

historical linguistics, immunology, “junk” DNA, Kolmogorov complexity, learning machines, mass extinction, and so on—right up to Zipf’s law. Yet there is no sound, introductory textbook on complexity, one from

which students will absorb more valid insights than dubious metaphysics. Thankfully, Nino Boccarra’s *Modeling Complex Systems* is full of useful knowledge and free from odd notions about complexity.

Complex systems have been infiltrating physics for about two decades and have also crept into biology, computer science, and economics. They come from two sources that have led us to the recognition of computer simulation as an important tool to gain more knowledge about these systems. One source is dynamics, which involves studying the qualitative and effectively stochastic (that is, chaotic) properties of nonlinear systems; the other source is the statistical mechanics of critical phenomena. The study of criticality has taught us to derive large-scale order from local interactions and to expect that stylized models of those interactions would yield universally valid results. (Statistical mechanics of critical phenomena is underappreciated by nonphysicists because “fixed point of the renormalization group” sounds less intriguing than “strange attractor.”)

The chapters in Boccarra’s book fall into three sections: the first contains two introductory chapters, the second contains three chapters on mean-field type models (part 1), and the third has three chapters on agent-based models (part 2). Every chapter contains a remarkable number of examples that mix classical and up-to-date models from many disciplines with physicists’ contributions. Many of those contributions, such as the susceptible-infected-recovered model from epidemiology, recur throughout the book, revealing new aspects each time. The book’s cornerstone is chapter 2, where Boccarra gives a marvelous demonstration of how one models complex systems. He guides the reader through the construction of increasingly elaborate models of predator–prey oscillations in ecology, incorporating more and more sophisticated mechanisms of interaction and testing the results against stylized empirical facts. Much of the rest of the book elaborates the ideas presented in chapter 2.

The part on mean-field type mod-

els covers finite-dimensional global dynamics. Boccarra, a physicist at the University of Illinois at Chicago, carefully states rigorous results of nonlinear dynamics, especially bifurcation theory, along with precise definitions of the concepts involved. He omits proofs and instead uses the theorems to analyze real models. The final part of the book, on agent-based models, delivers excellent, up-to-date chapters on cellular automata (Boccarra’s specialty), power-law distributions, and networks. Readers should know that Boccarra defines “agent-based model” in a way that is different from, but ultimately equivalent to, the definition computer scientists or economists would give.

Chapter 8 on power laws deserves special mention: It gives cautionary examples showing how easy it is to mistake other things—for example, log normals—for power laws and offers a prophylactic introduction to statistical hypothesis testing. The book’s cover promises deep thoughts on the nature of complexity, emergence, and so forth. Boccarra wisely leaves these topics alone: Although interesting scientific work has been done on such issues, the science is quite advanced and is often obscured by a lot of fluff when discussed in other books. Instead, the author provides a guide to actual model building and covers an astonishing range of examples along the way.

Despite Boccarra’s broad scope, I was struck by three omissions. First, the author does not mention what one might call “traditional physics” complex systems: spin glasses, turbulence, polymers, and soft or far-from-equilibrium condensed matter. Second, Boccarra’s book has very little on the theory of information and computation—crucial components in meaningful complexity measures that are surprisingly underappreciated by physicists. Remo Badii and Antonio Politi’s *Complexity: Hierarchical Structures and Scaling in Physics* (Cambridge U. Press, 1997) is a great but demanding guide to these subjects. Third, Boccarra omits the subject of adaptation at the individual, population, or evolutionary level. Not even cases where physical methods have proved useful, such as understanding neural network learning, make it into the book. The best introduction I know to this subject is Gary W. Flake’s *The Computational Beauty of Nature: Computer Explorations of Fractals, Chaos, Complex Systems, and Adaptation* (MIT Press, 1998), which is at a much lower mathematical level than Boccarra’s book. However, correcting these three omissions would have taken another 100 pages—at least.

