EBENEZER CUNNINGHAM

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Ebenezer Cunningham, mathematician and teacher of mathematicians, one-time Britain's leading relativist, dedicated college man, family man and churchman, and steadfast witness for the faith that was in him died on 12 February 1977 in his 96th year. He was then the senior member of this Society and doubtless of most other associations to which he belonged; he had been Senior Fellow of St. John's College since H. F. Baker died in 1956; he was the last surviving un-bracketed Senior Wrangler; his eminence in relativity theory had been so long ago that scarcely anyone remembered it; even his Chairmanship of the Congregational Union of England and Wales had been nearly a quarter of a century past.

In his 90th year Cunningham composed a concise autobiography [35] of some 200 pages of typescript. It is a well-ordered narrative of a life of rich and varied experience, but it contains little in detail about mathematical and scientific concerns. Inevitably, it forms the general basis for the biographical part of this notice; where I have made quite direct use of it I give the page number of the typescript.

Ebenezer was born on 7 May 1881 in Hackney, the second son of George and Fanny Caroline Cunningham. The father was a cabinet-maker, with his own workshop and showroom, until he was driven out of business by the competition of mass-production factories; the mother was a daughter of James (?) Dorrington who had been a reporter in the House of Commons. Their eldest son was Dr. George D. Cunningham (1878–1948) City Organist and University Organist in Birmingham, and one-time President of the Royal College of Organists; the youngest son was Charles H. Cunningham (1883–1955) successively of the School Board for London, of the Education Officer's Department, and of the Public Health Department in the LCC, who was leader of a madrigal quartet known as St. George's Singers. It was a remarkable flowering of talent in a family of no recorded previous intellectual pretensions; in particular, there was no known connection with another prominent member of the Society, Lt.-Col. A. J. C. Cunningham (1842–1928).

Cunningham was educated at a dame-school, a Board School and at Owen's School, Islington (Headmaster "Jimmy" Easterbrook). He entered St. John's College in October 1899 with a Major Scholarship in Mathematics, an LCC Scholarship and an Owen's Exhibition. In his last year at school he mastered sufficient Latin and Greek to pass in these compulsory subjects of the Cambridge "Little-go" examination. His College lecturers in mathematics were H. F. Baker, J. Larmor, J. G. Leathem and R. Pendlebury (soon succeeded by T. J. I'A. Bromwich). Baker was his director of studies and he coached with R. R. Webb, also of St. John's, the last of the famous Cambridge coaches.

Cunningham records that he worked 6 to 7 hours a day for 6 days a week. He led a regular and active life, his chief relaxations being choral music and rowing. He had a quite successful and unusually long career as an oarsman, finishing with places in the Lady Margaret first Lent boat and second May boat in 1904. An oar which he won in 1902 now hangs just outside the Senior Combination Room in the College.

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EBENEZER CUNNINGHAM (1881–1977)

He had a fine physique with an erect bearing that he retained into his nineties. He was a total abstainer from alcohol.

While an undergraduate, he developed ways of life that endured to the end. In particular, his undergraduate years 1899–1902 were those of the Boer War. Cunningham found himself opposed to this particular conflict, and thereafter he became a lifelong Christian pacifist, a circumstance that naturally profoundly affected his career, which spanned the two World Wars. Also right from the start of his Cambridge residence, Cunningham was associated with Emmanuel Congregational Church which came to play a great part in his life for the next 70 years. In deep matters of faith, Cunningham held firmly to well-tried ways, but in many applications he was an independently-minded non-conformist, but again in the ordinary conduct of life he had due regard, and even a taste, for convention and tradition.

Cunningham was Senior Wrangler in 1902 which turned out to be the start of a remarkable run of years for this distinction: 1902 Cunningham, 1903 H. Bateman, 1904 A. S. Eddington, 1905 J. E. Littlewood and J. Mercer bracketted. Nevertheless, Cunningham's career illustrates how intellectually self-contained the Cambridge colleges were before about the 1930's. He seems to have had little personal interaction with Eddington (Trinity) who in due course took his place as the British oracle on relativity. And a short-lived collaboration with Bateman (Trinity) resulted from their being thrown together in Liverpool, not in Cambridge.

