

Wave Optics

LECTURES IN OPTICS
Volume 3

By the Author

Lectures in Optics, Vol. 1, Introduction to Optics

Lectures in Optics, Vol. 2, Geometrical Optics

Lectures in Optics, Vol. 3, Wave Optics

Lectures in Optics, Vol. 4, Visual Optics

Lectures in Optics, Vol. 5, Ocular Imaging

Wave Optics

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Volume 3

George Asimellis

SPIE PRESS

Bellingham, Washington USA

Library of Congress Cataloging-in-Publication Data

Names: Asimellis, George, 1966- author.

Title: Wave optics / George Asimellis.

Description: Bellingham, Washington, USA : SPIE Press, [2020] | Series:
Lectures in optics ; vol. 3 | Includes index.

Identifiers: LCCN 2019001143 | ISBN 9781510622630 (softcover) | ISBN
1510622632 (softcover) | ISBN 9781510622647 (pdf) | ISBN 1510622640 (pdf)

Subjects: LCSH: Wave theory of light. | Light. | Polarization (Light) |
Dispersion. | Interference (Light)

Classification: LCC QC403 .A85 2020 | DDC 535/.13--dc23

LC record available at <https://lcn.loc.gov/2019001143>

Published by

SPIE

P.O. Box 10

Bellingham, Washington 98227-0010 USA

Phone: +1 360.676.3290

Fax: +1 360.647.1445

Email: books@spie.org

Web: <http://spie.org>

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Printed in the United States of America.

First Printing.

For updates to this book, visit <http://spie.org> and type "PM296" in the search field.

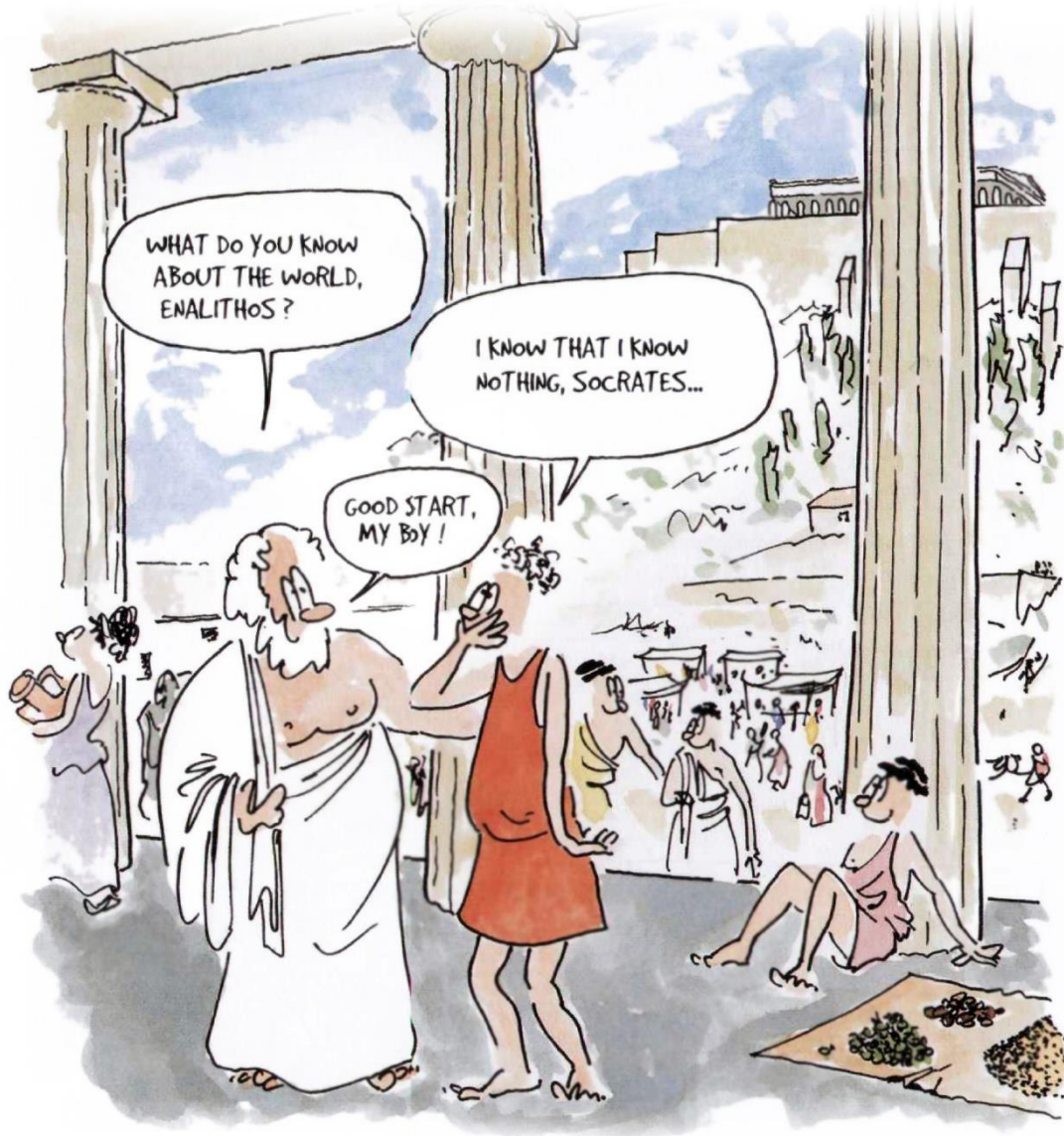
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COVER IMAGE:

MACRO PHOTO OF DIFFRACTION EFFECTS AND MISTY DROPLETS OVER A BLUE RAY DISK.

