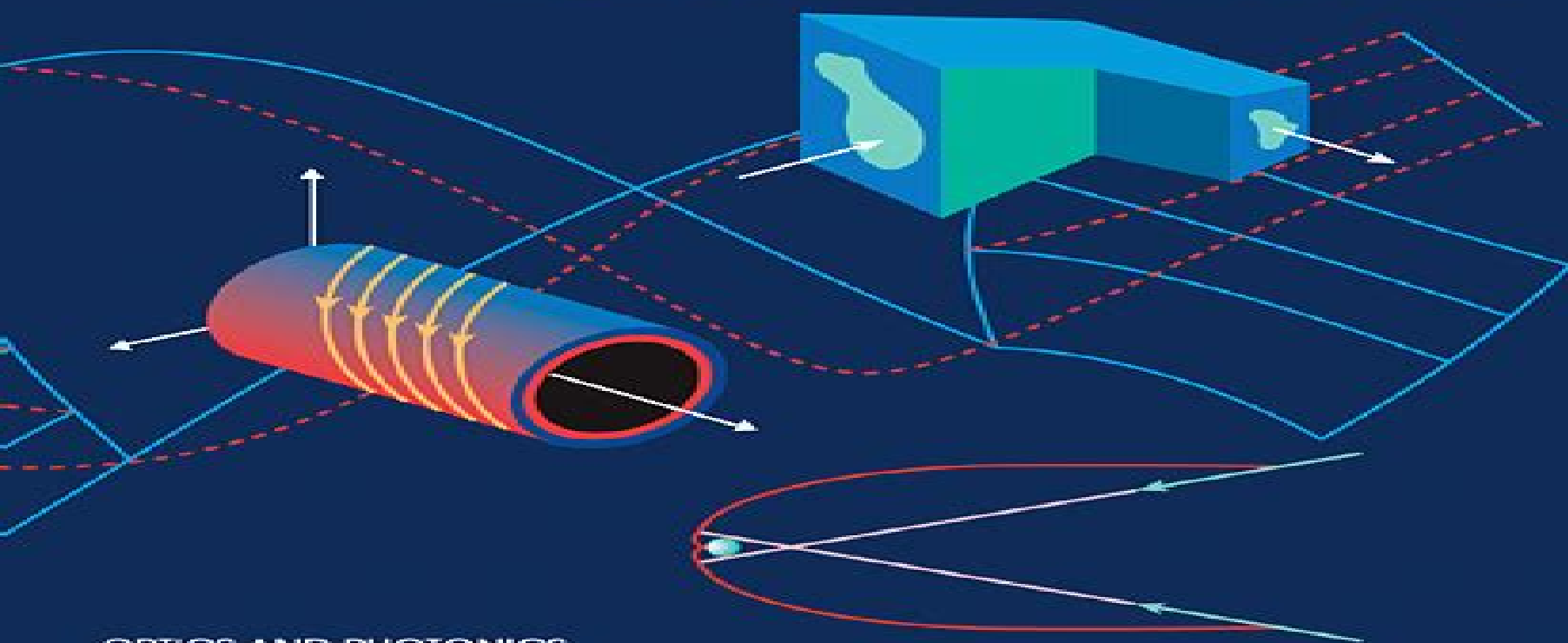




# NONIMAGING OPTICS

ROLAND WINSTON  
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*With contributions by*  
Narkis Shatz and John C. Bortz