Cunningham proceeded to work for the Smith's Prize, but very soon after he obtained results that he might have submitted, he found they had just been anticipated in a French journal [**35,** p. 25]. However, he began afresh and wrote an essay on matrices which gained a Prize in 1904. Later that year he was elected to a Prize Fellowship at St. John's. Meanwhile he had gone in October 1904 to Liverpool University as a Junior Lecturer in Mathematics under Professor F. S. Carey, but his Fellowship enabled him to spend parts of the vacations in Cambridge.

At that stage Cunningham seemed to be set on devoting himself to the sort of mathematical analysis that interested H. F. Baker before he turned to geometry. But then, as he records, " . . . a major element came into my mathematical work which gave me much thought and work for several years ". This was the theory of relativity, or special relativity as it came to be called after about 1916 following the publication of Einstein's general relativity. He says it was by accident that he found himself " involved in the early stages of the coming of this new element in science ". [**35,** pp. 27–29] During his fifth year in Cambridge he had read Larmor's book *Aether and Matter*, which had in many ways prepared the ground for the coming of relativity. Then in 1905 he " came across " what he describes as a " short contribution by someone called Albert Einstein which threw new light on the whole affair ". This can only have been Einstein's famous paper " On the electrodynamics of moving bodies " in *Annalen der Physik* 17, 1905. With his background of Larmor's book and his serviceable knowledge of German, Cunningham must have been about the first English-speaking scientist to master this paper. When in retrospect he thought of it as a " short contribution " this must have been because he came to see Einstein's work on special relativity as just one episode in the complex progress from Fresnel and Fizeau, Michelson and Morley and others on the experimental side, and Maxwell, FitzGerald, Lorentz, Poincaré, Larmor and others on the theoretical side, down to his own time. Over the next several years, Cunningham made significant mathematical contributions to the development of (special) relativity, and he gave some general non-mathematical expositions. All this led in 1912 to a request from the Cambridge

University Press that resulted in their publishing in 1914 *The Principle of Relativity* [31] the first treatise on the subject in English. Also in 1913 Longmans, Green and Co. asked for a book in *Monographs on Physics* edited by J. J. Thomson and F. Horton. This was first published in 1915 as *Relativity and the Electron Theory* [32] and was followed in 1921 by a second edition under the revised title *Relativity, the Electron Theory and Gravitation* [33]. The addition of " gravitation " was in order to cover the inclusion of an introduction to Einstein's general relativity which had been published in Germany in 1916 in the midst of World War I.

While in Liverpool Cunningham helped to start a University Settlement for social work in a slum area. The second Warden with whom he worked was F. J. Marquis, the future Lord Woolton, Minister of Food in World War II. Then in 1907 the Liverpool appointment lapsed, and Cunningham moved to a more senior post with Professor Karl Pearson in the Applied Mathematics department of University College, London (UCL) where he remained for the next four years. During this time, he married in 1908 Ada, daughter of W. J. Collins, a well-to-do builder of Ferne Park in North London. Their happy partnership of 61 years was obviously a paramount influence in Cunningham s life.

In August 1911 H. F. Baker personally conveyed to Cunningham the invitation of the Council of St. John's to return to the College as mathematical lecturer and Fellow. With leave of absence 1915–18, he held the lectureship until 1926, when he transferred to a University Lectureship which he held until he retired in 1946; he remained a Fellow for the rest of his life. To start with, his mathematical colleagues were Baker, Leathem and Bromwich, with Larmor and Webb still in residence. Owing to various changes, however, by 1914 Cunningham was left alone, with J. H. Grace of Peterhouse giving temporary help.

With professional aid and advice from Ada's family, soon after moving to Cambridge the Cunninghams built the house " Wayside " at the corner of Huntingdon Road and Storey's Way where he lived until 1975, and where together they dispensed warm hospitality to innumerable members of the University, as well as very many visitors to Cambridge.

