

"Power-law distributions in empirical data," by Aaron Clauset, Cosma Shalizi, and Mark Newman.

Another unfortunate weakness is inadequate proofreading. The back cover, for example, suggests that the book will interest "ecologists with little familiarity with the concepts and methods of statistical physics," whereas the first page refers instead to ecologists "already familiar" with the same. Occasionally one finds apt neologisms, like a reference to "statistically coercive" quantities, though more often the proofreading misses typos like "VHS" radio waves or a reference to the albatrosses of "southern (instead of "South") Georgia." Hopefully such mistakes will be fixed in a future edition.

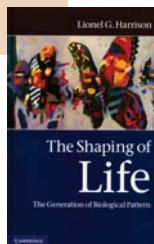
Despite those problems, I think *The Physics of Foraging* is useful and will find a place in the literature of the physics and ecology communities. Over the past 40 years, Stanley has given us a number of excellent books. His *Introduction to Phase Transitions and Critical Phenomena* (Oxford University Press, 1971) remains a classic. Three other books co-written or co-edited by Stanley are among a select few that have inspired many scientists, myself included, to pursue criticality-based approaches to the study of complex systems. They are *On Growth and Form: Fractal and Non-Fractal Patterns in Physics* co-edited with Nicole Ostrowsky (Springer, 1985); *Fractal Concepts in Surface Growth* with Albert-László Barabási (Cambridge University Press, 1995); and *Introduction to Econophysics: Correlations and Complexity in Finance* with Rosario Mantegna (Cambridge University Press, 2000).

As the exciting, cross-disciplinary field of complex-systems science develops, it faces the twin challenges of analyzing rich new data sets (see Stanley's review of *Complex Webs: Anticipating the Improbable* in PHYSICS TODAY, November 2011, page 58) and, at the same time, incorporating the relevant prior knowledge and expertise of existing disciplines. I expect to use *The Physics of Foraging* as part of that process. For advanced courses, the book could be supplemented by Klafter and Igor Sokolov's excellent new book on anomalous diffusion, *First Steps in Random Walks: From Tools to Applications* (Oxford University Press, 2011); both books would stimulate learning and debate among graduate students and postdocs.

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The Shaping of Life The Generation of Biological Pattern

Lionel G. Harrison
Cambridge U. Press, New York, 2011.
\$99.00 (247 pp.).
ISBN 978-0-521-55350-6



In 1917 D'Arcy Wentworth Thompson penned the classic *On Growth and Form* (revised edition, Dover, 1992), in which he argued, contrary to the Darwinian orthodoxy of the time, that structure originates before function and that growth and form can be explained through mathematics and physics. By the early 1950s, Alan Turing would demonstrate how spatial patterns could arise through chemical instabilities inherent in a simple set of coupled reaction-diffusion equations. Turing patterns, as they came to be known, are evident in nature; for example, some resemble the spots on a leopard, others the stripes on a zebra or the complex fractal-like patterns on seashells. But it was not until the 1980s that chemists could actually set up reactions that would produce Turing patterns.

Though embraced by mathematicians and physicists, Turing's mathematical approach to biological pattern formation is hardly accepted by most experimental biologists. The late physical chemist and theoretical biologist Lionel Harrison laments such resistance in *The Shaping of Life: The Generation of Biological Pattern*, which he drafted before his untimely death in 2008 and which was completed by friends and colleagues. Harrison pioneered a quantitative approach to developmental biology in the 1970s, an era when few thought it was useful to mathematically model the complexities of biological growth and development.

The Shaping of Life makes the case for simple coarse-grained mathematical models in biology—simple, that is, in comparison to models that explain the phenomena at a genetic or systems level. Many of the topics in the book's first half are drawn from Harrison's own research on plant development. His work had led him to investigate a variety of novel creatures such as *Acetabularia*, a seaweed that grows to several centimeters and generates multiple whorls of hair-like filaments along its exterior. Those organisms are ideal laboratories for studying the dynamics of growth, since they are mostly transparent and grow in two-dimensional

sheets. Another favorite of Harrison's are the somatic embryos of conifers, such as the hybrid larch *Larix x leptoeuropaea*. As an embryo, *Larix* is a multicellular organism accessible to observation in much the same way as *Acetabularia*. Despite its multicellular nature, the development of outgrowths called cotyledons from *Larix* embryos greatly resembles the whorl formation in the single-cell *Acetabularia* and, indeed, can be modeled on a similar mathematical formalism.

