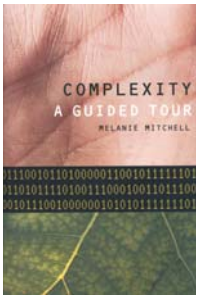
or is it also our physical inability to make sense of the spectrum of behaviors produced by an interacting multicomponent system? Even the human brain, with its vast number of representational degrees of freedom, is limited by biophysical constraints.



Writing a book on complexity is a brave undertaking—anyone who chooses to do so becomes a target for criticism from both experts and journalists who feed on controversies. In *Complexity: A Guided Tour*, accomplished computer scientist Melanie Mitchell courageously takes the reader on an entertaining and illuminating journey through the jagged world of complex-systems research. Mitchell's writing on each topic she addresses is lucid and factual, based on research by her and others in the field and reported on in peer-reviewed journals. When discussing a controversial idea, she gives a balanced presentation of the views of both its proponents and opponents.

Mitchell suggests—in my opinion, rightfully so—that researchers should focus on "common principles" and pull back from talking about things that must hold "generally" in complex systems. Her philosophy echoes Nigel Goldenfeld and Leo Kadanoff's conclusion, expressed 10 years ago at the end of their article "Simple Lessons from Complexity": "But each complex system is different; apparently there are no general laws for complexity. Instead, one must reach for 'lessons' that might, with insight and understanding, be learned in one system and applied to another" (*Science*, volume 284, page 89, 1999). Complex behavior could then be interpreted as emerging from a network interaction of those principles, as implicitly suggested in the book's penultimate section and explicitly discussed in its concluding chapter.

Complexity: A Guided Tour occasionally reads as a list of seemingly unrelated topics, including universal computation, emergence, chaos, self-representation, species and genetic-level evolution, and complex networks. However, in some cases, Mitchell carefully chooses examples to illustrate the connection between complex behaviors in different systems; for instance, her computer model for making analogies (which only humans do well) is based on genetic algorithms and has much in common with models of how ants forage for food. She then considers a number of common principles that could be used as building blocks for a complexity science. That approach will inspire the reader to search for additional commonalities and principles.

Naturally, given the author's background, the book provides a computer-science-like view of complex systems and emphasizes information processing (that is, computing) in various systems. That, I would argue, is the main strength of the book. As Mitchell asserts throughout the text, our brains are themselves complex systems, where we store, access, represent (or simulate), and generate information. And in part, learning and understanding occur through pattern matching between internal neuronal activity and external input. So it may not be surprising that representation and information theory will have a large role in foundations of complexity science, as suggested by Mitchell's focus on the works of mathematicians and computer scientists such as Alan Turing, John von Neumann, Claude Shannon, and Norbert Wiener.

Although the emphasis on information and computation is, in my opinion, one strength of the book, I feel that the author could have explored its basic aspects in greater detail. In particular, two key issues deserve further discussion: the hierarchical (or terraced) encoding of information that occurs, for example, in the primate cerebral cortex, as shown by neuroscientists David Van Essen and Daniel Felleman; and the separation of scales in complex systems. Regarding the latter, I again quote Goldenfeld and Kadanoff: "Don't model bulldozers with quarks" (page 88). In general, there's no need to, because many complex systems exhibit a separation of scales—length, time, energy—that allows one to replace complex dynamics at a certain scale with effective models that statistically mimic the system's behavior at that scale. Those models are then hierarchically put together (the brain processes information that way) to produce a multiscale description of the system. A section on how such models are generated could have included current research by practitioners and further strengthened an already solid book.

Complexity: A Guided Tour is well written and engaging, laced with candid humor and occasional blunt remarks about some of the major characters in the field. It is a fine introduction to complexity science and could serve as a first-rate text for an advanced course for undergraduates and an excellent guide for courses at the graduate level. Experts and nonspecialists alike will have a hard time putting it down.