The 1914–18 War made the greatest interruption in Cunningham's academic career, although compared with the experience of other academics in both World Wars he may appear to have suffered no great upheaval, with little separation from his family. In 1915 he was called up for compulsory military service; having been granted leave of absence from his College post, he appeared before the appropriate Tribunal in Cambridge and declared that, as a Christian, he could not take part in war in any capacity. However, he did desire to serve his country and he had an offer of employment as a master in a Cambridge school. The Tribunal ruled that he would not be allowed to teach, but must find work growing food. He then had two spells of working on the land, with an interval in an office at the Y.M.C.A. in London. At the end of 1918, he was able to return to Cambridge, and most of the Fellows of St. John's seem to have been friendly in the way they received him back to his old position.

While he was away from Cambridge, Cunningham evidently made some attempt to keep up with what was becoming known outside Germany about the development of general relativity, but with limited success. His attempt to give lectures on it after his return proved abortive. He did write some non-technical descriptions of general relativity and some reviews of other people's books; also, as mentioned, he incorporated some account of general relativity into the second edition of his smaller book. Even though he was still only forty when this appeared, it was almost the last scientific

work he published. The mathematics of general relativity offered no difficulty to Cunningham, but from slight hints in his writings, I think he may have had doubts as to whether the physical results were an adequate return for the mathematical elaboration. And I think he had justifiable doubts about the validity of some of the physical interpretations of the mathematics. Anyhow, for the topics of his lectures thereafter he preferred to keep to applications of the sort of mathematical physics he had himself helped to develop in the past.

While continuing his mathematical teaching with enthusiasm, Cunningham now embarked upon a new career as a College officer in various capacities. In 1921 St. John's College appointed him one of the four Tutors—work for which he was clearly well-suited—and Tutorial Bursar as well. But the College then had second thoughts, being persuaded, as he was given to understand, that it was not to its advantage to have a wartime conscientious objector as a representative in dealing with the schools of potential entrants. So in 1923 Cunningham unselfishly agreed to become Steward instead of Tutor; he then held both posts of Tutorial Bursar and Steward until 1935, being responsible for the office dealing with undergraduate accounts, for the kitchen and for the grounds. With bland mixing of metaphors, in taking up his duties he called himself " a new broom, not steeped in tradition and rather given to planning " [35, p. 79]. Obviously, he discovered a flair for such work and within the space of about five years he had overhauled and modernised, in organisation and equipment, the entire working of his domain.

A problem looming large at an early stage was of cockroaches that infested the College kitchen. These were alleged to be of an Asiatic species which had arrived in England in the time of Elizabeth I; Cunningham's predecessor as Steward, the zoologist H. H. Brindley, had resisted their extermination because he said they constituted a unique strain of the species. But now their fate was sealed—never can any army of insects have been annihilated by a more ruthless and distinguished adversary than this pacifist Senior Wrangler. Later, about the time of his retirement from his lectureship, he was persuaded to hold office as Junior Bursar for the two years 1945–47. He had then to organize the entire re-roofing of the Library building of 1624, to repair the ravages of the death watch beetle, followed by the re-slating of the Chapel roof, to repair the ravages of the weather. All this administrative work was superlatively well done. But Cunningham admits that it " for some years came between me and any freedom to follow up and keep abreast of the extremely rapid advance of science " [35, p. 73]. These were the years of the coming of quantum mechanics and of the beginnings of modern astrophysics and cosmology. It cannot be in the best interest of a great College to have one of its most distinguished members devoting his talents to a welter of routine chores. One ventures this comment without suggesting an apportionment of responsibility in a particular case; also one supposes that such a case is less likely to happen now—but that it is avoided only by increasing still further the sum total of administrative officers.

Cunningham is remembered in St. John's College also for what Sir Harold Jeffreys calls his " wonderful Chairmanship at the time of the election of the present Master ". This task fell to him as Senior Fellow when he was 88 years of age. Earlier in life, he had served for many years as Treasurer of the Lady Margaret Boat Club.

