ponder his observation, at the conclusion of his chapter on interhemispheric interaction, that

to some extent, the emergence during the last thirty years of so much research dealing with the *differences* between the left and right cerebral hemispheres has resulted in a particular view of the brain: the brain has been "taken apart," and there has been a tendency to analyze and conceptualize the pieces as separate processing systems. Indeed, the same thing could be said about the highly fine-grained modularity that has come to characterize much of cognitive neuroscience. The time has come to put the brain back together again.

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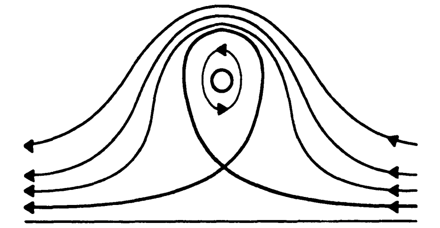
Vorticity

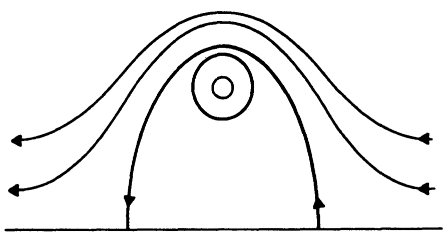
Vortex Dynamics. P. G. SAFFMAN. Cambridge University Press, New York, 1992. xii, 311 pp., illus. $69.95 or £35. Cambridge Monographs on Mechanics and Applied Mathematics.

Vortices are ever present in liquid and gaseous motions, from the eddies seen behind bridge posts in fast-moving streams and rivers (as sketched by Leonardo da Vinci in the 15th century) to the pair of counterspinning white trails behind high-flying jets, which lazily approach each other, twist, and reconnect. Vortices are also found in the ocean and in the atmosphere. For example, the Gulf Stream spins off large gyres, observable from satellites, that may last for months. Storms often bring localized vortices in the form of hurricanes, tornadoes, and typhoons; vortex regions are also present in slowly moving weather patterns that may cause unusual conditions, as in the East Coast heat wave of 1993. Although vortices have been characterized by D. Küchemann as the "sinews and muscles of fluid motions," they are really very fragile and amorphous structures, easily deformed ("stretched," "strained," or "stripped") and topologically modified by interactions with other vorticity-dominated regions and boundaries. Vortex dynamics are strongly nonlinear and most often chaotic; they govern the properties of turbulence and the associated phenomena of heat and pollutant transport.

Philip Saffman, continuing in the tradition of Lord Kelvin, Lord Rayleigh, and G. I. Taylor, is a pioneering contributor to the field of physical and mathematical vortex statics and dynamics. Drawing mainly from his own previous work as well as that of D. Moore, D. Pullin, and their students and colleagues, he



(a)



(b)

"Sketch of relative streamlines for (a) thin and (b) fat vortex rings." [From *Vortex Dynamics*]

has now attempted to update chapter 7 of H. Lamb's classic 1932 monograph *Hydrodynamics*. The contents of *Vortex Dynamics* fall into three basic categories: general considerations, theory and applications of two-dimensional problems, and theory and applications of three-dimensional problems. Heuristic derivations are followed by careful calculations using energy principles and, often, linear stability analyses. Saffman has an admirable talent for rendering the content of formulas into physical insights, and he keeps mathematical formalism and theorems to a minimum. Although he presents a few illustrations to illuminate the textual description and several simple graphs that show the consequences of linear analyses, results of laboratory experiment or numerical simulations unfortunately are mentioned only in passing.

Saffman includes good discussions of impulse, energy, helicity, and virtual momentum. In the two-dimensional realm he deals mostly with the Euler equations, as represented by singular vortex points and sheets as well as contours, which bound piecewise, constant vortex regions. In the three-dimensional realm he discusses the formation, core structure, stability, and properties of the vortex ring, a commonplace torus-like structure (as in the ring blown by a smoker). In a chapter on the dynamics of vortex filaments he discusses the regularization of motion due to the core cutoff approximation and provides a clear and concise review of the linear stability of vortex columns. The motions described are typically applicable to steady and near-steady (laminar) or short-time unstable solutions.

In my opinion, Saffman does not place sufficient emphasis on longer-time nonlinear evolutions of nonsingular vortex distributions. For example, in his final chapter he presents a concise derivation of the equations of motion for the Hamiltonian dynamics of vortex patch moments in two dimensions. It would have been more useful to continue with a discussion of the analytical and computational aspects of vortex merger, rather than relegating it to a footnote. Merger is a fundamental process in turbulence, and these results would have helped the reader to appreciate the present controversy regarding scaling laws of coherent-structure models of two-dimensional turbulence.

Although *Vortex Dynamics* contains a minimum of graphics and no problem sets, I recommend it as a graduate text for students with a basic understanding of fluid dynamics, a good background in vector analysis, and some knowledge of complex variable theory. But the book will be most useful to the researcher. Saffman provides important physical and mathematical frameworks to help us visualize, quantify, and understand the emerging nonlinear, intermittent, and turbulent computational results of large-scale direct numerical simulations. Despite its omissions, this is a major contribution to the literature of physical and mathematical vortex dynamics.

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Understanding the Universe

Principles of Physical Cosmology. P. J. E. PEEBLES. Princeton University Press, Princeton, NJ, 1993. xviii, 718 pp., illus. $59.50 or £55; paper, $29.95 or £19.95. Princeton Series in Physics.

