PHYSICS AND PHYSICISTS IN THE UNIVERSITY OF ADELAIDE THE FIRST SEVENTY FIVE YEARS

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[No date]

Preface by Keith Briggs

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`Keith.Briggs@bt.com` 2008 December 30 11:51

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Contents

During this year of 1974 the University of Adelaide has been celebrating its centenary. Having been associated with an attempt to organize an exhibition of the work of the Physics Department over this period I have been persuaded to write a short account of its achievements. Realizing that this essay will fall far short of the scope and elegance of the product of an historian, I hope, nevertheless, that this story will be of interest to physicists and perhaps do something to stimulate an interest in the proper preservation of historical material. When one comes to attempt something of this kind it is sad to find how little effort has been made in the past to care for such records and equipment even when associated with persons of the highest distinction, let alone those lesser mortals who have, nevertheless, made their contributions to the growth and traditions of what ought to be among our most respected institutions.

Throughout most of the period under review the Professors of the University were singularly exalted personages about whom lesser luminaries moved as satellites, not infrequently undergoing total eclipse. In Sir William Mitchell's phrase "the professors were the University". For this reason, and because it is convenient, this account will be presented in terms of the incumbencies of the first three Professors of Physics.

1 HORACE LAMB 1849 - 1934

The University of Adelaide was founded in 1874, and with a gift of £20,000 from W. W. Hughes, and a similar sum from Thomas Elder, established its first chairs. Hughes's donation was devoted to the founding of two Professorships, one for Classics and Comparative Philology and Literature, and the other for English Language and Literature and Mental and Moral

Philosophy, perhaps not so much chairs as chaiseslongues. Thomas Elder's contribution was left at the disposal of the University Council and used to found two chairs, one of Mathematics, and one of Natural Science. The task of selection of the Professor of Mathematics was entrusted by the Council to a British committee consisting of "J. Todhunter, Esq., M.A. F.R.S., Hon. Fellow of St. John's College, Cambridge; P.G. Tait, Esq., M.A. Professor of Natural Philosophy in the University of Edinburgh; Henry W. Ackland, Esq., L.M., Regius Professor of Medicine in the University of Oxford, and President of the Medical Council; and Thomas H. Huxley Esq., Professor of Natural History in the Royal School of Mines (the first association of a distinguished name with the University of Adelaide); assisted by the Right Hon. Sir James Fergusson, Bart., and F. S. Dutton, Esq., C.M.G., the Agent-General".

Living in Adelaide at this time was the Reverend Slaney Poole who had been a master at Stockport Grammar School where he had been particularly impressed by a pupil Horace Lamb whose subsequent career he had followed. He knew that this young man had proceeded to Trinity College Cambridge and graduated as Second Wrangler and had been elected a Fellow and Lecturer of his College. He sought to interest Lamb in the Adelaide vacancy and in a letter to the Adelaide Advertiser of October 12th 1934 recalled the part he played in Lamb's appointment to the Elder Chair of Mathematics. He wrote

> "My acquaintance and, indeed, I may say, my friendship with the late Professor Lamb, extends over many years before his arrival at Adelaide. I had just taken my degree at Cambridge before I was 21 years of age, and had obtained the position of a classical mastership at Stockport Grammar School. Lamb was

> at that time head boy, and only some three years my junior. We were drawn together in as friendly way as was possible in those days by being much of the same age, not only in the school, but in the playground; his Latin and Greek was one of my duties, and I found him so apt in his studies that I always thought of him as one who would eventually "go out" in classics. Nobody who knows me well would ever attribute any of his mathematical development to anything that I could teach him. He went after a year or two, to Cambridge and went out in the mathematical tripos as Second Wrangler, and was eventually a Fellow of Trinity College. I had only been a year at Stockport when I accepted a classical mastership at St. Peter's Collegiate School in Adelaide; this I never took up, but I did come to South Australia, and have been here ever since. I was then 22 years old. My earlier years here were spent in the rough life of a bush clergyman, 67 years ago, and I had lost sight and touch of many of my old friends in the Old Land. I had, however, noted Lamb's career in some respects, and when in the late seventies the University of Adelaide was founded, and was on the look out for professors, I wrote to my friend and suggested making application for the professorship in mathematics. I had heard that he was married, and would therefore have had to resign his Fellow-ship at Trinity College, and I thought that he might be glad to start his new life in helping to build up a seat of learning in this new country. He followed my suggestion, applied for the post, and was appointed."

At the time of his appointment Lamb was 26 years of age. In Cambridge he had studied and taught applied mathematics and Sir Richard Glazebrook [1935] in a Royal Society Obituary Notice, tells of his time as one of Lamb's students.

He says

> "his lectures were a revelation" and that "he had read Helmholtz's memoir in Crelle's Journal for 1858, and Thomson's Edinburgh paper [1867] 'On Vortex Motion'. In these and in the writings of Cauchy, Reimann, and others dealing with complex variables, in "Thomson and Tait", "T & T" it used to be called, and in the works of Stokes and Rayleigh on waves and vibrations generally, he found material for the course he gave us, for which he earned our gratitude and our regrets when we heard shortly afterwards that he was to go to Adelaide as professor".

With such a range of interest Lamb was well equipped to lecture in pure and applied mathematics, and also to give instruction in Natural Philosophy which he was called upon to do. And so although Lamb was formally the Elder Professor of Mathematics he began the teaching of physics in Adelaide University.

The newly wed Professor and his wife, born Miss Elizabeth Foot the sister-in-law of his former headmaster the Rev. Charles Hamilton, arrived in Adelaide in March 1876 in time for the beginning of the first teaching year of the new University. Only temporary accommodation in Victoria Square was available to the University and it was not until 1882 that its first building was opened, the building now known as the Mitchell Building. The four professors who now constituted the teaching staff were to face a student body of eight matriculated students and fifty two others, of whom the Council's report of 1876 comments

"It is a gratifying sign of the times that so large a number as thirty-three ladies have, as non-matriculated students, attended some of the University Classes during the first year of its operation, for it is certain that high mental culture on their part must react on the other sex, and give a powerful impetus to self-education, and the acquirement of literary as well as social knowledge. It is hoped that ladies will become matriculated students, and compete for Degrees and Scholarships".

In fact the community of South Australia, in its attitude to women, was enlightened beyond the general standards of the time, and it must have made a marked impression upon the young professor from the exclusively masculine preserve of Cambridge University to find young women sitting at his feet.

The scope of Lamb's teaching may be assessed from entries in the University Calendar for 1877. In Mathematics the first year course consisted of three lectures per week on Geometry, Algebra, and Trigonometry, Elementary Analytical Geometry, and (if time permits) the elements of the Differential Calculus". In Natural Philosophy the first year course of two lectures per week covered Statics, Kinetics, Hydrostatics, the Elements of the Science of Heat, and Elementary Astronomy. In the second year Lamb gave three lectures per week on Heat, Sound and Light.

The text books for these latter courses being Deschanel's "Natural Philosophy", Brinkley's "Astronomy" and Maxwell's "Theory of Heat", and, to quote again from the Calendar "In each of these courses the lectures will be illustrated as far as possible by experiment. In the Second Year's course opportunity will be given to the students, as far as possible, of practising physical methods of observation, and of becoming acquainted with the use of the various instruments".

In the following year a Third Year course in Mathematics was added consisting of "The Statics of Solids and Fluids, and the Kinetics of a Particle, with the requisite subsidiary parts of Pure Mathematics", and the above comment on experimental work was supplemented thus: "In addition to the above courses, instruction in Practical Physics will be given in the Physical Laboratory at times to be arranged. The work will consist partly of repetitions and variations of the lecture experiments, and (in the case of the more advanced students) of experiments of a more refined nature, such as the accurate determination of physical quantities, etc.".

Reference has already been made to Glazebrook's reaction to Lamb's lecturing in Cambridge and two other comments have been recorded. One, from a member of Lamb's first classes held in Adelaide who later became Sir T. H. Beare, Regius Professor of Engineering in Edinburgh reads [Glazebrook, 1935]

"Lamb was a wonderful teacher; he was carrying out at that time a good deal of his original work in hydrodynamics. He was an excellent lecturer, very clear, very lucid, and, as he had to deal with somewhat raw material, it was a difficult task for him'. Another from an unidentified student writing to the Adelaide Advertiser [10/12/34] runs "Lamb was a marvellous mathematician. He would fill the blackboard with an algebraical problem, written too speedily for us to follow. He would then turn and say, 'Is that clear?' We tried to say, 'Yes'; when one impudent fellow said, sotto voce, 'Clear as mud'. The professor seeing the doubtful look on our faces, would rub off the figures and start all over again - a little more deliberately". These somewhat opposed estimates perhaps suggest only that a student's assessment of his teacher may depend a good deal upon the former's aptitude for the subject.