Cunningham's Christian faith was the mainspring of all he did in life. It found outward expression in his membership of the Congregational Church to which he gave a lifetime of service. There was, besides, from 1933 until about 1940 a spell during which he and his wife became much involved in the activities of the Oxford Group,

later the campaign for " Moral Rearmament ". This had much influence upon their relationships with other people, particularly those with whom they were drawn to share their experiences, sometimes at Group meetings in various places in Europe. When in 1939, not long before the outbreak of World War II, they went to Berlin for their son's wedding, it consequently happened that Cunningham was in a position to have talks with several influential people and some leading sufferers under Nazi oppression. In this way he made what contribution he could to international understanding. Soon afterwards contacts made in the Group led to the Cunninghams' visit to Canada and the United States where Group members spread across the continent gave them enthusiastic welcomes. However, Cunningham began to feel some conflict between attitudes of people he was meeting in this way, especially towards the War, and some of his own deepest convictions. He quietly withdrew from the Group, expressing himself as " still grateful for many things I learned from it " [**35,** p. 104]. In due course his innumerable services to his own Church culminated—a rare honour for a layman—in a year of office from May 1953 as Chairman of the Congregational Union of England and Wales. As such he was one of the four representatives of the Free Churches in the Procession of Entry at the Coronation of Queen Elizabeth II. During the next twelve months his duties took him far and wide in England and Wales. And after that he journeyed to Moscow and Leningrad as a member of a small group, led by Canon Charles Raven, invited by the Patriarch of All Russia in the Eastern Orthodox Church.

Although Cunningham seems never to have travelled abroad for scientific meetings, he and his wife made a number of trips for various other reasons. In particular, he took some months of sabbatical leave in 1939–40, which they spent on the extended journey round North America already mentioned, He took the opportunity to visit A. N. Whitehead at Harvard and Einstein at Princeton. This was his only personal contact with Einstein, and they discussed world affairs, not relativity [**35,** p. 114].

The Cunninghams celebrated their diamond wedding in 1968. Ada died the following year. Their devoted housekeeper then looked after Ebenezer until 1975. It was when she died that he left Cambridge to stay with his family until his death nearly two years later.

As a man, Cunningham was considerate and unassuming, and right to the end those whom he met seemed to fall under the spell of his warm and caring friendship. He took trouble to understand other people's problems and as a result he was able to give wise counsel for which many are lastingly grateful.

His elder child Barbara, who read Medicine at Cambridge, is the wife of Professor R. C. Browne of the University of Newcastle upon Tyne. His son Morris, who read Moral Sciences at Cambridge is the Principal Clinical Child Psychologist at the Crichton Royal Hospital, Dumfries. There are seven grandchildren, all with high professional qualifications in science, medicine or nursing, several being gifted musically, and there are (1977) six great grandchildren.

Teaching

At UCL Cunningham did all the teaching of conventional applied mathematics to the honours students, since Karl Pearson chose to devote himself to mathematical statistics. In retrospect, he saw in his teaching in Liverpool, London and Cambridge, in his earlier years as a lecturer there, " an increasing desire to present the major studies of Mechanics and of Electromagnetic Theory as an organic growth, having in

itself the essential quality of beauty . . . and it was the continuous search for further beauty in truth that led me on to the Principle of Relativity . . ." [**35**, pp. 42–43]. This was a theme upon which he enlarged in an address on " Mathematics and Morals " in 1926 to a joint meeting of the Adams Society and the Girton Mathematical Society held at Girton College [**27**].

Later on in Cambridge, Cunningham lectured also on Lorentz electron theory, without which it was scarcely possible to appreciate the developments then taking place in quantum theory and its applications, on the Born theory of crystal structure, on radio antennae, and so on. I attended some of these courses in the 1920s. It was a time when nearly all mathematical lectures to undergraduates in Cambridge were badly presented, but Cunningham's were much clearer and better-prepared than most. In particular, Dr. F. Smithies remarks that " Cunningham's lectures on mechanics were the first I ever heard that presented the subject, and in particular its fundamental concepts, as a logically coherent structure ". Also in my time he seemed to be the only one who interjected the occasional comment on the significance of what he was doing and on topics calling for further study.