The ideal audience for Boccarra’s book is first- or second-year physics graduate students who have had a one-semester course in modern statistical mechanics and therefore would have some grasp of criticality, fluctuations, and correlation functions. Readers so prepared will find the book clear and well worth reading. *Modeling Complex Systems* should be the standard introductory textbook to the physics of complex systems for the foreseeable future.

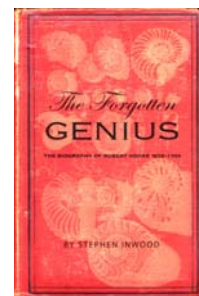
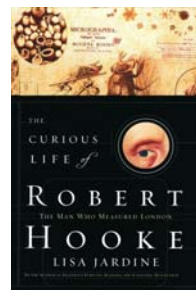
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The Curious Life of Robert Hooke: The Man Who Measured London

Lisa Jardine
HarperCollins, New York, 2004.
\$27.95 (422 pp.).
ISBN 0-06-053897-X

The Forgotten Genius: The Biography of Robert Hooke 1635–1703

Stephen Inwood
MacAdam/Cage, San Francisco, 2003. \$28.50 (482 pp.).
ISBN 1-931561-56-7



Robert Hooke has never really been forgotten. But he is usually remembered only as a peripheral figure of the scientific revolution, famous for his controversies with the great Isaac Newton or, especially in Great Britain, for being a minor colleague of Christopher Wren, the architect of St. Paul’s Cathedral in London who also rebuilt the city after the great fire of 1666. *The Curious Life of Robert Hooke: The Man Who Measured London* by Lisa Jardine and *The Forgotten Genius: The Biography of Robert Hooke 1635–1703* by Stephen Inwood are both biographies by British authors, and Jardine’s book

in particular reminds us of Hooke's major, albeit overshadowed, role in that astonishing rebuilding effort. He would have been much better remembered had he received the kind of hagiographical treatment after his death that so benefited Wren.

Hooke was a founding member of the Royal Society when it received its final royal authorization in 1663. He was its lifeblood for many years, the one who made it much more than just a talking shop. He was appointed the society's first "curator of experiments," charged with producing experimental demonstrations for the group's discussions at each weekly meeting. Hooke received the post after being Robert Boyle's experimental technician in Oxford for several years; he built Boyle's air pumps and probably was responsible for the initial formulation of Boyle's law. (Hooke's law, of course, is itself well known to engineers and physicists.)

Hooke published on many topics and left a large collection of manuscripts on many others, including geology, astronomy, watchmaking, gravity, chemistry, mechanics, and microscopy. His interest in microscopy in particular produced his greatest lasting legacy: *Micrographia*, or *Some Physiological Descriptions of Minute Bodies made by Magnifying Glasses* of 1665. That book is perhaps best known for its huge fold-out engraving of a magnified flea, an image that is frequently reproduced without attribution. The magnificent illustrations, some perhaps due to Hooke's friend and colleague Wren, ensured the book's success. It was the book's textual contents, however, that laid the foundation for Hooke's contemporary reputation. His discussion of the nature of light and color caught the attention of the young Newton—Hooke first described "Newton's rings" in *Micrographia*—and set the stage for the controversy between him and Newton in the 1670s after Newton published his own ideas on the same subject.

Readers interested in learning more about Hooke and this controversy with Newton, and about *Micrographia*, may be disappointed by Jardine's book. Jardine evidently intended that her book join the ranks of the countless "The Man Who . . ." books whose many subjects "changed the world," following the example of the 1995 biography *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time* (Walker, 1995) by Dava Sobel. Although Jardine begins with a theme-setting account of Hooke's battle for credit when Newton's *Principia* was published, her nar-

rative provides no discussion of the optical controversy between the two men and, more surprisingly, no real discussion of *Micrographia* and its contents. Inwood's *The Forgotten Genius*, on the other hand, dedicates several pages to each of the famous controversies and an entire chapter (although of modest length) to the *Micrographia*. His book discusses many of Hooke's scientific and technical innovations, including all of the major ones, whereas Jardine often mentions them only in passing.

