

EXPLAINING EINSTEIN

BY HENRY CHARLES SUTER

NOT a few people are experiencing some difficulty in understanding Einstein's theories. We can realise how that may be in the land of the laity with their limitations of learning. However many students also experience the same difficulty in this respect and seek to have Einstein explained and simplified, so that they may interpret his theories to others in an understandable way. Therefore let us spend a little time in dealing with Einstein, in the Socratic method, and thus from the student standpoint.

"Long before you became any sort of student do you remember your first experience in an elevator?"

"Yes! as a child it seemed to me that we got into a little room and the upstairs came down!"

"That is so, and even Einstein would quite approve of such a statement, since he asserts the dependence of natural law upon the movement of the observer. In a word, we judge all that happens about us from the standpoint of our own system that is stopping as it were and that is at rest. There is but one exception to this and that is the velocity of light, which travels constant and certain, no matter how we may be moving."

"But as a student I find Einstein so paradoxical. In fact the haunting fear of paradox seems to me to be the bane of all science. It is not so with mathematics you know. From the conceptual conclusions arrived at there and the logical terminations met with in mathematics there seems from such a standpoint to be a position continually taken that is impregnable. But while I was a dunce at mathematics, I delighted in its definite decisions and was glad when it constantly showed up the absurdities of science, something that I more or less hated."

"Ah, as a student of science, no doubt you had your troubles, and when you considered the theory of relativity, you found that very full of paradoxes."

"Why! yes! when first introduced to Einstein, I felt like Alice Through the Looking-Glass. I had supposed that a yard was always and everywhere thirty-six inches long; that time was accurately measured by clocks and watches; that an object weighing a pound in one place would weigh sixteen ounces in another place; and that when you had measured the length, breadth and thickness of an object, you could state the volume with confidence. But Einstein tells us that there are circumstances in which a yard may be contracted to a span, an hour may shrink to a mere fraction of sixty minutes, and an object which started weighing a few ounces may come to weigh a ton. All that is necessary to accomplish these miracles is to get the objects moving fast enough, approaching the velocity of light, which, it may be said, is the fastest thing in the world. He tells us, moreover, that there is a fourth dimension, namely, time, and that no measurements are correct which leave this out. In Einstein's world, cause and effect have no meaning, except for purposes of explanation; there are no straight lines; space is curved and imparts its curvature on to the movements of objects in space. Newton's famous apple then for instance, did not fall to the ground because a mysterious power called gravitation drew it down. Circles exist without tangent, and the ratio between the diameter and circumference of a circle varies from time to time, depending upon whether the circle is rotating or at rest. Why, in such a world as Einstein depicts to lapse into a little levity, I'm reminded of the reason why Pat preferred a train wreck to a shipwreck. "In a train wreck," he said, "there you are; but in a shipwreck, where are you?"

"Ah! but the worst of it ever seems to be that Einstein proves that what he states in his seeming contradictions, is true. His world is not the conceptual world of mathematics, but rather a real world of experience. In fact he followed the example of his great forerunner, Galileo. Up to the time of this great physicist, it used to be thought that a heavy weight would fall faster than a light one. Had not Aristotle said so, and no one thought of disputing with such a man as Aristotle did they? But one day Galileo ascended

the leaning tower of Pisa, and let two objects of unequal weight fall, and they reached the ground at the same time. In similar manner Einstein based his conclusions upon the observance of actual events."

"Well while Einstein has somewhat disturbed my student mind, I must admit that he has strengthened my confidence in the deliverance of experience. The curse of formal education, from which, like other lads, I suffered, is that it takes a lad out of a world rich in experience and introduces him to a world of authority. He is taught that one and one makes two figuratively, but in the world of experience it does not necessarily mean that two lads placed together will perform twice as much work, because experience shows that they will probably be swapping yarns and the result of the sum total of work done may not be equivalent to that of even one. Scientifically one and one do not always make two, for instance, as in the case of the two drops of mercury, nor naturally in the case of two birds in a nest, or fish in a pool. Then again he is taught that a straight line is the shortest distance between two points, and then that only one straight line can be drawn between two points, while on the globe before him he can see plainly a large number of lines passing through the two poles by the shortest distance possible on the surface of the earth."

