopplung in magnesiumoxid dotiertem periodisch gepolten Lithiumniobat (MgO:PPLN) effizient Strahlung bei 671 nm erzeugt werden. Die Effizienz beträgt hierbei 51%, was einer Leistung von 10 W entspricht. Mit Hilfe aktiver Güteschaltung durch einen akusto-optischen Modulator (AOM) ist es möglich, den gegebenen Dauerstrich-ND-YVO<sub>4</sub>-Laser für die Emission von Nanosekundenimpulsen mit sehr hohen Impulsspitzenleistungen von bis zu 108 kW zu modifizieren. Durch eine Verkürzung des Resonators kann dabei eine minimale Impulsdauer von 14,8 ns erreicht werden. Die mittlere Ausgangsleistung liegt je nach Repetitionsrate zwischen 10 W und 20 W. Der Laser ist dabei für den Repetitionsratenbereich zwischen 6 kHz und 30 kHz optimiert. Weshalb er für diese Repetitionsraten stabilen Betrieb im gaußschen Grundmode aufweist, die hohen Spitzenleistungen und sehr gute Strahlqualität des vorgestellten ns-ND-YVO<sub>4</sub>-Lasers gewährleisten eine effiziente Erzeugung der zweiten und dritten Harmonischen in Wismutborat (BiBO) beziehungsweise Lithiumtriborat (LiBO). Es werden dabei mittlere Ausgangsleistungen von 12,2 W bei 671 nm und 6,8 W bei 447 nm erzeugt. Dies entspricht hohen Konversionseffizienzen von 62% und 49%. Die Ausgangsleistungen für ps-Laser bei 1342 nm sind bisher zum einen aufgrund der thermischen Problematik bei 1342 nm, aber vor allem wegen des Fehlens von geeigneten Modenkopplungsverfahren bei 1342 nm beschränkt. Das Verfahren der parametrischen Kerrlinsen-Modenkopplung (PKLM) basiert auf einer dem Kerr-Effekt äquivalenten Linsenwirkung, die durch einen kaskadierten 2-Prozess in einem nichtlinearen Kristall erzeugt wird. Mit PKLM wurde in der Vergangenheit stabile cw-Modenkopplung bei 1064 nm erreicht. Daher kann durch die in dieser Arbeit vorgestellte Übertragung dieses Verfahrens auf eine Emissionswellenlänge von 1342 nm eine Möglichkeit der Leistungsskalierung aufgezeigt werden. Der vorgestellte Pikosekunden-ND-YVO<sub>4</sub>-Laser bei 1342 nm weist selbststartende cw-Modenkopplung mittels PKLM auf. Dabei ist kein Anzeichen für cw-Untergrund der modengekoppelten Strahlung erkennbar. Zur Umwandlung der Phasenmodulation in eine Verlustmodulation wird eine Modenblende verwendet. Dadurch wird eine mittlere Ausgangsleistung der modengekoppelten Strahlung von bis zu 6,5 W bei einer Impulsdauer von 20 ps erreicht. Eine maximale Impulsspitzenleistung von 7,3 kW wird bei einer mittleren Ausgangsleistung von 4,8 W und einer Impulsdauer von 4 ps emittiert. Die Modenkopplung ist dabei über mehrere Stunden stabil ohne Anzeichen von Einbrüchen. Das System stellt damit den ersten mittels reiner PKLM-Modengekoppelten Laser bei 1342 nm dar. Durch externe Frequenzverdopplung des ps-ND-YVO<sub>4</sub>-Lasers in einem kurzen MgO:PPLN-Kristall wird eine mittlere Ausgangsleistung von 2,28 W im roten Spektralbereich bei einer Konversionseffizienz von 49% erzeugt. Zum anderen kann dadurch das Fehlen von cw-Untergrund in der modengekoppelten Strahlung bestätigt werden. Die vorliegenden Arbeiten belegen, dass mit Hilfe der optischen Anregung bei 888 nm und der Analyse der thermischen Eigenschaften des Lasermaterials eine Leistungsskalierung von Lasern bei 1342 nm möglich ist. Basierend auf einem leistungsstarken Dauerstrich-Laser können mittels AOM ns-Impulse und mit dem PKLM-Verfahren ps-Impulse erzeugt werden. Zudem kann durch die Frequenzverdopplung und Frequenzverdreifachung der 1342 nm-Laser leistungsstarke Strahlung im sichtbaren Spektralbereich erzeugt werden.

a laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation the term laser originated as an acronym for light amplification by stimulated emission of radiation laser applications provides a firm grounding in the fundamental concepts governing the field on optics this reference book is useful for the students of b e b tech and m tech courses the present book is an attempt to treat the subject of laser as an introductory course with recent major breakthroughs in ultrafast laser technology and femtosecond nonlinear spectroscopic techniques femtosecond laser spectroscopy is currently a burgeoning field in many branches of science including physics chemistry biology and materials science attempts have also been made to cover the frontline areas in the subject the development of laser and its various applications in communications radiation medicine holography etc has been given due importance

beam weapons examines the directed energy weapons that became a central part of the reagan administration's strategic defense initiative better known as star wars first published in 1984 it describes the science and technology behind directed energy weapons the state of the art at the time reagan launched the program and the military issues involved the first full length book published on the topic it exhaustively documents the technical and military realities and uncertainties

as the editor i feel extremely happy to present to the readers such a rich collection of chapters authored co authored by a large number of experts from around the world covering the broad field of guided wave optics and optoelectronics most of the chapters are state of the art on respective topics or areas that are emerging several authors narrated technological challenges in a lucid manner which was possible because of individual expertise of the authors in their own subject specialties i have no doubt that this book will be useful to graduate students teachers researchers and practicing engineers and technologists and that they would love to have it on their book shelves for ready reference at any time

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