From the beginning the University endeavoured to reach as wide an audience as possible and instituted courses of Public Elementary Lectures to which Lamb made a widely varied contribution with courses on "Sound and the Physical Bases of Music", "Optics, with special reference to the Theory of Vision", "The Earth and our Knowledge of It", "Demonstrations in Physics", "The Scientific Principles involved in Electric Lighting, and in the Electric Transmission of Power", and "Acoustics".

In addition to these teaching duties Lamb was busy laying the foundations of a most distinguished career in applied mathematics with his researches in hydrodynamics, elastic vibrations and electromagnetism. During his stay in Adelaide he wrote some nineteen papers, the first being "On the free motion of a solid through an infinite mass of liquid" [Lamb, 1876] and the last "The cause of the luminosity of flame" [Lamb, 1886]. Among these papers is one dealing with the vibrations of an elastic sphere a subject followed up, after leaving Adelaide, with a paper on the propagation of tremors over the surface of an elastic solid which was one of the fundamental contributions to theoretical seismology. Another paper "On electrical motions in a spherical conductor"

[Lamb, 1884] was a discussion of Maxwell's Equations as applied to a spherical conductor, and he also delivered a discourse at the annual commemoration of the University of Adelaide on December 17th, 1884 on "The history of electromagnetism". It is of interest to realize that this was several years before Hertz's demonstration of electromagnetic wave propagation was published in 1888.

Undoubtedly Lamb is best known for his book on hydro-dynamics. He had lectured on this topic at Cambridge and "the need for a treatise on the subject was strongly impressed on (his) mind". In 1879 he published his

"Treatise on the Motion of Fluids". The first edition was a volume of 258 pages but with successive editions, the last appearing in 1932, the book increased in size to some 600 pages while the title shrank to "Hydrodynamics".

Much of the material incorporated into later editions was the result of Lamb's own researches and the book became one of the most significant volumes of its time in the field of applied mathematics. In 1884 Lamb was elected a Fellow of the Royal Society in recognition of these researches carried out in Adelaide, quite alone and in an isolation not easy for a modern scholar to fully appreciate.

In 1885 Lamb was granted leave of absence from Adelaide University for a visit to England. It seems to have been expected that he would not return, and it came as no surprise to the University to learn that he had accepted the Chair of Pure Mathematics at Owens College, Manchester. He was fare-welled in the University Library by a gathering of students and staff and presented with an illuminated address engrossed on vellum which reads:

"Professor Lamb, M.A., F.R.S. - Dear Sir - We who have enjoyed the rare privilege of sitting at the feet of so able an instructor as yourself gladly avail ourselves of the occasion of your departure for England to enjoy a well earned holiday, to express in some slight form our high appreciation of your ripe scholarship and the universal esteem in which you are held. The zeal displayed in the discharge of your arduous duties, and the interesting and happy manner in which you have delivered your able lectures, will not soon be forgotten by those who have attended them.

Your ready and generous assistance in times of difficulty, and the kind interest you have always shown in our welfare, have become bywords to us who in the pursuance of our studies have come under your care. It is therefore with mingled feelings of pleasure and regret that we join in wishing Mrs. Lamb and yourself a very pleasant journey, and we trust that at no distant date we shall have the pleasure of seeing and hearing you again".

In his reply to the presentation Professor Lamb said, among other things, that "The portion of the address and of the remarks which pleased him most was that which referred in far too flattering and far too feeling terms to his personal relations with the students. It had been his constant endeavour that the relations between a professor and his pupils should be those of good-fellowship and friendship, and not those of a domine and his pupil". [Adelaide Register 30.7.85]

The address has recently been returned to the University of Adelaide, having been presented by Lamb's granddaughter Mrs. E. M. Cohen wife of Dr. Henry Cohen of Queens' College Cambridge, who, as a result of a chance conversation with Professor Trevaskis of Adelaide University, searched for and found the document.

Another piece of good fortune occurred in 1965 when Professor R. B. Potts [1966] was staying with friends in London and found that the next door neighbour was Lady Pansey widow of Henry Lamb, a well-known artist, who was one of the six children born to Horace and Elizabeth Lamb in Adelaide. This lady introduced him to Lady Dorothy Nicholson, one of the two surviving daughters of Horace Lamb, who, in the course of conversation, recalled the existence of a silver rose bowl presented by the University of Adelaide to Professor Lamb and still in the family's possession. After some searching it was found and presented to the University of Adelaide, a very fine piece of silver, which with the illuminated address make two splendid mementoes of the very distinguished first Professor of, Mathematics in Adelaide.

Much of Lamb's best work was yet to be done after leaving for Manchester. His famous book on hydrodynamics was followed by others on infinitesimal calculus, on statics and on dynamics and no doubt many a practising physicist of today will have one or two of these volumes on his shelves, perhaps a little dusty now, but much used in his student days. But the story of his career after returning to England will not be followed here, except to record that he was the recipient of many honours*, *was twice Vice President of the Royal Society from which he received both the Royal and Copley Medals. He was knighted in 1931. After his retirement from the Manchester Chair he spent the remainder of his life as an Honorary Fellow of Trinity College, Cambridge, where he continued his researches until the end. He died in 1934 aged 85 years.

It seems appropriate to end with a tribute paid to him by Lord Rutherford on the occasion of the presentation of a Portrait of Lamb to the University of Manchester in 1913. He said "If Professor Lamb will allow me to say so, he reaches more nearly my ideal of a university professor than anyone I have known. His wisdom and prudence in council are proverbial. Many of us try, though I am afraid with indifferent success, to follow his example of unswerving rectitude and to emulate his high ideals of duty to our University".

2 WILLIAM HENRY BRAGG 1862 - 1942

Lamb's last service to the University of Adelaide was to join with J. J. Thomson and Sir Arthur Blyth, the Agent-General for South Australia to elect a successor to the Elder Chair. Their choice fell upon W. H. Bragg a young Cambridge graduate.

The sources of information upon which I have relied for the following account are the Royal Society Obituary Notice written by E. N. Da C. Andrade [1943], a biographical essay by his son and daughter, Sir Lawrence Bragg and Mrs. G. M. Caroe, (Gwendolen Bragg) [1962], which both make use of some auto-biographical notes which Bragg himself wrote in 1927, or there abouts, and the Murtagh Macrossan Lecture on "The life and work of Sir William Bragg" delivered by Sir Kerr Grant [1952].

William Henry Bragg was born on July 2nd, 1862 to Robert John Bragg, formerly an officer in the British Merchant Navy, but then farming near Wigton in Cumberland, and his wife, born Mary Wood the daughter of the vicar of the parish. His mother died when he was seven years old and he went to live with his Uncle William Bragg at Market Harborough in Leicestershire. There he went to school in the re-established Grammar School, in the reviving of which his uncle had taken a leading part. Uncle William was, apparently, a formidable character, but "he was very kind, and he had lots of humour", and was anxious that young William should do well in life. Uncle William's was a bachelor establishment consisting of himself and Uncle James,

"a dear kind man, very simple and earnest, repressed and overpowered by Uncle William", his nephew and a niece Fanny. Much later Sir William wrote "We lived a very quiet life at Harborough. Before breakfast Uncle James and I went out riding for an hour to an hour and a half: we got to know well the villages round. Our longest rides would be to Kibworth or Kelmarsh, six miles away. I was not fond of riding for some reason, though I liked the morning air and I liked the pony. Ballgames of all sorts have always interested me more than country sports: I enjoyed them very much, while hunting, fishing the like did not attract me at all; moreover they never came my way.

After the ride the day was filled with school, preparation for school, and an occasional walk. There were very few games in those days as the school was a day-school without grounds. At the end of my six years there we had a little football, which was a great delight. There were no parties for children: we never went to other people's houses, and no children came to ours. I think my Uncle was too "particular" - he was indeed a refined and educated man - to let us fraternize with the children of the small shopkeepers, and as he was a shopkeeper himself, we were not asked to the houses of the lawyer, the parson and so on."

After six years with Uncle William, Bragg's father took him away and sent him to school at King William's College in the Isle of Man. In recalling this experience he wrote "after the first year or two, when the bullying was rather unpleasant, I was happy enough. I stood high in the school and liked my work, especially the mathematics: and fortunately I was fond of all the games and played them rather well. So, though I was a very quiet, almost unsocial boy, who did not mix well with the ordinary schoolboy, being indeed very young for the forms I was in, I got on well enough". In fact he became head of the school, and when he was seventeen won an Exhibition at Trinity College Cambridge. He was advised to return to school for another year and to try again with a view to improving his position. Unfortunately his second attempt was less successful than his first, but he was elected to a minor scholarship in consequence of his earlier performance.

This set-back was due, principally, to an outbreak in the school of an extreme religious fervour of the kind which exhorts the sinner to be "saved" lest he suffer the punishment of eternal damnation and hellfire. Bragg wrote "we were terribly frightened and absorbed: we could think of little else. ... it really was a terrible year". Little wonder that his work suffered, and that the memory of this experience was still strong upon him when in 1941 he referred to it in his Riddel Memorial Lecture.

