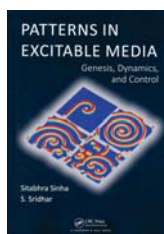


Patterns in Excitable Media

Genesis, Dynamics, and Control

Sitabhra Sinha and S. Sridhar

CRC Press/Taylor & Francis, 2015. \$89.95 (316 pp.). ISBN 978-1-4665-5283-8



Many patterns in nature, from the organization of vegetation in arid ecosystems to stripes and spots on animal skin and fur, can be described with standing waves produced by reaction-diffusion equations. Other solutions to reaction-diffusion equations, however, can lead to dynamical waves—for example, in predator–prey populations, the heart, and the brain. The above systems are all examples of excitable media—dynamical systems with domains that can be individually “excited” and that also interact with each other, potentially spreading the excitation along.

In their new book, *Patterns in Excitable Media: Genesis, Dynamics, and Control*, Sitabhra Sinha and S. Sridhar provide a good introduction for undergraduates and early graduate students to the dynamic formation of patterns in reaction-diffusion systems. Because an understanding of excitable media is applicable to so many disciplines—including physics, biology, chemistry, physiology, math, and biomedical engineering—the book should be of interest to a wide variety of students.

Patterns in Excitable Media is divided into three parts. The first begins with a detailed description of excitable media: Specific examples considered use mathematical models that range from simple and generic to complex. Part one continues with descriptions of the different types of wave dynamics that the mathematical models can produce in one and two dimensions. Particular emphasis is given to spiral waves and their transition to chaos. This part concludes with an image gallery of biological and chemical examples in which spiral waves are readily observed.

The second part focuses on the dynamics and instabilities of waves, particularly spiral waves, in the presence of heterogeneities that can either be static, arising from the domains’ structure and coupling, or dynamic, emerging as a function of the medium’s nonlinear dynamics. In several examples, the authors present

numerical simulations in which the degree and nature of the inhomogeneities are modulated and in which the different regimes that arise are illustrated.

The final part of the book is dedicated to methods for controlling spatially disorganized patterns such as those responsible for deadly cardiac arrhythmias. Previous chapters showed different mechanisms that can destabilize propagating waves in excitable media and turn them into single or multiple spiral waves with chaotic behavior. This final part presents a series of control methods, each specifically designed to target a particular destabilization mechanism. The strength of this part—and of the book—is that it demonstrates the importance of understanding a system’s dynamics and the physics behind an instability before designing an appropriate and successful control method.

As acknowledged in the preface, *Patterns in Excitable Media* is mostly a collection of the authors’ publications, adapted and expanded into book form. That approach comes with advantages and disadvantages. Content from publications introduces relatively fresh material and exposes readers to some of the latest research themes. However, the book chapters are a bit disconnected. On many occasions, the background added to convert articles into chapters is rather thin. And in several instances, sections read more like checklists of topics that needed to be covered than as full explanations of important concepts.

Moreover, the book left me with three disappointments. The first is the low resolution and overall poor quality of many images; that’s a pity, because one of the great appeals of patterns in excitable media is the impressive images they can generate. Second, the book’s title promises much more than the content delivers; the majority of the book focuses on one system, cardiac dynamics. And third, the book’s back cover sets the reader up for discussion of high-performance supercomputer applica-

tions and computer-code examples. However, only two pages are dedicated to parallelization, and only five simple codes, all written in Matlab, are supplied: three codes for zero-dimensional excitable models and two very simple 2D codes.

Nevertheless, I would recommend *Patterns in Excitable Media* as supplemental material for multidisciplinary courses that deal with nonlinear dynamics, chaos, computational physics, and applied math.

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Three Scientific Revolutions

How They Transformed Our Conceptions of Reality

Richard H. Schlagel

Humanity Books, 2015. \$39.00 paper (250 pp.). ISBN 978-1-63388-032-0

The history of science used to be fairly sedate. Emeritus professors spent their golden years listing their respective disciplines’ triumphs and linking each scientific achievement to heroic dead white males who overcame foes gripped by terror, superstition, malice, or plain stupidity. Johannes Kepler and Nicolaus Copernicus demonstrated heliocentricity; Galileo Galilei faced down the Inquisition; God said “Let Newton be!” and all was light; Louis Pasteur demolished spontaneous generation; and Charles Darwin divorced life from divinity. In sum, science was a series of heroic efforts that piled truth upon truth. For the political record, a parallel approach depicting the past as inexorably leading to the perfection of Victorian England is called “Whig history.” Up to a half century ago, “Whig science” was the standard approach.

