Bookshelf

Advances of Accelerator Physics and Technologies (Vol. 12 of Advanced Series on Directions in High Energy Physics), Edited by Herwig Schopper, Published by World Scientific (ISBN 981-02-0957-6, in paperback 981-02-0958-4)

Particle accelerators have always drawn upon the most advanced technologies. For Cockcroft and Walton it was high voltages, while the cyclotrons and synchrotrons that followed depended upon acceleration systems designed in the race to perfect wartime radar.

As accelerators became too big for the university workshop to handle, the manufacturers of heavy electrical machinery were brought in to make hundreds of metres of electromagnets. They found the requirements of precision and reliability surpassed the quality of the best of their products and had to develop new methods of insulation and precision assembly. They now readily admit that in meeting our challenge they extended their own grasp of technology to the benefit of their less exotic customers; not to mention their shareholders.

The stimulation of industry did not stop there - the physicist, by the nature of his craft, is always the first to know of what has just become possible. In their turn many industries, from those which prospect for petrochemicals to others constructing the channel tunnel, have become the technological beneficiaries of this big science.

The latest of these technologies is of course that of superconductivity, and this is fully covered in this book. But in the many chapters which describe the state of the art of accelerator design, the reader will encounter numerous examples where the possible awaits an everyday application.

This excellent compendium of advances in the accelerator field is therefore obligatory reading for anyone in an industry striving to deserve the label of high-tech.

Not only does it for the first time draw together authoritative contributions by those who lead these technologies, but it explains how the large majority of today's accelerators are put to work to cure patients in hospital and to provide synchrotron radiation for a rich spectrum of new industrial applications. In addition there is much in the volume that is essential reading for the accelerator specialist. Until now books in this field tended to ignore practicalities and be entirely devoted to the mathematics of the subject.

The camera-ready typescript is varied but always legible - a comment that might equally apply to the quality of the prose. Happily, all of the more difficult chapters are nevertheless rewarding in their technical content. There is also one chapter, contributed by Montague, that is worth the price of the book for those who may delight in his humorous and ironic style.

Bravo to the editor, Herwig Schopper, for making a success out of a timely compilation.

E.J.N. Wilson

Early Quantum Electrodynamics - A Source Book, by Arthur I. Miller, Cambridge University Press, ISBN 0 521 43169 7)

Many people these days would say that quantum electrodynamics, the quantum picture of electromagnetic radiation, dates from 1947-8 with the work of Sin-itoro Tomonaga, Julian Schwinger and Richard Feynman. However this was the modern reformulation of a theory whose genesis was Paul Dirac's 1927 work on the quantization of radiation and was subsequently, and painfully, pieced together in the 1930s.

Until the Second World War, the science of quantum electrodynamics advanced steadily, driven for the most part by the intellects which had produced modern quantum mechanics - notably Dirac, Heisenberg and Pauli. After Dirac's 1928 relativistic theory of the electron, Heisenberg and Pauli went on to cast an initial quantum formalism for the interaction between radiation and electrons.

During this time many intellectual hurdles had to be crossed - the negative energy states predicted by Dirac's equation and their final identification as antimatter electrons (positrons), the whole problem of explaining quantum force mechanisms as particle exchanges, Fermi's explanation of beta decay, and Yukawa's explanation of the nuclear force. Heisenberg's invention of the S-matrix and his ideas on the transmission of nuclear forces through exchange mechanisms revolutionized both our picture of the quantum world.

These problems were not easy - several times during the 1920s even these intellects almost despaired.

A shadow across the subject was the continual problem of troublesome infinities in mass terms and elsewhere. It was not until the ordered renormalization recipes of the immediate post-war period that these infinities were finally hidden from sight.

Science historian Arthur Miller traces these developments in the first half of the book, and signals how these early developments were eventually to dovetail with the exciting new developments of the late 1940s. Supplementing the survey are eleven fascinating landmark papers by Heisenberg, Dirac, Weisskopf, Fierz and Kramers spanning the period 1930-8. Many of these were originally not written in English.

