Unworldly genius

N. Kemmer

Dirac: A Scientific Biography. By H. S. Kragh. *Cambridge University Press: 1990. Pp.389. £35, $44.50.*

PAUL Dirac, one of the greatest brains of this century and also one of the strangest, unworldliest characters, deserves a lengthy biography, though the number of worthy tributes that appeared after his death in 1984 is already quite large. The 14 main chapters of *Dirac: A Scientific Biography* contain over 1,000 numerical superscripts related to 45 pages of annotations drawn from extensive and varied archival material. In addition there are a number of miscellaneous appendices.

The subtitle '*A Scientific Biography*' should not mislead readers to expect text devoted entirely to Dirac's scientific work. The text has accounts of his life and extraordinary character with outlines of his achievements skilfully interwoven.

It was a surprise to learn from the preface that the author had never met Dirac. (And also surprising that no information is given about the author.) No reader should skip chapter one; to understand Dirac's character one must appreciate his almost frightening background. His domineering single-minded father saw no other aim in educating his hugely talented son than a career in engineering. Dirac was denied all distracting contacts, but the academic hurdles he had to face proved to be so low that he had time for deep lone study of mathematical subjects. At a very early age he took up a studentship at St John's College, Cambridge and was taken further into postgraduate study when only 21. Cambridge received him still as a withdrawn, unworldly lad with a brain concentrated entirely on his mathematical thinking, which did not cease even on his long solitary walks every Sunday.

Dirac had intended to carry on with relativity, but instead his supervisor Ralph Fowler introduced him to the theory of atomic structure, which was still in a very incomplete state — but not for long. Heisenberg's pioneering paper that gave birth to quantum mechanics was sent in prepublication form to a privileged few, including Fowler. His student was able to study and, as always, to master it. Heisenberg received Dirac's version of his own theory in November 1925. The printed version had been published only four months earlier. In one quick transition the young student became a member of the select international community of research workers just beginning to absorb Heisenberg's ideas, which revolutionized our understanding of many branches of physics.

In the space left for this review I can only do justice to some of Paul Dirac's greatest contributions, barely touching on the accompanying story of his life, travels and honours — and eventual marriage. Even the whole chapter devoted to the humorous side of this strange man's life cannot receive more than brief mention. Dirac's major achievements can be summarized under two headings: electrodynamics and relativity. The latter continued his earlier interest, but the current difficulty was that the new quantum mechanics could not be reconciled with relativity. In 1927, Dirac hit on the strange-looking linear 'Dirac equation' for the electron; it settled the problem and eventually produced a Nobel prize for its discoverer.

Unfortunately it had one flaw: useless solutions with negative energy had to be avoided. Dirac found the way out. Pauli's exclusion principle forbids more than one electron to occupy any energy level. Dirac redefined the vacuum as having all negative energy levels filled. Positrons were still unknown, but predicted as holes in the vacuum; Dirac's theory was soon to be confirmed experimentally.

The story for electrodynamics is unhappier. Dirac himself was first to quantize it, creating the picture in which photons are created, annihilated and scattered. These events are well described in first approximation of the theory, but not further.

To Dirac the whole theory and related ones designed for new particles were wholly unacceptable and what is further remembered of his own work remained outside the mainstream of physics today. There is still much good reading in them.

However, I feel that Dirac was not quite fair to all the physicists who saw in the idea of renormalization the solution to the troubles of electrodynamics. The agreement between experiment and theory had become quite stunning and while the new procedure was not a thing of mathematical rigour, was it so different from his own departure from rigour when he introduced the infinity of occupied states in the vacuum?

Finally, I cannot help wishing that Paul Dirac was still with us for me to remind him that both S. Tomonaga and J. Schwinger chose a road to renormalization along which he himself had taken some first steps in his paper with V. Fock and B. Podolsky — and that the very different road trodden by R. Feynmann, the Lagrangian one, was familiar to you also, my dear Isolated Singularity! □

N. Kemmer is at 35 Salisbury Road, Edinburgh EH16 5AA, UK.

■ Also from Cambridge University Press comes *Unification of Fundamental Forces: The first of the 1988 Dirac Memorial Lectures* by Abdus Salam. Price is £8.95, $14.95.

Regulated change

Knut Schmidt-Nielsen

Rheostasis: The Physiology of Change. By Nicholas Mrosovsky. *Oxford University Press: 1990. Pp. 183. £40, $49.95.**

WHEN I first read the title of this book, *Rheostasis*, and the subtitle, *The Physiology of Change*, I thought that it somehow had to do with blood flow or possibly with a broader range of fluid flow topics. I was mistaken.

Before he introduces the novel term 'rheostasis' and defines it, Professor Mrosovsky discusses homeostasis, the concept of the constancy of the internal environment that was introduced by Claude Bernard and later popularized by Walter Cannon who coined the word 'homeostasis'. But then he asks "how does the sweeping concept of homeostasis stand up in the light of recent facts?" His answer to this question is what the book is all about.

Mrosovsky explains that changes in regulated levels have often been regarded as failures of homeostasis. But, he says, keeping the internal environment constant is not always imperative, nor does the body always seek constancy. Consider body temperature. Body temperature is not kept constant, it undergoes well regulated diurnal changes. And hibernation certainly entails a regulated drastic change in body temperature. There are many other regulated changes, and this book deals with such changes, for which Mrosovsky uses the term rheostasis.

'Rheostasis', then, is used "to describe a condition that is regulated at changing . . . levels or values". Or with more words: "*Rheostasis* refers to a condition or state in which, at any one instant, homeostatic defenses are still present but over a span of time there is a change in the regulated level. Therefore rheostasis includes a change in set-point, both when the term is used descriptively without specifying mechanism . . . and when it is used to indicate a mechanism comprising negative feedback with a reference signal."

The concept of constancy is so ingrained in all physiological thinking that it is useful to be reminded that changes may be both desirable and well regulated. Consider the fat content of the body, which normally is thought of as an energy reserve. If the fat content is maintained constant, it obviously cannot function as a reserve. And specifically, consider the pre-migratory accumulation of fat in a migrating bird, which may have nearly half its body weight as fat. This tremendous increase in

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