an abbreviated presentation, but even then how can one speak of the origins of differential calculus without ever mentioning Leibniz? Or, for instance, Röntgen's name never appears. Even worse, several pages are devoted to the wave nature of light, but Huygens is not included.

The second criticism is that there are a number of inaccuracies that could have been avoided with a little care. One of these is the description of the work by J. C. Adams on the perturbations of the orbit of Uranus. No reference is made to the role G. B. Airy played in suppressing his work; the impression is given that a more general lethargy was responsible for it. Another example is that de Broglie is called consistently "Duc Louis de Broglie." As far as I know Louis de Broglie does not insist on his title (he is too great a scientist for that), but if one wants to give it, it should be "Prince Louis de Broglie." The "Duc" was his brother Maurice de Broglie.

Another shortcoming of the book is its relative lack of references. As I stated before, it is very well written and it could easily entice a student to further reading. At an important school such a student would easily find guidance, but at a small college any such attempt may be stifled because of inadequate facilities. Even a short list "for further reading," at the end of each chapter such as *Scientific American* has, would have helped enormously.

At the end of the book, 33 pages are devoted to biographical notes on most of the scientists quoted in the text. They are very well done and enhance the usefulness of the book.

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Part of the whole

THEORY AND APPLICATIONS OF HOLOGRAPHY. By John B. DeVelis, George O. Reynolds. 196 pp. Addison-Wesley, Reading, Mass., 1967. $12.95

by Robert J. Collier

HOLOGRAPHIC INTERFEROMETRY. Fringes in a hologram image of a notched metal bar under stress. The pattern indicates there is plastic flow near the notch.

Holography is the photographic recording of the interference between coherent light waves and a phase-related reference wave and the reconstruction of the original waves as a result of illumination of the record with the reference wave. In 1948 Dennis Gabor founded it and named it after the Greek word Θολοσ ("holos"), meaning whole. The record or hologram contains the whole record of light waves because it preserves both amplitude and phase information. John B. DeVelis and George O. Reynolds, the authors of *Theory and Applications of Holography,* state that their primary aim is to develop a basic, unified, analytic treatment of holography. Their approach to this problem is found in chapters 3–7. A secondary purpose is to acquaint less mathematically inclined readers with the state of the art of holography by means of the introductory chapters 1 and 2 and the final chapter, 8. This, the second book to be published on holography, while deserving of a place on any modern optics shelf, does not wholly succeed in realizing these aims.

DeVelis and Reynolds are both associated with Technical Operations, Inc. (DeVelis is also a member of the physics department, Merrimack College.) They have made numerous contributions to the theory of holographic imaging and to the theory of coherent optics. At a time when applications of holography are being attempted and evaluated in diverse fields, there is definite need for a tying together of the basic concepts with a unifying analysis. The book under review represents progress in this direction and is thus of value. Its best aspects appear in chapters 3 and 4, where the analyses of the several types of holograms, Fresnel, Fraunhofer, Fourier transform and off-axis Fresnel, are presented and where some of us who have not been much concerned with the in-line hologram properties are enlightened. Chapters 3, 4 and 5 do represent a unified, consistent approach to the analysis of formation and imaging properties of various hologram types. They deal with image quality, magnification and resolution under conditions of planar and spherical wave illumination. Other equally valid approaches could have been taken, of course, and one may be more pleasing than another. But I feel that within the limits of planar holograms and the limits prescribed by chapters 3–5, DeVelis and Reynolds have, to a satisfactory degree, done what they set out to do. Accompanying the analysis are a great many photographs, very well reproduced and well chosen to illustrate the points made in the text. To this extent the book is instructive and useful.