The availability of these difficult ideas in English in a single volume is itself valuable, offering fresh insights into these pioneer developments.

(Among them is Weisskopf's 1934 calculation of the self-energy of the electron, including the original version with the error and the subsequent correction. Weisskopf has related how, humiliated, he went to Pauli, his boss at the time, and asked whether such an error warranted him giving up physics. 'No,' replied Pauli adamantly. 'Everyone makes mistakes, except me.')

However the new approaches of the late 1940s which revolutionized the field are outside the scope of the book, considerably reducing its appeal.

As Heisenberg said, the new Feynman diagrams provide the intuitive appeal that previously had been so difficult. The pre-war history of quantum electrodynamics and related matters is also related in Abraham Pais' fine book 'Inward Bound' (Oxford University Press), which also goes on to cover immediate post-war developments, where precision spectroscopy measurements (the Lamb shift) provided fuel for accurate quantum electrodynamics calculations. In Dr. Miller's book, the emphasis is more on the need to understand which drove the pre-war efforts.

G.P.S. Occhialini 1907-93

G.P.S. Occhialini, a legendary figure for all who remember the very beginnings of cosmic ray particle physics, died on 30 December. Born on 5 December 1907 in Rossombrone, near Urbino, he studied in Florence. Here he met Bruno Rossi, whom, although only two years his senior, he always regarded as a master.

In 1932 Occhialini went to Cambridge where he worked with P.M.S. Blackett. They invented and perfected the counter-triggered Wilson chamber technique, recording cascade showers which confirmed the existence of the positron, discovered slightly earlier by Anderson, and demonstrating its symmetry with the electron. Their counter-triggered chamber technique was also to endow physics with the mesotron (later known as the muon), the neutral kaon, the lambda, and other strange particles.

In 1938 Occhialini left for the University of São Paulo in Brazil, returning to Britain in 1944 where he joined the Bristol group directed by C.F. Powell, studying nuclear reactions with the aid of photographic emulsions. Obsessed by cosmic rays, Occhialini rapidly realized that useful work in this field meant greatly increasing the silver bromide density in the emulsion to show particle tracks more clearly.

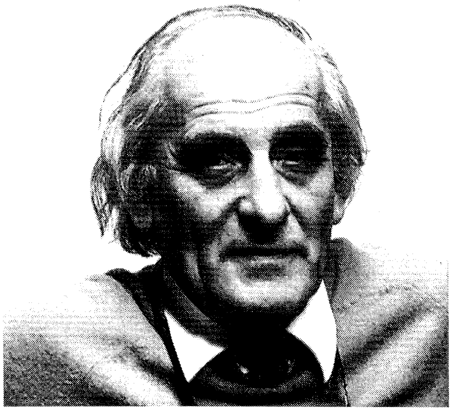
Urged by Powell and Occhialini, the Ilford company produced the desired emulsion in 1946.

That same year, a packet of plates coated with the new emulsion was set up at the Pic du Midi de Bigorre in the Pyrenees at an altitude of 2850 m. After six weeks the plates were returned to Bristol to be developed. In May 1947, Lattes, Muirhead, Occhialini and Powell published the first two examples of 'double' mesons - the decay of a pion into a muon.

In 1979 Occhialini was awarded the Wolf prize for his outstanding controlled chamber and emulsion contributions to cosmic ray and particle physics.

Shortly after the pion discovery he rendered another fundamental service to the emulsion technique. With the aid of C. Dillworth and R. Payne he heat-treated cold emulsions impregnated with cold developer. This made possible the uniform development of emulsions 600 mm and more thick, whereas those used for the pion-muon decay were only 50 mm thick. This elegant but little-known invention made the whole of post-pion emulsion physics possible, especially the study of charged kaons.

Occhialini abandoned elementary particles in 1960 and spent a year at MIT with his old friend Bruno Rossi and his team learning about the field that was to become space physics. In Italy, where he had become a professor at Genoa, and subsequently at Milan, he directed and organized the space operations of a number of the Italian laboratories.



G.P.S. Occhialini 1907-1993