Bragg weathered the storm and entered Trinity College where he settled down happily to work and play. He says of these years "I went up to Cambridge in 1881, taking the rather unusual course of beginning work there in the Long: I suppose I was in Cambridge six weeks or so, July and part of August. But I forget the exact date. I had rooms in Master's Court. I appreciated thoroughly the beauty of the whole place; and I liked going to Routh's classes. It was lonely, because I was doing the unusual thing: and I had no companions. But it was good all the same. As a scholar of the College I went up every Long afterwards: it was always a jolly time. Very few restrictions: just the regular classes three times a week with Routh, and the preparation for them. After that tennis in plenty: boating on the river above Cambridge, and the summer weather, and Cambridge looking its best. I tried during that preliminary Long to get through an exam that would excuse me the Littlego: and I failed in Latin, which seems to me now to be very odd, as I had studied Latin from the time I was seven, and given a lot of school time to it, and worked conscientiously too! I had to take the Littlego in November after all.

Cambridge gave me a good time, of course: although I might have done much better if I had known more or been more easily sociable. I ought to have gone to lectures on other subjects than mathematics, and taken an interest in other things. It simply did not occur to me. I could not afford, or thought I could not afford, to join the Union or the Boating Club; which cut off a good many opportunities. I had none of those experiences of discussion of the world and its problems with other young men, which many men seem to look back upon with so much pleasure. I worked at the mathematics all the morning, from about 5-7 in the afternoon, and an hour or so every evening, and then bed fairly early. Every afternoon I played a game, generally tennis, or went for a walk: my tennis was fairly good, so that I always found people ready to play."

"He was indeed good at games of all kinds" wrote his son and daughter adding that "at Cambridge he was one of the first to play hockey and has told us how he and his fellow enthusiasts had to cut their own sticks out of the hedges. To the end of his days he carried a scar on his forehead which he used to tell us was given him by the Duke of Clarence, Queen Victoria having selected hockey as a nice quiet game for him to play when he came up to Cambridge."

In 1884 he sat the Mathematical Tripos and was placed Third Wrangler, about which he recalled "I was afraid I had not done well in the exams: I remember my anxious mind as I walked up Senate House Passage to hear the results. When I heard my name called out as Third Wrangler, I was really amazed: I had never expected anything so high, not even when I was in my most optimistic mood. I was fairly lifted up into a new world.

I had a new confidence: I was extraordinarily happy. I can still feel the joy of it! Friends congratulated me: Whitehead (of Harvard now) came and shook me by the hand saying "May a Fourth Wrangler congratulate a Third?" He had been fourth the year before. As for the Uncles!"

After this he continued his mathematical studies, took part III of the Tripos, as it then was, and was awarded a First. Later he said "I believe that none of us did too well, but nearly all got Firsts because the Senior Wrangler did not do any better than we did and they could not give him a second."

Bragg was now 23 years old and he had to look to his future. This was settled by a chance meeting one morning at the end of 1885 when, on his way to attend a lecture by J. J. Thomson fell in with the speaker, who, as they walked along King's Parade asked if Sheppard, the Senior Wrangler of that year, intended to apply for the vacant chair of mathematics at Adelaide.

Bragg was astonished to learn that so young and inexperienced a man, notwithstanding his academic record, might be considered for such a position, but he asked Thomson if he thought he would have a chance himself, and receiving an encouraging reply hastily telegraphed an application just within the time limit. In due course Bragg, with two others (Sheppard was not a candidate), appeared before the selectors and Bragg was appointed. In this connection Andrade quotes from a letter written by Bragg to Sir J. J. Thomson on the occasion of the latter's eightieth birthday: "I must be allowed to add my own personal congratulations. Just fifty-one years ago, I was walking with you along the K.P. on our way to the Cavendish where you were going to lecture and I was going to be one of the audience. You asked a chance question, which sent me off to the telegraph office after the lecture was over and I applied for the Adelaide post which Lamb was vacating. It was the last day of entry; and of course your remark sent me to Australia. Perhaps you were the one who asked a certain Adelaide man then visiting London - whether the Council of the University of Adelaide was likely to prefer a senior wrangler who occasionally disappeared under the table after dinner to a young man who had so far shown no signs of indulging in the same way. The man was Sir Charles Todd, whose daughter I married a few years afterward."

The news of his success reached Bragg at Market Harborough where one "evening as Fanny and I were playing about on the piano, a telegram was brought to me." "As new professor of mathematics and physics in Adelaide University, would I give some particulars of my career"' Well, you can imagine my delight! which was reasonable. An assured position, a salary beyond all expectation, a new country with all the adventure of going abroad to it, a break away from being a subject, to be now my own master. I took the telegram across to my Uncle at the shop: he read it, finished without a word the posting that he was doing, took me home across the square in the dark, and on the way he broke down. It had not occurred to me that the glorious success would mean to him a parting that he would feel so badly. But I hope that his own pride in the result of what he had always worked for through me carried him through."

He left for Australia in January 1886 sailing on the P and C ship "Rome" of 4500 tons, the largest of the line, and apparently enjoyed the voyage. He spent a good deal of time aboard ship in studying physics for he had not previously worked at subject except for a short time spent in the Cavendish Laboratory after graduating. He says "it was supposed by the electors that I would probably pick up enough as I went along to perform my duties at the Adelaide University. So I read some Deschanel's Electricity and Magnetism". Concerning this Andrade remarks "Apparently the demands on a professor of physics were not very high in those days".

Although the telegram from Adelaide quoted above referred to Bragg as professor of mathematics and physics, the professorship was formally one of mathematics and is referred to in the University Calendar of 1887 as "The Elder Professor of Pure and Applied Mathematics, who shall also give instruction in Physics", suggesting that physics was officially regarded as a lesser part of the responsibilities of the chair, and had not yet acquired the academic respectability of mathematics. It could scarcely have been foreseen that the well trained mathematician, ignorant of physics, would become one of the most eminent physicists of his time. Nor would his early years in Adelaide have generated any such expectation. Certainly he took up the new subject with enthusiasm, rapidly acquiring mastery of the theoretical aspects and also going to the exceptional lengths of apprenticing himself to a firm of instrument makers in order to make apparatus himself for his deficient teaching laboratory. Thus early interest in practical work, which he frequently stressed as a most important part of the teaching of physics, and his development of his own manual skills was to bear fruit some eighteen years later.

From the moment of his arrival in Adelaide he thoroughly enjoyed, his life in Australia. He met with a friendly reception, not least from the family of Charles Todd who, as we have seen, played a part in Bragg's appointment. Todd was Postmaster General and Government Astronomer of South Australia: he was elected F.R.S. in 1889 and later knighted.

Bragg soon became a regular visitor to this household in which prevailed a relaxed easy-going atmosphere quite unlike the more rigid formality to which he had been accustomed in Victorian England. The young man, who later regretted that he had not been more easily sociable in Cambridge, found in Adelaide a society in which his personality blossomed so that he enjoyed a wide popularity. Here, as at school, his interest in games helped him. He played tennis and took up golf of which his son (W.L.B.) remembered "I used to caddy for him as a boy and I remember going round with him when he was planning a new course at Seaton near Adelaide, which later became a well known course". He also played a leading part in introducing lacrosse to South Australia, and there exists an excellent photograph of the North Adelaide team, taken soon after his arrival in Adelaide and which he captained for some years.

And so Bragg found a full and happy life in Adelaide compounded of an agreeable blend of work and play and social activity. Then three years after meeting the Todd family he married one of the daughters, Gwendoline. This marriage was a very happy one and Bragg was fortunate in finding a wife whose support was invaluable to him, particularly after his return to England. Three children were born to them in Adelaide, William Laurence, Robert who was killed at Gallipoli, and a daughter Gwendolen.

As we have seen Bragg entered on his teaching duties energetically. He also played a full part in University affairs and took a particular interest in student activities. The formation of the University Union, in which Cannon Poole, whom we have already met, played a leading role, occurred at two meetings on May 9th and April 25th 1895, at the second of which Bragg was elected as one of the two Vice Presidents. The minute book of these earliest meetings of the Adelaide University Union exists with the minutes of the first Ordinary Business Meeting and of the first Annual General Meeting signed by Bragg chairman. This book also shows that Bragg was a leading spirit in a scheme for building a room for the Union and in the third annual report (1898) of the Committee of the Union a reference to expenditure on furniture and carpets for the Union Room precedes the comment "we have reduced our debt to Prof. Bragg to a very appreciable extent" which surely indicates that he had, personally, helped with the finances.

His main academic interest shifted from mathematics to physics and he rapidly developed latent talents for expounding the latter subject both in formal classes, and in public addresses to more general audiences. In commenting on a remark of Andrade's Kerr Grant wrote "Bragg, from the very first, was marked as a born teacher and lecturer. Professor Andrade says (quoting - no doubt from hearsay - some Adelaide source) that in his early days "he was one of the least impressive of lecturers."

If there is any justification at all for this disparagement it may rest either on his complete inexperience in the art of lecturing or in his disdain of the use of rhetoric in which one of his colleagues, himself a master in that "poison of sincerity" was wont to appraise the quality of another's oratory."