However, in the larger sense, DeVelis's and Reynolds's effort is, to this reviewer, somewhat disappointing. The introductory chapters 1 and 2 are too brief, too limited in scope and do little towards providing the less mathematically inclined reader with the feel of the subject. The concepts of associative storage, the thick or volume holograms, use of the conjugate-to-the-reference wave to obtain the real image, pseudoscopic properties of the real image and effects of reflecting-subject motions are ignored. The frontispiece is a beautiful color print

of a photograph of a multicolored hologram image, but the reader is never given an explanation of the multicolor problem in holography. The highly mathematical presentation of chapters 3–5 should be supplemented by a chapter containing a good qualitative discussion of physical principles supported by illuminating ad hoc arguments. Chapter 8, dealing with applications, does not explain holographic interferometry despite its development into a first-rate tool in several technologies. These aspects of holography, not properly covered in the book under review, deserve inclusion in a unified treatment. If the book is to be as broad as its title implies, it is not sufficient to liberally sprinkle the text with references to the literature (the book does have a good reference list) in the hopes that the reader will pursue the subject to its source.

The book's unfortunate overemphasis on in-line holography (as against the off-axis holography with which E. N. Leith and J. Upatnieks in the early 1960's introduced holography to most of us) can cause confusion. While the in-line method is useful for pulsed-laser holographic imaging of small particles, I think most holographers work with the off-axis method. Thus it is confusing to see, time after time, in the first 85 pages of the book an enunciation of the need to process the photographic medium according to conditions desirable for Fraunhofer holograms (gamma = −2) with no mention of the fact that these conditions are not practiced with the off-axis method. Only on pages 86–87 is there the suggestion that negative holograms are sufficient and that operation on the linear portion of the amplitude transmission as opposed to exposure curve is desirable for off-axis holography. The consequence is to propound a rather unbalanced parochial view of holography.

The task of unifying the results in holography is admirable, necessary and not easy. Perhaps if DeVelis and Reynolds had delayed their start until holography is more completely unfolded or had updated the text as they did their reference list, they might have better presented the whole record.

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In the beginning . . .

THE ORIGIN AND EVOLUTION OF THE UNIVERSE. By Evry Schatzman. Trans. from French. 287 pp. Basic Books, New York, 1966. $8.50

by S. Fred Singer

A physicist who wants to enter into cosmogony faces the following problem: how to absorb as efficiently as possible the observational basis underlying the theory of the origin of the universe and of cosmology without having to become an astronomer. To meet this problem, the distinguished French astrophysicist, Evry Schatzman, has condensed astronomical phenomena and knowledge into a tightly written but easy-to-follow volume.

About one third of the book reviews the present state of knowledge, concentrating mainly on the properties of stars, on galactic structure and interstellar matter. Most of this is descriptive, concisely tabulated and well presented. The second third of the book deals with one of the author's specialities, the origin and evolution of stars and stellar systems. There is a good review of the internal structure of different types of stars and of the nuclear reactions in their interiors. Following this review, there is a concise account of the formation of stars, of stellar systems and of galaxies. The last part of the book is concerned mainly with extragalactic nebulas and cosmology. It starts with a brief discussion of Olber's paradox and a careful review of observational data on properties of galaxies and galactic clusters. Much attention is given to the red shift of spectral lines and to the many objections against interpreting them in terms of an expansion of the universe. A Doppler shift remains, however, the most reasonable interpretation.

There finally follows a very brief and quite painless account of cosmological theories. It is really more in the nature of a classification of cosmological models, but it serves as an orientation and useful overview.

It is at this point where the new results of the last two or three years are badly missed. Schatzman's book was originally published in 1957 but translated into English and brought up to date in 1965. Quasars, unfortunately, are not mentioned, and one would have to refer to recent review papers or books to amplify the discussion. (See, for example, S. P. Maron and A. G. W. Cameron, *Science* **157**, 1517, 1967; D. W. Sciama, *New Scientist* 29, 16, 1966; and a summary by Thornton Page, Smithsonian Astrophysical Observatory, "Conference on Observational Aspects of Cosmology;" as well as *Quasi-Stellar Objects* by G. and M. Burbidge, Freeman, San Francisco, 1967.) Of course it is not all settled whether quasars are at a "cosmological" distance, that is, whether the extreme red shifts ob-