Preface

This book is intended to give insight into the emerging field of *quantitative phase imaging (QPI)* as it applies to biomedicine. It is an invitation extended to researchers at various stages in their careers to explore this new and exciting field of study. I devoted particular effort toward providing enough introductory material to make the book self-contained, as much as possible. Thus, the structure of the book progresses from basic to advanced concepts as follows.

The motivation and key concepts behind QPI are presented in the *Introduction*, with particular attention to clarifying ideas such as "nanoscale" and "three-dimensional", which often generate confusion. *Chapter 2 (Groundwork)* reviews the basics of light propagation in a vacuum and inhomogeneous media (scattering), with emphasis on Fourier optics. Coherence properties of optical fields are described in *Chapter 3*. Very basic properties of images (e.g., resolution, contrast, contrast-to-noise ratio) are reviewed in *Chapter 4*. Light microscopy concepts, from Abbe's image description to Zernike's phase contrast are discussed in *Chapter 5*, while the main developments in holography are reviewed in *Chapter 6*. The remaining chapters, 7-15 are devoted specifically to various aspects of QPI.

Except for *Chapter 7*, which is dedicated to point-scanning QPI methods and includes a thorough introduction to low-coherence interferometry, all chapters deal with full-field QPI methods. *Chapter 8* presents the main ideas behind full-field QPI and specifies the main figures of merit in QPI: acquisition rate, transverse resolution, temporal phase stability, and spatial phase uniformity. The following four chapters, 9-12, describe four QPI approaches that, by default, excel in one of these figures of merit: off-axis (high acquisition rates), phase-shifting (high transverse resolution), common-path (high temporal stability), and white light (high spatial uniformity).

Chapter 13 presents *Fourier transform light scattering*, essentially establishing the equivalence between QPI and light scattering measurements. The last two chapters, 14 and 15, are devoted to recent developments, both in methods and applications, which currently appear to be very promising. Finally, the book contains three

appendices on complex analytic signals (A), Fourier transforms (B), and interesting QPI images (C).

It is my belief that QPI will continue to grow at an accelerated pace and become a dominant field in biomedical optics in the years to come. It is hoped that this book will contribute to this process by providing a logical structure of this new field and a condensed summary of the current research.

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