In these early years in Adelaide Bragg undoubtedly cultivated those powers of clear presentation of physical topics, found a delight and skill in experimental demonstration, which were to become so conspicuous a feature of his lectures at the Royal Institution. In 1895 he gave courses of extension lectures on "Radiation", in 1896 on "X-rays" and in following year on "Sound". He was acutely interested in developments in physics and incorporated new material into his lectures. In particular he concerned himself with electro-magnetism and X-rays.

In 1895 he published his fourth paper on electromagnetism but these papers were mainly concerned with alternative derivations of known results and contained no significant new findings. However in that year he was experimenting with the electromagnetic waves which had been investigated experimentally by Herz, who had published his work in 1888. One day while engaged in trying to make a Herzian oscillator work he received a young visitor who was passing through Adelaide on his way to

England, from New Zealand.

The visitor was Ernest Rutherford then aged 24, who had been awarded an 1851 Exhibition (after first choice had declined the offer) on the strength of some experimental work on radio transmission carried out at Canterbury College, Christchurch. He had with him the magnetic detector which he had devised. This meeting was the beginning of a life-long friendship, an encounter which proved of great value to both men and to their scientific work.

Bragg returned to work on radio transmission three years after an interval during which his attention was attracted the discovery of X-rays. The news of Röntgen's astonishing discovery, published in December 1895, reached Australia in paragraphs in the South Australian Register and Sydney Telegraph of January 31st 1896, and several attempts were immediately made to reproduce Röntgen's experiments. Professor Lyle in Melbourne had already been experimenting with discharges in gases and was well placed to carry out these investigations. He was probably the first man in Australia to obtain an X-ray photograph. In Adelaide Bragg, with his assistant A. L. Rogers set about producing X-rays. Rogers was a remarkably versatile and able man whose workshop and laboratory skills were invaluable to Bragg. Of him W. L. Bragg wrote that he "had genius, and with my father designed pieces of equipment remarkable for their simplicity, elegance and fitness for their purpose."

Rogers tackled the problem of making X-ray tubes. This was, then, a formidable task, not so much because of difficulties of mechanical construction, but rather those of evacuating the tubes to the required degree, and ensuring that the gas pressure in the sealed-off tubes stayed at the appropriate working value. Rogers overcame the difficulties and made the first successful X-ray tubes to be produced in South Australia. He kept a diary, still in existence, recording the progress of some of Bragg's earlier work, from which I have been allowed to copy relevant extracts. The first is

Monday June lst 1896. Röntgen rays just reached us.
Startling like the telephone.

Clearly this cannot refer to the first news of the discovery of X-rays, for this had been reported four months earlier in the local press, and must refer to some demonstrations of X-ray photography given in Adelaide as reported in the South Australian Register of Saturday May 30th 1896. According to this account

Mr. S. Barbour, a senior chemist of Messrs. F. H. Faulding and Co., had recently returned to Adelaide from a holiday in Europe, bringing with him Crookes tubes suitable for the production of X-rays, and "on Thursday he secured a fair impression of a human hand". The report continues "On Friday evening Mr. Barbour took his tubes to the University Laboratory where further successful experiments were carried out ...".Professor Bragg, assisted by Mr. Barbour conducted the experiments, while Mr. Rowe developed the plates.

Those present were Drs. Giles, Swift, and Lendon. "First of all Professor Bragg submitted his hand with a coin placed under one of the fingers as a subject, and it is no exaggeration to say that the result was marvelous, and fully equaled any of the photos which had been seen in Adelaide".. A defect in one of the digits was plainly revealed. This was secured with only five minutes exposure".

Again on Monday June lst a second demonstration was given to an audience including many medical men at the University.

There seems no doubt that Rogers's entry in his diary refers to these events. The next entry strikes a triumphant note.

Saturday June 13th 1896. Got photo with our own Röntgen tubes.

This was a photograph of a mouse with remarkably good definition. The original X-ray plate has disappeared but a lantern slide made from it survives in the Physics Department, which also has a print of an X-ray photograph taken by Rogers, showing the lower part of Mrs. Rogers's head and neck, dated 13th 1896. One of Rogers first X-ray tubes also survives.

On June 17th 1896 Bragg delivered a lecture on X-rays in the University Library before the Governor and a fashionable audience who evidently paid for the privilege, the proceeds being donated to the Building Fund of the Students Union.

In the course of this lecture he referred to Rogers success of a few days before and showed the lantern slide of the mouse.

Naturally the possible medical applications of the new radiation attracted most attention and it happened that the young W.L. Bragg was one of the first to benefit from the new discovery. He wrote in the foreward to "Salute to the X-ray Pioneers of Australia" (published by W. Watson and Sons Ltd.)

> "I well remember my father's first, experiments with X-ray tubes, although I was only six years old at the time. I think I must have been amongst the first to be employed as a patient. I had smashed my elbow badly by a fall and was taken to a cellar in the University for the exposure.
>
> The flickering greenish light, crackling and smell of ozone were sufficiently terrifying to impress the incident deeply in a childŠs mind. When I think, however, of the early experiments, the

> interest which they aroused in medical men is not their chief significance to me! I see them as fore-runners of my father's interest in the ionisation of gases leading to his experiments with X-rays from radium and finally the experiments on the diffraction of X-rays by matter which we carried out together."

Many years were yet to pass before Bragg embarked upon that serious study of X-rays to which his son refers, but in the meantime Mr. Rogers was active in the making of X-ray tubes and assisting with medical equipment in Adelaide.

In 1898 Professor Bragg was given a year's leave of absence to visit England. This was the occasion for the following tribute from the Committee of the University Union.

"We shall this year be without the invaluable services of Professor Bragg who has gone for a holiday trip to Europe. The Committee made an effort before his departure to show how we recognize his unceasing labours on our behalf but owing to his hasty departure we were unable to arrange for any general expression in the name of appreciation and had to content ourselves with a written expression in the name of the members of the Union".

In England, following his earlier experiments with Herzian waves, he became very interested in the beginnings of radio communication. In the year of Röntgen's discovery the young Marconi was working in Bologna on the transmission of signals by means of electromagnetic waves, and in 1896 he moved to England where he secured the support of the British General Post Office for his work. Already, in his first two terms at Cambridge, where he began work early in October 1895, Rutherford had created a stir with his successful transmission and reception of radio-signals over half a mile across the town. Rutherford did not pursue this work any further* *himself, but by the time Bragg reached England it was clear that wireless telegraphy over considerable distances was feasible, and on his return to Adelaide he began work with his father-in-law Sir Charles Todd on this new means of communication. The story of progress is outlined by entries in Rogers's diary.

These show that before his trip to England Bragg had been lecturing on "Marconi's apparatus" and Rogers had been busy working on such equipment. But following Bragg's return we find

Wednesday May 10th 1899 Observatory.[1] Marconi telegraphy a great success up to 600 yds splendid morse messages.

These messages were recorded on a paper tape of which two fragments still exist in the Physics Department. These are dated April 20th and May 9th 1899 and are, almost certainly, the first recorded messages transmitted by wireless telegraphy in South Australia.

The diary continues:

Saturday May 13th 1899. Observatory messages sent a measured mile.

and this is followed by references to work on improving coherers, the detectors generally used at that time. Then a receiving station was set up at Henley Beach, on the coast about five miles from the observatory.

[1]The observatory referred to was the old State Observatory situated in the West Park Lands where the Adelaide Boys High School now stands.

Friday June 23rd 1899.	Wave signals to Henley Beach from Observatory with iron coherer, very wet.
Saturday July 8th 1899.	Bragg wires success for Henley Beach wireless telegraphy.
Thursday July 20th 1899.	Good messages from Henley Beach to Observatory.

An additional comment on these achievements exists in an account given by Miss Lorna Todd and quoted by Kerr Grant

> "I think I am right," she says, "in saying that the first wireless pole to be erected in Australia was in the Observatory grounds. A receiving pole was put up on the sand-hills at Henley Beach. My brother-in-law did much experimental work there. One afternoon I remember that my father asked me to tea and drive down with him to Henley Beach, saying he would send a 'wireless' to say that we were coming.
>
> I felt a very 'doubting Thomas' as I packed a specially nice tea and tied paper around the blackened picnic billy-can (there were no thermos flasks in those days). However, when we got within sight of the tall pole on the sand-hill there was my brother-in-law waving his arms and his cap, as thrilled as any schoolboy that the message had come through. It seemed a miracle. Both he and my father were almost boyish in the delight and the fun of the discoveries then being made so rapidly in science."

Continuing Rogers' diary we come across an entry showing that X-rays had not been forgotten, and giving an indication of the rigours of X-ray examination in those days.

Monday August 14th 1899.	X-photo taken with 'jubilee' tube of young Waite's collar bone 55 minutes exposure including stoppages to cool down. Extra rapid plate used and Dr. Verco's coil with 8 accumulators failure.

