

Keeping abreast of the revolution

Frank Close

The Forces of Nature, 2nd Edn. By P.C.W. Davies. Cambridge University Press: 1986. Pp.175. Hbk £22.50, \$39.50; pbk £7.95, \$12.95.

The Forces of Nature first appeared in 1979 and established Paul Davies as a popularizer of science. This is probably the best of his non-technical books and the appearance of a second edition is most timely.

When the first edition was completed in mid-1978, particle physics was in the midst of a revolution. The high-energy physicists had recently established that protons, neutrons, pions and other strongly interacting particles are all composites of smaller particles, the quarks. The quantum chromodynamic theory of quark interactions had been formulated and the first quantitative tests of this fundamental theory were being made. The fathers of the theory uniting electromagnetic and weak interactions were about to receive the accolade of a Nobel Prize, even though final confirmation of the theory — the discovery of the W and Z particles — was still four years in the future.

Today the W and Z are known to exist, and the electroweak and quantum chromodynamic theories are referred to as the "standard model" — there being no well-established phenomenon in high-energy physics that is in conflict with this paradigm. For a few months we have opportunity for pause and reflection on what has been achieved in our quest for understanding of the fundamental laws and forces of Nature.

Deeper insights undoubtedly await the experiments at new accelerators that are due to begin at the end of this decade. Physicists are confident that there is far more to be learned because the standard model is not the last word. There are no data in conflict with it, yet there are several theoretical issues on which understanding is hazy. The mystery of the origin of mass is explained in these theories if "Higgs particles" exist; these particles may be produced under conditions obtainable at the new machines. There are many reasons to suspect that the standard model is but a pale glimpse of a more profound unified theory of all forces, including

• Just published in Britain is *Origins: A Sceptic's Guide to the Creation of Life on Earth*, by Robert Shapiro. The book was first published by Summit, New York, and was reviewed by James Lovelock in *Nature* 320, 646 (1986). British publisher is William Heinemann, price is £12.95.

gravity, which will address questions concerning the origin of matter and the evolution of the Universe from the initial big bang. Indeed, the most significant development since the appearance of Davies's first edition is arguably the realization that high-energy particle accelerators are reproducing in the laboratory conditions similar to those that were prevalent within fractions of a second after the big bang. Thus high-energy experiments have much to tell us about cosmology and the formation of the Universe.

Paul Davies's own contributions have been primarily in general relativity and cosmology. The new symbiosis between high-energy particle physics and cosmology may eventually be seen as one of the great advances in human culture and is discussed in the later pages of this book, though (unfortunately in my view) in relatively little detail compared to the structure of matter and nuclear physics which are covered in the earlier chapters. On the particle physics side of this marriage, Davies describes the phenomenon of CP violation and mentions its importance for

the asymmetry between matter and anti-matter in the Universe. He also mentions the search for three families of quarks. Yet I found no mention that CP violation is natural in such a "three generation" universe. This is a surprising omission from the author of *The Accidental Universe*: is this the reason why Nature "requires" three generations when the standard model and life on Earth would, at first sight, be quite happy with just one?

These are minor quibbles when set against much that is good. The most important thing about this book is that you do not need to be a scientist, let alone a physicist, to get a lot from it. Together with its bibliography, it is an important contribution to the growing literature by professional physicists, writing coherently and without recourse to jargon, who wish to share their excitement with a general audience. □

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Who's in favour?

M.S. Bretscher

Protein Secretion: A Critical Analysis of the Vesicle Model. By Stephen S. Rothman. Wiley:1985. Pp. 347. £81.25, \$85.

How is it that certain theories or models become accepted, whilst others are rejected? We like to believe that different models consistent with the evidence are proposed, critical tests to distinguish alternatives are performed and eventually one model emerges as closest to the truth, the evidence having been carefully weighed by the scientific community. It is the force of evidence and argument, rather than the personalities of the advocates, that determines the outcome.

In practice, the scientific community does not always weigh the evidence carefully. Today, there is a tendency greater than ever before for the worth of a model to be decided democratically: the more supporters, the better the model. In this democratic process, votes are cast for all to see — the winners are quoted and invited to advertised meetings, and their papers are accepted more readily in the best journals. The leaders of fashion get the laurels and, if there is one person who manages to be seen as the founder of the successful paradigm, he may be elected pope of the field.

Reflecting society at large, science is becoming dominated by media men, who replace reason with glib slogans or polychrome slides. As entertainers fill the

minds of society with a vacuum of trivial news, so the scientific media men are taking over; they can do so because there are too many papers — so many that most never get read at all. Of those papers that receive more than a cursory glance, most only get their titles, abstracts and references scanned. The references, of course, are a poll: they may not tell us which papers are relevant, but rather who is in favour. The plethora of papers arises because of the principle that all observations are novel and must be published: indeed, everyone has a democratic right to publish. The result is that the average paper is really of no interest to anyone and often of little interest to its authors. In this buyers' market, you have to sell, so that everything is hyped. Indeed, good stories are actively fragmented by their authors, the shrapnel being tossed into several journals to create the largest target area, and achieve the greatest chance of a hit.

The reigning paradigm may have much weak evidence in its favour — evidence which in the absence of the model would be regarded as inconsequential. And even if the evidence is against the model — well, its blind adherents will tell you that the model has to be right and the evidence discounted. Behind it all, there grows an infallibility of the pope and his cardinals. This is no new form of mass hysteria, as Peter Mitchell would surely agree.

With this background, Stephen Rothman might identify himself as a heretic, leading a crusade against one of the central dogmas of cell biology: that secreted proteins are forever separated from cytoplasmic proteins by their insertion into the