For instance, it was in his lectures that I first heard raised explicitly the question as to why we adopt *retarded*, and not *advanced*, solutions of the equations of electromagnetism, a problem that has been discussed repeatedly in more recent times. I am told that he subsequently produced an ingenious suggestion that, since there is no distinction between retarded and advanced solutions for a purely static system, one should be able to obtain an unambiguous treatment of any system by regarding it as having been derived by appropriate operations from an initial static state. Apparently he claimed that this does lead to the orthodox results.

Cunningham had a long line of pupils of high distinction including, at UCL, E. N. da C. Andrade, (Sir) Frank Engledow, G. B. Jeffrey, and at St. John's, (Sir) Edward Appleton, (Sir) John Cockcroft, P. A. M. Dirac, S. Goldstein, (Sir) James Grigg (of Churchill's wartime Ministry), (Sir) Harold Jeffreys (his successor as Senior Fellow), (Sir) Nevill Mott, M. H. A. Newman, R. O. Redman, L. Rosenhead, F. P. White, besides many members of other Colleges who went to his lectures. Despite the stimulus of these gifted men, Cunningham confessed that his main interest was in presenting the beauty and order of classical mathematical physics to students of any grade from whom he got a response, and he had special pleasure in supervising students, both of mathematics and of natural science, in small groups.

Mathematical work

References are to the publications listed. The most substantial single paper Cunningham wrote [**3**] is presumably mainly his Smith's Prize essay. It deals with a set of n linear differential equations of first order, equivalent to one linear equation of order n, and their solution in matrix form, the matrix elements being power-series in the independent variable. As he presented it, it is mainly an exercise in matrix algebra, which he handled with formidable mastery. In a short note [**1**] he showed the invalidity of a general solution to this type of problem proposed by L. Schlesinger. In [**6**] he dealt again with the linear differential equation of arbitrary order, discussing in a rather abstract manner the equation with rational functions as coefficients and its solution in the form of a definite double integral. The paper [**10**] was another on linear differential equations, but treated from a different standpoint. It resulted from Cunningham's association with Karl Pearson, who had developed a mathematical

theory of random migration. Cunningham remarked that the differential equation of central importance in Pearson's work was—not surprisingly—equivalent to the equation of heat conduction in two or three dimensions. Again not surprisingly, the eigenfunction problem was soluble in terms of Whittaker's confluent hypergeometric function. It was left to Whittaker (1927, p. 353) to appreciate this; Cunningham derived all the solutions *ab initio*, again with impressive skill.

Another topic, related to that of differential equations, which attracted the attention of mathematicians about the time concerned, was asymptotic expansions. One may conjecture that it was the topic of Cunningham's frustrated first attempt to produce a Smith's Prize essay. For amongst his early papers are two notes **[2]**, **[5]**, giving proofs of certain rather naturally expected properties of these expansions. Then he had a more substantial contribution **[4]** in which he showed that a solution of a differential equation by a definite integral may be expressed as a summable divergent series instead of an asymptotic series.

Thus within less than four years, during which he was beginning to write also on mathematical physics, Cunningham published a quite astonishing amount of pure mathematics. In association with this should be mentioned also his very significant, largely expository, paper **[16]** in which he derived all the usual results of vector calculus by what are still the " modern " methods. As someone said of his tutorials, all this work shows " the Senior Wrangler in action ". It may not break entirely new ground, but all of it shows extraordinary mathematical power. The range of his abilities is demonstrated by his writing at the same time these papers that are severely mathematical and papers on mathematical physics with emphasis on the physics. Indeed, of all the early writers on relativity he was almost certainly the one who gave greatest prominence to the experimental evidence and its historical development. At the same time he explicitly adopted the perhaps obvious but nevertheless still modern standpoint that the theory is the construction of a " mental model " and it is this which " is susceptible to mathematical treatment " and is to be tested by observation (see for example **[32,** p. 9]). His clear-mindedness on this issue in due course saved him from the fruitless discussions about whether space is *really* curved, and the like, which became fashionable in the early days of general relativity.

