at the boundaries), the different types of fiber guides—as it is introduced. Unger then derives the modes from Maxwell's equations plus the boundary conditions.

The brief discussion of planar-waveguide technology that concludes the section on these waveguides is the least adequate part of the book. Although the publication date of the book is 1977, the references in this section essentially end in 1974. Great advances have taken place since then, particularly in the technology of integrated optical circuits made entirely of gallium arsenide and its alloys with aluminum and other materials ("monolithic" integration). Unger's statements that "we obtain more efficient optical devices when the best materials for the respective functions are combined" ("hybrid" integration) and "usually only such hybrid integration results in optical circuits with satisfactory performance" stand in contradiction to the current state of affairs in integrated optics.

The chapters on fibers are extensive in their coverage, with attenuation and dispersion both discussed at length. The dispersion analysis takes account of mode, material and index-profile dispersion to arrive at near-optimum profiles for minimizing pulse broadening in transit. Unger devotes a chapter to the effects of fiber imperfections such as bending, deviations from circularly symmetric geometry, and microscopic and macroscopic fluctuations in refractive index. He develops the solutions of coupled-wave and coupled-power equations and a power-diffusion approximation to make possible the specification of fiber tolerances for particular levels of signal degradation. The final chapters on fiber fabrication and cabling, junctions and transitions, provide much more comprehensive coverage than the section on planar-waveguide technology.

Unger, writing well and clearly, has digested and presented in logical fashion material from many diverse sources. Starting from first principles as it does, the book provides a good introduction to waveguide theory and fibers. It should serve well as a text for a course on optical waveguides, including fibers, provided more recent references on the technology supplement it. One suspects that Unger, who is Professor of Electrical Engineering and Director of the Institut für Hochfrequenztechnik, Technische Universität, Brauschweig, developed it through teaching such courses. Additional pluses are numerous references at the end of each chapter and a 9-page "List of Principal Notation."

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Galileo at Work: His Scientific Biography

S. Drake
536 pp. Univ. of Chicago, Chicago, 1978.
$25.00

Galileo at Work begins with a charming vignette of the famous scientist as an old man tending his garden, dressed as a "clown" rather than in his philosopher's robes. This introduces us to Drake's purpose, which is to show Galileo in his "working clothes" and to give a "fair overall view of Galileo's scientific career." He turns from perennial questions concerning philosophical influences on and implications of Galileo's work and gives instead a careful and detailed chronological account of what Galileo actually did.

As the major translator of Galileo's works into English, Drake has also written many articles about Galileo. His forte is discovery and translation of documents previously unknown in English—sometimes previously unpublished anywhere—and his series of "Galileo Gleanings" (in various history-of-science journals) includes much useful analysis of documents and events pertaining to Galileo's life and work. (A few of these "Gleanings" were collected together in Drake's *Galileo Studies: Personality Tradition and Revolution* (University of Michigan, 1970.)

Galileo at Work, Drake's first attempt at a book-length treatment of his subject, pulls together into a comprehensive chronological account materials found in his earlier papers as well as other sources. There is also much that is new. Among the most striking bits is, perhaps, the background to Galileo's development of a theory of errors (page 307), the extent and frequency of Galileo's illnesses and the bearing of these on his work, and many details surrounding Galileo's numerous controversies. Most of these and similar nuggets are found in Galileo's correspondence, which Drake has probably read more thoroughly than anyone else since the early years of this century. Also, much important material is here translated into English for the first time, including a number of Galileo's manuscript notes on motion and the so-called "Fifth Day" of the *Discourses and Mathematical Demonstrations Concerning the Two New Sciences Pertaining to Mechanics and Local Motion.*

Galileo at Work contains much that will be of interest to a wide range of

The Whirlpool Galaxy, shown here with its irregular companion galaxy NGC 5195, is M51, the fifty-first of about one hundred nebulous objects that the astronomer Charles Messier (1730–1817) observed and recorded. *The Messier Album* by John H. Mallas and Evered Kreimer (248 pp.; Sky Publishing Corp., 1978; $9.50) contains photographs, drawings and descriptions of each of the Messier objects. Owen Gingerich introduces the volume with a biographical essay.

