for great caution before assuming that we can second-guess prehistoric responses to the sky.

And what about Stonehenge? Despite many disagreements, leading luminaries in the history of astronomy, archaeology, geography and archaeoastronomy concur in seeing Stonehenge as a cosmic monument. Yet Ruggles notes: "While we would not wish to dismiss ideas such as these without good reason, we also need good reason for continuing to support them." Such is the measure of his caution, skepticism, and deliberate judgment.

The book ends with extensive appendices of data from Ruggles's surveys, an account of data reduction, and indexes.

A short review cannot do justice to the richness, depth, or scope of a book that looks like a landmark in the investigation of megalithic monuments. Whether skeptics or enthusiasts, all specialists with a stake in this project will need to come to terms with Ruggles—and so should every lecturer who broaches the subject of prehistoric astronomy.

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The Odd Quantum

Sam Treiman
Princeton U. P. Press, Princeton, N.J., 1999. 256 pp. $24.95 hc
ISBN 0-691-00926-0

In the 1960s and 1970s, Princeton University's Sam Treiman was known as an experimenter's theorist. Through his publications, and especially his talks, he made the latest theoretical ideas accessible to all, and he pointed experimenters to the crucial measurements they needed to make. In this modest volume, *The Odd Quantum*, he tries to provide access to the quantum theory to a wider audience.

Perhaps not *quite* as wide an audience as the blurb on the book jacket promises—"popular science readers." Treiman's book presumes, rather, a reader comfortable with the full language of the calculus, including partial differential equations. It does not demand any skill at computation, and its derivations are largely algebraic, but it will lose any reader intimidated by, for example, Maxwell's equations in full vector notation or by noncommuting differential operators.

That said, the text is accessible to nearly all physical scientists and more than a few biologists or economists who might want to see the quantum theory with much of its full conceptual apparatus arrayed. It might also appeal to a bright sophomore, in an introductory physics course, impatient for a glimpse ahead at what he or she will be learning a couple of years down the line.

The treatment is largely formal. The only major concession to intuition is the use of the Schrödinger formulation for the nonrelativistic theory, although enough of the Heisenberg/Dirac approach is exhibited to support the valuable lesson that physical theories contain truths that transcend their mathematical frameworks.

A work of this brevity is necessarily concise. In just one 22-page chapter, Treiman reviews the foundations of classical mechanics, electricity and magnetism, and relativity. Another short chapter covers the historical development of the "old" quantum theory. The narrative is too sparse to convey accurately the subtle interplay of theory and experiment that characterized that period.

As a rule, Treiman separates applications from the formal development, a pedagogically risky approach. For example, quantum tunneling and alpha decay are in separate chapters. But the applications are well chosen, ranging from the conventional particle-in-a-box to more daring examples, including qualitative treatments of the Lamb shift and of the Bohm–Aharanov effect.

A strong chapter on quantum statistics contains an excellent discussion of the reason that identical particles must be treated differently in quantum and classical statistics. It also draws the connection between Bose–Einstein condensation (BEC) and stimulated emission. But it is short on applications; it is not made clear why a BEC of Cooper pairs would have zero electrical resistance. Nor are lasers explicitly dealt with.

Treiman's discussion of the problem of interpreting the quantum theory is perhaps the strongest feature of the book. He rejects the conventional Copenhagen assertion that it is the process of measurement that converts quantum probabilities to observable actualities. He points out that this interpretation leaves the mystery intact by not telling us how the measuring apparatus forces a system to "decide," resting instead on a distinction between the microworld and macroworld that is difficult to defend. In a section on the Einstein–Podolsky–Rosen (EPR) paradox and its experimental realization through Bell's inequality, he correctly pinpoints locality as the key issue, and he concludes that "the EPR notion of physical reality is too demanding for the quantum world that we actually inhabit."

On the other hand, Treiman has little sympathy with Eugene Wigner's resolution of quantum ambiguity in the mind of the observer, finding it "hard to falsify but hard to build upon, and hard to swallow without leading to rank solipcism." He concludes: "At the end of the day, quantum mechanics remains both intact and puzzling." Treiman reiterates this in the final sentence of the book, in which (paraphrasing Richard Feynman) he exhorts the reader to accept this theory in all its queerness because "that's the way the world is."

In its penultimate chapter the book explores the "zoo" of subatomic particles, using a conventional historical development of the quark model from hadron symmetries. The final chapter is on quantum field theory. Unlike most popular treatments of the subject, this one does not simply introduce Feynman diagrams but also constructs a simple "toy" quantum field—a scalar field with mass. Despite the abstract nature of this approach, Treiman's presentation is remarkably easy to follow.

This book can perform a great service by opening the quantum theory to a broader range of science professionals, many of whom now use its results without being fully aware of the concepts from which they arise.

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Reason Enough to Hope: America and the World of the Twenty-first Century

Philip Morrison and Kosta Tsipis
MIT Press, Cambridge, Mass., 1998. 210 pp. $25.00 hc
ISBN 0-262-13344-X

Alfonso X ("the Wise"), King of Castille and Leon, is noted for his great academic work of law, the *Siete Partidas*. Although he was not a very successful ruler, he thought so highly of his own wisdom that he once commented on Ptolemaic astronomy, "Had I been present at the creation, I would have given some useful hints for the better ordering of the universe."

Some of that flavor of Alfonso comes through in *Reason Enough to Hope*, by physicists Philip Morrison and Kosta Tsipis, a tightly reasoned argument for the better ordering of human society. Although the authors are physicists, verbal eloquence