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GUEST EDITORIAL

A Celebration of Albert Einstein

For the physics community worldwide, from start to finish the year 2005 has been one continuous celebration of the life and magical works of Albert Einstein – AE. Countless seminars, conferences, lectures and exhibitions have brought home the personality and achievements of AE as never before to students at school and college levels, scientists in other fields, and the general public. This journal too joins these celebrations with a special section of invited articles of exceptional quality by leaders in their fields.

Among all scientists of all time, it is probably true that there are more documents and books relating to AE than to anyone else. To talk or write about him there is so much material – such an embarrassment of riches – that one must limit oneself and choose very carefully. The AE archives housed in the Hebrew University in Jerusalem contain some 43,000 documents, and the project to bring out *The Collected Papers of Albert Einstein* has only recently reached volume 9 of the projected 40 volumes, covering the period up to early 1920. Details of his life and relationships continue to be explored, and books on him and popular accounts of his work continue to be published. AE once said about the philosopher of the Enlightenment: '... I believe that every philosopher has his own Kant'. In the same vein, AE has left us such a staggering amount of material, added to his own eloquently worded essays, opinions and aphorisms on so many aspects of life – science, religion, society, politics, humanism... – that each of us can create her or his own AE!

AE's work in the Year of Miracles 1905 relating to the light quantum hypothesis, Brownian motion and the Special Theory of Relativity (STR) sowed the seeds for the flowering over the succeeding century of the physics of the small, the complex and the large, in the words of T. V. Ramakrishnan in the December 2005 issue of *Resonance*. Prior to this, greatly inspired by Ludwig Boltzmann and independently of Josiah Gibbs, he had created for himself the statistical mechanical foundations of thermodynamics. He and Max Planck are rightly regarded as the joint founders of quantum theory. Right up to the late 1930's – thus for more than three decades – he remained scientifically active at the highest imaginable levels. His General Theory of Relativity (GTR) created over the period 1907–1915 is still rightfully regarded as the most beautiful of all existing physical theories, and as the supreme example of the power of speculative thought. While the relativity theories are essentially his single-handed creations, the quantum theory and the later quantum mechanics – in Abraham Pais' words, 'that uniquely twentieth century mode of thought' – were the results of contributions from many of the most gifted physicists over two generations. However even here he was for long an undisputed leader, so often far ahead of his contemporaries in unravelling the mysteries of quantum phenomena. Thus one remembers the revolutionary character of his discovery of the light quantum concept in 1905 from an incisive study of the properties of black body radiation in the nonclassical Wien limit; the inauguration in 1907 of the application of quantum ideas to matter through the specific heat problem; the first ever description in 1909 of wave-particle duality for light; the 1916–17 discovery and role of stimulated emission of radiation by matter, and his sensing so early the role of probability in elementary processes; the need to quantize the electromagnetic field, which Planck and even Bohr so long resisted; the elaboration of the properties of light quanta, in isolation and in the face of strong opposition by Millikan, Planck and Bohr; and the elucidation in 1925 of particle wave duality for matter.

With respect to relativity, it was AE who first elevated the idea of symmetry or invariance of physical laws from a descriptive to a creative principle. The courage he displayed at 26 in resolving the clash between Galilean–Newtonian mechanics and Faraday–Maxwell electromagnetism by revising the notions of space, time and simultaneity is reinforced by this 1915 recollection of Lorentz, 26 years senior to AE:

> 'The chief cause of my failure was my clinging to the idea that only the variable t can be considered as the true time and that my local time t' must be regarded as no more than an auxiliary mathematical quantity.'

In his own statements AE displayed remarkable boldness and command over concepts. He peremptorily disposes of the aether in these words from 1907: '... electromagnetic

forces appear here not as states of some substance, but rather as independently existing things that are similar to ponderable matter and share with it the feature of inertia'.

