at the American Physical Society's centennial conference held in Atlanta in 1999. In this slim volume, he summarizes the great advances made by physics in the 20th century.

The accomplishments of physics in the 20th century are among the most illustrious achievements of our civilization, and Bromley is certainly one of those advocates of physics with the credentials to articulate them. Given so nearly impossible a task, Bromley nevertheless manages to pull it off. Although the book contains not a single equation, it offers a panoramic view of the physics landscape of the past century, in which are embedded an impressive number of major physics accomplishments. And it describes these accomplishments in a language that is comprehensible to an educated reader with or without training in physics.

Among the most admirable aspects of *A Century of Physics* is the huge collection of photographs that the author has gleaned from friends, his own collection, and especially from the remarkable Emilio Segrè Visual Archives at the American Institute of Physics. Among the photographs you will encounter some old favorites, but there are also some that you probably have not seen before.

Naturally, in a volume containing 116 figures in only 114 pages, little room is available for subtleties or qualifications; on occasion great accomplishments reduce to short descriptions of only a few sentences each. This brevity inevitably leads to the question, To whom is this volume addressed? Readers of PHYSICS TODAY will find the volume useful to help reinforce their enthusiasm for their chosen profession: How truly wonderful it is! The book can also be used as a tool to expound the value of physics to government, industry, and academic decision makers. For me it was a welcome refresher course in physics history that, for physicists of a certain age, is a reminder of what we have lived through. The physics of the second half of the 20th century is within the living memory of many physicists who have entered or are nearing retirement age, and no more than several degrees of separation connect virtually any physicist to the original masters. However, Bromley does not restrict himself to the distant past—his work is quite up-to-date, including mention of recent developments in everything from string theory and gravitational radiation to atom cooling and Bose–Einstein condensation.

In choice of topics, Bromley is about as complete as can be imagined, including arguably topics that other disciplines, such as chemistry, might claim as their own. I would, however, add to the ten choices he enumerates in his final figure, "some open questions in physics." In my own opinion, apart from the obvious questions of origins and final fate of the universe, there is the ultimate mystery of physics: the nature of quantum mechanics itself. Where does this beast come from or, as I. I. Rabi might have said, "Who ordered this?" One might ask a similar question about relativity. Furthermore, recent advances in the exquisite tweaking of simple quantum mechanical systems in both gas and condensed matter phases, and in the not-too-distant future, possible observation of gravitational waves, offer real promise that some new insights into these may appear in the next few decades.

To be sure, I yearned for a somewhat heavier book that included considerations of nuances. Above all, I would have liked a more calibrated discussion of the ways in which physics has contributed to some of our society's darker aspects. This would, in my opinion, not in any way have derogated physics; rather, it would have revealed the immense impact physics has had on society beyond the obvious contributions it has made to improving our living conditions and adding to our intellectual achievements.

We have by now learned that the march toward the light, while perhaps inevitable, contains pitfalls, traps, and detours that in the end may confound us all. There is an irony about the optimistic presentation of the century of physics. The cover photograph is a picture of the Super-Kamiokande detector, taken, of course, before its disastrous implosion. The image could be read as a metaphor for the other side of the wonderful physics story: that, as with all else in our culture, the dark side can rear its ugly head at most inauspicious moments. However, the Bromley presentation in Atlanta and this book that grew out of it are in the spirit of celebration. They honor a century of physics and the almost exact coincidental centennial of the American Physical Society, occasions for great pride and satisfaction.

I found the volume to be an immensely entertaining and illuminating read, and I was greatly impressed by the amount of thought and just plain hard work the author imposed on himself to get it done.

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Navier–Stokes Equations and Turbulence

C. Foias, O. Manley, R. Rosa, and R. Temam
Cambridge U. Press, New York, 2001. $90.00 (347 pp.). ISBN 0-521-36032-3

Physical Hydrodynamics

Etienne Guyon, Jean-Pierre Hulin, Luc Petit, and Catalin D. Mitescu
Oxford U. Press, New York, 2001. $ 100.00, $50.00 paper (505 pp.)
ISBN 0-19-851746-7,
ISBN 0-19-851745-9 paper

Turbulence is one of the most difficult problems in classical physics. In spite of tremendous progress on both the experimental and theoretical fronts, it still is far from being completely understood. The apocryphal discussion between Wolfgang Pauli and God, in which God considers turbulence a harder problem than calculating the value of the fine structure constant, is still valid in the 21st century. Some of the leading physicists and mathematicians of the 20th century contributed to the study of turbulence: Richard Feynman, Lev Landau, Werner Heisenberg, Andrei Kolmogorov, Jean Leray, Eberhard Hopf, David Ruelle, Robert Kraichnan, among many others.

The two books reviewed here are written at quite different levels. *Navier–Stokes Equations and Turbulence*, by Ciprian Foias, Oscar Manley, Ricardo Rosa, and Roger Temam, is an exposition of the known mathematical facts about turbulence and is aimed primarily at physicists and engineers; *Physical Hydrodynamics*, by Etienne Guyon, Jean-Pierre Hulin, Luc Petit, and Catalin D. Mitescu, is a highly original introductory text. Nonetheless, the two books do complement each other nicely.

I will devote most of this review to the first book. But I want to bring the second one to the attention of the physics community because of its interesting and unusual approach to the subject, emphasized in a beautiful foreword by Pierre-Gilles de Gennes.