readers interested in science and its history. It is weak, however, in conceptual analysis and, in my view, the book fails to give a satisfactory overall picture of "Galileo's scientific career." In fact, Drake is a much better translator than interpreter of Galileo's writings. His preconceptions often lead him to misread his own usually accurate translations. Among Galileo's notes on motion, for example, Drake thinks perfectly clear and correctly translated remarks about motion along different lengths of a single vertical are about motion along differently inclined planes (pages 115–116). As another example, although folio 85v does not contain the term *gradus,* Drake interprets the passage as if it does, even while correctly omitting it from his translation (pages 98–99, 114 and 125). Only rarely do his misconceptions lead to actual mistranslations, but one is worth mentioning. In translating folio 138v (pages 111–112) Drake omits a whole paragraph that contains three instances of an expression he claims did not occur on that page as originally composed. Also, he supposes the term *equale* to be a later addition to the last paragraph, which it is not (see the National Edition of Galileo's *Opere,* volume VIII, page 372, where Antonio Favaro, the editor, accurately indicates all additions and corrections on this page of the manuscript).

What lies behind a number of such misreadings may be various fixed ideas such as one that dominates much of Drake's discussion of motion: the belief that Galileo's central conceptual problem in the development of his new science was coming to believe that velocity in free fall is continuous from rest. Much evidence indicates that Galileo came to realize this earlier than Drake supposes and that later preoccupation with continuity of motion from rest stems from the problem of formulating an adequate mathematical treatment of it. Drake's interpretation runs into particularly conspicuous difficulties in his discussion of Galileo's so-called "paradox of speed," where Drake conflates three related but nonetheless distinct problems: continuity of motion from rest; the relation between uniform and accelerated motion, and the relation between accelerated motions along differently inclined planes. (See pages 81 and 124–25 and compare Galileo's discussion of the "paradox" in Drake's own translation of the *Dialogue Concerning the Two Chief World Systems,* 2nd revised edition (University of California, Berkeley, 1967), pages 23–27, and especially remarks by Salviatti appearing at the bottom of page 25.)

Drake's interpretations of other fundamental conceptual developments in Galileo's mechanics also raise doubts, and his preconceptions concerning Galileo's method seem to lead to misunderstandings, both of other secondary discussions of this topic and of crucial passages in Galileo's own works, including the old *De motu* (written about 1591), the early *Cosmografia* (written probably before 1600), the somewhat later *Discourse on Bodies in Water* (first published in 1612), the published *Two New Sciences* (1638) and some related correspondence. Fewer difficulties appear to arise in Drake's treatment of Galileo's astronomical work and the various controversies in which he was involved. However, the reader should be warned that even here some of Drake's interpretations are at least moot.

Misinterpretations of manuscript notes and other texts can, of course, lead to errors in dating them, and, consequently, to wrong reconstruction of the development of Galileo's work. Thus, Drake's choice of a strictly chronological order of exposition makes his book particularly vulnerable to such errors. Any biography, of course, may follow either a strict chronological or a thematic order, and Drake chooses the former, claiming that it is the best way to understand how Galileo's thought actually developed. But for the nonspecialist particularly, this method makes it more difficult than it should be (despite an unusually good index) to follow Drake's account of the development of any particular line of work and to evaluate the evidence for his reconstructions. Nonetheless, the cautious reader will find *Galileo at Work* to be rich with rewarding details concerning a scientific personality of perennial interest.

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Principles of Magnetic Resonance, 2nd edition

C. P. Slichter
397 pp. Springer-Verlag, New York, 1978 (first edition, 1963). $24.90

A graduate course given by Charles P. Slichter as Loeb Visiting Lecturer at Harvard was the basis of the first edition of this book (reviewed by John H. Van Vleck, PHYSICS TODAY, January 1965, page 114). In this second edition he includes new fundamental developments in nuclear magnetic-resonance methods and concepts. Three new major chapters, two new appendices, added material to the