is not found. There has been a flood of new observations and predictions in a variety of areas: in plasma physics and controlled fusion; the transition to turbulent flow in the atmosphere and oceans; the loss of coherence in a laser beam; the irregular tumbling of a spacecraft; various chemical and biological reactions; and in quantum and molecular physics. The theory of chaos goes beyond the physical sciences to cast new light on economic cycles and the spread of epidemics. As part of a new program in nonlinear dynamics, a group of scientists from the Naval Research Laboratory, Office of Naval Research and Naval Surface Warfare Center organized the first scientific meeting devoted entirely to experimental chaos. This well-written and well-edited volume contains the proceedings of the pioneering conference. The material has been carefully selected and organized to provide a broad overview of chaos as observed in physics, engineering, biology and even medicine. Attention is paid to clear formulations of problems and unambiguous interpretations of experimental results.

The papers in the book are divided into seven sections. Only one of these sections, data analysis, can be referred to as theoretical. Chaos stimulated new ideas in time series analysis, and the papers in this section elaborate on some of those methods, such as the computation of Lyapunov exponents, the evaluation of embedding dimensions and the extraction of nonlinear or coherent properties. The second section deals with optics, in which chaos in laser turbulence has been studied successfully for a long time. A good review introduces articles on chaos in semiconductor laser arrays, multimode solid state laser systems, nmr lasers and optical fibers.

The third section, on applications, deals mainly with controlling chaos. Two articles detail the Ott–Grebogi–York method for controlling chaos in commercially available magnetic glasses. The OGY method has also been used in experiments on heat and mass transport. It allows experimenters to induce chaos, switch back and forth between chaotic and nonchaotic motion and stabilize chaos. The possibility of controlling nonlinear phenomena such as the generation of magnetostrictive subharmonics, noise enhancement and low-frequency magnetic field mixing is demonstrated. There are ideas other than OGY for controlling chaotic systems.

A paper by Arnold J. Mandell and Karen A. Selz reveals novel and unexpected manifestations of chaos in biology. This paper features a striking admixture of terms from nonlinear science and medicine. Nonlinear dynamics in clinical cardiology and in mind–body processes, and synchronized chaos in cultured neuronal networks make a good start for the fourth section of the book, general chaos. There are new arenas here, such as chaos in some semiconductors, in film flows and in electrochemical processes. All of these examples give a strong impression that nonlinear dynamics has penetrated deeply into experimental physics.

The fifth section of the book, magnetism, covers a field in which new ideas of nonlinear analysis have met with some difficulties. Fairly obvious results on irregular motion in a magnetoelastic ribbon are followed by pioneering work by G. Gibson and C. Jeffries on spin-wave chaos in yttrium iron garnet films.

The sixth section considers chaos in electric circuits, which are perhaps the best and most explicit objects for such study. Nevertheless the processes under investigation are not trivial. They include fine simulations of a strange nonchaotic attractor in a semiconductor quantum interference device, phase locking in a large array of coupled oscillators and synchronization of chaos in a coupled tunnel diode.

The last section of the book is about spatiotemporal chaos. Spatial charge domains in ultrapure germanium, Rayleigh–Bénard convection in a ^3He–^4He mixture, Tollmin–Schlicting turbulence in waves, atmospheric attractors determined by Doppler radar and sonar, and evolution to chaos in flames—these and other examples demonstrate the great connection of nonlinear dynamics to a variety of physical systems.

I have no doubt that the book will be of interest to a wide range of scientists: theorists who are looking for realizations of their curious constructions, experimenters who would like material incarnations of these, as well as researchers from biology, chemistry and other areas who are attracted by the new and exciting ideas.

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Applied Chaos

Edited by Jong Hyun Kim and John Stringer.
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This volume reports the proceedings of the International Workshop on

Applications of Chaos, which was sponsored by the Electric Power Research Institute and held in San Francisco in December 1990. The aim of the workshop was to explore existing and potential applications of chaos, particularly in engineering, physics, and chemistry.

The book contains 20 chapters divided into five parts: chaos in engineering and technological applications; applications in the physical sciences; applications in the physiological sciences; chaotic time series and forecasting; and general topics. Almost all of the authors are well known to the chaos community. The volume concludes with a discussion of the various articles by the workshop participants.

The articles and discussion illustrate three important points about using the concepts of chaos. These are of special concern to engineers who deal with parameter control problems: the need to avoid chaotic basins of attraction; the need to be in chaotic basins of attraction; and the importance of analyzing transient behavior. While most physicists and engineers would anticipate the importance of the first point, many might not anticipate the importance of the latter two.

