books

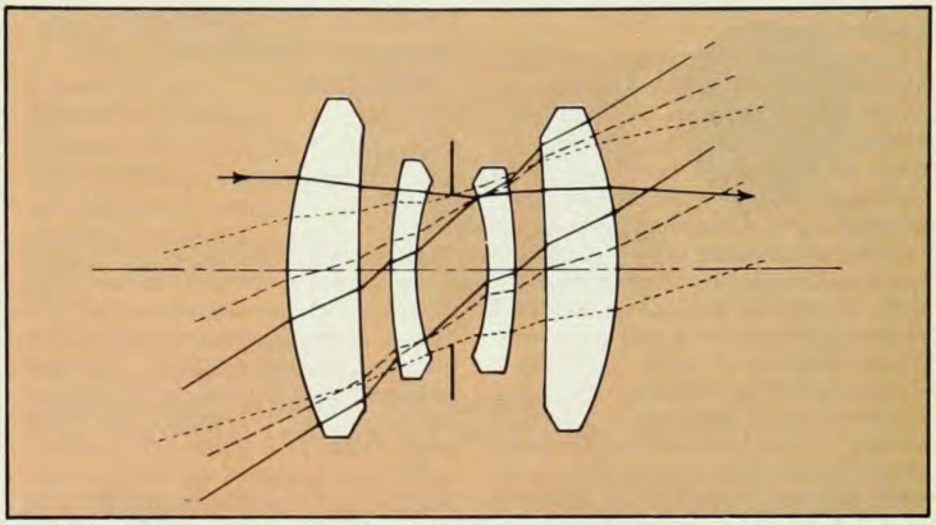
Classical lens design: a "how to do it" text

Lens Design Fundamentals

R. Kingslake
366 pp. Academic, New York, 1978.
$26.00

Reviewed by Robert R. Shannon

The subject of the design of lenses has interested many physicists and mathematicians over the years. Lens design has evolved from the "black-art" stage of the pre-computer days to what now appears on the surface to be a "mathematical exercise" using a computer. Success in lens design, however, is not found through magic or mathematics alone, but is developed through an appreciation by a specialist of the limitations and possibilities for the application of a few simple principles that can be explicitly evaluated only through extensive numerical computation.



Passage of rays at various field angles through a typical lens is shown in the above illustration from Rudolf Kingslake's *Lens Design Fundamentals,* reviewed here. Kingslake discusses in detail the interpretation of aberration plots, which describe the aberration correction of the lens. The lens designer generates these plots from numerical values obtained from ray tracing.

Rudolf Kingslake's *Lens Design Fundamentals* stands as the best text on the subject of classical lens design. Classical lens design here is defined as the exercise of determining and predicting the aberration correction that may be attained in a lens through the examination and understanding of the limited set of aberration coefficients that may be easily computed on each surface of the lens system. Today, the use of high-speed computers permits the exploration of hundreds of possible variations of a lens type within the brief span of a few minutes. The lens designer then serves in the role of an observer, entering the design process to suggest a change in the direction of the program. No method has yet been developed that completely eliminates this human intervention, and it is no accident that the designer who comprehends the principles of design enumerated in this book is likely to be the more successful designer. In short, a solution cannot be found if it just is not there.

This book is a "how to do it" text in the sense that Kingslake describes several examples of lenses from the point of view of aberration correction. The specialist will learn much of value from these examples, while the novice will gain an appreciation for the reason that lens types take on the form that they do.

Kingslake begins with a general discussion of the design process, and develops several formulae and techniques for tracing rays and setting up the first-order, or paraxial, characteristics of lens systems. A minor complaint is that he has chosen to retain a traditional "backwards" sign convention for ray angles that is the opposite of standard geometrical convention. This choice is unfortunate, as it makes integration of the formulae and techniques into other optical-analysis programs somewhat more difficult and subject to possible errors.

The discussion of the source of aberrations and their correction on a surface-by-surface or element-by-element approach is excellent and informative. Although most modern lens design uses a high-speed computer to vary all parameters simultaneously, the principles discussed in this book will be useful in understanding why many of the computer-derived solutions tend to look the way they do. The discussion of the aberrations in terms of ray-intercept curves has long been a standard for comparing types of lenses used by the specialist in optical design. The discussion of the topic here will help to make this description more widely understood and help in communication.

This book is directed toward the specialist. The generalist may feel that the approaches of classical lens-design methods described here are more empirical than would seem to be appropriate for such an old field. If anyone spends a little time studying this book, however, he will learn that the process of lens design is not, and likely never will be, subject to complete automation. This book summarizes many years of experience in the subject, and will likely be the last word on the subject of optical design for several years.

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Physical Metallurgy

P. Haasen
381 pp. Cambridge U.P., New York, 1978 (German edition, 1974). $42.50 clothbound, $9.95 paperbound

The field of physical metallurgy is, by now, a fairly mature one, not only in terms of the sophistication of much of the research in the field, but also because many facets and techniques of physical metallurgy have been adopted by other fields such as ceramics and polymers. This is, in a way, appropriate because physical metallurgy has itself evolved from and is nurtured by solid-state physics and chemistry.

Peter Haasen, the author of the present book, has himself evolved from such a background and is in the midst of a productive career in physical metallurgy. He is the director of the Institute of Metal Physics, Göttingen University and is well known for his studies of the mechanical properties of materials, especially studies of dislocation motion in covalently bonded crystals.