This is followed by references to more work on coherers and then

Monday September 11th 1899.	Fixing experiment for Extension lecture on Wireless telegraphy.
Wednesday September 13th 1899.	Professor Bragg gives extension lecture in Wireless telegraphy a great success.
Wednesday September 20th 1899.	Professor Bragg lectures on wireless telegraphy, large audience.
Monday September 25th 1899.	Conversatzione to teachers. Wireless from Observatory to University. Wehnelt, Syntonic jars of Lodge. Mirage, Ripple tank. Refraction and reflection of the ether waves for the first time.

This last reference is particularly interesting because there survives in the Physics Department a large sulphur prism and a cylindrical sulphur lens used by Bragg. Sir Lawrence Bragg believed that the prism was made to determine whether or not X-rays could be refracted, but Professor R. W. Chapman, who had been appointed Lecturer in Mathematics and Physics in 1888 (subsequently professor of engineering in 1907), and may be presumed to have been well aware of Bragg's laboratory work, told Sir Kerr Grant that it was used for experiments on the refraction of Herzian waves. This would appear to be substantiated by Roger's note on the conversatzione programme. It is, of course, possible that it was made originally for the one purpose, and being available was later used for the other.

We now approach the turning point of Bragg's scientific career which occurred in 1904 when he was 42 years of age. Prior to this time, he had developed a capacity for clear and precise thought about physical matters, and had cultivated the art of lucid exposition and the craft of the experimentalists, but he had not published any significant piece of original work. But in January of that year the Australasian Association for the Advancement of Science (now more familiarly known as A.N.Z.A.A.S.) met a Dunedin and Bragg gave the Presidential Address to Section A. It was entitled "On some recent advances in the theory of the ionization of gases", [Bragg, 1904a] and was a thorough revue of the considerable body of knowledge that had been built up within, roughly, the previous ten years, and more expecially since the discovery of the electron in 1897. The latter part of the address delt with the ranges and ionizing powers of α and β particles in matter. These constituents of the radiation from radio-active substances had been distinguished by Rutherford in 1899, and in 1903 he had established that the α particles were much more massive than the β particles, which were easily identified as electrons.

Bragg discussed the mechanism of absorption of these two kinds of particles, attributing the experimental absorption of β particles mainly to the effects of scattering, and pointing out that "in the case of the α ray we could hardly expect that a close collision between an electron of the α particle and an electron of the gas molecule through which the particle is passing would have much effect in turning the α particle to one side. Scattering must be a less important couse, and gradual stoppage through expenditure of energy must be a more important cause, of the absorption of the α radiation".

He goes on to describe an experiment of the Curies which appeared to confirm this view and wrote "If the α particles are stopped through sheer expenditure of energy, and if they all start with the same speed, they must all come to a stop at the same distance".

On his return to Adelaide Bragg began his well known experimental work on the ranges of α particles. An anonymous donation of £500 enabled him to buy some radium bromide and other necessary equipment, and he designed, and Mr Rogers constructed an apparatus for the measurement of the ionization along the length of a well collimated beam of α particles from a source which could be moved relative to a very shallow ionization chamber. Provision was made for varying the pressure and temperature, and the nature of the gas I the chamber. This apparatus has been lost but a replica of it, in its final form, was made, for our Centenary Exhibition, from a drawing by Rogers which appears in one of Bragg's papers [1906 c].

As he was about to begin this work, by a stroke of good fortune, Bragg obtained the services of a most capable assistant. A young man named Kleeman, employed as a blacksmith in the Barossa Valley town of Tanunda, wrote to Bragg asking for help with some mathematical problems. Bragg responded and became sufficiently impressed with the young countryman to invite him to study at the University, paying his way by acting as his experimental assitant. Kleeman accepted the offer, proving his worth with his very painstaking observational work for Bragg, and also by graduating, and in 1905 receiving the award of an 1851 Exhibition. This he took up at Cambridge where he worked with Sir J. J. Thomson studying the velocity of cathode rays ejected from substances exposed to the γ-rays of radium. Subsequently he was appointed Associate Professor of Physics at Union College Schenectady, but later moved to the Research Laboratories of the General Electric Company.

Bragg's first experiments [1904b] showed clearly the well defined ranges of the α particles and, with Kleeman [1904], he showed that a radium source in equilibrium with its products of disintegration gave four groups of α particles of distinctly different ranges, in air, which could be associated with radium, radon, RaA and RaC, the sequence which had been established by Rutherford and Soddy at McGill University. Bragg's early papers were usually published in both the Transactions of the Royal Society of South Australia and in the Philosophical Magazine, but he also wrote long letters to Rutherford, in Canada, giving detailed accounts of his work. Rutherford was keenly interested in Bragg's findings, replying in encouraging vein, and an extensive corrrespondence between the two exists, which I understand is being prepared for publication.

In the third paper by Bragg and Kleeman [1905a] they reported improvements to their apparatus and gave accurate values (to within 0.05 cms) for the ranges of the four groups of particles. They also investigated the stopping powers of substances for α particles and showed that the loss of range of the particles in traversing any atom is nearly proportional to the square root of its weight.

They next investigated [1906b] the recombination of ions in air and other gases and cleared up a discrepancy between observation and the current theory by introducing the idea of "initial recombination", i.e. the possibility that an electron dislodged from an atom might return almost immediately to its parent atom. Before the completion of this work Kleeman left for Cambridge.

This work was continued with studies of the ionization of various gases by the α particles of radium, [1906a and c], in which Bragg was helped by J. P. V. Madsen who had been appointed lecturer in mathematics and physics in 1901, and lecturer in electrical engineering in 1903. Madsen played a considerable part in Bragg's work in Adelaide but left for Sydney in 1909 when Bragg moved to leeds. In sydney he became Professor of Electrical Engineering, was instrumental in founding the Radio Research Board of which he was chairman for many years, and will be well remembered as Sir John Madsen by many readers.

A study of the α particles from uranium and thorium was also carried out [1906 b], and then the influence of the velocity of the α particle on the stopping power of substances was examined. The results of this latter work were presented at the A.N.Z.A.A.S. meeting of 1907.

Next we come to a paper "A comparison of some forms of electric radiation" [1907 a] in which Bragg discusses in detail the ionizing properties of α,β γ, and X-rays, and develops his idea of X-rays and γ-rays as consisting of neutral-pair particles. He wrote "Having thus discussed the properties of the various rays which do exist, it seems interesting to make an attempt at the estimation of the properties of some rays which might exist, though the fact has not been proved as yet. Radio-active substances emit both positive and negative particles. It does not seem at all out of place to consider the possibility of the emission of neutral particles, such as, for example, a pair consisting of one α or positive particle and one β or negative particle. The recent additions to our knowledge of the laws of absorption of α and β particles give us some grounds on which we may attempt to found an estimate of the properties of such pairs". He then went on to conclude that the relatively small field of the dipole, compared with the Coulomb field of either component, would make the neutral particle highly penetrating and a poor ionizer, incapable of deflection by magnetic or electric fields and not subject to refraction. Such a particle would conform to the known properties of γ-rays. However he conceded that an explanation of X-rays on this basis met with a difficulty since Marx [1905] had shown that certain X-rays had the speed of light, and it seemed inconceivable "that material particles can move with such a speed and yet be scattered on impact with atoms". Nevertheless Bragg thought it not entirely useless to think of X-rays in this way since most of the properties of X-rays were consistent with it, including even the possibility of polarization since the neutral pair would have a definite axis of rotation. Also the neutral-pair particle hypothesis was able to explain the ejection of secondary cathode rays from atoms with energies independent of the intensity of the radiation. this was quite beyond the "ether pulse theory" in which the X-rays were thought to be pulses of electromagnetic radiation.

A month later Bragg [1907b] read another paper to the Royal Society of South Australia in which he re-examined Marx's experiment and concluded that it did not entirely rule out the neutral-pair hypothesis He also used some arguments based on work done by his protegé Kleeman in Cambridge to advance further the particle hypothesis.

Other papers appeared on "The ionization curve of methane" [Bragg

1907c] and "The quality of the secondary ionization due to β rays" [Bragg and Madsen 1907] in which Madsen first appears as co-author with Bragg. Then, together, they began a study of γ-rays in an attempt to reach a definite decision as to their nature, neutral particles or electromagnetic waves. This work appeared on two long papers [1908a and b]. It was based on the argument that an "ether pulse" falling on a thin metal plate, too thin to cause absorption, would produce secondary radiations, whether scattered γ-rays or emitted β particles, which would diverge symmetrically from the target, whereas a particle scattered by the atoms of the foil, or an electron ejected from them, would be far more likely to move in the forward than the backward direction. Also a secondary electron resulting from a break up of a neutral-pair particle would move forwards. Thus whatever the details of the interaction of the γ-ray with the atom the "ether pulse" theory should lead to symmetrical production of secondary radiation, but the neutral-pair theory should not. A number of experiments were made and it was found that the secondary radiation was indeed asymmetrically distributed, the total ionization in the forward hemisphere being greater than in the backward hemisphere. This strengthened Bragg's belief in the neutral-pair model of γ- and X-rays although he wrote "It may still remain an open question whether or no the X-ray stream contains ether pulses".

