ence in policy" and "policy in science" during the Bush Administration. The book is well written, although at times enigmatic.

WOLFGANG K. H. PANOFSKY
Stanford Linear Accelerator Center
Stanford, California

Mind, Matter, and Quantum Mechanics

Henry P. Stapp
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The question of the relationship between mind and matter has traditionally been an area for philosophers. With the rise of experimental access to the brain, it also became the province of psychologists, neurologists and molecular biologists. Finally, with the emergence of cognitive science, it has become fair game for computer scientists. Possibly, in some of its aspects, there is also a role for theoretical physicists.

As with all fields where significant data are still sparse and where the most important breakthroughs probably lie well in the future, many books now claim to have completely solved the problem or to have at least opened the field sufficiently so that no other approach than the author's is significant. On the issue of consciousness, for example, there is a large school of scientists who, awed by the success of empiricism in the hard sciences, will tell you that consciousness doesn't exist, that it is an illusion, since it is very hard to find any experimental consequences that would flow from its existence. My own opinion is that, for all their influence in the field, these people have done untold harm in many areas.

Given that consciousness does exist, however, how can one get a handle on it? How do physical events arising in the brain lead to such nonphysical results as thoughts, feelings and concepts? There is a growing group of people who would answer this question by saying that consciousness is an emergent quality, one that arises at a higher, integrative level and cannot be reduced to the sum of the simple particles and reactions that produce it. The question is how to create a scientific model for such a grand conception.

Biologists have created elaborate models to show how higher processes might have evolved, how they might work and how they might use and store information. Most of these models presuppose classical physics. (Actually, most nonphysicists do not think physics will have anything to do with solving the problem and, since neurons, synapses and most of the relevant hardware seem to be classical, macroscopic devices, why should anyone disagree?)

This is the starting point for Henry Stapp's more modest theory, presented in *Mind, Matter and Quantum Mechanics*. (By the way, Stapp is a leading expert on scattering theory who has made major contributions to the interpretation of quantum theory.) He argues that classical physics is conceptually inadequate to treat the problem. He widely quotes William James, who in the late 1800s felt that the physics of his time could not provide the concepts to go beyond a simple Cartesian picture of the subject. Stapp argues not only that one needs the richness that quantum theory provides but also that this richness is sufficient to solve the problem. He quotes Niels Bohr to the opposite effect, that further new concepts are needed. Nonetheless Stapp believes that by going beyond the Copenhagen interpretation to one inspired by James, Werner Heisenberg and Karl Popper, one can find the key in quantum theory.

Bohr was hampered by the belief that only by making a classical measurement could one reduce the wavefunction of a system. But Stapp believes that by using the Heisenberg concept of "tendencies," which is similar to Popper's "propensities," he can give an objective meaning to quantum events. This, in turn, allows certain neuronal firings to "reduce" the quantum state. These become the conscious acts in the brain. Until then, the wavefunction evolves according to the Schrödinger equation, splitting into either–or amplitudes that give different probabilities for different behaviors. Such state-splitting and reduction are impossible in classical mechanics.

Rather than go into detail, I will say that the book considers only a qualitative statement of this one aspect of the problem. The theory is tentative and is not a complete solution to the problem of consciousness by any means. While the author does compare his results to those of some others, there is little discussion of the subject in its overall historical and biological context. Except for the introduction, the book is actually a collection of papers the author wrote for various publications. There is thus much repetition and almost no mathematics, although there is a good discussion of Bell's theorem and the various interpretations of quantum theory along the way.

One has to be courageous to write such a book as this. The idea that quantum theory may be necessary to a solution of the problem of consciousness is novel and intriguing, and it should be pushed further. It has occurred to other physicists, such as Roger Penrose (*The Emperor's New Mind*, Oxford, 1989), Michael Lockwood (*Mind, Brain, and the Quantum: The Compound I*, Basil Blackwell, 1984) and Euan J. Squires, (*Conscious Mind in the Physical World*, Adam Hilger, 1990)—the first two are briefly discussed in this book—but it has not yet sifted down to the more traditional members of the mind–brain club.

DANIEL M. GREENBERGER
City College of New York

Wavelets: Mathematics and Applications

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In many areas of science, the understanding of complex phenomena often relies on a representation of the object under consideration in terms of simpler and more understandable objects. Wavelet analysis may be seen as a generic toolkit for performing such representations. The basic tools are the (sometimes generalized) wavelets, obtained from a unique function (the mother wavelet) by applying simple transformations. In the classical wavelet case, the original function $\psi(x)$ is simply scaled and shifted:

$$(\psi_{(b,a)}(x) = 1/\sqrt{a}\ \psi((x-b)/a))$$

The wavelet representation (or transform) of a function $f(x)$ then consists in the set of coefficients

$$\langle f,\psi_{(b,a)}\rangle = \frac{1}{\sqrt{a}}\int f(x)\,\bar{\psi}\left(\frac{x-b}{a}\right)dx$$

The analyzed function can be "reconstructed" as a superposition of wavelets.

A remarkable aspect of wavelets is that they are naturally associated with fast decomposition–reconstruction algorithms that were introduced before, in a completely independent way, in image processing. Wavelet-type methods have now been generalized and extended to include other types of transformations (for example, the wavelet packet methods) or local versions of trigonometric series.

Wavelet analysis is a relatively new interdisciplinary subject. It finds its roots in approximation theory as well as signal and image processing and quantum mechanics. There are many different approaches to wavelets, corresponding to different points of view. *Wavelets: Mathematics and Applications*, edited by John J. Benedetto and Michael W. Frazier, is a collection of tutorials written by some of the leading experts in the field. It is mainly a mathematics book and, although the material is described in a quite mathematical way, it generally remains accessible to a wider audience. In particular, the reader more interested in practical aspects can usually skip some sections, selecting that information necessary to the use of the methods. In addition, although all the aspects of the theory are not described in each part, the subjects covered represent self-contained accounts of many of the available methods. This is a unique characteristic of the book, compared with monographs in which single points of theory are covered in great detail from different points of view. The form of the book is similar to *Wavelets, A Tutorial in Theory and Applications*, C. K. Chui, ed. (Academic, 1992) and *Wavelets and Their Applications*, M. B. Ruskei et al, eds. (Jones and Bartlett, 1992). It is more recent, however, and perhaps more oriented towards mathematical aspects.

The present work focuses on the mathematical aspects of wavelet methods and their applications to digital signal processing and numerical analysis, two of the fields in which wavelet-based techniques have contributed the most. The first part, describing some of the main aspects of discrete wavelet series, is remarkably complete and self-contained. The second part of the book is devoted to the mathematical aspects of wavelet methods and signal processing. Here all aspects are not described, which would have required additional volumes; the book concentrates instead on aspects close to sampling problems. The last part is devoted to the use of wavelet methods for the analysis of operators and their application to numerical analysis. There is a long tradition of using wavelets to study certain pseudo-differential operators, which eventually converged to become the Calderon–Zygmund theory. More recently, Gregory Beylkin, Ronald Coifman and Vladimir Rokhlin showed how these methods could be adapted for numerical purpose. This volume shows how