Navier–Stokes Equations and Turbulence is part of the series Encyclopedia of Mathematics and its Applications; its explicit aim is to serve as an introduction for physicists and engineers to recent developments in the mathematics of turbulence. It is also intended to be an introduction for mathematicians to some of the physics and engineering aspects of turbulence. From a theoretical physicist's point of view, one of the book's most attractive features is the fact that the authors tried to interpret seemingly artificial mathematical assumptions in physical terms: for example, a particular choice of norms in Sobolev spaces is described as setting bounds on the energy or the enstrophy (the square of vorticity).

The book is written in such a way that the details of the proofs can be easily skipped without losing an understanding of the main reasoning. For example, the fact that solutions of the Navier–Stokes equations in two and three dimensions become more regular than their initial conditions leads to the need to consider so-called Gevrey spaces, and this is clearly explained. One highly original feature of the book is its insistence on statistical aspects of turbulence without getting lost in hairy details. The details are relegated to the more technical appendices of each of the chapters.

Here is a brief overview of the book's contents: Chapter 1 sets the background, with a brief account of the fundamental contributions of Kolmogorov and Kraichnan. Chapter 2 discusses the mathematical theory of the Navier–Stokes equations and the physical interpretation of the various spaces used. Chapter 3 discusses the finite dimensionality of turbulent flows—the fact that, in a harmonic decomposition of the flow, the high-wavenumber components decay so rapidly that the energy is carried by a finite number of components with low wavenumbers. The corresponding Kolmogorov and Kraichnan "guesstimates" lead to finite but very large numbers for these dimensions; as a consequence, low-dimensional truncations, such as Edward Lorenz's three-dimensional model, are only a caricature of the real chaotic character of the flow. The second half of the chapter deals with the fractal dimensions of the "attractors"—the long-term evolution of the flows.

Chapter 4 deals in detail with stationary statistical solutions of the Navier–Stokes equations, time averages, and attractors, focusing especially on the problem of "equality" of time and ensemble averages without appealing to ergodic hypotheses. It is the hardest and most interesting of the chapters: It deals with nonstationary statistical solutions of the Navier–Stokes equations and their relation to the conventional statistical approaches. As far as I know, this chapter is the first account of a mathematical validation, based on the Navier–Stokes equations, of the results obtained by conventional, heuristic approaches to turbulence. This includes a justification of the Kolmogorov spectrum and of intermittency, but is far from solving all fluid dynamics problems.

Physical Hydrodynamics is a rather original introduction to fluid dynamics and emphasizes the molecular and microscopic origins of fluid phenomena. It is well illustrated with pictures resulting from actual experiments and numerical simulations, which are cleverly used to motivate the more mathematical developments. The authors have been involved in experimental and numerical modeling of fluid flows and related subjects, and many illustrations in the book are from their original work.

The book starts with discussions of the solid–liquid transition, plastic flows, and macroscopic transport coefficients. It exploits models and numerical simulation to develop the reader's intuition. The text describes in detail experimental aspects, as well as such "unorthodox" fluids as Bingham fluids, thixotropic fluids, bubbles, smoke rings, and others. Another nice feature is the authors' exploitation of electromagnetic analogies, particularly in explaining vorticity and the motion of vortex filaments. Hydrodynamic instabilities and transition to turbulence are beautifully illustrated. In short, this is a book that can be read with pleasure by college seniors, graduate students, or professors familiar with the subject. It nicely complements *Navier–Stokes Equations and Turbulence*, which could have benefited from an index of notations and a more detailed author index. Although, like the authors, I am not a native English speaker, I noticed some Franco–Romanian syntactic structures and nonstandard punctuation in both books. The copyeditors of both could have done more to make the text-flow more laminar.

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Curve Ball: Baseball, Statistics, and the Role of Chance in the Game

Jim Albert and Jay Bennett
Copernicus / Springer-Verlag, New York, 2001. $29.00 (350 pp.). ISBN 0-387-98816-5

The game of baseball produces a plethora of statistical information relating to both team and individual performance: hitters' batting and slugging averages, pitchers' earned run averages, and the like. To translate these data into evaluations of the true ability of a player or team is a difficult challenge, one that is often handled poorly by baseball journalists and TV commentators.

Jim Albert and Jay Bennett's *Curve Ball* is an attempt to apply the techniques of statistical analysis to the understanding of baseball statistics. The authors are both professional statisticians. Both (like the reviewer) are members of the Society for American Baseball Research. Both, (definitely unlike the reviewer) are lifelong fans of the Philadelphia Phillies.

Among the questions addressed in their book are: When a player or team experiences periods of poor and of good performance during a season, is this necessarily (or probably) due to ups and downs of actual ability, or can it be explained by chance? Are some hitters significantly better than others at hitting in particular situations, such as with runners on base, or in night games, or on artificial turf? What offensive statistics are most useful in evaluating a player's true contribution to the scoring of runs? Can the "clutch" performance of a player be objectively evaluated? Is the winner of the World Series really the year's best team in true ability?

The book seems to be addressed primarily to baseball fans who are not necessarily educated in probability theory. The authors do not use even elementary statistical concepts, such as standard deviation, without explanation, and, using various models, they treat examples of player and team performance by computer simulations of entire seasons rather than by proving theorems about the expected spread of this or that result. Physicists who understand baseball will find the mathematical reasoning quite easy to follow; in fact, they may find themselves skimming over some of the explanatory text.

Some idea of the content of the book may be conveyed by citing a few examples of the specific problems treated:

In the treatment of situational effects, the book uses data from *Player Profiles* (Stats Publishing, 1998) for the 1998 season to reach the following conclusions: (a) There is no evidence that players' batting averages differ appreciably between grass and turf, the observed differences being explainable as chance fluctuations. (b) Differences in batting averages between