sexual behavior in Darwin's private notebooks dating from 1837–39. Brent cannot resist the observation:

> The sexual instinct, its manifestations and attendant organs interested him more than they had before, and it need not be a prurient point to see in this a sublimated reflection of his own sharpened sexuality [p. 298].

And Brent also speculates on the Darwins' sex life as husband and wife:

> Unspoken in the humility and gratitude with which he [Charles] received her [Emma] accepting him as husband, implied in the recurring description of himself as "brute," one senses the sexual "demand," that physical transaction in which the wife gives in, as graciously as she can and the husband, almost despite himself, struggles briefly for his own satisfaction. Convulsed by guilt, he afterwards thanks her for permitting such a violation, and lives out his sexual life in a mixture of resentment and contrition [p. 320].

But the most revealing of all concerns the Health Diary that Darwin kept from 1849 to 1855.

> In 1850, too, there appear occasional little ticks in the record, four or five a month, and it is possible that these marked the occasions of sexual intercourse. It seems unlikely that he would have neglected this factor, yet impossible that he would have mentioned it directly. There is no indication, however, that such a conclusion is correct, rather than based on the wishful prurience of a biographer [p. 384].

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Vibrations of the Earth

Free Oscillations of the Earth. E. R. LAPWOOD and T. USAMI. Cambridge University Press, New York, 1981. xii, 244 pp., illus. $49.95. Cambridge Monographs on Mechanics and Applied Mathematics.

It is more than 20 years since the free oscillations of the earth were first observed. Yet the book under review is the first one devoted exclusively to the subject. Lapwood and Usami have written a thorough monograph emphasizing the mathematical and theoretical aspects of this active subject of research.

The book begins with a survey of work from the second half of the 19th century and the first half of the 20th. Both observational and theoretical studies are presented. Without good instrumentation and recording systems, and without computers, progress during this period was modest. Nevertheless, considerable insight into the subject was achieved.

In 1960 perhaps the largest earthquake in a century occurred in Chile. By then, theoretical and computational developments were well advanced and data acquisition systems were improved. The Fourier spectra of the seismograms clearly showed the resonance peaks of the free oscillations of the earth, and a new branch of observational geophysics was firmly established, albeit without the benefit of the fast Fourier transform algorithm.

The authors approach the formulation of free oscillation theory pedagogically, making their book well suited as a basis for a series of lectures. Chapters 2, 3, and 4 are devoted to the oscillations of a homogeneous sphere, a shell, and a two-layered sphere. These are two-point boundary value problems, and the authors discuss in detail the interpretation of the eigenvalues (squared frequencies of oscillation) and eigenfunctions. The authors, as is usual, treat the outer core as a fluid, but they also include a discussion of small, finite rigidity of the outer core. As the rigidity vanishes the spheroidal equations drop from sixth to fourth order and the toroidal from second to zero. This is an example of a singular perturbation problem where one class of eigenvalues collapses onto the origin. A discussion of singular perturbation theory (such as is found, for example, in *Perturbation Methods in Applied Mathematics* by J. D. Cole) could have been included without loss of clarity or style.

The effects of self-gravitation and methods of computation for stratified models are treated in chapters 5 and 6. Experience has shown that the most stable and efficient numerical methods for computing eigenfrequencies and eigenfunctions are the Rayleigh-Ritz method and the finite difference method. The former is made more tractable by using Hermite cubic splines as the basis, as has been done by both Buland and Wiggens. The latter is rendered numerically very stable by using the method of minors in the formulation of the equations, as has been done by Woodhouse.

After a brief discussion of rotational splitting in chapter 7, chapter 8 is devoted to the solotone effect. The usual theory of the asymptotic distribution of eigenvalues in a Sturm-Liouville problem requires that the relevant parameters be twice differentiable. When they are not there are internal resonances and the simple asymptotic distribution breaks down, leading to the solotone effect. Sturm-Liouville theory has made numerous contributions to geophysics in the past. In the matter of the solotone effect geophysics has returned the favor.

The formulation of the excitation of free oscillations in terms of the source moment tensor is presented in chapter 9. This is followed by a discussion of array processing techniques for identifying spectral peaks and measuring their frequencies. The use of free oscillation spectra to determine source mechanisms is a subject of current research and is an approach that can be applied to all events of magnitude 6.5 or larger.

A survey of current research concludes the book. The book provides a firm foundation for anyone who would engage in research in the free oscillations of the earth. In fact, in this reviewer's opinion, astronomers could benefit from reading it. It is a fitting companion to the recent volume *Nonradial Oscillations of Stars* (W. Unno, Y. Osaki, H. Ando, and H. Shibahashi, University of Tokyo Press, 1979).

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Flatworms

The Biology of the Turbellaria. Proceedings of a symposium, Diepenbeek, Belgium, Aug. 1980. ERNEST R. SCHOCKAERT and IAN R. BALL, Eds. Junk, The Hague, 1981 (U.S. distributor, Kluwer Boston, Hingham, Mass.). xiv, 302 pp., illus. $69.50. Reprinted from *Hydrobiologia*, vol. 84. Developments in Hydrobiology 6.

This book consists of papers presented at the Third International Symposium on the Biology of the Turbellaria. The first two symposia of this series convened under different names: the Libbie H. Hyman Memorial Symposium (Chicago, 1970), and the Alex Luther Centennial Symposium on Turbellaria (Tvärminne, Finland, 1977).

