Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering

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dicting phase behavior, especially of weaker amphiphiles. But they do not lead easily to the well-defined membranes and large correlation lengths characteristic of strong amphiphiles. Lattice models also violate the scale invariance of the bending energy of physical, "off-lattice" membranes, because the imposed lattice breaks rotation invariance (a point not emphasized by the authors).

▷ Ginzburg–Landau theories are convenient for discussing possible phase diagrams and the structure and fluctuations of phases, but, of course, they require some adjunct microscopic model for computing their several (often many!) phenomenological parameters.

▷ The membrane approach is best for strong amphiphiles, summarizing the complex microscopic association behavior in a few properties of the resulting interface. But it is less successful in predicting phase diagrams, mainly because of the difficulty of a unified description of phases with large-scale structures (microemulsions) and those without (micellar solutions).

The authors give the least time and attention to the membrane approach, with tantalizingly short discussions of and few references to many fascinating topics (lamellar phases and vesicles and their fluctuations, for instance). I found myself wishing that this well-organized, well-presented article had been longer than its 166 pages of text, perhaps with more discussion of questions left unanswered and speculations as to the direction of future work. This volume will certainly be of interest to researchers in this area and may be useful as supplemental material for graduate students.

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Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering

Steven H. Strogatz
Addison-Wesley, Reading, Mass., 1994. 498 pp. $55.95 hc ISBN 0-201-54344-3

As nonlinear dynamics has matured as a subject, the demand has grown for an effective introductory text. The subject is multidisciplinary with applications in diverse fields, and it can be approached from foundations in physics or in the mathematics of differential equations. Presenting such material in a self-contained and comprehensive fashion poses significant difficulties. Steven Strogatz has produced a text that succeeds admirably with this goal.

The book is suitable for a one-semester, advanced undergraduate course; it requires a standard background in calculus and introductory classical mechanics. The details associated with applications to lasers, pendula, fireflies, rabbits and sheep and foxes, superconductors, chemical reactions, love affairs, insect outbreaks and the coding of secret messages with chaos are self-contained. The richness of the variety of applications emphatically underscores the significance of nonlinear dynamics. It also makes the study of the subject exciting and even amusing.

Strogatz, who is still in the early part of his career, has been recognized for his outstanding teaching at MIT and has been an active contributor to the research literature, especially in the area of coupled oscillators in physics and biology. His approach places geometrical methods at the center of the presentation. The book contains several hundred carefully conceived illustrations, dozens of worked examples and hundreds of instructive problems for the student. The problems are of graded difficulty, with some problems providing the student with a taste of current research. The examples impressed me with their subtlety and incisiveness. Important, delicate distinctions and exceptions are highlighted and accessible.

The first two thirds of the book are devoted to one- and two-dimensional flows, bifurcations and stability diagrams and the lexicon of dynamical systems; the last third of the book is about chaos, covering Lyapunov exponents, renormalization and fractals. Close contact with real applications is maintained throughout this section, and the intuitive treatment of renormalization methods for the logistic map is especially effective.

Two other books of high quality intended for advanced undergraduates are Robert Devaney's *An Introduction to Chaotic Dynamical Systems* (Addison–Wesley, 1989), and Gregory Baker and Jerry Gollub's *Chaotic Dynamics: An Introduction* (Cambridge, 1990), both of which I like. Compared to Strogatz's book, they are narrower in scope and thereby more thorough in the treatment of their chosen topics. Nevertheless, it is the variety of topics in *Nonlinear Dynamics and Chaos* that is one of its great strengths.

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Introduction to Cosmology

Matts Roos
Wiley, New York, 1994. 206 pp. $39.95 pb ISBN 0-471-94298-7

Cosmology was once a discipline reserved for philosophers and theologians. Echoes of this esoteric past remain, especially in some European countries where the practitioners of the more traditional disciplines of mathematics and physics seem to disdain cosmologists. But this is changing, and a notable indication of the shift is that physicists are transferring in droves to cosmology. After all, new data in physics enter the scene at most a few times per decade. In cosmology, the acquisition of qualitatively new (if sometimes contradictory) data occurs at a breakneck pace; a month does not pass without some new pronouncement. One month it may be a new detection of fluctuations in the cosmic microwave background, a second month may herald a new measure of the Hubble constant, a third will highlight new evidence for dark matter in galactic halos and a fourth may bring yet another independent measure of the Hubble constant (that blatantly disagrees with the earlier announcement). Keeping up with this flood of information requires familiarity with both classical astronomical concepts and the new insights into cosmology that are being produced by particle physics.

Matts Roos has produced a new introductory text on cosmology that strongly reflects his background as a particle physicist. His *Introduction to Cosmology* is aimed at undergraduate physics majors and makes use of only the simplest questions and concepts from modern particle physics. The physics emphasis provides the author with the opportunity to develop the thermal history of the big bang. He describes the imprints of inflation and symmetry breaking on the observable universe, supplemented by more conventional discussion of the cosmic microwave background and cosmological tests. It is rare to find an elementary discussion of such findings, and the book should prove a useful addition to more astronomically oriented introductory discussions of cosmology.

A penultimate chapter is devoted to