Physical cosmology has rapidly advanced from the discovery of the 2.7 K cosmic microwave background radiation 28 years ago to the detection of small variations in its temperature in different parts of the sky to an accuracy of one part in a million. Similarly, maps of the distribution of galaxies surrounding Earth that were very local only 30 years ago have now expanded to show galaxies within the surrounding 10^{12} cubic megaparsecs. The tremendous increase in the quantity and quality of data has done far more than simply add a few more decimal points of accuracy to astronomical measurements; it has led to the discovery of new phenomena and unsuspected relations. Some of the most important developments in cosmology through the late 1970s have been chronicled and their implications explored by P. J. E. Peebles in his *Physical Cosmology* (1971) and *The Large-Scale Structure of the Universe* (1980)—books that to a significant degree have even motivated and guided cosmological research. His newest work, *Principles of Physical Cosmology*, presents a completely updated overview of the field.

Principles of Physical Cosmology will appeal to an even wider audience than did Peebles's earlier volumes. Its first main section, spanning 226 pages, is a semihistorical account of the development of physical cosmology; much of this material could be taught in a first-year course in astronomy. This serious overview of "the attempt to make sense of the large-scale nature of the material world around us" is remarkably compact, comprehensive, and readable—a real page-turner, at least by the standards commonly applied to physics monographs. Interspersed throughout this overview are some "lengthy but strengthening" technical discussions that amplify certain deceptively simple-sounding assertions in the main text. These sections can be skipped by those who feel no need for strengthening.

The second major section begins with a development of general relativity from first principles in 42 pages. The brevity of this discussion will shock and disappoint some, but others will welcome the presentation of some essential physics in a manner that does not overwhelm the student whose main interest is physical cosmology. The mathematical and dynamical basis of the general relativity theory is followed by discussions of small-scale and weak-field limits; wall, string, and spherical solutions; and Robertson-Walker geometry. Peebles then works out the practical consequences of general relativity for everyday astronomy, presenting many useful formulas and graphs of various cosmological tests for the parameters of the Robertson-Walker geometry. Gravitational lensing is acknowledged to have evolved from a test of general relativity to an extremely useful tool for measuring mass distributions.

The third, rather lengthy, section of the book explores a number of research topics in cosmology. The list spans the range of modern research but is not comprehensive, concentrating on structure mapping and dynamical issues, Peebles's own interests. Each chapter begins with a readable overview of its focal topic, usually with some reference to the classical literature on the subject (for example, an account of the mass function of stars in the solar neighborhood) as a reminder that cosmology did not just spring up by itself but grew out of the mainstream astronomical tradition. The discussion then takes a technical turn, describing current theory and results. One important topic covered is inflation, the ruling paradigm for understanding the large-scale structure of the universe. A complete exposition of inflation would require a lengthy presentation of quantum field theory, but Peebles manages to lay out the fundamental ideas here, presenting insight into the basis of the theory as well as sufficient technical detail to illustrate how it works and why it is so compelling. The other topics addressed have to do with our attempts to measure and understand the structure of the universe. Although an immense amount of progress is reported here, in most cases the answers remain elusive and in some cases the problems are not even well understood. This is particularly evident from the chapter on galaxy formation, which presents the current state of conjecture in the field. In his final chapter, "Lessons and issues," Peebles acknowledges that "the pictures under discussion are far from seamless."

Given the value of Peebles's previous books, many astrophysicists and graduate students will purchase *Principles of Physical Cosmology* sight unseen. They will not be disappointed. Accessible to anyone with an undergraduate background in physics, it succeeds in conveying the excitement of modern research through a straightforward presentation of the basic technical details. In the end there is no other way to appreciate the nature of the quest than to become immersed in these details. I recommend this book to anyone with an interest in astrophysics.

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Books Received

Asymptotic Behaviour of Solutions of Evolutionary Equations. M. I. Vishik. Cambridge University Press, New York, 1993. x, 155 pp. $39.95; paper, $18.95. Lezioni Lincee.

Atmosphere, Weather and Climate. Roger G. Barry and Richard J. Chorley. 6th ed. Routledge, Chapman and Hall, New York, 1993. xxii, 392 pp., illus., + plates. $99.95; paper, $35.

Automotive Ergonomics. Brian Peacock and Waldemar Karwowski, Eds. Taylor and Francis, Philadelphia, 1993. xii, 485 pp., illus. $85.

Butterflies Through Binoculars. A Field Guide to Butterflies in the Boston, New York, Washington Region. Jeffrey Glassberg. Oxford University Press, New York, 1993. xviii, 160 pp., illus., + plates. Paper, $19.95.

Causation and Disease. A Chronological Journey. Alfred S. Evans. Plenum, New York, 1993. xvi, 238 pp., illus. $35.

Chemistry Imagined. Reflections on Science. Roald Hoffmann and Vivian Torrence. Smithsonian Institution Press, Washington, DC, 1993. 168 pp., illus. $19.95.

The Many-Body Problem. An Encyclopedia of Exactly Solved Models in One Dimension. Daniel C. Mattis, Ed. World Scientific, River Edge, NJ, 1993. xxiv, 958 pp., illus. $86.

Mapping It Out. Expository Cartography for the Humanities and Social Sciences. Mark Monmonier. University of Chicago Press, Chicago, 1993. xiv, 301 pp., illus. $37; paper, $15.95. Chicago Guides to Writing, Editing and Publishing.