In his books and expository articles on relativity, Cunningham started from the classical concept of the *luminiferous aether*. He marshalled, more systematically than anyone else, the results of attempts to detect motion through the aether. He reviewed the theoretical discussions that led to the formulation of the *Principle of relativity*. In the first place this was simply the working hypothesis that it is impossible by physical experiment to detect such motion. At a suitable stage he combined this with the hypothesis of the constancy of the speed of light. The theory was guided by the electron theory of matter developed by Larmor and Lorentz. Cunningham's own contributions are more readily described under a few headings rather than by taking his writings seriatim.

Particular items. Cunningham showed that the model for a moving electron proposed by M. Abraham was inconsistent with the relativity principle. **[7]** **[9]**

His concern with electron theory naturally led him back to the famous problem of the fall of a particle, or cloud of particles, through a gas or other fluid, which was crucial for the standard methods of measuring the charge of an electron. If the particle-size is not large compared with the mean free path of a gas molecule, or if the gas is appreciably disturbed by a falling cloud of similar particles, a correction is

required to the Stokes formula for the resisting force. Cunningham [12] pointed this out, and evaluated the correction. I am informed that aerosol scientists have a standard expression known to all of these as the "Cunningham correction", which is an adaptation of his result (details in unsigned obituary *J. Aerosol Sci.*, 8 (1977) 217).

Cunningham appears to have been the first to give a correct expression for the Fresnel "dragging coefficient" for light travelling through a dispersive fluid in motion relative to the observer [32, p. 43].

General contributions. On 11 February 1909 H. Bateman and E. Cunningham read a paper to the Society on "Conformal Transformations of a space of four dimensions and the generalization of the Lorentz-Einstein principle". Cunningham published the "chief parts" of this paper [11] and Bateman (1910) published his share just afterwards. As is well known, it may be regarded as the starting point of special relativity that the equations of electrodynamics are covariant under the Lorentz group of transformations. Cunningham enquired whether they are covariant under any other group, and proved that they are also covariant under the conformal group, and no further group. He amended and extended some of the results in [15]. This topic was subsequently developed in many papers by other mathematicians (see Whittaker 1953 p. 195) and has had an abiding influence upon the development of the theory on the mathematical side; for instance, in several different papers published in the 1960s, R. Penrose cites [11] directly, generally in conjunction with Bateman (1910). However, one is not aware that it has proved to have much direct physical application.

Another general feature was a continuing preoccupation for Cunningham—the status of the aether. He tended to the view that the arguments for what he called an "objective aether" as the carrier of the electromagnetic field were not invalidated by the coming of relativity theory. So he considered that it ought to be possible to construct an aether model whose properties are relativistically covariant. In fact he achieved this with an aether that at each point moves with light-speed in a direction determined by the electromagnetic field [32, Ch. VIII] following [13]. Although this concept still appeals to some minds, it has not been shown itself to predict new observable effects, and Cunningham himself omitted it in [33]. On the other hand, present-day quantum field theory does assign properties to "the vacuum", and Cunningham may be credited with, in some sense, anticipating this requirement.

General relativity. In the preface which he wrote in June 1914 for [31], Cunningham declared, "No attempt has been made to present the highly speculative attempt of Einstein at a generalisation of the principle in connection with a physical theory of gravitation". This is interesting because (a) it shows what Cunningham thought about whatever indications he had at that time as to the nature of Einstein's general relativity, (b) it shows that he did somehow possess such indications even though the main announcement of the theory did not come until about two years later in the midst of World War I, and (c) it shows that from the outset he rightly regarded general relativity as being essentially a theory of gravitation.

It is fair to claim that Cunningham had a significant share in preparing the way for general relativity in the form in which it actually appeared. He and Bateman (and Hargreaves (1908)) were pioneers in expressing relativity theory in terms of four-dimensional space-time. Minkowski's famous presentation which is usually regarded as having originated this concept actually pre-dated the publication of their

work by a few months, although their work owed nothing to it. But Cunningham was remarkably swift to recognize the significance of Minkowski's contribution. And, although general relativity was in itself Einstein's invention, it was much more a development from Minkowski's rather than Einstein's own formulation of special relativity. In fact Cunningham [**23**] wrote (in a set of articles the first of which was by Einstein himself!) " Whether he would ever have done it without the genius of Minkowski we cannot tell."

