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SIR JOSEPH LARMOR AND MODERN MATHEMATICAL PHYSICS

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SIR JOSEPH LARMOR, MATHEMATICAL PHYSICIST

ON May 19th last the scientific world lost a notable mathematical physicist, Sir Joseph Larmor, Lucasian professor of mathematics at Cambridge, England, from 1903 to 1932, successor to Sir George Stokes in this celebrated chair once held by Sir Isaac Newton. After being graduated from Queen's College, Belfast, Larmor took highest honors in the Cambridge Mathematical Tripos of 1880 at about 23 years of age, J. J. Thomson being second wrangler in the same year. Larmor was called at once as professor of natural philosophy to Queen's College, Galway, where he remained until 1895. He then returned to St. John's College, Cambridge, as lecturer, and was named for the Lucasian professorship in 1903. From 1901 to 1912 he was secretary of the Royal Society, and was awarded the Copley Medal of the society in 1921. Always deeply attached to his native country, Ireland, he entered Parliament in 1911 as Unionist representative of Cambridge University and served there for eleven years. He received various distinctions besides those mentioned.

Larmor grew to scientific maturity at a time when every attempt was being made to explain all physical phenomena on a dynamical or at least a quasi-dynamical basis, involving the concepts of absolute space (the ether), of absolute time and simultaneity, of mass and force, characteristic of the Newtonian era of physical speculation. Larmor was already forty-three years of age when Planck in 1900 propounded his revolutionary idea of quanta of energy, destined to modify profoundly the current of physical ideas. In 1905 Einstein formulated his justly celebrated special theory of relativity, which was equally subversive of accepted classical ideas.

Up to that time Larmor and his great compeer, the Dutch mathematical physicist, H. A. Lorentz, were both well in the van of the group attempting to reconcile current dynamical and electrodynamical theories, and in particular to explain the null effects of the famous Michelson-Morley experiments of 1887 and other attempts to ascertain the absolute motion of the earth in space. It had occurred somewhat earlier (around 1892) to another noted Irish mathematical physicist, Fitzgerald, as well as to Lorentz, that there might occur a minute contraction of length in the direction of motion, often called the "Fitzgerald-Lorentz contraction," which would explain such null results. But it was Larmor who, working independently in the same circle of ideas, began to undertake a thoroughgoing mathematical study of the whole situation involved.

The outcome was his great book "Aether and Matter" of 1900, which was perhaps his crowning achievement. As he states in the Introduction, "a complete formal correlation is established between the molecular configurations of a material system at rest and the same system in uniform translatory motion, which holds good as far as the *square* of the ratio of the velocity of the system to the velocity of radiation. This correspondence carries with it as a consequence the null result, up to the second order, of the very refined experiments of Michelson and Morley. . . ." Beyond the second order of this velocity ratio, Larmor was not much interested, since such small effects would be well outside of the range of experimental determination. Indeed, the whole spirit of the work, in a mathematical sense, is extremely close to that of Einstein's later special theory of relativity of 1905, as the above quotation sufficiently shows, even if the concept of the ether as a particular frame of reference is employed.

Larmor goes so far in this book as to speculate concerning the explanation of gravitation from the same point of view. In a section with the title "Are the linear equations of the Aether exact?" (p. 186), he asks boldly: "Why then should not relatively minor phenomena like gravitation be involved in similar non-linear terms . . . in the analytical specification of the free aether . . .?" At the end he concludes somewhat in favor of the "natural prepossession" that the equations are truly linear, and so against his own extremely interesting suggestion.

The now familiar complete ("relativistic") form of the ponderomotive forces of the electromagnetic field and the corresponding Lorentz (or Larmor-Lorentz!) transformations are used in this notable work. This was essentially completed in 1898 (see the Preface). It was not until the end of 1903 that Lorentz's important article on electromagnetic theory in the German Mathematical Encyclopedia appeared. In his later article on "Relativity" in the Encyclopedia (1920), Pauli has stated the case thus (section 1, my translation):

Now it became important to work this ''Lorentz-contraction'' organically into the theory, and also to clear up the other negative attempts to find an influence of the earth's motion upon phenomena. Here Larmor is to be mentioned first, who already in 1900 set up the formulas now generally known as the Lorentz transformation, and thus also had in view the variation of time-measurement. Lorentz's comprehensive article which was finished at the end of 1903, added some brief comments, which were to show themselves later very fruitful. . . .

Larmor himself has said a generous final word of appraisal on this question of priority. (Appendix II, (1927) "On Relativity and Convection," Vol. 1, Mathematical and Physical papers (1929)):

This transformation was developed for the complete scheme of the electric equations of the field . . . in *Aether and Matter* (1900), Chap. XI, but only up to the second order of v/c; being so restricted on the tacit ground that the finite size of the electrons . . . must in any case introduce uncertainty beyond the order of 10^{-10} [cm.]. . . . This complete scheme for the electromagnetic field *outside the atomic sources* was obtained in exact form independently by Lorentz (1904) . . .; and the correspondence leading to it is appropriately called by his name as having been the initiator . . . in 1892.

