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Book Review: *Chemical Oscillations, Waves and Turbulence*

Chemical Oscillations, Waves and Turbulence. Y. Kuramoto. Springer-Verlag, Berlin, 1984.

This book concentrates on the dynamics of self-oscillating fields of the reaction-diffusion and related types. The perspective of the author is to build up a large number of interacting similar units to form a cooperative field generally described by an equation of the Ginzburg–Landau type. This field is capable of existing in a number of stable and metastable states because each local subunit itself is an active dynamical system functioning far from equilibrium. These fields are considered to be representative of H. Haken's synergetic systems and admit of a number of curious patterns and turbulence-like behaviors quite unlike those arising in the traditional thermodynamic cooperative fields. The author emphasizes his use of Haken's *slaving principle* whereby multiple periodic processes with different natural frequencies come to acquire a common frequency as a result of their mutual influence.

The paradigm used is that of a system of diffusively coupled oscillators, treated in isolation as well as driven by deterministic and/or stochastic forces. These separate model systems are analyzed using a small number of asymptotic techniques developed in the text. These techniques are generalized to include spatiotemporal inhomogeneities and are applied to the understanding of such phenomena as chemical waves and chemical turbulence. The topics discussed include chemical waves emanating in concentric circles from one or more pacemakers, rotating spiral waves and their three-dimensional analog called scroll wave and also trigger waves. These wave forms, having arisen in reaction-diffusion systems, are shown to manifest spatiotemporal chaos in various circumstances. The cases discussed include the randomization of uniform oscillations, of propagating wave fronts, and of rotating spiral waves. The mechanisms giving rise to chaos include diffusion instability, wavefront instability, and phase singularities in spiral waves.

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The author provides a broad overview of this rapidly growing area of nonlinear dynamics, drawing the experimental and theoretical literature into his discussion with equal facility. I found the book to alternate between lucid expository sections emphasizing the physical–chemical interpretation of the model systems and arid mathematical sections that are very high in information density and often difficult to read. To reduce the density of information and not lose any content, the book would probably need to double its modest size of 150 pages. I would recommend this book as a nonstandard text to supplement a special topics course on the self-organization of physical, chemical and/or biological systems.

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