The fatigue of cables due to chaotic flexing, the dynamic instability of ships in chaotic waves and the chaotic fluctuations of large transport belts are examples of the need to avoid chaotic basins of attraction. Chaotic mixing for heat transfer enhancement and in chemical reactions, and the removal of impurities using chaos-enhanced convection are examples of the need to be in chaotic basins of attraction. Many engineering problems—transport belts, dynamical stability of ships at sea, atmospheric flight dynamics and the forecasting of catastrophes—reflect the need to pay close attention to transient behavior.

Two chapters indicate considerable potential for using chaotic concepts in electrocardiography and physiology. It is interesting that a persuasive case can be made for the presence of subtle arrhythmias in the heart beats of healthy animals and that disease can sometimes be characterized as "decomplexification." Other articles in the book are more methodological and will interest a very wide audience. For example, one deals with the nonlinear modelling of noisy chaotic time series, and another is on forecasting catastrophes by exploiting chaotic dynamics.

The articles are for the most part well written and easily understood, and in most cases they provide fascinating examples of actual or realistically implementable applications of the concepts of chaos. This book will be warmly received by the scientific community and by engineers who are interested in the applications of new scientific ideas.

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Local Quantum Physics: Fields, Particles, Algebras

Rudolf Haag
Springer-Verlag, New York, 1992. 356 pp. $59.00 hc
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This superb book, appropriately dedicated to three "grand masters" of the previous generation—Eugene Wigner, and the late Valja Bargmann and Res Jost—aptly summarizes Rudolf Haag's fundamental contributions to the understanding of quantum field theory. If one wants to characterize either the work or the book in four words, they are "common sense mathematical physics." Indeed, both the expert in the field and the novice will enjoy Haag's insightful exposition of the basic physics behind the abstract mathematics, and his unique way of making complicated mathematical theorems plausible without getting bogged down in tedious details.

Technically, the book is nicely presented. I particularly appreciated the combined author index and references, which refer back to the chapter and section in which the work is cited. Unfortunately the book contains a large number of typos and misspellings, which a good copy editor should have caught. There is also a lack of consistency between British and US spellings and an unorthodox placement of commas. But these tiny flaws in no way detract from the value of the book, which should be in every serious theorist's library.

The book starts out with a masterful overview of quantum mechanics, the principle of locality, Poincaré invariance, the action principle, and "basic quantum field theory." Worth mentioning are an illuminating discussion of the fundamentals of quantum mechanics (leading naturally to the need for an algebraic treatment) and a very clear definition of states as positive linear functionals on the algebras of observables. Though this chapter covers traditional material, it contains many insights not found in other books.

Chapter II takes us (in about 50 pages) from Haag's theorem on the unitary non-equivalence of free and interacting field theories, through Wightman's axioms for quantum field theory, covariant perturbation theory and a smattering of "constructive field theory" to Haag's original contributions to the understanding of the particle picture and to the Haag–Ruelle scattering theory. Again, the reader will enjoy the physical insight behind the mathematical formalism. Chapter III is devoted to a discussion of C* algebras and von Neumann algebras in the context of quantum field theory. The proposal to base the theory on a net (a generalization of a sequence, with a "continuous label") of local algebras corresponding to different space–time regions originated in Haag's contribution to the 1957 Lille Conference. He suggested that the algebras should be generated by both observable and unobservable fields and taken as operator algebras acting on Hilbert space. This led to a deeper understanding of collision theory by eliminating the distinction between elementary and composite particles and basic fields. Huzihiro Araki helped to develop the theory in terms of nets of von Neumann algebras of observables. The idea that one should take an abstract C* algebra as the basic object and that its specific representation is irrelevant to physics was advocated by Irving Segal in 1947 and again at the 1957 conference. However, it took several years until Haag and Daniel Kastler realized that a *net* of (abstract) C* algebras of observables, associated with regions of spacetime, provided the natural setting for understanding superselection rules and the role of unobservable fields. These issues are discussed in the book.

The analysis of superselection sectors put forth by Sergio Doplicher, Haag and John Roberts, and its extension by Detlev Buchholz and Klaus Fredenhagen to topological charges which possibly occur in massive gauge theories, is described in detail in chapter IV. It consists of a derivation of the superselection structure of quantum field theory essentially from the Haag–Kastler axioms. The remarkable result of this analysis is that from very few assumptions one can deduce results such as the existence of the Bose–Fermi alternative and of unobservable fields, as well as the equivalence of parastatistics with the existence of a unitary group of internal symmetries (at least for theories of massive particles). It is strange that until fairly recently these deep results were not generally known by particle theorists. In this chapter, as before, the author manages to keep