Haasen has now written a very good intermediate-level textbook on physical metallurgy, covering a well designed treatment of physical metallurgy. He states that the main aim of *Physical Metallurgy* is "... a discussion of the principal object of metallurgy, namely the mechanical hardening of metals ...." In pursuing this goal he treats various aspects of physical metallurgy, including microstructures and how they are studied, thermodynamics of solids (including a physicist's approach to phase diagrams) and a number of chapters on defects in crystals. These subjects form the background for the final portion of the book, which includes a treatment of the hardening of materials—work hardening, transformation hardening, alloy hardening—followed by a shorter discussion of the reverse process of recrystallization.

Haasen, however, does not give all the topics equal weight. For example, he mentions the importance of microstructure quite early in the book, in conjunction with a section on grain boundaries, but he does not emphasize this aspect of physical metallurgy throughout the book. The emphasis of the book is on relating properties—mechanical properties—to dislocation structure(s).

The level of presentation of these subjects is quite high, well above those found in many books, mostly qualitative or phenomenological, used in American universities. The treatment does assume, however, some background in solid-state physics—a suggested reference being Charles Kittel's well known book *Introduction to Solid State Physics* (3rd edition, Wiley, New York, 1966)—but Haasen includes enough material in the text to make it reasonably self-contained. These factors make the book more suitable for a second course in physical metallurgy or perhaps for a graduate course for physics or chemistry students first entering physical metallurgy. Haasen, however, does not treat corrosion, a subject that is usually included in introductory books on physical metallurgy and is of importance to the use of metals and alloys, although he does include a discussion of the question of oxidation.

This is a minor point, though, because the book is written at a relatively high level, is quite readable, and should serve as a very useful book on the subject. Graduate students may find it more challenging than present texts, but for those starting out in physical metallurgy the effort of reading it will be amply rewarded.

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Electrical Interactions in Molecular Biophysics: An Introduction

R. Gabler
352 pp. Academic, New York, 1978. $25.00

The purpose of this book is to provide the reader with introductory discussions on the subject of electrical properties of biological molecules and the origin of electrostatic forces between them. Raymond Gabler assumes no previous knowledge of the subject by the reader. He makes great efforts to explain, using easy-to-understand language, the meaning of existing concepts and theories about electric charge, dipole moment and polarizability and also the mechanism by which these quantities contribute energies that may attract or repel neighboring molecules.

Roughly, this book consists of two parts. The first part describes basic concepts of electrostatics and dipoles. The second provides detailed discussions of electrostatic interactions between biological molecules utilizing the concepts and theories discussed in the first part of the book. The discussions of electrostatics and dipole moments are rather elementary and by no means complete. However, Gabler's intention is obviously to discuss the basic concept behind theories. He explains derivations of fundamental equations step by step so that the reader will have a clear understanding of the meaning of the theory. Many textbook authors ignore these discussions and, in that sense, Gabler takes a unique approach to the problem. Therefore, the book is valuable to the reader who does not have a background in electrostatics. Many biochemists and biologists are not familiar with the concepts of dipole moment and dielectric constant. One of the reasons for this is the lack of good introductory books on this subject. This book will certainly serve the purpose of introducing these concepts to those readers.

The second part of the book describes various types of electrostatic interactions between biological molecules. Gabler lucidly explains the origin of attractive and repulsive forces due to charge–charge, charge–dipole and dipole–dipole interactions. He further discusses the origin and physical nature of hydrogen bonds and van der Waals forces, which are sometimes loosely understood by biological scientists. In the discussion of the Debye–Hückel theory for electrolytes, he takes great pains in deriving the Poisson equation starting from Gauss's theorem. This may be very useful for many readers in understanding the meaning of this important equation.

Gabler's book is very easy to read and his description of the development of theories systematic and clear. Discussions are careful, thorough and tactful. He uses mathematical equations whenever their use facilitates the understanding of theories; the extent of this use, however, is quite reasonable. As stated before, he does not assume any previous knowledge by the reader and often discusses, in detail, elementary topics such as pH and chemical formulae of simple molecules. Some readers may wish to simply skip these discussions and move on to the next section. For advanced readers, this book may not provide satisfaction because the author did not intend to do so. On the other hand, the book may be very helpful for undergraduate-, as well as graduate-course instructors. It is often difficult to find a book that describes derivations of basic equations of theories. For teaching, explanation of basic concepts and meaning of equations are most important to students. This book will be very valuable for these purposes. Gabler supplies sufficient numbers of references for each subject and they will be convenient for interested readers. He gives no exercise problems and thus this book may not be most suitable for use as a textbook. However, this can be an excellent reference book to supplement standard textbooks.

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Diffraction from Materials

L. H. Schwartz, J. B. Cohen
558 pp. Academic, New York, 1977. $27.50

Investigations of the interactions of x rays and, to a lesser extent, neutrons and electrons, with matter provide students of materials sciences and related disciplines with their most powerful tools for the analysis of the relationships among structures and properties of solids. *Diffraction from Materials* represents an ambitious effort to provide the reader with a sound theoretical basis for an understanding of such interactions.

The authors, Lyle H. Schwartz and Jerome B. Cohen of the Department of Materials Sciences and Engineering of Northwestern University, are well known