

A GUIDEBOOK FOR PHYSICISTS TO THE FRONTIERS OF MODERN PHYSICS

The New Physics

Edited by Paul Davies

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Reviewed by James Trefil

What is the frontier of science, or more specifically the frontier of a science like physics? Of all human activities, research—the act of pushing back the layers of ignorance that surround our little island of hard-won knowledge—must be the messiest, the hardest to categorize. Yet in this handsomely produced volume from Cambridge University Press, noted British theoretical physicist and popularizer Paul Davies attempts to do just that for our science. As he himself says, such an attempt is bound to be risky. To his credit, he succeeds.

The book is a series of essays written by people whose names are well known in their own fields of research. It represents, I think, a major attempt by the physics research community to make its thinking and current research available to a wider audience. The essays are tied together by Davies's introduction, in which he tries to present an intellectual framework for his tour of the frontiers of modern physics. In many ways, this introduction is the most challenging and interesting of the many challenging and interesting essays in the book. In it Davies attempts to bring some systematic order to the activities of modern physicists.

Davies delineates three major areas where research is booming. Two of them are predictable: elementary par-

ticle physics and modern cosmology. Both of these areas have been the subject of intense theoretical and experimental work throughout the 1980s. It can be argued that one of the great developments in 20th-century science has been the realization that the two subjects are connected—when we learn about the basic constituents of matter and the forces that govern them, we also learn about the origin and evolution of the universe. It may very well be that the greatest intellectual legacy of physics in the 1980s will be the understanding we have achieved of the all-important first microseconds in the lifetime of the universe.

Davies's third frontier is somewhat more problematical. He defines it as a frontier of "complexity," more or less by analogy with his characterization of elementary particles and cosmology as the frontiers of "smallness" and "bigness." I must admit to having some questions about whether this third category is a true division of science or simply a procrustean bed for imposing order on an area of research that is not orderable at present.

Perhaps I have been sensitized to the problems of cataloging and ordering phenomena through my close association with paleontologists in the past several years. One thing I have discovered is that you can always find categories of natural phenomena that seem right and natural, but once you've delineated all of these, there will always be a remainder that is "none of the above." Paleontologists refer to these as "garbage classifications." Sometimes these are nothing more than footnotes in a generally well-thought-out classification scheme, but other times they hide important facts and actually impede understanding.

I have no idea whether the complexity frontier is a useful or an obstructive garbage classification, or indeed whether the phenomena it includes should be so characterized at

all. As Davies develops it in his book, complexity includes such disparate areas as critical-point phenomena, chaos, quantum optics and superfluidity. Although most of the complex phenomena he discusses involve nonlinear mathematics, I see little else that unifies them. In other words, it seems to me we have a typical messy situation on this frontier. Enormous progress is being made in a large number of related fields, but the fields are not really connected. Perhaps in the future, as we learn more about them, connections will be discovered and we will see that some or all of these fields are indeed united in a fundamental way, much as we have found that elementary-particle physics and cosmology are united. It is equally likely, however, that we will discover that chaos and laser optics are no more fundamentally alike than the number 4 and the color green. Either way, though, they're both interesting.

Leaving the overall organization of the book and looking at the individual essays, what can one say? First, that Davies has done a splendid job of assembling first-rate physicists to explain what they're up to: The author's list is a veritable "who's who" in modern physics research. Furthermore, thanks either to personal inclination or to gentle harassment from the editor, the essays have a decidedly pedagogical turn—they really are meant to be read by nonexperts. Almost all of them start out at a level accessible to the average working physicist or graduate student, although some may require closer attention further on.

As might be expected, there is a certain disparity in style among the contributions. Some of them, such as Stephen Hawking's splendid "The Edge of Spacetime," are written entirely without mathematics and could be read at a single sitting by almost any student of physics. Others, such as Chris Isham's essay on quantum gravity, involve a level of mathemat-

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