The 36 papers included in the book are grouped in five sections. In the first section, Systematics and Zoogeography, I. R. Ball discusses the phyletic status of the Paludicola and points out that this taxon may not be monophyletic and may have evolved from two marine ancestors. Several papers deal with the karyology of polyclads and triclads. W. Teshirogi and S. Ishida study the electrophoretic band patterns of proteins of a species of *Polycelis*, and R. Biersma and H. G. W. Wijsman analyze enzyme variations in two closely related species.

The section Ecology and Faunistics contains papers on various aspects of the ecology of freshwater and marine Turbellaria. P. M. Martens and E. R. Schockaert discuss sand-dwelling micro-

turbellarians from the Netherlands, including descriptions of six new species. N. W. Riser reports on Coelogynoporidae from New England, the majority of them also newly discovered.

Under Nutrition and Reproduction, papers by J. B. Jennings and by G. L. Shinn deal with the physiological adaptations and diets of entosymbiotic neorhabdocoels. M. Benazzi and G. Benazzi Lentati discuss the relations between asexual fission and sexual reproduction in freshwater triclads.

Turbellaria, specifically planarians, have long been classical objects in the study of regeneration. The papers presented under the heading Regeneration and Differentiation refer to the problems of cell types, cell totipotency, and transdifferentiation and to biochemical processes related to regeneration.

The final section, Ultrastructure, includes a valuable review by R. M. Rieger of ultrastructural investigations of Turbellaria and several papers dealing with the fine structure of cilia, epidermis, parenchyma, eyes, copulatory organs, and spermatozoa of various turbellarian representatives.

It is interesting to note how far the study of the Turbellaria has progressed beyond the description of their morphology, distribution, classification, and general ecology, which were the center of attention in the early classical stages of turbellarian investigations.

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Ocean Imagery by Satellite

Spaceborne Synthetic Aperture Radar for Oceanography. Papers from a symposium, Laurel, Md., Mar. 1980. ROBERT C. BEAL, PAT S. DELEONIBUS, and ISADORE KATZ, Eds. Johns Hopkins University Press, Baltimore, 1981. 216 pp., illus. $19.50. The Johns Hopkins Oceanographic Studies, No. 7.

This volume is an outgrowth of a symposium held to explore the potential of synthetic aperture radar (SAR) for oceanography. The book is built upon a specific set of experiments centered on a coastal region of North Carolina that was repeatedly observed by the Seasat satellite (August–October 1978). At one level the volume is self-contained, moving from an introduction to the relevant SAR technology through a review of the data base to a consideration of experimental results and conclusions. At another level it draws heavily on external resources, appearing to be an extensive annotated bibliography to specialized aspects of the field. For this reviewer, the book is successful at both levels.

Following the introduction, there are five sections: Air-Sea Interactions and the SAR; Wind; Waves; Circulation; and Panel Discussion. Each of the first four sections is introduced by a concise summary by the editors of the principal results of each paper. The reader would be well advised to start with the introduction and then jump to the section on circulation, for it is very readable, provides a helpful perspective on the purpose and effectiveness of SAR oceanography, and introduces several of the more subtle considerations in qualitative fashion. The panel discussion is recommended next, for it outlines the conclusions and the problems discussed in the rest of the book. One should then progress section by section toward the beginning of the book, coming to grips finally with the theoretical material of the first section. The three papers in the section (Phillips, Kitaigorodskii, and Harger) are meant to provide a solid foundation for the work that follows; they could equally well serve as the basis for graduate-level courses in physical oceanography and SAR.

Several papers stand out. "Surface signs of internal ocean dynamics" (Mollo-Christensen) is an excellent description of phenomena observed by SAR imagery for which no theoretical model existed and which served as the impetus to outline and partially develop a suitable theoretical exploration of the internal waves in question. "Spatial evolution of ocean wave spectra" (Beal) is an overview of pioneering work at the Applied Physics Laboratory in wave-spectral analysis of SAR ocean data. It illustrates the potential of SAR to contribute to the solution of problems in wave dynamics, coastal bathymetry, and air-sea interaction. Striking color plates are used by Beal to present wave-directional spectral data.

There are many examples of SAR imagery in the book, together with a rather complete set of optically processed Seasat SAR data collected over the western North Atlantic. Identification of the location of images is concisely presented. The reader is left with the impression that digitally processed imagery is far superior to analog optically processed data. The editors have included a list of sources for Seasat SAR data products.

The book is unified but not neutered. Notation is not standardized, but symbol appendixes suffice. Several papers, notably those by Pierson, Ross, and Mollo-Christensen, retain the distinct style of their authors, adding to the readability of the book. There is evidence of the editors' gentle hand in the introductions to the sections, in the organization of the papers, and in the understated tone of the conclusions. Typographical errors are nearly nonexistent.

In summary, the book provides an effective overview of the Seasat SAR experience. Portions of the book (for example the section on waves) could serve as an introduction to satellite oceanic observation as well as a concise description of some of the less well known circulation phenomena.

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Actinides in Man and Animals. Proceedings of a workshop, Oct. 1979. M. E. Wrenn, Ed. RD Press (University of Utah Radiobiology Division), Salt Lake City, 1981. xviv, 636 pp., illus. $35.

Advances in Environmental Science and Engineering. Vol. 4. James R. Pfafflin and Edward N. Ziegler, Eds. Gordon and Breach, New York, 1981. xiv, 174 pp., illus. $68.

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Advances in Immunology. Vol. 31. Henry G. Kunkel and Frank J. Dixon, Eds. Academic Press, New York, 1981. xii, 324 pp., illus. $39.50.

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The Development of Gas Turbine Materials. G. W. Meetham, Ed. Applied Science Publishers, London, and Halsted (Wiley), New York, 1981. xii, 306 pp., illus. $44.95.

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