The second of the papers by Bragg and Madsen [1908b] reported further experiments with improved apparatus, using magnetic deflection to ensure that nothing but γ-rays fell on the targets, and the results confirmed the earlier ones. Since the ionization produced by scattered γ-rays was negligible compared to that of the secondary β particles the results showed that these were emitted in the forward direction with a speed increasing with the penetrating power of the incident γ-radiation, and independent of the nature of the atoms in which they arose. These findings were then discussed in terms of three different hypotheses, firstly that the energy and material of the $beta$ particles was supplied by the atom which was merely triggered off by the γ-ray, as argued by W. Wien [1907]; secondly the theory of J. J. Thomson that the energy came from the γ-rays considered as a localized pulse of electromagnetic radiation which could eject an electron from an atom; thirdly the idea of Bragg that γ-rays were neutral-pair particles which could be disrupted by the field of an atom so that the electron component of the pair emerged as a $beta$ particle.

The first two of these proposals were convincingly dismissed while the third was shown to be wholly in agreement with the observation. Bragg was more than ever convinced of the correctness of his neutral-pair theory.

It seems strange that so late as May 1908 Bragg was apparently unaware of Einstein's explanation of the photoelectric effect, the more so as he comments on an attempt of Wien to apply Planck's quantum theory to the problem. In none of Bragg's publications of his Adelaide period is there any mention of Einstein.

Bragg's last paper written in Adelaide was read to the Royal Society of South Australia in October 1908. It was a paper by Bragg and Glasson (later an 1851 Exhibitioner) reporting a study of the secondary X-rays generated when a primary beam fell on a thin target. Madsen [1908] had shown that secondary γ-rays similarly generated were asymmetrically emitted, and recognizing the close resemblances of X- and γ-rays it was expected that a similar asymmetry would be found for secondary X-rays. This indeed proved to be the case and since it was not conformable with the "ether pulse" notion Bragg considered that he had further support for his neutral-pair theory for both X- and γ-rays.

In parenthesis, a speculation of perhaps some interest may be made at this point. At a later date Bragg was, of course, convinced of the wave nature of X- and γ-rays and abandoned, with some reluctance, his neutral-pair picture, but this idea may have borne fruit in another direction. It had been discussed in the correspondence between Bragg and Rutherford's second Bakerian Lecture to the Royal Society in 1920, in which he argued the possibility of an electron combining with a proton to form a neutral pair, and predicted the properties of such a particle, subsequently discovered as the neutron.

Returning to Adelaide in 1908, it remains to speak of two other pieces of work carried out by Madsen with Bragg's guidance. The first [Madsen1908] was a study of ionizathion and recombination, and particularly a further exploration of the initial recombinatiuon theory advanced earlier by Bragg. It is a very substantial piece of work showing, among other things, that the initial recombination occurred within $\frac{1}{10}$ to $\frac{1}{20}$ of a second after the act of ionization. The second paper [Madsen 1909] was on the scattering of $beta$-rays. The experiments measured the fractions of the incident beam scattered into the forward and backward hemispheres, the object being to look for any parallel between the scattering of $beta$ particlesa and γ-rays. The asymmetry previously observed with γ and X-ray scattering was again found but was much more pronounced. Nevertheless it was concluded that there was a close similarity in the scattering of the three types of radiation, such differences as were observed being perhaps due to the "distributions of the fields of the rays" i.e. of the fields of the particles of which the rays were believed to consist.

In January 1909, shortly before leaving Australia, Bragg delivered the Presindential Address to the A.N.Z.A.A.S. meeting at Brisbane. It was largely a summary of his own, and other related work, of the previous five years and includes a reiteration of his views on the particle nature of γ and X-rays. Ineterestingly the address ends with a discussion of the significance of scientific research, both pure and applied, for the development of Australia, and urges the need for proper support for these activities.

In less than five years Bragg's vigorous attacks on fundamental problems of contemporary physics had won him a world wide reputation. He was elected F.R.S. in 1907, being proposed by Rutherford with whom a friendly relationship had grown as close as the thousands of miles between them, and the communications of the times, would allow. The sense of isolation from the centres of scientific activity became increasingly trying to Bragg as he became a notable leader in his field of endeavour, and he began to consider moving from Adelaide.

In 1907 Rutherford left McGill Univeristy for Manchester, and was succeeded at McGill by H.T. Barnes, but a proposal was put forward for the establishment of a Chair of Theoretical Physics with the intention of appointing someone likely to continue the kind of work which Rutherford had initiated. This idea was broached by Rutherford in a letter to Bragg, dated July 5th 1907, soon after his translation to Manchester University. He wrote of the attractions of the proposed appointment and hoped that Bragg would be interested. The prospect appealed to Bragg and negotiations went forward, but McGill University suffered a severe financial reverse with the destruction by fire of its fine Engineering School and, soon after, of a large part of its Medical Building. As a result the suggestion for the establishment of the new chair had to be abandoned.

However, before the end of the year Rutherford wrote, in confidence, that Bragg could expect to be offered the Chair of Physics at Leeds University, and in 1908 the offer was formally made and accepted. And so, soon after giving the Brisbane address, Bragg and his family set out for England, and at about the same time John Madsen left for Sydney. Thus ended a brief period of high achievement in Adelaide, and a prelude to yet greater work in England, much of it to be done with his son William Lawrence who had graduated at Adelaide in 1908.

This story will not now be followed any further, except to add that what has been related was only the beginning of an extraordinary research career, as may be illustrated by remaking that the bibliography of his work, prepared by Kathleen Lonsdale and appended to Andrade's obituary notice, contains 29 entries relating to his work in Adelaide and a total of 237, the output, apart from the first four papers, of a man who began serious research work at the age of forty tow. He and his son were joint recipients of the Nobel Prize for Physics in 1915. Many honours came to him, Knighthood in 1928, the Order of Merit in 1931, the Presidency of the Royal Society from 1935 to 1940 all of which he regarded, according to the biographical note of his son and daughter, "with a kind of mild amazement, almost as if he felt some mistake had been made".

We leave him, then, sailing from Adelaide, and end this little history with a quotation from Andrade "During his 22 years in Australia Bragg had identified himself with the life of the community in which he lived and had established himself as a good man, a great teacher and a firm friend".

3 KERR GRANT 1878 - 1967

The loss of Professor Bragg left a gap which was filled by the appointment of two Acting Professors. They were H. J. Priest who had been appointed Lecturer in Mathematics and Physics in 1907, and a Melbourne graduate named Kerr Grant who continued in the role in 1910 and was appointed to the Elder Chair of Physics in 1911, there now being separate chairs of mathematics and physics. He was to occupy the chair until his retirement in 1948 at the age of seventy.

Kerr Grant was born at Bacchus Marsh, Victoria, on June 19th , 1878. His father was a Scot who operated a flour-milling business there, but later moved to Gippsland to farm. His mother, born Janet Kerr passed on her maiden name as the given name of her son. With the help of a scholarship the boy went to South Melbourne Grammar School, and then in 1897 entered Melbourne University to study engineering. He soon found a more natural inclination towards science and after discussing the matter with the Master of Ormonde College (later Sir John MacFarland, Chancellor of the University) Kerr Grant changed over to mathematics, physics and chemistry. Three years later he graduated with first class honours, and a distinguished under-graduate record lay behind him. After graduation he spent another year at the University where, in addition to his academic work, he found time to cultivate a proficiency at billiards, as a result of which he won the college billiard tournament.

Then he moved to an appointment as a lecturer at the Ballarat School of Mines, but two years later he returned to Ormonde College as a tutor. After one year of this work he set out, in 1904, for Europe where he studied at the University of Göttingen and acquired a mastery of German, for which language he had an enthusiasm which lasted into his retirement, when he still delighted in giving classes for the Honours Physics students in Adelaide. On completing his semester in Göttingen he found that he had an interval of six weeks before his ship was due to sail from London and he chose to spend some time in Paris. There he decided that instead of going on to London he would cycle from Paris to Rome and pick up the ship at Naples. He set out at the beginning of December 1904 and he recalled the experience some 55 years later in an article in Focus. Evidently he enjoyed the journey which took him to Pasteur's birthplace, Dole in the Jura Mountains, Milan, Genoa, Pisa, and Rome, and included a very cold and uncomfortable crossing of the Simplon Pass which left him very grateful for the offerings of the Hospice at the summit. He reached Naples safely and caught his ship back to Melbourne.