In the second half of the book, Harrison turns the reader's gaze from plant development to animal development. Here one learns about segmentation in the *Drosophila* egg, amphibian heart development, the rearrangement of stripe patterns in angelfish, vertebrate limb development, the growth of slime molds, and much more. The examples are highly varied, some touched on in more detail than others, but taken together they clearly display that there is no shortage of complex developmental behavior that can be understood through mathematics.

One notable omission, which Harrison admits early on in the manuscript, is any discussion about the genetics of development. That is fair; as Harrison's numerous examples show, much can be said about understanding complex developmental behavior through course-grained mathematical models of pattern formation at the level of abstraction presented in *The Shaping of Life*. In fact, a mathematical approach to developmental modeling is the subject of numerous complementary books, including *Biological Physics of the Developing Embryo* (Cambridge University Press, 2005) by Gabor Forgacs and Stuart Newman and *The Self-Made Tapestry: Pattern Formation in Nature* (Oxford University Press, 1999) by Philip Ball. For a technical discussion of the genetic origin of bodily form, interested readers can consult *Imaginal Discs: The Genetic and Cellular Logic of Pattern Formation* (Cambridge University Press, 2002) by Lewis Held Jr; for a more readily accessible popular account on the same topic, readers can check out the immensely pleasurable *Endless Forms Most Beautiful: The New Science of Evo Devo and the Making of the Animal Kingdom* (W. W. Norton, 2005) by Sean B. Carroll.

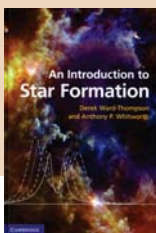
Besides being a text about biological pattern formation, *The Shaping of Life* is an exposition on how human beings

pursue the unknown. Reading it, I was reminded of *Operators and Promoters: The Story of Molecular Biology and Its Creators* (University of California Press, 2001), written by Harrison Echols and edited by Carol Gross. That book spends at least as much time on the human aspect of scientific research—the confusions, blind alleys, and eventual clarity that comes with great effort—as it does on the science. In an age of ever-increasing pressures to pursue what is fashionable in science—be it to secure a position, tenure, funding, prestige, or other personal rewards—Harrison's book, and life, provides a felicitous allegory in favor of engaging in science that, while less stylish at the moment, touches on the truly infinite questions.

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An Introduction to Star Formation

Derek Ward-Thompson
and
Anthony P. Whitworth
Cambridge U. Press,
New York, 2011.
\$65.00 (208 pp.).
ISBN 978-0-521-63030-6



Principles of Star Formation

Peter H. Bodenheimer
Springer, New York,
2011. \$124.00
(343 pp.).
ISBN 978-3-642-15062-3



How stars form out of diffuse interstellar matter is a fundamental problem of astrophysics and one that has witnessed remarkable progress over the past few decades. Several textbooks at both the undergraduate and graduate levels already exist, including *From Dust to Stars* (Springer Praxis, 2005), by Norbert Schulz, and *The Formation of Stars* (Wiley-VCH, 2004), by me and Francesco Palla. Yet somehow the subject has not made its way into the standard curriculum, at least in US physics and astronomy departments. With the publication of two more texts, both written by active and respected researchers, that situation hopefully will change.

Two recent books, *An Introduction to Star Formation* by Derek Ward-

Thompson and Anthony P. Whitworth and *Principles of Star Formation* by Peter H. Bodenheimer, are superficially very similar. Both are relatively slim volumes, meant to be digested in a single semester. Neither presumes any prior knowledge of astronomy; instead, each introduces the relevant concepts as needed. By now, both the choice of topics in a star-formation text and even their order are well established, and the authors follow that convention. There the similarity between the two books ends.

An Introduction to Star Formation is an informal survey of the main ideas in the

field. As many of those ideas are quite beautiful, the book is a pleasure to read. Ward-Thompson and Whitworth, who both teach at the University of Cardiff, Wales, guide the reader step by step through the basics of interstellar clouds, the physics of gravitational collapse, and the connection of stellar birth to the formation of both planets and galaxies. They weave together observational results and relatively simple theoretical derivations, and they provide ample figures to illustrate both. The tone and content are generally most appropriate for an upper-level undergraduate

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