The Art of Radiometry

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Foreword

The material for this book grew out of a first-year graduate-level course, “Radiometry, Sources, Materials, and Detectors,” that Jim Palmer created and taught at the University of Arizona College of Optical Sciences for many years. The book is organized by topic in a similar manner, with the first five chapters presenting radiation propagation and system building blocks, and the final two chapters focusing on instruments and their uses. Chapter 1 provides an overview and history of the subject, and Chapter 2 presents basic concepts of radiometry, including terminology, laws, and approximations. It also includes examples that will allow the reader to see how key equations may be used to address problems in radiation propagation. Chapter 3 introduces radiometric properties of materials such as reflection and absorption, and Chapter 4 extends that discussion via a detailed consideration of sources. Point and area detectors of optical radiation are considered in Chapter 5, which also includes thermal and photon detection mechanisms, imaging arrays, and a discussion about film.

In Chapter 6, the focus shifts to instrumentation. Concepts introduced in Chapter 2 are here applied to instrument design. Practical considerations relating to radiometer selection are detailed, and a “Make or Buy?” decision is explored. Several monochromator configurations are examined, and spectral instruments are discussed. Proceeding from instruments to their uses, Chapter 7 details types of measurements that may be made with radiometric systems and provides a discussion of measurement error. The philosophy of calibration is introduced, and several radiometric calibration configurations are considered.

The material in the appendices covers a variety of topics, including terminology, standards, and discussions of specific issues such as Jones source calibration and consideration of solar glint. Due to Jim’s attention to detail and the length of time over which he accumulated material, the long lists he provided here may be viewed as comprehensive, if not current by today’s standards.

The level of discussion of the material is suitable for a class taught to advanced undergraduate students or graduate students. The book will also be useful to the many professionals currently practicing in fields in which radiometry plays a part: optical engineering, electro-optical engineering, imagery analysis, and many others.

In 2006, Jim Palmer was told that he was terminally ill, and he asked me to complete this work. I was humbled and honored by the request. I’d met Jim as a graduate student in optical sciences in the late 1980s, and he had served on my thesis committee. My career after graduation had focused on systems engineering and analysis, two areas in which radiometry plays a significant role. For nearly the last ten years of Jim’s life, I’d been able to receive mentoring from the master simply by showing up at Jim’s office door with a question or topic for discussion, but I never anticipated that our discussions would one day come to an end. Upon Jim’s death, I sought to weave his collection of resources and narrative together
with newer material and discussion in a manner I hope will be both informative
to read and valuable to reference. The preface that follows was written by Jim
before he died and has been left as he wrote it.

I am grateful for the assistance of many. First is William L. Wolfe, Jim’s
professor and mentor, who offered helpful comments on each chapter and
adapted Chapter 6 on radiometric instrumentation. Others for whose help I am
grateful, all from or associated with the University of Arizona College of Optical
Sciences, are Bob Schowengerdt, who contributed the narrative on film; Anurag
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appendix material; and L. Stephen Bell, Jim’s close friend and colleague, who
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student and trained me in remote sensing and absolute radiometric calibration
from 1987 to 1989, and Michael W. Munn, formerly Chief Scientist at Lockheed
Martin Corporation, who instilled the value of a systems perspective in the
approach to technical problems.

Finally, I am grateful to my family for providing financial support; to Ralph
Gonzales, Arizona Department of Transportation, and Sylvia Rogers Gibbons for
providing professional contacts; and my friends at Calvary Chapel, Tucson,
Arizona, whose donations and prayers sustained me as I worked to complete this
book.

Barbara G. Grant
Cupertino, California
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Preface

This volume is the result of nearly twenty years of frustration in locating suitable material for teaching the subject of radiometry and its allied arts. This is not to say that there is not a lot of good stuff out there—it’s just not all in one place, consistent in usage of units, and applicable as both a teaching tool and as a reference. I intend this book to be all things to all people interested in radiometry. The material comes from teaching both undergraduate and graduate-level courses at the Optical Sciences Center of the University of Arizona, and from courses developed for SPIE and for industrial clients. I have unabashedly borrowed the tenor of the title from the superb text *The Art of Electronics* by Paul Horowitz in the hope that this volume will be as useful to the inquisitive reader.

I gratefully acknowledge the contributions of my mentor, William L. Wolfe, Jr., and the hundreds of students whose constant criticism and occasional faint praise have helped immeasurably.

This book is dedicated to the memory of my mother, Candace W. Palmer (1904–1996) and my father, James A. Palmer (1905–1990). She was all one could wish for in a Mom, and he showed me the path to engineering.

*James M. Palmer*
*1937–2007*