The focus of Jardine's book is on Hooke as a social being who moves around London consorting with peo-

ple of many different sorts and social classes, from lords to laborers. Even before his intensive work on the surveying and rebuilding of London after the fire, Hooke appears in a variety of settings, from bookshops to the court of Charles II. He is most typically seen in coffeehouses, a new feature of London life in the 1660s that Hooke took to like a duck to water, where he could meet with Royal Society colleagues, mathematical instrument makers, and sailors. His technical and intellectual capacities, combined with his social skills, recommended him to the City of London as a practical surveyor.

The advertisement features a dark blue background with orange and white text. At the top, the website address www.physicstoday.org is displayed in large orange letters. Below this, there is a collage of three overlapping window-like images showing the website's interface. The top window shows a navigation menu with categories like 'New', 'Improved', and 'Expanded'. The middle window shows a list of research papers under the heading 'research today'. The bottom window shows a specific article titled 'Condensed Matter: Materials Science' with a list of authors and titles. To the right of the collage, the text 'New, improved, and expanded.' is written in a large, white, serif font. At the bottom of the advertisement, the text 'See the latest research papers from more than 100 journals updated three times daily.' is written in a white, serif font.

The appointment, together with his work for Wren's architectural firm, made him the single most significant figure in the grand project for rebuilding London, an enterprise whose swiftness amazed foreign visitors. It is in Jardine's accounts of this period of Hooke's life, rather than in her accounts of his scientific labors, that Hooke really comes alive.

A feature that recommends Hooke to biographers is the existence of his famous diaries, which both Jardine and Inwood use well. The diaries sketch out the business of Hooke's everyday life, the breadth of his social acquaintance, and the details of his domestic existence. Jardine and Inwood both discuss his constant concerns with his health and with medical remedies, few of which seemed to have done much good. The diaries are also the source for what historians know about his sex life, without which no biography is nowadays complete.

Jardine's book is lavishly illustrated and is more appealing to the eye. Inwood's, by contrast, is comfortable and old-fashioned and takes its biographical task seriously, proceeding largely chronologically and trying not to leave out important events in the course of Hooke's life. Jardine attempts more vigorously to develop themes, such as the long-lasting importance of Hooke's childhood in the Isle of Wight. His early years on the island seem to have shaped his later geological ideas and provided social connections (including sources of servants) that continued to be important to him until the end.

Anyone seriously interested in Hooke has, in addition to Jardine's and Inwood's books, plenty of specialized scholarly work available. The layperson who wants to learn something about Hooke's tremendously inventive scientific career would do well to start with Inwood, whereas the reader who is interested in the social and cultural life of later 17th-century London will profit much from Jardine's colorful and insightful book.

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New Books

Acoustics

Marine Acoustics: Direct and Inverse Problems. J. L. Buchanan, R. P. Gilbert, A. Wirgin, Y. S. Xu. SIAM, Philadelphia, 2004. \$80.00 *paper* (336 pp.). ISBN 0-89871-547-4

Astronomy and Astrophysics

Astronomical Data Analysis: Software and Systems XIII. F. Ochsenbein, M. G. Allen, D. Egret, eds. *Astronomical Society of the Pacific Conference Series 314*. Proc. mtg., Strasbourg, France, Oct. 2003. Astronomical Society of the Pacific, San Francisco, 2004. \$77.00 (850 pp.). ISBN 1-58381-169-9

Asymmetrical Planetary Nebulae III. M. Meixner, J. H. Kastner, B. Balick, N. Soker, eds. *Astronomical Society of the Pacific Conference Series 313*. Proc. mtg., Mt. Rainier, WA, July–Aug. 2003. Astronomical Society of the Pacific, San Francisco, 2004. \$77.00 (600 pp.). ISBN 1-58381-168-0