OPTICS AND PHOTONICS

# Nonimaging Optics

**R. John Koshel**



## Nonimaging Optics:

*Nonimaging Optics* Roland Winston, Juan C. Minano, Pablo G. Benitez, 2005-01-05 Publisher Description [Introduction to Nonimaging Optics](#) Julio Chaves, 2008-05-22 The world's insatiable consumption of energy must be met with new technologies that offer alternative environmentally conscious sources of light and power The relatively young field of nonimaging optics is an ideal tool for designing optimized solar energy collectors and illumination optics and holds great promise in the development of solid state lighting **Nonimaging Optics** Roland Winston, Lun Jiang, Vladimir Olier, 2020-10-07 This book provides a comprehensive look at the science methods designs and limitations of nonimaging optics It begins with an in depth discussion on thermodynamically efficient optical designs and how they improve the performance and cost effectiveness of solar concentrating and illumination systems It then moves into limits to concentration imaging devices and their limitations and the theory of furnaces and its applications to optical design Numerous design methods are discussed in detail followed by chapters of estimating the performance of a nonimaging design and pushing their limits of concentration Exercises and worked examples are included throughout *Nonimaging Optics in Solar Energy* Joseph O'Gallagher, 2008-08-11 Nonimaging optics is a subdiscipline of optics whose development over the last 35 40 years was led by scientists from the University of Chicago and other cooperating individuals and institutions The approach provides a formalism that allows the design of optical devices that approach the maximum physically attainable geometric concentration for a given set of optical tolerances This means that it has the potential to revolutionize the design of solar concentrators In this monograph the basic practical applications of the techniques of nonimaging optics to solar energy collection and concentration are developed and explained The formalism for designing a wide variety of concentrator types such as the compound parabolic concentrator and its many embodiments and variations is presented Both advantages and limitations of the approach are reviewed Practical and economic aspects of concentrator design for both thermal and photovoltaic applications are discussed as well The whole range of concentrator applications from simple low concentration nontracking designs to ultrahigh concentration multistage configurations is covered Table of Contents Introduction CPCs Practical Design of CPC Thermal Collectors Practical Design of CPC PV Concentrators Two Stage Nonimaging Concentrators for Solar Thermal Applications Two Stage Nonimaging Concentrators for Solar PV Applications Selected Demonstrations of Nonimaging Concentrator Performance The Importance of Economic Factors in Effective Solar Concentrator Design Ultrahigh Concentration Bibliography [Introduction to Nonimaging Optics, Second Edition](#) Julio Chaves, 2015-08-18 *Introduction to Nonimaging Optics* covers the theoretical foundations and design methods of nonimaging optics as well as key concepts from related fields This fully updated revised and expanded Second Edition Features a new and intuitive introduction with a basic description of the advantages of nonimaging optics Adds new chapters on wavefronts for a prescribed output irradiance or intensity infinitesimal étendue optics generalization of the aplanatic optics and Köhler optics

and color mixing Incorporates new material on the simultaneous multiple surface SMS design method in 3 D integral invariants and tendue 2 D Contains 21 chapters 24 fully worked and several other examples and 1 000 illustrations including photos of real devices Addresses applications ranging from solar energy concentration to illumination engineering Introduction to Nonimaging Optics Second Edition invites newcomers to explore the growing field of nonimaging optics while providing seasoned veterans with an extensive reference book *High Collection Nonimaging Optics* W.T.

Welford,2012-12-02 High Collection Nonimaging Optics covers the many developments and the wider range of applications of nonimaging optics This book is organized into 11 chapters that emphasize the application of nonimaging optics to concentrators for solar energy This text begins with discussions on the development of formalisms in nonimaging optics specifically in the use of geometrical vector flux concept which have led to entirely different concentrator designs These topics are followed by a description of the so called compound parabolic concentrator the prototype of a series of nonimaging concentrators that approach very close to being ideal and having the maximum theoretical concentration ratio The next chapters examine the concept of the flow line approach to nonimaging concentration the geometrical optics model of nonimaging optics and constructional tolerances and manufacturing methods for nonimaging optical components A chapter highlights the applications of concentrator designs to solar energy concentrations The last chapter surveys the applications of nonimaging optics to optical system design and to instrument design with particular reference to utilization of light sources with maximum efficiency This book will be of great benefit to nonimaging optics scientists and design engineers

**Illumination Engineering** R. John Koschel,2012-11-27 This book brings together experts in the field who present material on a number of important and growing topics including lighting displays solar concentrators The first chapter provides an overview of the field of nonimaging and illumination optics Included in this chapter are terminology units definitions and descriptions of the optical components used in illumination systems The next two chapters provide material within the theoretical domain including etendue squeezing and the skew invariant The remaining chapters focus on growing applications This entire field of nonimaging optics is an evolving field and the editor plans to update the technological progress every two to three years The editor John Koschel is one of the most prominent leading experts in this field and he is the right expert to perform the task **Nonimaging Fresnel Lenses** Ralf Leutz,Akio Suzuki,2012-12-06

Nonimaging Fresnel Lenses Design and Performance of Solar Concentrators what are we talking about It is easy to forget that you dear reader may not be one of those who work in exactly the same field as we do nonimaging optics for the concentration of sunlight You may be a researcher in some optical science interested in the core subject of this book the world's first practical design of a nonimaging Fresnel lens concentrator You may not be too excited about the collection of solar energy but you would want a full description of the optical performance of the lens Which you will get mostly in terms of nonimaging optics complete with test results and set against the competition of imaging Fresnel lenses and mirror based

