Many features of the theory had been foreshadowed by other workers. In Einstein's intensely original presentation, these features fell into place in a system based upon a single principle. Moreover, Einstein saw a significance in the work that was beyond the range of vision of his predecessors. Their merit was in having so exposed the difficulties of the matters concerned that the magnitude of Einstein's achievement could the more readily be appreciated.

It was another ten years before Einstein attained what was almost certainly his greatest triumph, the theory of general relativity. The restrictions in the scope of the special theory are well known, as are also some of the considerations, particularly in regard to the equivalence of inertial and gravitational mass, that guided Einstein in removing the restrictions. He was guided also by Minkowski's geometrical formulation of special relativity. But in general relativity the geometry of space-time and what is happening in space-time are interdependent; hitherto it had been universally assumed that space-time had an independent existence. If ever any single advance may be called epoch-making, this is one that must earn the description. In whatever way physical theory may develop in the future, it cannot be believed that this step will ever be retraced. For it is easy to recognize that the behaviour of clocks, measuring-rods and light-signals must be related to the behaviour of the physical system of which they form part. It had previously been implicitly supposed that there nevertheless exists an underlying space-time that can somehow be 'explored' by the use of the measuring-rods, etc. In effect, Einstein showed the emptiness of this concept. When we consider what we call the spatial and temporal relationships of a physical system, we are concerned with aspects of its behaviour that cannot be conceived in separation from its other aspects.

It was one thing to appreciate the advance that was needed; it was another to give it mathematical expression. Einstein accomplished this in brilliant fashion in the limited domain of the 'general' theory. For he regarded this as being satisfactory only in its treatment of a pure gravitational field. He described as only 'makeshift' the way in which he introduced the matter-tensor. According to his view, in this provisional state of the theory, material bodies are essentially regions where his gravitational field-equations ($G_{\mu\nu} = 0$) are not satisfied, and so, in this sense, the bodies are singularities in the field. In 1938 and succeeding years, Einstein and his collaborators improved upon the original formulation of the theory to the extent of showing that the motion of such singularities in each other's presence is determined by the field-equations alone. Thus general relativity has no need to postulate equations of motion in addition to the field-equations, by reason of the non-linearity of the latter. However, Einstein's ultimate aim was to obtain field-equations such that actual physical systems correspond to solutions free from singularities. He believed this would be possible if, and only if, he could represent all physical forces, electromagnetic and nuclear as well as gravitational, in the theory—hence the name 'unified field theory'. If successful, such a theory would account for the existence of material particles in terms of the field and so, in the most fundamental manner that Einstein could envisage, it would reconcile these aspects of reality. In doing so, he further believed, it would reproduce 'quantum' effects, but without the need for the statistical interpretations to which he objected in current quantum theory. After various discarded attempts, he thought the field-equations which he proposed in 1949–51 to be "the most natural generalization of the equations of gravitation". Whether these equations possess solutions free from singularities has not yet been determined.

The problem of unifying the basic concepts of physics has, of course, the importance that Einstein thought. However, most physicists expect it to be solved rather by a generalization of quantum theory than by the opposite approach attempted by Einstein. His view and comments by its leading critics are to be found in "Albert Einstein: Philosopher Scientist" (edit. P. A. Schlipp, New York, 1949, 1951). Here it need only be said that Einstein's position should be judged only in the light of his doctrine of concepts as being "freely chosen conventions".

Besides the main development of his work, Einstein made numerous other important contributions. These include, for example, the 'Einstein coefficients' in connexion with atomic transition-probabilities, his work from which the Einstein–Bose statistics emerged, and his enunciation of the 'Einstein universe' and other contributions to relativistic cosmology.

Einstein was deeply and increasingly concerned about world affairs. In the First World War he took a courageous stand as a pacifist in Germany. However, he could not but approve of the war against Nazism, and in 1939 he sent a historic letter to the American President warning him that Germany might succeed in manufacturing an atomic bomb. He became a leading spokesman for Jews throughout the world, particularly in regard to their return to Palestine. He was for long an advocate of world government. His opinions on these matters and his attitude towards philosophy and religion are expressed in the collection of essays "Out of my Later Years" (New York and London, 1950).

Einstein's gifts inevitably resulted in his dwelling much in intellectual solitude. While he was not sociable in the usual sense, he had a penetrating understanding of his fellow-men. Music played a great part in his life, and the satisfaction it gave him he gladly shared with his friends. The many tributes paid to his personality all testify that his moral stature matched his intellectual pre-eminence.

W. H. McCrea

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My first contact with Einstein was at the eighty-fifth meeting of the German *Naturforscherversammlung*, held in Vienna in September 1913, when I was a postgraduate student in the Radium Institute there. In his usual attractive and friendly manner, he lectured to the Physics Section on "Gravitation", and his lecture quite obviously impressed most of his hearers as the work of a master-mind. But it was clear in the discussion which followed that many German-speaking men of science were not yet converted to his ideas. Doubts were expressed on the validity of his views on the equality of inertial and gravitational mass, on the velocity of propagation of gravitational processes, on the possibility of ever being able to detect the deflexion of light rays in a gravitational field or the predicted red-shift of spectral lines in such a field. The over-riding impression left on my mind was that the older generation was more sceptical than the younger and, indeed, several of these young men, then in their

twenties, later became distinguished workers in special and general relativity. But throughout the discussion Einstein remained smilingly unperturbed and said he was prepared to stand or fall by the results of an empirical examination of his predictions. He had not very long to wait, for when I translated his popular work on "Relativity" in 1920, I suggested to him that he might like to include an appendix on the experimental confirmation of the theory and he immediately agreed, there being already much experimental evidence available in his support.

