ing these methods, like the fast Poisson solvers, are treated in a rather comprehensive fashion.

A somewhat minor problem that readers may run into the course of using this book may be terminology. The author appears to have tried to unify both the Eastern and Western mathematical terminologies. For example, some theorems that are referred to in the Western literature by certain names are sometimes referred to in this book by their Eastern names, perhaps in an attempt to be chronological. However, he has also tried in many cases to explain such a situation; therefore, this should not distract the reader too much. More practical examples of the applications of the fine theorems and methods could have been presented, particularly the application of methods of constructing conformal mapping functions to computational nonlinear fluid dynamics. Another possible criticism of this fine book is its lack of treatment or mention of the method of characteristics for treating partial differential equations. In particular, a book of this caliber might be expected to discuss some aspects of complex characteristics, a relatively new analytical complex, and computational method, developed in the 1960's at the Courant Institute of Mathematical Sciences. It was found to be not only elegant mathematically, but also a powerful computational tool (in conjunction with the hodograph transformation) in the computation of two-dimensional transonic flow. However, because of the current size of this book, it may be argued that the addition of such a topic to the material currently covered in the book would have made the book too long. Therefore, since the author seems to be suggesting that another new volume in this series may be forthcoming in the future, he may have a legitimate reason for leaving out such a topic at this time.

A review of this book cannot be complete without pointing out another of its unique features; it contains informative notes giving the chronology and other dimensions of the topics treated, as well as references, for most of the sections of the book. Judging from the quality of its contents, it is clear that a lot of effort has gone into preparing this book. It is very informative and up-to-date. Therefore, this reviewer would recommend it to mathematicians, engineers, scientists, researchers, and graduate students of these disciplines.

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Hydrodynamic Instabilities and the Transition to Turbulence, Second Edition, H. L. Swinney and J. P. Gollub, Editors, Springer-Verlag, Inc., New York, 1985, 306 pp., $19.50.

The first edition of this book appeared in 1981 and it consisted of an introduction by the editors and eight well-written review articles by recognized authorities. It was published in a hardcover edition with 292 pages at a substantial price. The new edition is a high-quality paperback at a much reduced price and the original articles are unchanged from the first edition. To update the book, a final article entitled "Recent Progress" has been added. This article, by F. H. Busse, J. P. Gollub, S. A. Maslowe, and H. L. Swinney, consists of nine pages of text, including one figure, and 131 references. In my opinion this addition, although welcome, is not sufficient reason for an owner of the first edition to rush out and purchase the second edition. It does, however, make the book more timely, and together with the lower price gives someone who does not have the first edition an incentive to acquire the second edition. As there may be many readers of the *AIAA Journal* who are not acquainted with the first edition, a few comments on what it contains are in order.

An idea of the scope of the book may be obtained by listing the eight articles that make up the bulk of both editions. They are 1) "Strange Attractors and Turbulence" by O. E. Lanford, 2) "Hydrodynamic Stability and Bifurcation" by D. D. Joseph, 3) "Chaotic Behavior and Fluid Dynamics" by J. A. Yorke and E. D. Yorke, 4) "Transition to Turbulence in Rayleigh-Benard Convection" by F. H. Busse, 5) "Instabilities and Transition in Flow Between Concentric Rotating Cylinders" by R. C. Di Prima and H. L. Swinney, 6) "Shear Flow Instabilities and Transition" by S. A. Maslowe, 7) "Instabilities in Geophysical Fluid Dynamics" by D. J. Tritton and P. A. Davies, and 8) "Instabilities and Chaos in Nonhydrodynamic Systems" by J. M. Guckenheimer. The approach to instability from the abstract mathematical ideas of nonlinear dynamical systems, rather than from the Navier-Stokes equations, is presented in the articles by Lanford and by Yorke and Yorke. This approach, that quite loosely can be referred to as chaos theory, is shown by Guckenheimer to have applications beyond fluid dynamics. Another qualitative approach to instability and transition is that of bifurcation theory, and this theory is well presented in the detailed and enthusiastic article by Joseph. Of the four applications articles, the one by Tritton and Davies is firmly based on laboratory experiments and traditional theories. The article by Maslowe, which covers mainly boundary layers and free-shear flows, is more mathematical, but again the theories are the traditional linear and nonlinear theories, as these technically important flows still await a contribution from chaos theory. The comprehensive articles by Busse and by Di Prima and Swinney cover both theory and experiment, but again, except for one section in the latter on numerical solutions of model systems with a small number of degrees of freedom, the theories are the usual quantitative analytical theories of applied mathematics.