Having returned to the University he collaborated with B. D. Steele in the Chemistry Department in a project to construct an extremely sensitive micro-balance. This arose out of investigations intended to establish a possible relation between the ionization produced at the surfaces of certain heated metals and the amount of oxidation of the surface. This called for measurement of changes of weight of the order of 1 mgm. After some experimenting with a Nernst type of micro-balance, which depended upon the torsion of a quartz fibre, they concluded that a more reliable instrument could be constructed by refinement of the ordinary beam balance and the use of a buoyancy method of measurement. An essential requirement was a very light beam, and one weighing less than 0.5 gm was made of fused quartz rods supported on two finely ground quartz points resting on a polished plane quartz surface. The resulting balance was capable of weighing masses of up to 0.2 gm with an accuracy of 1 mgm, but as it was clear that the sensitivity of this kind of balance could be greatly increased.

Steele and Kerr Grant considered the possibility of making an instrument which would allow of the measurement of the change of mass of a radium source due to the evolution of radon.

Rutherford had shown that 1 gm of RaBr evolved 2×10^{-11} gm of radon per second, so that assuming the availability of 10 mgm of RaBr the loss of weight per day would be 1.73×10^{-8} gm, and to detect this a sensitivity of 10^{-8} gm and long term stability of the zero would be required. Ultimately two types of all-quartz micro-balances meeting these requirements were built. One was designed for measurements of small changes of mass and had a sensitivity of 4×10^{-9} gm. The other was intended for the absolute determination of masses of up to 0.1 gm with an accuracy of 10^{-7} gm. A full account of this work appears in a paper [Steele and Kerr Grant 1909] which was communicated to the royal Society of London by Sir William Ramsay with whom Steele had worked earlier in London. It ends with a lament that the authors were unable to obtain a suitable source of RaBr with which to attempt the measurement of the rate radon evolution.

Ramsay and Steele appear to have corresponded about the work on the balance before its completion, and Ramsay realized that it offered the possibility of measuring the atomic weight of radon, which at that time Ramsay called niton. Working in collaboration Whytlaw-Gray and Ramsay [1911] built a Steele-Grant balance and successfully obtained the atomic weight of radon.

I understand that the two balances of the types described above have recently been found in the Chemistry Department of the University of Melbourne. It may be hoped that they will be preserved as a memorial of a very fine piece of work.

Before this research appeared in print Kerr Grant was appointed acting

Professor of Physics at Adelaide University and in 1911 he became the Elder Professor of Physics. The year before he had married Kate Moffat, the daughter of an Adelaide lawyer. They settled in a large two-storeyed house in the suburb of St. Peters where Kerr Grant lived until his death, and where three sons were born and brought up.

The first investigation that he carried out in Adelaide was on the ionization produced by the impact of solid bodies in air [Kerr Grant and Jauncey 1912] in which his collaborator G.E.M. Jauncey [1888-1947] was a student who, in consequence of this work was later awarded an 1851 Exhibition. Subsequently he went to the U.S.A. where he became Professor of Physics at Washington University, St. Louis. Jauncey worked mainly in the field of the scattering of X-rays and his book Modern Physics [1932 revised 1937] may be remembered by some readers.

In 1919 Kerr Grant spent some time at the Research Laboratories of the General Electric Company at Schenectady. He worked with F. K. Richtmyer of the measurement of the X-ray mass absorption coefficients of water, aluminium, copper and molybdenum. This was at the time of the controversy over the existence of a J series of characteristic X-ray lines of shorter wavelength than the K series. Their careful work with a Bragg X-ray spectrometer disproved the alleged occurrences of discontinuities in the mass absorption curves which Barkla had adduced as evidence for the J radiation, and together with other evidence helped to settle the controversy.

Prior to his American visit Kerr Grant had conceived the idea of constructing a high power siren in which vibrations were excited in plates or membranes by making use of Bernoulli's Principle [Kerr Grant 1922]. At the Schenectady laboratory he had the opportunity of trying out this idea and met with considerable success. On his return to Adelaide he did some further work before writing the paper already mentioned. Some twenty years later, after the outbreak of World War II, he was asked to give his opinion of an air raid siren which had impressed the Civil Defence authorities. "You know" he said "a Swedish firm had come along with my hooter".

In 1922 Kerr Grant was a leading spirit in an enterprise of great interest touching on the Theory of Relativity for which he had the greatest admiration. On September 21st , 1922 there was to be a path of total solar eclipse across Australia passing through Christmas Island and south of Broome, Alice Springs and Brisbane, and a number of attempts were organized to make further observations of the Einstein effect of the deflection of light in a gravitational field, such as those at Sobral and Principe in 1919. An English, and a Dutch, party planned to make observations o Christmas Island. A combined American and Canadian expedition led by Dr. W. W. Campbell of the Lick Observatory chose Wallal on the coast of Western Australia, where they were to be joined by Australian and New Zealand groups. The New South Wales government supported an expedition to Goondiwindi in south west Queensland, a site chosen also by a party from Melbourne. In south Australia an early start was made on the preparation of an expedition to a position suitably spaced between the Wallal and Goondiwindi observers. The project was sponsored by influential people and secured private and Government financial support so that planning could go ahead. Kerr Grant and the Government Astronomer, G. F. Dodwell, being appointed Joint Secretaries of the South Australian Eclipse Committee played leading roles in the work of the expedition and wrote the report on it [Dodwell and Kerr Grant 1926]. A generous offer was made by the Beltana Pastoral Company, through their Chief Director, Mr. Peter Waite, to provide free transport of all equipment to their sheep station at Cordillo Downs in the far north east corner of South Australia, and to provide hospitality and other facilities for the party. Without this very material assistance it is doubtful if the project could have been launched. It remained to acquire the necessary apparatus and as a result of requests for the loan of suitable instruments a quadruplet camera, for photographing the stars in the neighbourhood of the eclipsed Sun, was obtained from the Allegheny Observatory. The Lick Observatory offered a 40 ft coronagraph, and a smaller instrument for long exposure photographs of the corona.

This equipment reached Adelaide early in May. Some necessary ancillary parts were made locally under the supervision of Mr. A. L. Kennedy, Chief Assistant at the Observatory, who then left for Cordillo Downs in charge of all the apparatus at the end of the month. Referring to this journey the Report says "It was expected that camel wagons would be available for taking the instruments from Lyndhurst Siding, the nearest point on the railway, to Cordillo Downs, a distance of about 400 miles, much of which was over very rough and arid country. Unfortunately the camel wagons could not, for fear of being held up by the floods in the Cooper River, await the arrival of the instruments, and it was therefore necessary to transport them by pack camel, involving the daily unloading and reloading of numerous heavy packages, containing in some cases delicate apparatus". Kennedy reached his destination safely and set about laying concrete foundations and erecting the instruments. By August 8th the Allegheny camera was ready for taking preliminary photographs of the stars in the eclipse region.

The programme of observations had been discussed at Greenwich by Mr. Dodwell, the Astronomer Royal

(Sir Frank Dyson), and Drs. Crommelin and Davidson who had been the Greenwich observers at Sobral. Dodwell returned to Adelaide in mid August and soon set out by car for Cordillo Downs, which he reached on September 2nd after several days delay caused by failure of the car in the "Cobbler" sandhills, near Mt. Hopeless, from which it had to be extracted by camels. Kerr Grant arrived a few days later, after a less eventful journey, and final preparations were made with the help of a number of interested persons who had arrived at the improvised observatory.

The day of the eclipse was fine with beautifully clear skies and during the period of totality the viewing conditions appeared to be ideal. The observing programme was carried out as planned and the photographic plates were sent back to Adelaide for development.

As there were no suitable facilities in Adelaide for the necessary precise comparison of the eclipse and reference plates they were sent to Greenwich for measurement, and reduction of the results, by C. R. Davidson. The final results were disappointing, for although the mean results for the displacements of a number of stars were in satisfactory agreement with Einstein's theory, the spread of individual results was too high to allow of much confidence in the mean value. Davidson commented that "considering the size of the telescope and the low altitude of the Sun I think this is as much as we had any right to hope for", and the Astronomer royal wrote "I am very pleased the result has come out as well as it has done, but the close agreement with the Einstein value is a matter of luck. For really first rate results you need twice the focal length, a higher Sun, and (I think) longer development to bring out the images more clearly. Still, under the difficult conditions, you have every reason to be satisfied, and I offer heartiest congratulations".

The 40 ft coronagraph was successfully operated and the resulting plates were sent to Lick Observatory for comparison with those secured at Wallal where Dr. Campbell's group was very successful in its measurements of the Einstein effect.

Among others observations made during the eclipse were magnetic measurements, and an interesting observation of the strength of radio signals received from the Sydney transmitter during the eclipse. These measurements were made by E. A. Thrum and Lt. V. D. Bowers after a desperate effort to construct, on the spot, a two stage amplifier needed to enhance the very weak signals received from the Australian radio stations at Cordillo Downs during daylight. This was completed 15 minutes after the first contact of Moon and Sun and with it a very marked decrease in the signal strength on passing through totality was observed. The expedition report refers to this as "a peculiar and unexpected phenomenon".