"Ah, the world of experience is full of movement, but in Euclid's world the movement has no place, in fact it is a static world."

"True, for I remember what a shock I got when, in the fourth proposition of his first book, Euclid proposed to make his proof by lifting one triangle and depositing it on the other. It seemed a sadly improper thing to do. In fact I felt that Euclid's world was not even a concrete world. It is a world of points and lines and planes which you cannot make concrete. As soon as you attempt to do so, as, for instance, when you put a point on the blackboard, it vanishes, for the point has magnitude, which Euclid's definition denies. Even his propositions, such as the one that the interior angles of a triangle are together equal to two right-angles, is only true in a flat world, which we do not inhabit."

"Yes, it is only too true, and even I remember how some years ago, I was awakened from the dogmatic slumber into which my formal education had plunged me when my little lad came

to me with a sliver of wood and cried, "Show me the inside, Daddy." I promptly took a penknife and split the sliver in two. But my lad's mind, in spite the fact he had not yet started school, was too acute for me. "But that is the outside now," he cried with glee; "show me the inside." It was then I first realized dimly what Bergson later taught me to see, namely, that the mind cannot penetrate into the inner heart of things, but must be content with surface only. That then is the reason why nature is so full of paradox, and Einstein's word to us is just simply this, the data of experience must be accepted no matter how paradoxical they may seem."

"It is so. How different the real every-day world which we experience is from the world of science and mathematics."

"Yes, but we recognize that we are not here referring to the world of atoms with their protons and electrons, for that is another story as Kipling would say. But take the ideas of space and time, with which relativity is chiefly concerned. We move to and fro; we let our eyes wander and thus we get the conception of space. We put our finger on our pulse, and count its beats. We remember that a short time ago we heard the clock strike, and are reminded that in half an hour we have a date with someone. Thus we get the idea of time. Then in the interests of formal knowledge, we invent standards and instruments for measuring time and space, clocks whose faces are divided into sections of twelve and sixties (which it is to be noted, are really space measurements) and measuring sticks which are divided into feet and inches. This is public time and space, and very useful when we wish to communicate with one another or make plans for buildings or keep engagements. But is it not the height of absurdity to say that an hour spent in agreeable company is the same length as an hour spent at an isolated station, waiting for a late train, or that a mile in a motor car is the same distance as a mile in an ox cart?"

"Ah you said something and so did Burns when he wrote:

"How slow ye move, ye weary hours,
As ye were wae and weary;
.It was not sae ye glinted by
When I was wi' my dearie."

That is not only experiential but is decidedly experimental let me tell you as a student."

"Indeed, and thus in Einstein's world space by itself and time by itself sink to shadows, and only a union of the two preserves reality. And this is true of experience—we live every day in a world not of three but of four dimensions and the fourth dimension is time. What we experience in daily life is not objects but events. Things not only are; but they happen also."

"Well now that you explain it thus, it seems that Einstein to my student mind certainly emancipates me from the dominance of merely spacial ideas, and reveals to me more fully the world of time."

"Indeed he has taught us to hear what the years and the centuries have to say against the hours and the minutes, to resist the usurpation of particulars and penetrate to their universal sense."

"Ah that's a lesson as a student of life that I sadly need to learn to-day. I am too largely led by spacial conceptions. I talk, like everybody else about bigness and swiftness; big business, big buses, big buildings; swift autos, swift planes, swift ships. While we have annihilated space, we say, nevertheless, space still rules our minds."

"Yes, then there is another test to which we must put these big, swift things. *Will they last?* That is the test you will remember Paul put the big things of his day—Prophecy, the big thing of the Hebrews; Knowledge, the big thing of the Greeks; and Tongues, the big thing of the Christians. The fault Paul found with these big things was that they did not last. Prophecies fail, tongues cease, knowledge vanishes away; only Love endures. Bergson teaches that duration—the time we feel—is the very heart of reality, and Einstein would seem to agree with that. He even refuses to accept the idea of an infinite universe. He thinks the universe is finite, and yet it has no boundaries. Its magnitude depends upon its density. If it were of the density of water, it would measure not more than three hundred and fifty million miles in diameter; but we know there are stars so distant that the light we see to-day started hundreds of thousands and perhaps millions of years ago; so the universe must be much larger than that. Some have estimated its diameter to be four hundred trillion miles, but we need not

bother about that. Einstein thinks the universe is curved like a sphere, or perhaps like a cylinder."

