A TRIBUTE TO ALBERT EINSTEIN

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TO DESCRIBE and to evaluate Einstein as a scientist is at once a very easy and a very difficult job. It is easy to say that Einstein towers far above any scientific figure of the 20th Century—a statement I believe to be true. It is even easy to say that he is the greatest figure in science since Isaac Newton—a statement I also believe to be true.

But, even though we see the towering peaks of Einstein's achievements, we are still too close to them to be able to evaluate them accurately. Einstein's work, without question, marked a turning point in the history of physics. But the full significance of that revolution will be more clearly visible 100 years from now than it is today.

Nevertheless, we do already have a perspective of 50 years since Einstein did some of his most important work in 1905 when he was only 26 years old. And, with this perspective, the towering nature of his contributions is already clearly evident.

In 1905 Einstein addressed himself to solving a riddle which had first been posed by the famous experiments made by A. A. Michelson and his co-workers beginning in 1889—experiments which, incidentally, brought the first Nobel prize in physics to the United States. Michelson attempted to measure essentially the velocity of the earth through the "ether"—the ether being that intangible medium which was assumed to be spread through all space and which accounted for the propagation of light. It seemed obvious that the earth's velocity through this medium could be determined by measuring the difference in the speed with which light travelled in two directions—say parallel and at right angles to the earth's motion. This was simply analogous to measuring the current in a river by comparing the speed with which a rowboat could go upstream with its speed when going across.

The shattering result of this experiment was that there was no difference in speed whatsoever. The velocity of the earth relative to the ether was zero—and remained zero—in spite of the fact that everyone knew that the earth was dashing along in its orbit about the sun at a speed of 1100 miles per minute.

Now this was but one of many experiments in the fields of optics and electricity which revealed contradictions with accepted theories. And a variety of attempts had been made—most successfully by H. A. Lorentz in Holland—to account for the troubles. However, in 1905 the mysteries still remained.

It was then that Einstein came along with the breathtaking proposal that we take Michelson's experiment seriously and take as a basic postulate of physics that the world is so constructed that the velocity of light in free space is an absolute universal constant whose value is always the same regardless of circumstances under which it is measured.

The consequences of this and the other postulates of special relativity were far-reaching. Many puzzles in physics were at once clarified; the concept of the ether was eliminated; a new concept of the significance of time was introduced, and also there followed the idea that the mass of a body was a function of its speed—a relation which had already been accepted for charged particles, and which now was extended to cover all matter. It was this relation which led to the idea of the equivalence of mass and energy, the basic idea of atomic energy.

Today the theory of special relativity is such an inherent part of physics that it is hard for us of this generation to imagine what physics could have been like without it. It is like asking what physics was like without Newton's laws of motion or of gravitation.

Quantum theory

Twentieth Century physics as contrasted to 19th Century "classical" or Newtonian physics is characterized by two major and far-reaching ideas; namely, relativity and quantum theory. I have already indicated how Einstein was responsible for relativity. I must now point out that he also had a major responsibility for the quantum theory.

The basic postulate of quantum theory was first enunciated by Max Planck in 1900. This was the idea that when light energy is produced it is emitted, not continuously, but in lumps or packets or "quanta." Now Planck, though he found that with this assumption he could solve his problem, really did not believe it, and, indeed, spent several years trying to show how to get along without it, or at least how to minimize its universality. In the end he had to give up.

Again it was Einstein who made the bold proposal that we believe in Planck's quanta and that we assume that light travels in these energy packets and that light is always emitted and absorbed in lumps—the energy of each unit being equal to Planck's constant multiplied by the frequency. Once this idea was accepted, a whole array of phenomena were explained and the basis was laid on which Niels Bohr a few years later built the first satisfactory theory of the structure of the atom. Today we realize that the quantum idea is absolutely basic to all physics.

So, in the one year 1905, the youthful Einstein by bold leaps of his constructive imagination laid the foundations for the two major new concepts of modern physics. If Albert Einstein had passed away in 1906 at the age of 27, he would still be remembered as one of the great figures in physics. But of course he did not stop there. He went on to develop further ideas in both relativity and quantum theory, making many contributions of great significance which I cannot take time even to mention.

General theory of relativity

But possibly the greatest and most characteristic achievement of Einstein, the idea which is of such profundity that we know of no other living mind that might have conceived it, was the theory of general relativity first propounded in 1916. This is clearly not the appropiate place, nor is the speaker the appropriate person, to describe the theory. If you wish a simple sentence to characterize the two theories of relativity, it is this: Special relativity deals with physical conditions encountered when observations are made on bodies moving relative to each other with a constant velocity; general relativity deals with cases in which the velocity is changing, in which there is acceleration. Since the most commonly observed cause of an acceleration is what we term the force of gravity, Einstein was led directly to a new theory of gravitation. And since the measurement of acceleration itself depends on measurements of space and time, general relativity propounded a new concept of space-time.

The full consequences of general relativity have not yet been worked out, but no aspect of it has yet been found which is contrary to experience. Einstein himself spent the next 35 years of his life in completing the theory and in trying to tie together the new ideas about gravitational fields with the quite different set of ideas relating to electromagnetic fields. But the achievement of a unified field theory is still apparently a far-off dream which may have to await, for its fulfillment, the birth of another intellect comparable to that of Albert Einstein.

And so today all scientists unite in saluting one of the great minds of the ages—one which ranged with originality and profundity from the unimaginable minuteness of the atomic nucleus to the unimaginable vastness of the universe.

This will suggest why it is that the scientists stand in awe of a mind so great. But scientists also salute the human qualities of this great man. He was a man of simplicity, of gentleness; a man with a great heart who never performed a selfish deed, who never expressed a thought that was not motivated by the most sincere and generous concern for the welfare, the freedom and the happiness of some individual human being—or, more likely, of the whole human race.

His monument lives in the structure of science and also in the hearts of men.