Bioastronomy 2002: Life Among the Stars. R. P. Norris, F. H. Stootman, eds. *International Astronomical Union Symposium 213*. Proc. symp., Hamilton Island, Australia, July 2002. International Astronomical Union, Paris, and Astronomical Society of the Pacific, San Francisco, 2004. \$95.00 (576 pp.). ISBN 1-58381-171-0, CD-ROM

Cox & Giuli's Principles of Stellar Structure. Extended 2nd ed. A. Weiss, W. Hillebrandt, H.-C. Thomas, H. Ritter. *Advances in Astronomy and Astrophysics 8*. Cambridge Scientific, Cambridge, UK, 2004 [1968]. \$110.00 (767 pp.). ISBN 1-904868-20-7

Dark Matter in Galaxies. S. D. Ryder, D. J. Pisano, M. A. Walker, K. C. Freeman, eds. *International Astronomical Union Symposium 220*. Proc. symp., Sydney, Australia, July 2003. International Astronomical Union, Paris, and Astronomical Society of the Pacific, San Francisco, 2004. \$95.00 (502 pp.). ISBN 1-58381-167-2

Recycling Intergalactic and Interstellar Matter. P.-A. Duc, J. Braine, E. Brinks, eds. *International Astronomical Union Symposium 217*. Proc. symp., Sydney, Australia, July 2003. International Astronomical Union, Paris, and Astronomical Society of the Pacific, San Francisco, 2004. \$95.00 (579 pp.). ISBN 1-58381-166-4

The Search for Other Worlds. S. S. Holt, D. Deming, eds. *AIP Conference Proceedings 713*. Proc. conf., College Park, MD, Oct. 2003. AIP, Melville, NY, 2004. \$125.00 (331 pp.). ISBN 0-7354-0190-X

Third Rome Workshop on Gamma-Ray Bursts in the Afterglow Era. M. Feroci, F. Frontera, N. Masetti, L. Piro, eds. *Astronomical Society of the Pacific Conference Series 312*. Proc. wksp., Rome, Sept. 2002. Astronomical Society of the Pacific, San Francisco, 2004. \$77.00 (554 pp.). ISBN 1-58381-165-6

Toward an International Virtual Observatory. P. J. Quinn, K. M. Górski, eds. *ESO Astrophysics Symposia*. Proc. conf., Garching, Germany, June 2002. Springer-Verlag, New York, 2004. \$54.95 (341 pp.). ISBN 3-540-21001-6

X-Ray Timing 2003: Rossi and Beyond. P. Kaaret, F. K. Lamb, J. H. Swank, eds. *AIP Conference Proceedings 714*. Proc. mtg., Cambridge, MA, Nov. 2003.

AIP, Melville, NY, 2004. \$149.50 (475 pp.). ISBN 0-7354-0193-4

Atomic and Molecular Physics

Femtochemistry and Femtobiology: Ultrafast Events in Molecular Science. M. M. Martin, J. T. Hynes, eds. Proc. conf., Paris, July 2003. Elsevier, San Diego, CA, 2004. \$175.00 (569 pp.). ISBN 0-444-51656-5

Biological and Medical Physics

Annual Review of Biophysics and Biomolecular Structure. Vol. 33. D. C. Rees, M. P. Sheetz, J. R. Williamson, eds. Annual Reviews, Palo Alto, CA 2004. \$84.00 (520 pp.). ISBN 0-8243-1833-1

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Encyclopedia of Biomaterials and Biomedical Engineering. Vols. 1 and 2. G. E. Wnek, G. L. Bowlin, eds. Marcel Dekker, New York, 2004. \$495.00 *set* (1789 pp. *set*). ISBN 0-8247-4798-4

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Chemical Physics

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Relativistic Electronic Structure Theory. Part 2: Applications. P. Schwerdtfeger, ed. *Theoretical and Computational Chemistry* 14. Elsevier, San Diego, CA, 2004. \$305.00 (787 pp.). ISBN 0-444-51299-3

Computers and Computational Physics

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