

sequence could convey several messages, depending on how it is read. We can easily translate the coding sequences into the corresponding linear amino sequence, but the function of the protein is a property of its three-dimensional structure; we need to deduce this from the linear amino acid sequence and then read the surface of the protein to decipher the 'meaning' of a gene. This is our old friend, the still unsolved protein-folding problem. Of course, we can determine the three-dimensional structure of a protein empirically, but although methods are being continually improved, the task is still uncertain, arduous and expensive.

What encourages us now to approach the question is the torrent of sequence information resulting from technical advances in cloning and sequencing DNA molecules. Not so long ago, protein sequences could only be obtained by long and painful excavation, but now the databanks provide us with an archaeological treasurehouse of tablets of Linear G. A wide range of computational tools is now available to help us in sequencing and in interpreting the sequences, and the computer has increasingly become an indispensable tool in molecular biology laboratories. These two books are recently published guides to this important area.

Doolittle's little book *Of Urfs and Orfs* ("urfs" are unidentified reading frames, "orfs" are open reading frames) is a very readable primer and is strongly recommended to those entering the field. It explains how sequence homology can be established from sequence comparisons and how this may be used to understand the evolutionary connections between proteins. The section on how to make peptides and antibodies to them enables the student to materialize his protein out of the computer. The combination of computer algorithms, chemistry and immunology is a remarkable product of the technology revolution in biology.

Nucleic Acid and Protein Sequence Analysis is a practical "aid to biologists wishing to use computers for the acquisition, storage or analysis of nucleic acid and protein sequences". It is a reference book by many different authors, covering the whole range of the subject from computer hardware and available software to methods of sequence analysis and comparison. It has sections on protein structure prediction and on secondary structure analysis of nucleic acid sequences.

We are at the beginning of a new era in biology. The decipherment of Linear G — the generation of organisms from their genetic scripts — is the fundamental problem in biology. Learning how to do it is going to be a most challenging and exciting scientific venture. □

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Modest innovation

William Rhodes

Tributes to Paul Dirac. Edited by J.G. Taylor. *Adam Hilger, Bristol/Taylor & Francis, Philadelphia: 1987. Pp.123. £9.95, \$22.*

In April 1985 a memorial meeting for Paul Adrien Maurice Dirac was held at Cambridge University. *Tributes to Paul Dirac* is a collection of talks given at that meeting, together with reminiscences of Dirac by other colleagues and students. It is a eulogy to one of the greatest scientists the world has ever known.

The short period of time 1925–1928 experienced the birth of modern quantum theory. Three names stand foremost among the developers of this exciting new field: Heisenberg, Schrödinger and Dirac. All three formulated fundamental quantum mechanical equations. However, it was Dirac who quickly developed the unifying understanding of the structure of quantum theory and its connections with classical theory. His relativistic equation for the electron established the basis for quantum field theory, which now spearheads modern theoretical physics. In later years Dirac also made notable contributions to field theory, relativity and cosmology.

After a concise chronological sketch of the highlights of Dirac's personal and scientific life, the book is divided into two parts respectively containing personal reminiscences and accounts of his scientific contributions. The several historical photographs and the portrait of Dirac are excellent. The personal chapters, by students and colleagues, display varying degrees of closeness to Dirac and offer glimpses of a great man whose most outstanding personality traits were reticence and modesty. Although all of them clearly convey a mixture of affection and respect, only a few give insights into Dirac's nature. Particularly illuminating and valuable are the comments of A. Salam, J.E. Lannutti and S. Shanmugadhasan. In some cases, however, it seems as though the writers are searching for significance in small anecdotes.

Most of the chapters on Dirac's scientific contributions also contain personal recollections. The chapter by J. Mehra on Dirac's early work on quantum theory should be of interest to the non-specialist as well as the specialist. Dirac is said to have had little inclination towards matters of philosophy, but J.C. Polkinghorne's discussion of Dirac's interpretation of quantum mechanics brings out Dirac's deep interest in the nature of physical reality. Dirac's persistent view that "physical laws should have mathematical beauty" (a statement he wrote on the

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Paul Dirac — "one of the greatest scientists the world has ever known".

blackboard at Moscow University in 1955) certainly has ontological content. But a few of the scientific presentations, all on subjects to which Dirac made notable contributions, are quite technical and are understandable only to the specialist.

In reading this book, one must realize that it is a tribute, not a definitive book on the life, character and scientific works of Paul Dirac. The world awaits a detailed and objective study of this outstanding figure of scientific history. Meanwhile, *Tributes* will serve as a pleasant introduction to those who were not fortunate enough to have known him. □

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● Cambridge University Press has just published a further collection of essays as a memorial to Dirac. Entitled *Paul Adrien Maurice Dirac: Reminiscences About a Great Physicist*, the book begins frustratingly, with an assortment of personal recollections that are occasionally interesting enough as biography but which, when anecdotal, tend to fall flat. Something in Dirac's persona, with his famous brevity of utterance, may have charged these incidents with a particular significance but it barely survives the retelling.

In contrast, the inspirational influence of his science and of the elegant way in which he communicated it are compellingly recounted by a variety of eminent ex-students and colleagues. Most interestingly, there is a posthumous contribution by Dirac himself setting out in plain and uncompromising language his fundamental objections to the very successful expedient of renormalization, together with a more technical but enjoyably informal survey of supersymmetry and superstring theories which, as Abdus Salam describes, better satisfy the criterion of mathematical beauty on which Dirac insisted. Price of the book is £30, \$49.50.

Philip Campbell