"It is all interesting and I feel Einstein has strengthened my student intellectual desire for unity. All philosophers have ever sought to bring all phenomena within a single formula. One found it in water, another in air, another in fire. Pythagoras said *man* was the measure of all things."

"True, and in seeking to bring the world of physical phenomena within one category—one supreme equation—Einstein is again following the pathway of his fellows in the past. Tycho Brahe brought harmony into the Aristotelian scheme of the universe. The position of Mars in the solar system refused to conform to Aristotle's mechanism by an amount as great as eight minutes of the arc. "Out of these eight minutes," said Kepler, "we will construct a new universe that will explain the motions of all the planets." In like manner the orbit of Mercury refused to conform to the Newtonian mechanism, and was found to be rotating in its own plane at the rate of forty-three seconds a century. Out of these forty-three seconds, Einstein revolutionized our nineteenth-century conceptions not only of astronomical mechanics, but also, as we have seen, of the nature of time and space, and the fundamental ideas of science, and in doing so, he has brought new unity into the universe. His theories have carried us to a height of knowledge which surpasses all elevations hitherto reached in the past thinking of the race. From this lofty peak we find ourselves contemplating nature with an insight such as no one has ever had before."

"Had we not already discovered that matter is made up of electrons, and that radiant energy is electro-magnetic?"

"Yes, but before Einstein, it was regarded as probable that all physical phenomena except gravitation were manifestations of the electro-magnetic field. Now Einstein has brought gravitation itself within the same structure. Gravitation is no longer a mysterious force acting at a distance, but a fundamental property of things. What philosophy has tried to do in the past Einstein has done for science. He has for the first time brought mechanical, electro-magnetic and gravitational phenomena into one structure."

"That is a great achievement, and in the realms of religion, ought to strengthen our faith in "one God, one law, one element." It makes me want to be more tolerant—to live and let live."

"Indeed, he teaches us that there are different orders of knowledge, and the reality we are seeking has different forms. These orders we must be careful to distinguish and not to confuse. We must not forget that truth in terms of one order may not necessarily be a sufficient guide in the search for truth in another order."

"Ah, as a student, I find much is said to-day about the conflict between science and religion, and Christian apologists have not always been wise in seeking to belittle this conflict. I suggest that it were far better to realize frankly that science and religion belong to different orders of truth and reality."

"Yes, indeed, for some of the critics may be competent authorities in mathematics, but that does not give them the right, which they frequently assume, to speak with authority about the futility of religious belief. There are five natural senses we know well, but there is also a sense of sin that comes of another order and of a spiritual nature that came in the consciousness of sinfulness when the Hebrew poet prayed, "Create in me a clean heart, O God!" He was probably ahead in his search for truth than many a modern critic. On the other hand one need not think that Christian apologists are following the course of wisdom by nailing the flag of the newer physics to their masthead. Since no matter how much you may attenuate matter, you do not in that way reach spirit. There is an infinite diameter between the dance of electrons and a sense of beauty or of purity of heart which sees God."

"After all you say of Einstein, it seems he teaches us to be critical of our own categories. We are shown the direction in which we may possess our souls with tranquillity and courage. Certain spectres which frequently obtrude themselves on the pilgrim's path, and the student's stride, such as materialism, scepticism and obscurantism, alike fade away and vanish into thin air. There comes to us a contentment and a peace that passeth understanding."

"Yes, we know that those whose frame of reference differs from ours may see things differently from what we do. Maybe they are right and we are wrong, but our right is satisfactory to us, and surely that is the main thing."

“Yes, indeed, and thank you for your patient explaining of Einstein to my student mind, for I feel with Browning:

“All that I know of a certain star,
Is it can throw (like the angled spar)
Now a dart of red and now a dart of blue;
Till my friends have said they would fain see too
My star that dartles the red and the blue!
Then it stops like a bird, like a flower stands furled;
They must solace themselves with the Saturn above it.
What matter to me if their star is a world?
Mine has opened its soul to me: therefore I love it.”