

BOOKS

Martin Rees's Compelling, Unified View of the Universe

Just Six Numbers: The Deep Forces that Shape the Universe

▶ Martin Rees
Basic Books (Perseus Group),
New York, 2000. 173 pp. \$22.00 hc
ISBN 0-465-03672-4

Reviewed by Edward W. Kolb

In the world of astrophysics, Martin Rees is the summarizer of choice for major international meetings. His clear, reasoned concluding remarks often make the most complicated and confusing astrophysical problems seem tractable. Rees brings the same clarity of exposition to *Just Six Numbers*, his most recent book. Few people see the big picture as Rees does, and he paints a big picture indeed.

Just Six Numbers offers much more than just six numbers. Rees uses the seeming "fine tuning" of six numbers, ranging from the cosmological constant to the ratio of the electric force and gravitational force between two electrons, as threads that weave a tale of the shaping of our universe by a few fundamental forces and concepts. In explaining how our existence depends on six numbers having values in a surprisingly narrow range of possibilities, Rees connects the nature of fundamental forces with the development of the universe.

Rees's breadth of vision and his ability to synthesize apparently disparate facts into a compelling whole are evident throughout the book. Among the subjects Rees touches on are stellar nucleosynthesis, the development of intelligence in our biosphere, black holes, gravitational entropy, the arrow of time, and the dimensionality of space.

Many of the topics in the book are at the leading edge of research. In a field as active and vital as modern cos-

mology, some of the subjects in the book are likely to evolve in fundamental ways in the next few years. Where appropriate, Rees is clear about how the picture may change. As he notes, we have only outlined our view of the universe; our view will evolve as the details are developed.

Although the details may change, many of the fundamental ideas Rees develops undoubtedly will survive. Throughout the book, Rees emphasizes that complex structures may emerge from a simple set of laws and initial conditions. The interplay of simplicity and complexity is sure to remain part of the way we understand the universe.

Thought-provoking questions, such as the existence of other "universes" beyond our cosmic horizon, are discussed with confidence and flair. Rees's ability to present his own viewpoint while still giving a fair hearing to other viewpoints is manifest here. For instance, the concept of "multiverses," the idea that the observable region of the universe is just one member of a possibly infinite ensemble in which even the laws of physics may vary, often elicits a discussion of the anthropic principle. Although he never explicitly mentions the controversial anthropic principle, Rees presents a well-balanced discussion of the concept.

The book is accessible to a wide audience. Although it is targeted toward the nonspecialist, Rees never "talks down" to his audience. Even specialists in the field can benefit from the book. Although it is not a textbook, it would be ideal supplementary reading for an undergraduate course in "cosmology for poets."

Concepts of Mass in Contemporary Physics and Philosophy

▶ Max Jammer
Princeton U. P., Princeton, N.J.,
2000. 180 pp. \$39.50 hc
ISBN 0-691-01017-X

Investigating the conceptual foundations of contemporary physics is an

activity to which both philosophers and physicists can contribute. Such an activity is important, not only to philosophers interested in such esoteric matters, but also to practicing physicists. In particular, the conceptual foundations of space, time, and, indeed, mass are important issues in ongoing research into quantum theories of gravity. In such cutting-edge fields, the overlap between physics and philosophy is most evident. Max Jammer's *Concepts of Mass in Contemporary Physics and Philosophy* contributes to the widening of that overlap.

Jammer treated space and time in his *Concepts of Space* (Harvard, 1957; Dover, 1993). Now he focuses on mass. "Next to space and time, mass is the most fundamental notion in physics . . ." Jammer declares in the preface of his new book.

In one sense, the book may be viewed as an up-to-date philosophical and thematic supplement to his previous historical survey, *Concepts of Mass in Classical and Modern Physics* (Harper & Row, 1964; Dover, 1997). The new book emphasizes developments since 1960, and thus provides a needed service in assembling current research on the subject. In a larger sense, however, the book stands on its own, combining historical elements of *Concepts of Mass in Classical and Modern Physics* with a thematic analysis to produce a coherent whole.

The book is unique in bringing together a number of diverse topics concerning the concept of mass in modern physics. These topics include inertial mass, relativistic mass, the mass-energy relation, gravitational mass, and the nature and origin of mass. Jammer begins by considering operational definitions of inertial mass and the related question of whether inertial mass should be viewed as a theoretical or an observational concept. His discussion of relativistic mass centers on the distinctions between relativistic mass, rest mass, and classical (Newtonian) mass, and the debate over their relationships. He then considers derivations of the mass-energy relation and its interpretations. The background for much of this material is presented in more detail in his *Concepts of Mass*

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