Having finished one piece of work, he rarely returned to it, preferring to investigate fresh fields. Once the original proofs of his popular book were sent to press, I think it unlikely that he ever re-read the text, contenting himself with adding new appendixes, the last of which appeared two years ago. Thus it was that a statement in the early editions, about the impossibility of testing empirically his mass-energy relation, remained uncorrected until two years ago, when, during proof-reading, I noted the oversight and was able to add a supplementary note to the relevant chapter.

His world-wide but unsought fame undoubtedly reached its zenith with the confirmation of his predicted gravitational deflexion of light rays by Eddington and others in 1919. This news caught the popular imagination and was a pleasant change from news of war. His first comments in Britain on the results of the solar eclipse expeditions were published at the request of *The Times*, rather than in a recognized scientific journal. Referring to this in a letter to me, he wrote: "It cannot do any harm, for, thank God, the solar eclipse and the theory of relativity have nothing in common with politics. In this work, English men of science have behaved splendidly throughout, and to my delight your letter shows me that the feelings of English colleagues have not been influenced as much by the war as one might have feared. Within the last few days I have had also from Eddington a very charming letter, about which I have been extremely pleased. I should like to utilize the favourable circumstances to contribute as much as possible towards the reconciliation of German and English colleagues". (My translation.)

I had been a civilian prisoner in Vienna throughout the First World War, but was allowed to continue my scientific work unhindered. Referring to this, Einstein wrote: "Your two letters have given me great pleasure and particularly the news that our Viennese colleagues treated you in such a friendly manner during the war". My next meeting with him was immediately after his lecture on relativity at the University of Manchester in 1921, when I had the pleasure of driving with Prof. and Mrs. Einstein and Dr. Erwin Freundlich in the environs of the city.

ROBERT W. LAWSON

# NEWS and VIEWS

## Linnean Gold Medal :

### Sir John Graham Kerr, F.R.S.

THE award of the Linnean Gold Medal on May 24 to Sir John Graham Kerr has given great pleasure to a wide circle of colleagues and former students who have had the benefit of his stimulating and original personality, and also to a much wider circle of naturalists throughout the world. Sir John is one of the last of the great zoologists of the beginning of this century, who seemed to possess an almost encyclopædic general knowledge of the subject, as well as being a specialist in one or more branches. He started his career as a naturalist in the Linnean and Darwinian tradition, by joining an expedition to the Pilcomayo region of the Gran Chaco, Paraguay, during 1889–91. The years following this expedition were spent at Cambridge, where the School of Zoology then occupied an unrivalled position as a centre for the study of comparative morphology and embryology. He joined Christ's College as a scholar and after taking his degree carried out a second expedition to the Gran Chaco—during 1896–97—to study the little-known lung-fish, *Lepidosiren*. The account of these two famous expeditions—"A Naturalist in the Gran Chaco"—was only published in 1950 and has been described as the best book about South America since Charles Darwin's "Voyage of the Beagle". He was appointed regius professor of natural history in the University of Glasgow in 1902, when the chair still included geology—which, however, became distinct in the following year. He held the chair for thirty-three years and built up a great Department of Zoology and a very fine museum in which the exhibits were beautifully displayed on black backgrounds with indirect lighting. During these years, apart from his numerous publications and text-books, he took an active part in public affairs and became chairman of the Glasgow Unionist Association and afterwards represented the Scottish Universities as M.P., 1935–50. He originated and communicated to the Admiralty in September 1914 the scheme for the protective coloration of ships by counter shading and strongly contrasting patches ('dazzle') based on his observations in the field.

The president of the Linnean Society, Lieut.-Colonel Seymour Sewell, in presenting the Medal, recalled that when he entered Christ's College, Cambridge, fifty-six years ago, Sir John was then a Fellow of the College and demonstrator in the Department of Animal Morphology, and he also referred briefly to the many distinctions of "the doyen of British zoologists". The Medal was received on behalf of his father by Mr. Ronald Graham Kerr, and the meeting expressed its deep sympathy with Sir John in his blindness, which prevented his attendance, and also their warm affection for him, both as an eminent scientist and Fellow of the Society, and a personal friend of long standing.

## Applied Geophysics at Imperial College of Science and Technology, London :

### Prof. J. McG. Bruckshaw

As part of the expansion programme of the Imperial College of Science and Technology, London, an entirely new Department of Applied Geophysics has been established in an extension of the Royal School of Mines, where it will function in appropriate juxtaposition to the Departments of Geology and of Applied Geochemistry. In charge of the new Department will be the first occupant of the recently instituted chair of applied geophysics, Prof. J. McG. Bruckshaw, who has been largely responsible for instruction and research in geophysics within the