Mermin habitually answers opinions, real and abstract FREE

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We humans are attracted to fanciful models that are often more exciting than reality; so I agree with Mermin's basic premise. But I cannot always be confident of distinguishing a real property from a fanciful abstraction. In fact, if pushed, I would have to admit I'm not sure what a real property really is. Possibly Mermin can enlighten me.

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David Mermin tells us that our "bad habit" of reifying the quantum state "induces people to write books and organize conferences about 'the quantum measurement problem.' " However, a quantum measurement problem does not arise only from an unfortunate perspective on quantum theory.

A quantum measurement problem, as close to magic as anything in science, is displayed in quantum-theory-neutral experimental observations that assume only the free choice of the experimenters. In the two-slit experiment, one can choose to demonstrate each object concentrated at a single slit or perform the contradictory demonstration, that each object spread over both slits. Facing this dilemma, George Greenstein and Arthur Zajonc note that "even had quantum theory never been invented, these [two-slit] experiments could have been performed, and we would still find ourselves unable to understand them."[1]

Quantum weirdness is increasingly misappropriated as a way to buttress pseudoscience. It is a responsibility of physicists to combat such misappropriation. (See our letter in PHYSICS TODAY, November 2006, page 14.)

Presenting the intriguing strangeness of quantum mechanics honestly and interestingly by the use of books Mermin might seem to deplore can effectively combat the misuse of the quantum mysteries. Dismissing the measurement problem as merely a bad way of viewing quantum theory abandons a fascinating mystery in physics to the purveyors of pseudoscience.

Reference

1. G. Greenstein, A. Zajonc, *The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics*, 2nd ed., Jones and Bartlett, Sudbury, MA (2006), p. 124.

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I am that friend of David Mermin's "who was enchanted by the revelation that quantum fields were the real stuff that makes up the world." I plead guilty to reification and offer the following defense.

I started out, as I think we all did, with the notion that there is a reality out there and that space and time are part of it—not just "an extremely effective way to represent relations between distinct events." When I read Arthur Eddington's *The Nature of the Physical World* (J. M. Dent & Sons, 1942) in high school, I learned that reality was not what it seemed—that Eddington's solid writing desk, for example, was mostly empty space. The next step in my understanding of reality came in college when I found that the electromagnetic field offered a more satisfying picture of the world than action at a distance, which even Isaac Newton derided.[1]

When I encountered quantum mechanics, of course, everything became confusion. However, along with David, I was fortunate to attend Julian Schwinger's courses at Harvard University just after he had perfected his treatment of quantum field theory.[2] I sat enthralled throughout the three-year series (1956–59), in which Schwinger developed QFT as a seemingly inevitable consequence of the most basic assumptions.

However, I came away with a different understanding of QFT than David's. I understood that the fields are physical properties of space that are described by field strengths—just as in classical physics, except that in QFT the state of the field at each point is represented by a vector in Hilbert space rather than by a pure number. That use of Hilbert space, which followed naturally from Schwinger's "measurement algebra," allows superpositions of values. The operators in Hilbert space, as I understood it, are mathematical tools that describe the evolution of the state vectors, and they are not to be reified.

When I saw how QFT resolves the paradoxes of modern physics, it became irresistible. The special relativity paradoxes—for example, Lorentz contraction and time dilation—are a natural result of the way fields behave.[3] The spacetime curvature of general relativity, which I could never really visualize, does not exist in QFT; the gravitational field equations are equivalent to spacetime curvature for those who can visualize it, but equivalent is not the same as identical.[4] Finally, the mysterious wave–particle duality of quantum mechanics vanishes; in QFT, reality consists of fields and only fields.