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Enalithos (Ena-, ένας = One & -lithos, λίθος = Stone) encounters the Greek philosopher Socrates, the questioner of everything and everyone. Athens, Greece, 400 BC (© www.fiami.ch).

Cartoon illustrations pertaining to Einstein's virtual colloquium with Greek philosophers are part of a series on the history of science entitled 'The Lives of Einstein,' published by www.fiami.ch. Enalithos later becomes Alberto Unasso (when meeting Galileo), and then Albert Singlestone (when meeting Isaac Newton), and finally, Albert Einstein.

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FOREWORD

The study of optics has had an enormous impact on modern life in so many different ways that we tend to take it for granted. Take for example telecommunications, medicine, entertainment, and the arts. Here is a text that introduces readers to various important behaviors of light so that they can understand how optics came to be such an integral part of our existence. It is accessible to anyone who has a basic background in mathematics.

I had the privilege of advising Professor Asimellis during his PhD studies at Tufts University. I have always enjoyed discussing optics with him and am very happy to see that he has written a textbook quite unlike any of the others.

The writing is colloquial and includes historical references and philosophical insights that shed light on the thought processes that went into making the underlying discoveries. We learn from the past to advance to the future. It takes some effort to understand how something invisible enables us to see, and how something you cannot hold has such a powerful influence on our lives.

The author appreciates these paradoxes and has done an excellent job helping us to go from understanding nothing to catching enough of a glimpse of the truth to be able to begin to make contributions ourselves. This textbook covers in its entirety the essential topics of wave and physical optics on a level suitable for most college and engineering curriculae. There are many other excellent texts that go more thoroughly into the theory and application of optics, but for a general introduction that encourages the reader to have the confidence to wade in more deeply, one need go no further than this monograph.

Mark Cronin-Golomb, PhD

Professor, Department of Biomedical Engineering, Tufts University
Medford, Massachusetts
June 2020

PREFACE

Wave optics...geometrical optics—Are they that different? At first glance, perhaps yes. They appear to be almost unrelated. The physical properties of light primarily influence wave optics, while the natural rectilinear propagation and the simple laws of reflection and refraction appear to be the main laws that govern geometrical optics.

Yet, upon diving into the details, one comes to realize that, while the location and size of an image are governed by simple geometrical laws, the fine details of an image, such as its resolution, are governed by the physical properties described by wave optics.

Light is ultimately a wave phenomenon. Hence, it is natural that a volume of this *Lectures in Optics* series should be devoted to presenting a view of optics deriving from electric field oscillations and waves. Wave optics concerns the nature of light, especially, its vector nature, its interaction with matter, the complexity of the refractive index, the interference of light with light, and realization of the infinitesimal wavelets that explain diffraction effects. Finally, wave optics and physical optics, as well as quantum optics, merge to form the principles of lasers.

The origins of this textbook can be traced back to the Laboratory Optics course that the author had the honor of teaching at the Department of Physics, Aristotle University of Thessaloniki, Greece. What grew out of that course text is an attempt to provide a modernized textbook based on updated lecture notes and the narrative flow of classroom instruction. Readers are expected to be knowledgeable of college-level mathematics, including algebra, trigonometry, linear algebra, ordinary differential equations, and partial differential equations.

A certain familiarity with vector notation and advanced calculus will be helpful; however, the derivation of certain results is outside the scope of this book and is not emphasized. This book covers the essentials needed for any college-level Wave Optics curriculum in Physics and Engineering departments, as well as Optometric professional programs, and will be useful to those seeking a bottom-up textbook that foregoes a formal style and presents an attractive and updated perspective.

George Asimellis, PhD

Pikeville, Kentucky

June 2020

Acknowledgments

I would like to thank the following colleagues for their helpful suggestions, encouragement, and recommendations:

Mark Cronin-Golomb, PhD

Professor, Department of Biomedical Engineering, Tufts University

Robert W. Arts, PhD

Professor of Education & Physics, University of Pikeville

Frank Spors, EurOptom, MS, PhD, FAAO

Associate Professor, College of Optometry, Western University of Health Sciences

I would also like to thank the following members of the Frank M. Allara Library, University of Pikeville for their contributions in providing grammatical and English-language corrections:

Karen Evans, Director of Library Services

Edna Fugate, University Archivist and Reference Librarian

Jerusha Shipstead, Reference and Instruction Librarian

Katherine Williams, Instructional Design Librarian & Coordinator of Instruction

Most of the artwork in this book was created by the author; any figure that was not created by the author is attributed to the source provided in the caption.