The articles, as stated in the Preface, were written with a nonspecialist audience in mind and I think this objective has been met with reasonable success. This does not mean that a great deal of solid material has not been included, and indeed there is much that is not at all easy to read, but each author has provided enough background information and general discussion to make his aims understandable to someone approaching the subject for the first time.

The final article of the new edition, entitled "Recent Progress," demonstrates that instability and transition continue to be active research topics, and that much was accomplished in the four years between the first and second editions. There has been encouraging progress in the application of ideas from chaos theory to temporally developing closed flows, and four instances are cited where a strange attractor has been determined to exist. The spatially developing open flows, however, continue to be studied by other means, and it is in this field that important developments have been overlooked in the new edition. These developments are the discovery of a subharmonic route to turbulence[1] in addition to the well-known Klebanoff breakdown, and a theory of secondary instability by Herbert[2,3] that encompasses both routes. This secondary instability is a *linear*, three-dimensional instability of a periodic, or nearly periodic, base flow consisting of the undisturbed flow and a primary instability wave of small, but finite, amplitude. As discussed by Maslowe, a subharmonic secondary instability was predicted some time ago by Craik[4] for boundary layers on the basis of a weakly nonlinear resonance theory. However, Herbert's linear theory, which proceeds from Floquet theory, is more general. It includes both subharmonic and fundamental resonance modes, applies to plane Poiseuille flow as well as to boundary layers and gives quantitative agreement with experiments and numerical simulations. The fundamental resonance mode is identified with Klebanoff breakdown, and this instability is closely related to that found by Orszag and Patera[5] (mentioned in the new edition) for near equilibrium, large amplitude, subcritical primary waves in plane Poiseuille flow.

I recommend this book to anyone with an interest in instability and transition. It can only broaden one's outlook on the entire field, and also offers an introduction to the new ideas developed in the 1970's that can be grouped under the healing of chaos theory. The book is attractively printed and I hardly noted any misprints. At the new low price it is a worthwhile addition to any library.

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[1]Saric, W. S. and Thomas, A. S. W., "Experiments on the Subharmonic Route to Turbulence in Boundary Layers," *Turbulence and Chaotic Phenomena in Fluids*, edited by T. Tatsumi, pp. 117–122, (Proceedings of IUTAM Symposium, Kyoto, Japan, 1983), North-Holland, Amsterdam, 1984.

[2]Herbert, T., "Subharmonic Three-Dimensional Disturbances in Unstable Plane Shear Flows," AIAA Paper 83-1759, 1983.

[3]Herbert, T., "Modes of Secondary Instability in Plane Poiseuille Flow," *Turbulence and Chaotic Phenomena in Fluids*, edited by T. Tatsumi, pp. 53–58, (Proceedings of IUTAM Symposium, Kyoto, Japan, 1983), North-Holland, Amsterdam, 1984.

[4]Craik, A. D., "Nonlinear Resonant Instability in Boundary Layers," *Journal of Fluid Mechanics*, Vol. 50, 1971, pp. 393–413.

[5]Orszag, S. A. and Patera, A. T., "Secondary Instability of Wall-Bounded Shear Flows, *Journal of Fluid Mechanics*, Vol. 128, 1983, pp. 347–385.

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