

UCSC physicists explore a boundary of their discipline in new book, *Quantum Enigma*

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Quantum mechanics, one of the most successful theories in all of science, says some strange things about the fundamental nature of the world. For all practical purposes, physicists can and do ignore the bizarre implications of the theory and use the equations of quantum mechanics to understand atoms and stars and to create the marvels of modern technology, from computers to flat-screen televisions. But the strangeness of quantum theory remains an enigma at the heart of modern physics.

In a new book, *Quantum Enigma: Physics Encounters Consciousness* (Oxford University Press, July 2006), physicists Bruce Rosenblum and Fred Kuttner of the University of California, Santa Cruz, present a clear exposition and entertaining discussion of the baffling mysteries of quantum physics. Their motivation, in part, was to counteract the irresponsible distortions of quantum physics that are often used to support pseudoscientific claims, as in the recent movie "What the [Bleep] Do We Know!?"

"Things like that movie upset me, but this is not a debunking book," said Rosenblum, a professor emeritus of physics at UCSC. "A mystery in quantum physics indeed hints at some really wild stuff. The problem is that a layperson can't tell where the quantum physics ends and the quantum nonsense begins."

Physicists have a responsibility, he said, to be more open and honest about the quantum enigma, which has been called the skeleton in the

physicist's closet. When Kuttner and Rosenblum proposed a course for nonmajors on the quantum enigma, one colleague told them that "presenting this stuff to nonscientists is the intellectual equivalent of allowing children to play with loaded guns." They said they'd teach gun safety, and it's now the most popular course in the department, Rosenblum said.

The book presents the quantum enigma in nontechnical terms--no scientific background is needed to grasp the essential mystery. The aim is to give readers a sound basis for evaluating the various interpretations that have been proposed (all of them unsettling in one way or another) and to engage in their own speculations. The issues raised are more philosophical than technical.

"The quantum enigma rears up at a boundary of the physics discipline, and beyond this boundary, a physicist flounders just like the next guy," Rosenblum said.

Both Rosenblum and Kuttner have spent much of their careers in industry, using quantum mechanics in their daily work. They note that one-third of the nation's economy involves products based on quantum mechanics.

"Physicists can use quantum mechanics and calculate with it beautifully, but nobody understands it," said Kuttner, now a lecturer in physics at UCSC.

The encounter with consciousness referred to in the book's subtitle arises in the classic quantum experiments in which physicists found that they could demonstrate contradictory things. An atom or a molecule can be shown to be in two places at once. That's hard enough to believe by itself, but the same atom or molecule can also be shown to be in just one place. Looking for it causes it to be in a single place, so that what is

observed depends on decisions made by the observer. And what is true for atoms and molecules is, in principle, also true for baseballs and cats, Rosenblum said.

The mystery does not emerge from quantum theory, but arises directly from the experiments. Quantum theory provides an explanation of sorts, in the form of equations that can be used to predict experimental results with unflinching accuracy. The theory is consistent with the experiments, but it conflicts dramatically with our sense of reality.

The book presents nine current interpretations of the quantum enigma (which physicists often refer to as the "measurement problem"). They range from the orthodox Copenhagen interpretation (which has been summarized as "shut up and calculate!") to the mind-boggling many-worlds interpretation. The authors do not endorse a favorite, but they do point out that each interpretation either involves consciousness or tries to evade the encounter so that physics need not deal with it.

"As far as what's really going on in the world, I don't have a clue, except that it's much stranger than we once thought, and somehow consciousness seems to be involved," Kuttner said.

Many years ago, when Rosenblum was a graduate student, he and a fellow student got to spend an evening with Albert Einstein, who tried to discuss the enigma of quantum mechanics with them. But they were ill-prepared.

"Our advanced courses in quantum mechanics taught us how to calculate, but avoided the mystery. Our ignorance of it disappointed Einstein," Rosenblum said. "The missed opportunity of that evening is one of the motivations behind this book. Physics courses still avoid presenting the quantum enigma. We would like to see our book used as collateral reading in such courses."

Source: University of California, Santa Cruz

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