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Cracking the Einstein Code

Relativity and the Birth of Black Hole Physics

Fulvio Melia
U. Chicago Press, Chicago, 2009. $25.00 (137 pp.). ISBN 978-0-226-51951-7

Black holes have resonated strongly with the general public since the term was coined in the 1960s. In part, that fascination is because the defining characteristic of a black hole—it is so compact that nothing, not even light, can escape from its surface—is a powerful catalyst for the imagination (particularly of science fiction authors and Hollywood screenwriters). Not surprisingly, some think of black holes as super vacuum cleaners in the sky that suck in everything around them. That common misconception is at the root of the widely publicized but completely unfounded concern that the Large Hadron Collider would create miniature black holes that would destroy Earth in a fraction of a second.

Interest in black holes has proved a great opportunity for physicists to educate the general public about the nature of gravity and, in particular, Einstein's theory of relativity. A recent addition to a long line of books that attempts to do just that is Fulvio Melia's *Cracking the Einstein Code: Relativity and the Birth of Black Hole Physics*. What makes Melia's book unique is that it focuses on the events and characters in the mid- to late 1960s when many of the fundamental properties of astrophysical black holes were elucidated. The hero of Melia's tale is New Zealander Roy Kerr, then a young postdoc at the University of Texas at Austin's new center for relativity. There, he single-handedly solved Einstein's field equations for the general case of a spinning collapsed object, thus cracking a problem that had stumped relativists for more than four

decades. His solution, now known as the Kerr metric, is the basis for all modern general relativistic calculations of spacetime around spinning black holes. Despite the magnitude of that achievement, Kerr's story has been largely untold. All too often, nonspecialist books on relativity refer to Kerr cryptically as the "New Zealand mathematician" and wrap up his contribution in a paragraph or less. In this book, Melia rightly brings Kerr back into the spotlight to ensure that his contribution to relativistic physics is celebrated.

The book reads well. It is the sixth book overall and third for a general audience written by Melia, a high-energy astrophysicist who specializes in astrophysical black holes. Melia adds a human element to a technical subject by including archival photographs of the participants from Kerr's era. He also spent months interviewing Kerr, now 75 years old and living in New Zealand. As a result, the reader gets a sense of immediacy in the descriptions of Kerr's struggle with the equations and the exhilaration of his success.

But the focus on Kerr and his achievement is also a weakness of the book. Because Kerr's breakthrough was highly mathematical, Melia could describe the technical details in only the most general terms; his complete biography of Kerr, including the derivation of the Kerr metric, takes up less than half of his very thin book. To make the story more self-contained, Melia adds at the beginning of the book a few short chapters describing the history of relativity and, at the end, a brief summary of recent astrophysical black hole observations. Although the introductory chapters assume no previous knowledge of relativity, they also contain no diagrams to aid in the understanding of the theory's difficult concepts. The author is in such a hurry to get to Kerr's story that most general readers will be left floundering over such topics as time dilation and the equivalence principle. Therefore, it is difficult for me to recommend Melia's popularization to those who have not yet encountered relativity in other books. It would be more appropriate for readers who have already encountered a more complete book on black holes and relativity, such as Kip Thorne's *Black Holes and Time Warps: Einstein's Outrageous Legacy* (W. W. Norton, 1995), but want more details on one of the unsung heroes of the field.

Perhaps the best audience for *Cracking the Einstein Code* would be current graduate students and postdocs. They would meet a man who, through the combination of luck, skill, and hard work, had that one insight to make an everlasting contribution to physics. Roy Kerr's story should be an inspiration to young scientists to keep their eyes and mind open for interesting problems and to follow their instincts. After all, who knows when the next "young mathematician from New Zealand" may shape the future of physics?

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The Fundamental Constants

A Mystery of Physics

Harald Fritzsch (translated from German by Gregory Stodolsky)
World Scientific, Hackensack, NJ, 2009. $36.00 (195 pp.). ISBN 978-981-281-819-5

Like Plato's *Timaeus* or Galileo's *Discorsi*, particle physicist Harald Fritzsch's *The Fundamental Constants: A Mystery of Physics* is an imagined dialog