He also expressed very early, in 1911, and clearly the spirit of STR, in contrast to the later GTR which is the supreme classical theory of gravitation:

> 'The Principal of Relativity is a principle that narrows the possibilities, it is not a model, just as the Second Law of Thermodynamics is not a model.'

The struggles faced by AE on the way from STR to GTR can be truly described as superhuman. His unerring instinct and the deep physical meaning of his Principle of Equivalence guided him during the several years he spent searching for the right mathematical expression of his ideas. There are few passages in science as eloquent as this one from his 1933 Glasgow lecture:

> 'The years of searching in the dark for a truth that one feels but cannot express, the intense desire and the alternations of confidence and misgiving until one breaks through to clarity and understanding are known only to him who has himself experienced them.'

In time, in AE's own hands, GTR provided the impetus and the language for formulating theories of the cosmos. His supreme confidence in his creation is expressed in this response to the suggestion that the experimental tests of the theory might fail: 'I would have felt sorry for the dear Lord. The theory is correct'. While the early tests were of comparatively limited accuracy, it is astonishing that in recent times the accuracy has been pushed to amazingly high levels like, for instance, a few parts in ten thousand for the gravitational red shift.

Returning to the quantum theory track, it is well known that AE never accepted the quantum mechanics born in 1925–26, and its interpretation fashioned by Bohr, Heisenberg and others in 1927, as convincing and final. He criticised it at great depth and subtlety in 1927, 1930 and finally along with Boris Podolsky and Nathan Rosen in 1935. Early on his way to GTR, before the metric entered the picture and he was still using the local light speed as a measure of gravitation, he had seen that his theory contained essential nonlinearities. This continued to be so after the final metric theory was in his hands. And it was his hope that both elementary particles and quantum conditions would come out of such nonlinear field equations as necessary consequences. Later developments have not gone the way he hoped for and imagined. As he wrote to Max Born in 1944:

> 'We have become antipodean in our scientific expectations. You believe in the God who plays dice, and I in complete law and order in a world which objectively exists, and which I, in a wildly speculative way, am trying to capture.'

As the one who had done so much preparing the way for the coming of quantum mechanics, he had the right to look for another path to his own conception of the truth.

AE's contacts with Asia were limited but significant. He made a memorable six-week trip to Japan in November–December 1922, during which he gave one of his most famous lectures titled 'How I constructed the theory of relativity'. This translation of his impressions from German into English by a Japanese is both touching and hilarious:

> 'The Japanese rightly admires the achievements of westerners and become absorbed in the science with success and great idealism. I wish they don't forget to keep those treasures pure which they have in excellence over the west: their artistic building of life, the simplicity and modesty in personal need, and the pureness and calmness of Japanese soul.'

His contacts with and admiration for Tagore, Gandhi and Nehru have been recounted recently by Rasoul Sorkhabi (*Curr. Sci.*, 2005, **88**, 1187). There were four occasions when AE and Tagore met: 1921 in Berlin; 1926 in Dusseldorf; July 1930 in Caputh, and August 1930 in Berlin. Several accounts and evaluations of their discussions exist; sadly, as one of them says, despite their deep mutual respect, 'Instead of their minds meeting, the two men seem mostly to have talked past each other'. AE himself said: 'My conversation with Tagore was rather unsuccessful because of difficulties of communication…'.

Half a century after his passing, AE continues to inspire physicists as ever before. The aim of his later years – a unified description of the basic forces in nature – though not realized in the specific form he visualized, still drives physicists forward. Added to this are the qualities of depth, beauty, independence and courage that characterized his work. Physics in every direction has witnessed remarkable advances in both experiment and theory since AE's days. Allowing for this and also for the change in context, we can well say of him what he wrote about Newton in the 1949 Autobiographical Notes:

'… you found the only way which … was just about possible for a man of highest thought and creative power. The concepts, which you created, are even today still guiding our thinking in physics…', as they will continue to do for a long time to come.

N. Mukunda