imaging and nonimaging concentrators If you are a solar energy professional you are likely to be interested in reading why nonimaging optics and solar energy coBection go together so weB They do so because the concentration of solar energy does not demand imaging qualities but instead requires flexible designs of highly uniform flux concentrators coping with solar disk size solar spectrum and tracking errors Nonimaging optics has been developed to perfection since its discovery in 1965 in dealing with solar power conversion Much of this experience is useful in nonimaging optical design in other fields where the markets already are more rewarding than in solar power generation such as optoelectronics [Nonimaging Fresnel Lenses](#) Ralf Leutz,Akio Suzuki,2001-07-31 A detailed and comprehensive account of the engineering of the world s first nonimaging Fresnel lens solar concentrator The book closes a gap in solar concentrator design and describes nonimaging refractive optics and its numerical mathematics The book shows the reader how to find his or her own optical solution using the rules and methodologies covering the design and the assessment of the nonimaging lens **Handbook of Optics, Third Edition Volume II: Design, Fabrication and Testing, Sources and Detectors, Radiometry and Photometry** Michael Bass,Casimer DeCusatis,Jay M. Enoch,Vasudevan Lakshminarayanan,Guifang Li,Carolyn MacDonald,Virendra N. Mahajan,Eric Van Stryland,2009-10-06 The most comprehensive and up to date optics resource available Prepared under the auspices of the Optical Society of America the five carefully architected and cross referenced volumes of the Handbook of Optics Third Edition contain everything a student scientist or engineer requires to actively work in the field From the design of complex optical systems to world class research and development methods this definitive publication provides unparalleled access to the fundamentals of the discipline and its greatest minds Individual chapters are written by the world s most renowned experts who explain illustrate and solve the entire field of optics Each volume contains a complete chapter listing for the entire Handbook extensive chapter glossaries and a wealth of references This pioneering work offers unprecedented coverage of optics data techniques and applications Volume II covers design fabrications testing sources detectors radiometry and photometry **Field Theory of Nonimaging Optics** Angel Garcia-Botella,Roland Winston,Lun Jiang,2023-07-10 This book aims to overcome the traditional ray paradigm and provide an analytical paradigm for Nonimaging Optics based on Field Theory As a second objective the authors address the connections between this Field Theory of Nonimaging Optics and other radiative transfer theories The book introduces the Field Theory of Nonimaging Optics as a new analytical paradigm not statistical to analyze problems in the frame of nonimaging geometrical optics with a formulation based on field theory of irradiance vector  $D$  This new paradigm provides new principles and tools in the optical system design methods complementary to flowline method overcoming the classical ray paradigm This new Field paradigm can be considered as a generalization of the ray paradigm and new accurate and faster computation algorithms will be developed In a parallel way the advance in the knowledge of the principles of Field Theory of Nonimaging Optics has produced clear advances in the connection between nonimaging optics and other apparently disconnected theories of

radiation transfer The irradiance vector  $D$  can be considered as the macroscopic average of Poynting vector with a clear connection with radiation pressure Lorentz geometry techniques can also be applied to study irradiance vector  $D$  There are clear thermodynamic connections between the nonimaging concentrator and Stefan Boltzmann law of radiation From this thermodynamic connection nonimaging optics and irradiance vector  $D$  can also be studied from a phase space point of view This book is intended for researchers graduate students academics and professionals looking to analyze design and optimize optical systems

**Nonimaging Optics**, 2005 With nonimaging optics it is possible to achieve concentrations of solar energy equal to 80 000 suns

**Nonimaging Optics, Maximum Efficiency Light Transfer**, 2003

The Optics of Nonimaging Concentrators W. T. Welford, Roland Winston, 1978

**Selected Papers on Nonimaging Optics** Roland Winston, 1995

Nonimaging optics Roland Winston, 1991

**Handbook of Concentrator Photovoltaic Technology** Carlos Algora, Ignacio Rey-Stolle, 2016-05-31 Concentrator Photovoltaics CPV is one of the most promising technologies to produce solar electricity at competitive prices High performing CPV systems with efficiencies well over 30% and multi megawatt CPV plants are now a reality As a result of these achievements the global CPV market is expected to grow dramatically over the next few years reaching cumulative installed capacity of 12.5 GW by 2020 In this context both new and consolidated players are moving fast to gain a strategic advantage in this emerging market Written with clear brief and self contained technical explanations Handbook of Concentrator Photovoltaic Technology provides a complete overview of CPV covering the fundamentals of solar radiation solar cells concentrator optics modules and trackers all aspects of characterization and reliability case studies based on the description of actual systems and plants in the field environmental impact market potential and cost analysis CPV technology is at a key point of expansion This timely handbook aims to provide a comprehensive assessment of all CPV scientific technological and engineering background with a view to equipping engineers and industry professionals with all of the vital information they need to help them sustain the impetus of this encouraging technology Key features Uniquely combines an explanation of the fundamentals of CPV systems and components with an overview of the market place and their real life applications Each chapter is written by well known industry specialists with extensive expertise in each particular field of CPV technology Reviews the basic concepts of multi junction solar cells and new concepts for CPV cells highlighting the key differences between them Demonstrates the state of the art of several CPV centres and companies Facilitates future cost calculation models for CPV Features extensive case studies in each chapter including coverage of CPV modules and systems

