

Albert Einstein

On 14 March 1879, Albert Einstein was born at Ulm in Germany. The centenary of his birth is being celebrated throughout the world and it is appropriate in a journal of high energy physics, a field of research where many of his insights are now the bread and butter of daily work, to pay tribute to this towering figure of modern physics.

In a single year, 1905, Albert Einstein made several dramatic contributions to physics. He deduced the true nature of Brownian motion (doing much to underline the molecular and atomic nature of matter), he demonstrated the particle nature of light in a way which was accessible to experimental investigation (the work for which he received the Nobel prize) and, most dramatically of all, he conceived the special theory of relativity.

From a few simple premises — the constant velocity of light, and the fact that motion is relative with no single object able to claim priority as the 'centre of rest' — Einstein was able to develop relativity theory, one of the man's greatest achievements in pure thought. From this theory emerge such revolutionary concepts as the equivalence of energy and matter, the inseparable nature of space and time, and the extension of lifetime with increasing velocity.

High energy physics Laboratories thrive on the outcome of this theory. The interchangeability of energy and matter, expressed in the most famous equation on physics ($E = mc^2$), underlies the production of the variety of particles which have been studied in the past few decades, and is the source of some of our most essential experimental tools — the secondary particle beams created at the accelerators. It is the relativity effect of increased lifetime at higher velocity that makes many of the experiments possible.

The mathematics of the theory with its interlocked space and time coordinates, is the bedrock of theory and of experimental interpretation. Yet, not many of these consequences could have been foreseen by Einstein in 1905.

It could be said that other scientists had been on the brink of evolving the 'special theory of relativity' but none were near Einstein's still more revolutionary leap in pure thought ten years later. He emerged with the 'general theory of relativity' bringing gravitation also within the grasp of the theory. It gave the rules for the workings of the Universe on a cosmological scale, superseding the classical work of Isaac Newton which had stood for the preceding two centuries. This opened the door to modern cosmology where there is considerable overlap with the problems and phenomena of high energy physics.

It is appropriate that, on the eve of the Einstein centenary, the most convincing evidence yet obtained for gravity waves — a long awaited consequence of the general theory of relativity — has emerged from studying a pulsar binary system (see page 24).

In the interval between his two great papers on relativity, Einstein made significant contributions to the development of the ideas of quantum theory — in particular with papers in 1913 and 1917 on the emission and absorption of light quanta. However, as the statistical interpretation of Nature took firm hold, Einstein shied away from accepting the behaviour of matter at microscopic level in terms of probabilities. His deep feeling about this is summed up in the famous remark about not believing in a God who plays dice.

From the 1930s until his death in 1955, he devoted himself to evol-

Albert Einstein in 1904, when he was working at the Swiss Patent Office at Bern.



ing a unified field theory which would encompass all aspects of the behaviour of Nature. He had accomplished such a theory with great elegance for all the manifestations of the force of gravity and his vision was to pull the electromagnetic and nuclear forces into a similar broadened theory.

This vision was never realized and it would be fascinating to have Einstein's reaction to the progress in high energy physics in the past few years, where gauge theories are holding out a new hope of unifying our interpretation of Nature.

Albert Einstein left a mark on science as no other person did, even from amongst the most brilliant generation of physicists who flourished in the early decades of this Century. And this mark was felt not only in science.

So great was the impact of his thought and personality that Ein-

stein is synonymous with *the* scientist in the popular imagination. Each budding genius is foisted with his name. His distinctive features are the popular vision of the face of the scientist. Many of the concepts from his relativity theory have now seeped into popular culture.

He had the respect of people from all walks of life. He was blessed with a great love of music and had considerable ability as a musician. He had a deep sense of social responsibility and took a firm stand on many of the important issues which welled up during his life.

His eminence in science, at a time when science and technology were leading to so many changes in everyday life, inevitably led to his being called into the political arena. This had its most telling moment in 1939 when, prompted by Leo Szilard, he wrote the letter to President Roosevelt which initiated the

atomic bomb project — an involvement which troubled Einstein for the rest of his life. Another indication of the esteem in which he was held was the offer in 1952 to become President of the State of Israel.

Albert Einstein was a man of great stature both as a scientist and as a human being. He developed a close relationship with the English philosopher Bertrand Russell and a very Russell-like statement, from the 1973 book of Einstein's 'Ideas and Opinions', makes a fitting conclusion to this short tribute — 'The ideals which have lighted my way... have been kindness, beauty and truth.'

Many events are being organized throughout the world to mark the anniversary of Einstein's birth.

The main event is being held in Bern, Switzerland, where Einstein was based when he did his work on relativity. An 'Albert Einstein Centenary' will be held from 13-

17 March with a very broad programme covering sciences, humanities, human relations and theology. There is a long list of sponsoring institutions including CERN. Leon Van Hove, CERN Research Director General, is Chairman of the International Committee and many other high energy physicists will be giving papers or chairing session (C.N. Yang, A. Salam, W. Thirring, V. Weisskopf, E.L. Feinberg, A. Zichichi...).

At the Institute for Advanced Study, Princeton, where Einstein worked from 1933, an 'Einstein Centennial Celebration' will be held from 4-9 March. The emphasis is on specific aspects of Einstein's scientific work and many leading figures in high energy physics will be involved (C.N. Yang, W. Panofsky, A. Pais, E. Amaldi, T. Regge, S. Weinberg, P. Dirac, R. Feynman, V. Weisskopf, Y. Ne'eman, G. 't Hooft...).

Some developments in detection techniques and applications

It is a rather obvious statement that developments in particle detection techniques have been crucial to developments in particle physics. It is not only the advancing abilities of accelerators in providing higher energies, intensities and qualities of particle beams that have taken our understanding of the nature of matter further but also the abilities of detectors to untangle the particle interactions which are produced. It is for this reason that every study of a new machine carries with it a study of detection systems to ensure that the new interactions that the ma-

chine can reveal will be observable by available detectors.

Since the advent of high energy accelerators, the abilities of particle detection have been revolutionized. The precision with which it is now possible to time the passage of a particle, to locate it in space and to identify it, and the rate at which this information can be collected, are orders of magnitude greater than they were twenty years ago.

As usual, such technological advances, which were pushed in the cause of high energy physics, have also found many applications else-

where. This article pulls together some recent developments in detection techniques and some indications of applications in other fields.

Multistep avalanche chambers

Perhaps the most significant of all the advances in detection techniques was the invention in 1968 of multiwire proportional chambers and drift chambers by the group led by Georges Charpak at CERN. These detectors locate the ionization initiated by the passage of a charged particle through a gas, either by