Following the successful observational test by British astronomers in 1919 of Einstein's predicted bending of light past the Sun, Cunningham gave a long non-technical account of the theory in *Nature* [**19**] and he contributed to a Royal Society discussion. Then, when his smaller book was re-issued in 1921, he included as the second half of the new edition [**33**] a sketch of general relativity—an account showing much grasp and insight. For a year or two longer he was in demand as a reviewer of writings on the subject in the spate that then appeared. Scattered through these contributions Cunningham had a number of penetrating critical comments and queries which are pertinent to this very day. For instance, he had a rather inconclusive exchange [**25**] [**26**] with Eddington (1922) as to how the fundamental tensor in a region of space-time can be determined by observation. As a general matter of formulation, he seemed to think that world-lines rather than events should be treated as the fundamental elements of space-time—some people still do, and wish they knew how. Naturally too, he took very seriously the deficiency of general relativity in not accommodating electromagnetism. In regard to a more particular feature, Cunningham criticised the usual prediction of the gravitational redshift of a spectral line for not taking explicit account of the way in which the emitting atom is supported against local gravity; almost all text-book accounts are even still deficient in this respect.

Having this occasion to look at Cunningham's writings on relativity after so many years, one comment on the history of the subject should not fail to be made. Whittaker (1953) has often been taken to task by modern workers for presenting special relativity in his monumental *History* as " The Relativity Theory of Poincaré and Lorentz ", and for thus denying preeminence to Einstein. But in Cunningham's writings we have a contemporary account of the subject as he found it and as he sought to contribute to it. This account shows how the body of physicists at the time had in fact arrived at all the essentials of the theory of special relativity without reliance upon Einstein. Even though Cunningham has recorded that his interest in the subject was stimulated when he " came upon " Einstein's paper of 1905, it is clear that he did not come to regard special relativity as predominantly Einstein's theory. The evidence of Cunningham's writings shows that Whittaker recorded history as it happened, and not as a later generation thought it ought to have happened.

As already stated, Cunningham's immersion in College business sadly brought this impressive record of scientific productivity to an untimely close. It is said that he was generous in helping others even if he lacked opportunity to publish anything himself. For instance, in the Appleton Room of Edinburgh University are preserved several letters he wrote during 1926–27 to E. V. Appleton in which he developed the mathematics of the propagation and polarization of radio waves traversing an atmosphere with non-uniform ionization [**34**]. Another service he performed for mathematics was to be from 1920 to 1937 joint Editor with G. H. Hardy of the *Cambridge Tracts in Mathematics;* his name appears on *Tracts* No. 21 (1927) to No. 37 (1937).

When his great teacher, Sir Joseph Larmor died in 1942, Cunningham wrote a well-informed notice for this Society [**29**]. He characterized Larmor as " A deeply

honest thinker, with wide interest in the world at large, never seeking publicity, but winning respect always for his judgement and his directness." No words could better describe Cunningham, the academic, himself.

Cunningham was elected into the Society in 1905 and served on the Council 1909–12, 1913–15. Mr. Morris Cunningham and Mrs. R. C. Browne (née Barbara Cunningham) have supplied me with invaluable personal information. Sir Harold and Lady Jeffreys and Dr. Frank Smithies of St. John's College obtained the list of Cunningham's writings and other essential particulars. I am grateful to all of these for much help and especially for their care in reading and commenting upon a draft of this notice. Sir Harold Jeffreys (1977, a, b) has himself written two notices. The Record Keeper for the Director-General of the GLC has kindly supplied information about C. H. Cunningham.

Writings of Ebenezer Cunningham

At least one published bibliography of relativity confuses Cunningham with a quite different contemporary author with a somewhat different name, while *Poggendorff Bibliographisch-Literarisches Handworterbuch* Vol. V 1904–1922 lists writings, all of which are by Ebenezer Cunningham, under "Cunningham, Elmer T.", as the Librarian of the Royal Astronomical Society has noticed.

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