Suspicions that we might be dealing with a new religion here are confirmed when on p.7 we read that "the only faith we need for the journey is the belief that everything can be understood and ultimately there is nothing to explain". But, I suspect most readers' quarrel with the contents of Atkins's book would not be these aims or declarations of intent but the fact that the case he argues thereafter is also based upon faith or "knowledge" that usually does not yet exist. A Panglossian approach is followed whereby the author creates the type of future knowledge that would support his argument. This argument reminded me of mediaeval "proofs" for the existence of God, and suffers the same weakness that removed their ability to persuade. The disproof of any step in the arguments would not shake their authors' position one inch because the foundation of their belief really rested elsewhere.

That the bulk of the author's argument is speculation is not in itself a bad thing, but if we examine the way in which he handles known facts it ought to give us some guide as to the likelihood that this speculation is reliable. A few results of this rain-check were not too encouraging: he erroneously claims that it is the Lorentz signature of space–time that prevents time-travel; that the rate of biological evolution is exponentially sensitive to the fine structure constant (in fact, doubling the present value of the fine structure constant would, according to modern grand unified gauge theories, cause all protons to decay before stable stars form rather than increase the human evolution time to 10^{62} years!); and that the temperature of the environment is independent of the fine structure constant (it is actually determined by it).

To my mind, the author does not even get close to showing his case is a scientific possibility since his explanation for the inevitability of the creation of space–time *ex nihilo* requires an initial state of "almost nothing" — a dust of unstructured points (supplied by a well-known American relativist).

I am afraid that I would not recommend this book to the audience of laymen and students for whom it was created. Scientific popularizers and even scientific evangelists have a responsibility to wait until we know something about the creation of the Universe before telling the public everything about it. If you say, as the author does, that "complete knowledge is just within our grasp", to your professional colleagues it is quite harmless because they will simply laugh at you. To make such a statement in a popular book is totally misleading. This book will be far from enlightening and, I believe, will do little more than create confusion between the known, the unknown and the unknowable in the mind of the inquiring reader. □

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The results of thinking small

Wolfgang K.H. Panofsky

The Nature of Matter. Edited by J.H. Mulvey. Pp.200. ISBN 0-19-8151151-5. (Clarendon/Oxford University Press: 1981.) £8.95, $15.95.

Good popular expositions on particle physics are rare; this is one of them. It is a sequence of separate lectures given by prominent figures in the field at Wolfson College in 1980. In contrast to the common pattern in such series, the lecturers — at least occasionally — cross-refer to one another's talks, and there are other elements of coordination which make the volume rather better than most multi-author works.

Sir Denys Wilkinson opens the book with an excellent overview, starting with the development of atomistic concepts and ending with the efforts at grand unification of forces and particles. The subsequent discussions of particles and forces are similar to traditional popular presentations of the subject. I found the lecture by Llewellyn-Smith on manifest and hidden symmetries particularly useful, since it gives a comprehensible account of what is more generally called symmetry breaking where the usual layman's exposition leaves the reader in doubt why a broken symmetry is a symmetry at all.

The section by Abdus Salam, on unification of forces, is a straightforward, logical exposition beginning with a historical summary of how the many apparently disjointed forces in nature became understandable in terms of a smaller and smaller set. He then goes into more detail on the history of the unification of the gauge theories of electrodynamics and the weak interaction. His lecture is nicely interwoven with anecdotes; at the same time I fear the reader will gain relatively little understanding of the intellectual content of the theory — this, however, would be a difficult job in any circumstances. The lecture ends with an enumeration of the problems faced in the formulation of a grand unified theory and the alternative approaches to a quantum theory of gravitation.

John Ellis has written a fascinating chapter on the very large and the very small, which is mainly an outline of the extent to which our growing knowledge of the reactions of particle physics limits cosmological models.

I was somewhat less impressed by the experimental sections, in part because they are very brief and overshadowed by the theoretical lectures. The lecture by D.H. Perkins, "Inside the Proton", attempts to give an overview of the quark structure of nucleons and provides the usual quark and lepton tables. The fundamental neutrino scattering experiments which are of particular interest to the lecturer are elaborated, but the balance of the evidence for hadron structure is covered only briefly. As a result the reader may get a misleading impression that the foundation on which the current theories of hadron structure rest is quite limited, while actually a firm experimental basis exists.

I have a similar reservation about the section on the tools of particle physics. The author, Sir John Adams, concentrates on the history and technical realization of proton circular accelerators. Since he is the creator of the CERN proton synchrotron and super proton synchrotron, this emphasis is fully justified. Yet, on reading this chapter, the layman will underestimate the richness of the arsenal of tools available to the experimentalist, in terms of accelerators, colliders and detectors. In particular — and here my own parochial view is evident — the essential role of electron–positron colliders, which have reaped a substantial fraction of recent discoveries, does not come through. This apart, the lecture includes some illuminating remarks on the social patterns that physicists have established in using the expensive tools of modern particle physics.

As a whole, *The Nature of Matter* does provide a readable account of various topics in elementary particle physics, ranging over the enormous breadth of dimensions to which modern theory applies. Yet what the layman will miss in the book is the appreciation that understanding of the forces and components of nature depends largely on experiment. The lecturers take little account of the impact of the major experimental discoveries — remember, for instance, the upset when the mu meson turned out *not* to be the carrier of the strong interaction predicted by Yukawa. Let us recall, too, the many unsuccessful attempts to explain theoretically the experimentally observed tau-theta paradox until Lee and Yang hit upon the right solution; the impact of the cosmic ray discovery of the "hooks and forks" which then became identified with the strange particles, from which then flowed the quark models of Gell-Mann and Zweig; the discovery of the Charmonium peaks which initiated the November Revolution of 1974; and finally the discovery of the third charged lepton which again was not predicted.

Somehow more has to be done in popular accounts of particle physics so that advances in the field are not conveyed as a sequence of events where theorists predict the future, machine builders construct suitable machines, experimenters design instruments and experimental arrangements to test the theory, and then theory is tested. That is not the way it is. □

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