*Modeling and Analysis of Shape with Applications in Computer-aided Diagnosis of Breast Cancer* Denise Guliato, Jeffrey Xu Yu, Joseph O'Gallagher, Lijun Chang, Rangaraj Rangayyan, Lu Qin, 2008 Nonimaging optics is a subdiscipline of optics whose development over the last 35-40 years was led by scientists from the University of Chicago and other cooperating individuals and institutions The approach provides a formalism that allows the design of optical devices that approach the maximum physically attainable geometric concentration

for a given set of optical tolerances This means that it has the potential to revolutionize the design of solar concentrators In this monograph the basic practical applications of the techniques of nonimaging optics to solar energy collection and concentration are developed and explained The formalism for designing a wide variety of concentrator types such as the compound parabolic concentrator and its many embodiments and variations is presented Both advantages and limitations of the approach are reviewed Practical and economic aspects of concentrator design for both thermal and photovoltaic applications are discussed as well The whole range of concentrator applications from simple low concentration nontracking designs to ultrahigh concentration multistage configurations is covered Table of Contents Introduction CPCs Practical Design of CPC Thermal Collectors Practical Design of CPC PV Concentrators Two Stage Nonimaging Concentrators for Solar Thermal Applications Two Stage Nonimaging Concentrators for Solar PV Applications Selected Demonstrations of Nonimaging Concentrator Performance The Importance of Economic Factors in Effective Solar Concentrator Design Ultrahigh Concentration Bibliography

**Fundamentals and Techniques of Nonimaging Optics for Solar Energy Concentration. Final Report**, 1980 Nonimaging optics is a new discipline with techniques formalism and objectives quite distinct from the traditional methods of focusing optics These new systems achieve or closely approach the maximum concentration permitted by the Second Law of Thermodynamics for a given angular acceptance and are often called ideal Application of these new principles to solar energy over the past seven years has led to the invention of a new class of solar concentrators the most well known version of which is the Compound Parabolic Concentrator or CPC A new formalism for analyzing nonimaging systems in terms of a quantity called the geometrical vector flux has been developed This has led not only to a better understanding of the properties of ideal concentrators but to the discovery of several new concentrator designs One of these new designs referred to as the trumpet concentrator has several advantageous features when used as a secondary concentrator for a point focusing dish concentrator A new concentrator solution for absorbers which must be separated from the reflector by a gap has been invented The properties of a variety of new and previously known nonimaging optical configurations have been investigated for example Compound Elliptical Concentrators CEC s as secondary concentrators and asymmetric ideal concentrators A thermodynamic model which explains quantitatively the enhancement of effective absorptance of gray body receivers through cavity effects has been developed The classic method of Liu and Jordan which allows one to predict the diffuse sunlight levels through correlation with the total and direct fraction was revised and updated and applied to predict the performance of nonimaging solar collectors The conceptual design for an optimized solar collector which integrates the techniques of nonimaging concentration with evacuated tube collector technology was carried out

*Nonimaging Optics, Maximum Efficiency Light Transfer V* Roland Winston, 1999

This book delves into Nonimaging Optics. Nonimaging Optics is a vital topic that must be grasped by everyone, from students and scholars to the general public. The book will furnish comprehensive and in-depth insights into Nonimaging Optics, encompassing both the fundamentals and more intricate discussions.

1. The book is structured into several chapters, namely:

- Chapter 1: Introduction to Nonimaging Optics
- Chapter 2: Essential Elements of Nonimaging Optics
- Chapter 3: Nonimaging Optics in Everyday Life
- Chapter 4: Nonimaging Optics in Specific Contexts
- Chapter 5: Conclusion

2. In chapter 1, this book will provide an overview of Nonimaging Optics. The first chapter will explore what Nonimaging Optics is, why Nonimaging Optics is vital, and how to effectively learn about Nonimaging Optics.
3. In chapter 2, the author will delve into the foundational concepts of Nonimaging Optics. The second chapter will elucidate the essential principles that must be understood to grasp Nonimaging Optics in its entirety.
4. In chapter 3, this book will examine the practical applications of Nonimaging Optics in daily life. This chapter will showcase real-world examples of how Nonimaging Optics can be effectively utilized in everyday scenarios.
5. In chapter 4, the author will scrutinize the relevance of Nonimaging Optics in specific contexts. The fourth chapter will explore how Nonimaging Optics is applied in specialized fields, such as education, business, and technology.
6. In chapter 5, the author will draw a conclusion about Nonimaging Optics. This chapter will summarize the key points that have been discussed throughout the book.

This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Nonimaging Optics.

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