Under the impact of the radical new theories, Larmor refused to abandon without further consideration the classical point of view which had served so well. He had realized very clearly how dynamics and electrodynamics were united deeply by means of the Principle of Least Action of Lagrange and Hamilton to which he always attached the greatest importance. However, there was a definite difference between his apologetic attitude for his lack of active mastery of quantum mechanics and its spectroscopic applications, and his repugnance, not so much towards relativity as for the setting in which it had been presented. Regarding the first, he says in the Preface to the second volume of his Papers: "the modern constructs in the problems of quantified spectroscopy . . . highly successful in their special fields . . . have hardly been entered upon [by himself], because the vast and tentative literature could not be justly appreciated except by a critic closely cognizant of the diverse evolutions of the last fifteen years in this field of knowledge." But, regarding the second, he speaks of special relativity as follows in the Appendix quoted above: "All convection, uniform translatory motion [in free, *i.e.*, empty aether], would then be indeterminate, there being no standard frame in which to locate it . . .: it in no way discredits the theory of an aether, unless the intrinsic atoms of matter can be abolished also." Larmor characterizes Einstein's postulate of relativity as an "algebraic correspondence," "masquerading in the language of kinematics." The second gravitational theory of relativity of Einstein (1915) is epitomized as an "auxiliary construct," while "the absence of space and time and motion in the auxiliary construct is against reality."

It is distinctly interesting to observe that although Lorentz followed the brilliant new theories with all attention and determination, yet there remained in his mind vestiges of similar feelings. Thus he states in his Leyden Lectures 1910–12 (Silberstein-Trivelli's translation): "If we do not like the name of the 'aether' we must invent another name as a peg on which to hang all these things," and "can not deny to the bearer of all these properties a certain substantiality; and if so, then one may in all modesty call true time the time measured by clocks which are fixed in this medium and consider simultaneity a primary concept."

One may sympathize with, and admit the accuracy in detail of Larmor's position in regard to the relativistic theories: it is true that the work of Fitzgerald, Larmor, Lorentz and Poincaré had shown the special theory of relativity to be "just around the corner"; but it was only Einstein who grasped the significance of the actual situation. It is likewise true that the general theory of relativity of 1915 has not effectively entered into physical speculation; yet this second achievement of Einstein has also exerted a considerable influence on the course of physical thought. In fact it has been Planck and Einstein together who have broken the magical spell which the classical concepts of Newton had cast over scientific and philosophical thinking.

Larmor's mathematical-physical contributions extend over the entire classical field. His papers are extremely thoughtful and always repay careful reading. In the field of electromagnetism his contributions have been especially influential. Larmor's formula for the rate of radiation of energy from an accelerated electron is well known to all physicists, and the dispersion formulas due to him and Lorentz have been very useful.

When occasion required, he brought in subtle mathematical considerations, and always had the greatest appreciation of purely mathematical work. Indeed a number of his papers are essentially mathematical in character. His Presidential Address of 1916 before the London Mathematical Society, "The Fourier Harmonic Analysis and its Scope in Physical Science," shows a deep intuitive insight into the nature of these remarkable series, and a wide knowledge of their extremely varied applications.

Larmor was a well-known and much valued figure at International Mathematical Congresses, being a participant in the Rome Congress of 1908 and the three succeeding congresses at Cambridge, England (1912), at Strassbourg (1920) and at Toronto (1924).

The unmistakable impression which one gathers from his activities and writings, and from accounts by those who have known him, is that of a life of absolute sincerity and of unselfish devotion to the highest ideals, scientific and personal. He had a deep sympathy with younger people as witnesses, for example, his bequest to the University of Cambridge for medical and surgical assistance to the younger members of the faculty.

His own attitude is clearly revealed at the end of the first part of his Presidential Address, referred to above, where he tries to look forward in the midst of the First World War to "the promise of nobler and more disinterested times." Perhaps, in the midst of the second World War, we could not close in any way that would be more in accord with his outlook upon life than in voicing, as he did, the hope expressed by Shelley:

> The world's great age begins anew,
> The golden years return,
> The Earth doth like a snake renew
> Her winter weeds outworn.
> . . . . .
> A brighter Hellas rears its mountains
> From waves serener far,
> A new Peneus rolls his fountains
> Against the morning star.

WHAT MORE CAN ENGINEERING COLLEGES DO THROUGH ESMWT?[1]

By Dean GEORGE W. CASE

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This topic is stated as a question. In line with the policies established since this program began, the effort will be to furnish information that may be useful to the institutions in answering the question

[1] Address at the fifty-sixth annual conference of the Association of Land-Grant Colleges, Chicago, October 28, 1942.