

such as a father and son walking on a beach or two neurons in the extrastriate cortex) and intermittency in nonlinear dynamical systems. Kelso is clearly proud of this insight — many of his original ideas pre-date the comfortable jargon (and mathematical formalism) of nonlinear dynamics. The second part of the book deals with intention, learning and perception. An interesting notion is that intentionality is meaningful only in terms of the system's order parameters. This precludes intention as a concept separable from the system enacting that intention. There is a seductive internal consistency here, but there is also a sense that some deep teleological question has been sidelined. Plasticity learning and memory are framed in terms of changes in the attractor landscape; although this is not as revolutionary as Kelso seems to think, his formulation of these changes in the language of coordination dynamics and synergistics is compelling. The final part addresses the brain as a self-organizing (pattern-forming) system using earlier themes as well as explicit measures of brain activity such as magnetoencephalography.

Is Kelso's account of brain and behaviour complete? It confronts the reader with many fundamental issues, such as the principles of pattern formation, the central role of instabilities and crisis in nonlinear systems, the brain as a self-organizing system, the fallacy of the computer-program metaphor, circular causality (where influences among different scales transcend notions such as top-down processing or reductionism) and learning as a plastic reshaping of the attractor manifold (where the learner is as important as what is learned). A mechanistic understanding is not one of Kelso's primary concerns, so the theory is a little incomplete when it comes to such questions as why the brain is poised in a state of metastability or what brings intentional systems to critical points and maintains them there. Answers to these questions have been proposed by authors referred to in the book but are not dealt with here in any great depth. For example, metastable systems may be more evolvable and, by selection for selectability, come to be a dominant phenotypic feature (such as Kauffman's "selective meta-dynamics"). Alternatively, metastability may be necessary for adaptive behaviour. Metastability itself could even be subject to selective pressure, with genetic mechanisms promoting it (such as Edelman's "value"). Whatever, Kelso's book will get you thinking. □

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Constructing reality

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Schrödinger's Kittens and the Search for Reality. By John Gribbin. Weidenfeld and Nicolson/Little, Brown: 1995. Pp. 261. £18.99, \$23.95.

In *In Search of Schrödinger's Cat*, his previous popular book on quantum mechanics, John Gribbin emphasized the empirical successes of this strangest of physical theories and read the lesson that we must be prepared to accept its incomprehensibility and be grateful that it works so well. In this sequel he is less severe, promising an account of new work that successfully dispels the mystery and paradox of quantum mechanics.

This is exciting news. To make it even more exciting, the mysteries of quantum mechanics have deepened and strengthened in the ten years since Gribbin wrote his earlier book. Advances in experimental techniques have brought many quantum effects out of theory textbooks and into the laboratory; thought experiments have become actuality, and paradoxes have become effects. Quantum jumps can now be seen (with the naked eye) in a single atom; the two-slit experiment is a genuine laboratory experiment; and the quantum-mechanical theorem that repeated observation of a system freezes its development ("a watched pot never boils") has been verified by real observations of trapped atoms.

Gribbin describes some of these experimental developments (although not, I am sorry to say, Hans Dehmelt's beautiful experiment on quantum jumps) and some recent theoretical ideas such as quantum cryptography, after a historical introduction that traces, in particular, the history of theories of light. But then comes the problem of making sense of it all. Gribbin describes the usual approaches to this problem. His attitude, which many would share, is summarized by his chapter title: "Desperate Remedies".

He is, on the whole, a reliable teller of this story, although there are disconcerting moments when a mad glint comes into his eye as he thinks of the amazing denouement he has in store. The logic of his narrative, however, is weak. There are several points at which an uninformed reader would be lost, possibly without realizing it — for example, in the story of the 'EPR paradox', David Bohm and John Bell. Particularly on matters of interpretation, I find Gribbin often confused or superficial or both: witness his description of recombining universes as a "neat development beyond Everett's original idea" when it is clearly implicit in Everett's

paper, or his apparent bafflement at David Deutsch's common-sense discussion of time. But the greatest confusion comes in the penultimate chapter, where Gribbin turns to the sociology of knowledge.

One of my favourite pieces of unconscious humour is the following quotation from Andrew Pickering's *Constructing Quarks*: "It is *unproblematic* that scientists produce accounts of the world that they find comprehensible: given their cultural resources, only singular incompetence could have prevented members of the [physics] community producing an understandable version of reality at any point in their history."

Gribbin quotes this passage in order to endorse it, even though he has just devoted a chapter to physicists' *failure* to produce an understandable version of reality. He proceeds to the idealist conclusion that "[r]eality is in very large measure what you want it to be". (I must get him to tell me what I'm doing wrong.)

He now finds himself, at the opening of his final chapter, in an awkward position. Having lured us on throughout the book with the promise of the one true answer at last, he finds that he has just admitted that his goods are worthless. Somewhat feebly, and with the air of someone who has written all this stuff and is damned if he's going to waste it, he gives us the answer anyway. This is John Cramer's transactional interpretation, which describes a negotiation between emitter and absorber, the latter sending its signals backwards in time. We are then left to decide whether this kind of market is what (in very large measure) we want reality to be. □

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New in paperback

The Collapse of Chaos: Discovering Simplicity in a Complex World by Jack Cohen and Ian Stewart. Penguin, £8.99. In a review in *Nature*, John L. Casti wrote: "A host of new and thought-provoking ideas about the workings of complex systems. . . as good an introduction to the science of the future as any you're likely to find".

The Stuff of the Universe: Dark Matter, Mankind and Anthropic Cosmology by John Gribbin and Martin Rees. Penguin, £7.99. A journalist teams up with an internationally renowned astronomer in a discussion of the relationship between humankind and the cosmos. Originally published as *Cosmic Coincidences* in 1990.

Atoms in the Family: My Life With Enrico Fermi by Laura Fermi. University of Chicago Press, \$15.95, £11.25. A classic account of the career of one of the world's great atomic physicists, written in 1954 by his wife.