

Preface

Biophotonics is a new discipline in biophysics and has emerged from research and development at the interface between the photonics and biomedical science and engineering. It covers all the processes initiated by quanta of light and occurring in biological objects as well as the whole complex of optical methods being employed to investigate them. Biophotonics is a photonic solution for biotechnology and medicine and therefore has become an important discipline in life sciences. Imaging through tissue-like turbid media is a fundamental topic in biophotonics. Optical microscopic imaging has played a crucial role in this area. However, due to the multiple scattering effect in a turbid medium, the standard microscopic imaging theory based on diffraction theory is not necessarily applicable in this case. An alternative way for understanding the microscopic imaging performance is based on Monte Carlo simulation that involves Mie scattering.

Research work on Monte Carlo simulation for optical microscopy in tissue media was initiated immediately after the first two authors joined Victoria University in 1995, where they developed the Monte Carlo methodology for optical microscopy. A systemic investigation into various microscopic imaging/gating methods including angle gating, confocal gating, and polarization gating was conducted during that period. As soon as the three authors joined Swinburne University in 2000, the research work on this topic was extended to coherence gating, fluorescence gating, and multi-photon fluorescence gating. The aim of this book is to provide a systematic introduction into these methods. The book can be used by research students, scientists, and engineers who are interested in biophotonics, optical microscopic imaging through tissue, and Monte Carlo simulation.

Although this book was completed by the three authors, many people made important contributions to the topic. We would like to acknowledge the significant contribution by Dr. Steven Schilders who, as a Ph.D. student at Victoria University in Australia, investigated the angle-gating, polarization-gating, and fluorescence-gating methods. Mr. Aernout Kisteman, a visiting research student from the University of Twente in Netherlands, conducted a careful experiment which determined the penetration depth of the single-photon and two-photon fluorescence-gating methods. Dr. Qiang Lu, a visiting scientist from Huazhong University of Science

and Technology in China, made an important contribution to the coherence-gating method when he visited Swinburne University of Technology, Australia. We would also like to thank other students and colleagues from Victoria University and Swinburne University of Technology who gave us comments and suggestions on the book. Special acknowledgments are given to South China Normal University, which has supported the third author to complete this book project after 2003. Finally, we would like to acknowledge the important support from the Australian Research Council on this research topic.

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Monte Carlo Modeling and Applications

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