Then Thomas Kuhn published *The Structure of Scientific Revolutions* (U. Chicago Press, 1962), and science history suddenly got more interesting. It opened the door to a new discipline: the social study of science, which examined the past in a radically new way. Galileo, it turned out, had no problem presenting his cosmology as astrology and extolling his thug patrons, the Medici family. Dar-

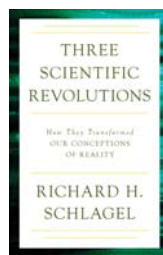
win's *Origin of Species* was used as a blunt instrument by Thomas H. Huxley and his pals to advance their careers; and the sainted Pasteur fudged data to counter Félix-Archimède Pouchet's claims that he experimentally observed spontaneous generation.

The new analytical approach to science studies has extended to the present, with interesting revelations. Today's science routinely abridges its putative formality of hypothesis, investigation, and verification: Few experiments are ever replicated, the overwhelming majority of papers are read by no one but authors and reviewers, scientific paradigms rest on unstable human alliances as much as on correspondence with nature, and results that contradict accepted paradigms are usually tossed away. Science past and present seems less the unavoidable unveiling of Platonic absolutes than a human enterprise that frequently aboufices on its definitions of facts, terms, and theories. For all its impressive achievements science is not, and never has been, wholly what it would seem to be.

All the post-Kuhnian developments seem to be news to Richard Schlagenel, an emeritus professor of philosophy at George Washington University and author of *Three Scientific Revolutions: How They Transformed Our Conceptions of Reality*. Schlagenel begins the book with the emergence in classical Ionia of various schools of systematic rational analysis, a protracted series of events that he terms the First Transition. He follows up by examining the scientific revolution in early-modern Europe, which culminated with Isaac Newton (the Second Transition). Then, after a high-speed review of 18th- and 19th-century science, Schlagenel presents the Transition to the Third (or present-day) Reality via 20th-century physics. It is an ambitious undertaking, but unhappily one in which Schlagenel's Whig approach falls short. His aim—the defense of rationality from the monstrous regiment that now besets it, including anti-vaxxers and biblical literalists—is admirable, but he patrols his scientific citadel with outmoded weapons.

To begin with, Schlagenel falls into the prime error of the would-be popularizer: assuming that what is clear to him is equally clear to his readers. Thus his initial sections descend at random intervals into ontological-epistemological discussions of great density and, for the lay

reader, alienating opacity. One of his key difficulties is in identifying, investigating, and characterizing his intended audience. First-rate popularizers such as the late Stephen Jay Gould and Richard Dawkins have mastered that task. Their language is direct and simple, their examples are numerous and relevant, their analogies demystify without presuming to be exact, and their logic is crystalline. The



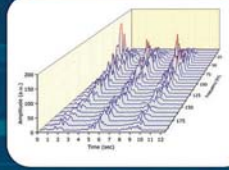
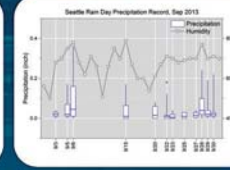
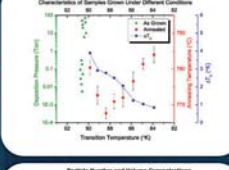
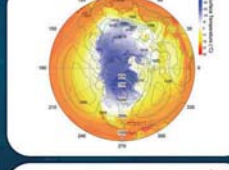
net effect is one of great rhetorical and factual persuasiveness; even if one disagrees with them, one can admire the skill of their performance. Schlagenel's new work is not in the same league.

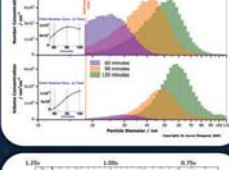
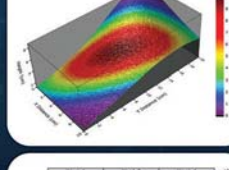
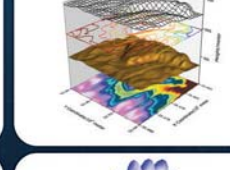
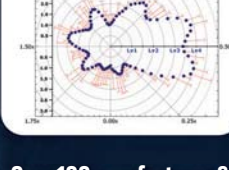
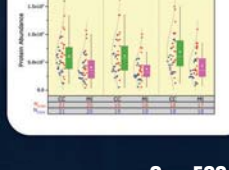
In fairness, the fault is not all Schlagenel's. His publisher appears to have dispensed with editing, both substantive (leaving untouched arguments of embarrassing silliness) and copy (80-word paragraphs done as single

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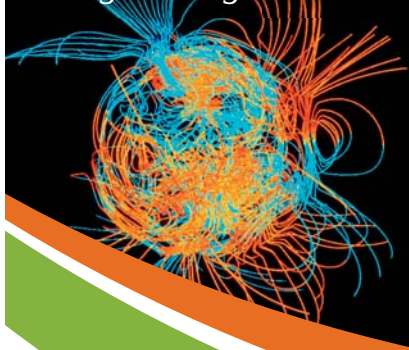
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sentences; *its* confused with *it's*). Given that editorial handicap, Schlagel deserves kudos for occasionally producing text of accuracy, clarity, and concision. For example, his discussion on the emergence of modern atomic theory is masterful, and his section on Niels Bohr rises to greatness. One can only imagine how much better this book might have been had it received intelligent editorial guidance and disciplined review.

Unfortunately, Schlagel's moments of glad grace are undermined by the book's Whiggish ending, in which he extrapolates present science to envision its near future—an Impending Fourth Transition. Schlagel seizes on genetic technoscience, including genomics and proteomics, to limn a world in which humanity identifies its defective DNA and snips it out. From envy to aggression, every human failing will be mapped onto a specific nucleotide sequence—one sin, one gene—and permanently scoured away. The true name for this cringe-inducing notion is eugenics, whose assumption of man's perfectibility condemned the 20th century to unprecedented woe.

Let me temper the severity of this review with a heartfelt tribute. Even a flawed book is notable coming from a scholar in his 10th decade. One rejoices to see a honed mind refusing to go gentle into that good night. Seen in that way, *Three Scientific Revolutions* is a tribute to the human spirit. As Nikos Kazantzakis noted, "When the spirit is proud it stands erect and does not permit the years to touch it." Well done, Professor Schlagel. Now go find a publisher fit for you.

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A Singularly Unfeminine Profession

One Woman's Journey in Physics

Mary K. Gaillard

World Scientific, 2015. \$24.00 paper (200 pp.).
ISBN 978-981-4713-22-1

"A most unfeminine profession," spoken by a fellow high school student about Mary K. Gaillard's university plans, catches the essential message that female scientists must put aside simply to go forward. And Gaillard

did go forward! Love and enthusiasm for physics and for a full life as a human being distills with all the joy of creation from the pages of her memoir *A Singularly Unfeminine Profession: One Woman's Journey in Physics*. At a presentation in October 2015, she gave the following advice to today's young women: "You just need to love physics enough, to let it be a true passion for you, and keep dismissing all that."

The fascinating adventure of particle physics from the 1960s to today is described by one of its major contributors. The hesitations, glimmerings, deceptions, and exhilaration of frontier research throb through the veins of her essay. Of high interest to physics experts, the text shows a larger audience how science is lived on a daily basis and how it blends with personal aspects to permeate and mold life trajectories.

Gaillard's story of her work is most interesting because during that time the core of our present understanding of the elementary components of the visible world was being built, and she worked in almost all that was relevant. Her contributions include such a historical landmark as the prediction, in collaboration with Benjamin Lee, of the mass of the charm quark. She also contributed to several other results that helped establish the standard model of particle physics: for example, recognizing that certain experimental data implied the light quarks were much lighter than the proton, a result that was instrumental to establishing the confinement of the strong force; or indicating how to discover the gluon; or making the first computation of Higgs decay into two photons. This Higgs paper still provokes a smile: Its final paragraph contains apologies for the enormous experimental resources the Higgs search would require; decades later the decay channel analyzed in it was central to the Higgs discovery at CERN.

The history is told in the first person, and it shows how difficult it was for even a gifted woman like Gaillard to take an active part in the development of particle physics. The way in which she slowly and painfully learns about discrimination and feminist issues is told with deep honesty and