In 1924 Kerr Grant gave the address at the University of Adelaide Commemorating Ceremony. It was entitled "Things Unattempted YetŤ and was a remarkably prescient account of possible scientific developments. A discussion of the exploration of the interior of the Earth by deep drilling anticipated the Mho-hole, and in his consideration of communication with the Moon and planets he accepted the possibility of rocket propulsion but went on to say that "it is not utterly incredible that some form of "radio-car" propelled, like the tail of a comet, by a rearward stream of radiation pressure from its own body, may be the future form of interplanetary locomotive". This led him to recognize the need for more concentrated sources of energy, and in discussing atomic energy he particularly mentioned (in

1924 be it noted) the possibility of energy release by the fusion of hydrogen nuclei to form helium, and calculated that 1 lb of hydrogen so converted would liberate the energy obtainable from 200 tons of coal.

Two years later Kerr Grant was President of Section A at the A.N.Z.A.A.S. meeting of 1926. The address he gave was a good review of the progress in atomic and nuclear physics up to the eve of the birth of wave mechanics, and went on to discuss atomic transmutation. He clearly recognized the need for an artificially accelerated beam of particles with a beam current of a fraction of a micro-amp, and an accelerating voltage of a few million volts. He saw no reason why such an apparatus should not be built at quite a modest cost. The address concludes with "some remarks, admittedly of a speculative character, on the cosmical aspects of the problem of transmutation" and goes on to argue in favour of the fusion of hydrogen into helium as the source of stellar energy.

Kerr Grant spent some time in 1927 at the National Physical Laboratory in England where he became interested in the accurate measurement of the gravitational acceleration, g.

I am not aware that he published on this topic but he gave papers at the Second Conference of Australian Physicists in August 1929 of which abstracts appeared recently in The Australian Physicist [Richardson 1975]. These refer to sources of error in the Kater Pendulum and its improvement, and to the design of a very light free pendulum made of silica swinging in a high vacuum. The Shortt Clock, which was also the subject of a paper, has recently been reconditioned and is now in good working order.

Early in his career Kerr Grant (1909) wrote a paper on Obsidianites, those extra-terrestrial objects apparently peculiar to the Australian continent. He was therefore greatly interested in the meteor seen in South Australia at 10:53 pm on November 25th 1930. It was, apparently, a spectacular phenomenon [Kerr Grant and Dodwell 1931] seen from Port Lincoln, Mt. Gambier and Broken Hill, and at its brightest "gave an illumination comparable to that of daylight, even in Adelaide". It fell near to Karoonda and Kerr Grant and Dodwell organized a search for it. They found most of the material in fragments in a small crater in sandy soil, the remainder being scattered over a radius of about 5 ft. The total weight of material recovered was 92 lbs. A report of a petrographical and chemical examination made by A. R. Alderman was appended to a second note by Kerr Grant [1931a].

In November 1930 Kerr Grant was able to take advantage of the summer cruise of the Discovery, attached to the B.A.N.Z. Antarctic Research Expedition led by his colleague Sir Douglas Mawson, to arrange for observations of the intensity of cosmic radiation into high latitudes [Kerr Grant, 1931b]. Geiger-Müller tubes were prepared in Adelaide by M. Iliffe of the Physics Department, and the observations on the voyage were made by A. L. Kennedy of the Adelaide Observatory. In spite of the very severe conditions often prevailing a series of observations was made which supported the findings of Millikan and others that the intensity of the penetrating radiation showed little variation with latitude even to within 250 miles of the magnetic pole.

Over the next few years Kerr Grant wrote papers describing various pieces of apparatus, a new electrometer [1932a], a contrivance for demonstrating the law of errors [1932b] and a new type of surface-tension meter [1932c]. With M. Iliffe [1935] he devised a portable Geiger- Müller tube, and together they designed and built an electrostatically maintained tuning fork operating in vacuo [Kerr Grant and Iliffe 1938].

On the eastern side of the flinders Ranges about 400 miles NE of Adelaide is the Paralana Hot Spring of which a geological account was given by Mawson [1927]. Some ten years later a syndicate of Melbourne medical men was formed with the intention (or hope) of building a spa at Paralana. These gentlemen asked Kerr Grant to investigate the radioactivity of the spring and offered financial support for the work. A party consisting of Kerr Grant and Messrs. Ilaffe and Thompson visited the spring to make measurements on the site, and to collect samples for more careful analysis in Adelaide. The gas bubbling from the sandy bottom of the spring was found to contain radon, and the radioactivity of the spring water was as high as that of any of the known European spas [Kerr Grant 1938]. But what value it might have had as a curative agent was never established for the Paralana Spa never materialized.

Then came the war years. Kerr Grant served as Chairman of the Scientific (Physics) Manpower Advisory Committee, Controller of the Adelaide Branch of the Army Inventions Directorate, a member, and later chairman, of the Optical Munitions Panel, and as a member of the Physical and Meteorological Sub-Committee of the Chemical Defence Board. He was also concerned with setting up in his department a State Centre for Pyrometric Control to assist with problems of Temperature measurement and control occurring in munitions production. Mr. G. R. Fuller was in charge of its operations.

Also the Physics Department's workshop was turned over to war work with the task of making precision spirit levels for gunsights and the like, a less simple matter than might be supposed [Kerr Grant 1940], and another group, supervised by Mr. Don Schultz, reconditioned binoculars for the armed forces.

During the war the deaths of two eminent Australian occurred, of whom

Kerr Grant wrote obituary notices for the Royal Society of London. They were Sir Thomas Lyle (1860 - 1944) Professor of Natural Philosophy in the University of Melbourne, and C. C. Farr (1866-1943). The latter was born in Adelaide, the son of Venerable Archdeacon Farr, headmaster of St. Peter's College. Farr graduated in mathematics and Physics under Professor Bragg and then served for a year as Bragg's demonstrator before moving to Sydney. He was responsible for the magnetic survey of New Zealand and remained deeply interested in magnetism. He collaborated with Sir Douglas Mawson in analyzing the magnetic observations made during Mawson's Antarctic expeditions of 1913 and 1930. Farr became Professor of Physics at Canterbury College and was elected F.R.S. in 1928. A bibliography of his publications was given by Kerr Grant [1944].

The A.N.Z.A.A.S. meeting of 1947 was held in Perth and Kerr Grant took part in a symposium on atomic energy. In the same year he went with Sir John Madsen, Professor J. A. Prescott and Mr. Grenfell Thomas on an Australian Scientific Mission to India. He was knighted in 1947 and he retired at the end of the following year.

I have written at some length about the more serious side of his activities because this has received rather less than justice in articles written about him which have concentrated more on the esteem in which Kerr Grant was held as a teacher and public figure. He would never have claimed to be an outstanding physicist but one can readily believe that he had many of the qualities which might have made him one if research had taken a firm hold of him. In writing of Bragg's career, and commenting on his late start on his major researches, Kerr Grant wrote of late nineteenth century attitudes "Research had not yet acquired the status of a professional business. Rather was it then regarded as a natural and unforced by-product of academic employment and intellectual interest; subordinate, nevertheless, to the performance of the professor's contractual obligation to train his students in the discipline of his special science, and to serve the general public as an authority and consultant on whom reliance could be placed for trustworthy information or wise counsel in all matters relating to his particular province of expert knowledge. It was in such a light, doubtless, that Bragg would view the responsibilities of his post". Perhaps this tells us more about Kerr Grant's own attitude to his professorial role than that of Bragg. Certainly he will be best remembered as a teacher and servant of the general public in the sense referred to. Stewart Cockburn writing in the Adelaide Advertiser [11/4/50] put it that "The University sometimes needs a bridge to span the intellectual chasm between its cloisters and the community at large. For as long as most people can remember the University of Adelaide has possessed such a bridge in the person of Professor Sir Kerr Grant".

He was a man of many interests, had read widely and, being blessed with a retentive memory, could quote freely from a varied range of literature. He had a strong sense of humour and evidently enjoyed the role of absentminded professor, a characteristic which perhaps owed something to art as well as to nature, and like the Gilbertian character who was "the very model of a modern Major General" Kerr Grant was the very model of the popular image of a University Professor. There grew up about him a host of good stories which one hears repeated with relish whenever a group of his old students or friends and acquaintances meet. The memory of one such story relating to a visit he made to Cambridge University has been stirred by the glass of excellent White Frontignac (Henschke 1971 - not a reference) which stands beside me as I write.

Kerr Grant was dining at high table and was deep in conversation with the neighbour on his left, when the don on his right, wishing to draw attention to the treasures of the college cellars, interrupted to ask if he knew what he was drinking. Although more interested in the talk Kerr Grant obligingly took a sip from his glass, and then another. "Oh! yes, yes" he said "that's wine" and turned again to his conversation.

His lectures, especially to first year students, were enlivened by a variety of experimental demonstrations which sometimes, as a result of student intervention, gave unexpected results. A famous example involved the dropping of a weight from the rafters, some 16 m above the floor of the lecture room into a box of sand below. Year after year the students, knowing its purpose, pushed the box from its proper position with the result that the eight fell, with a resounding crash, on to the concrete floor. Kerr Grant decided to defeat the students by marking the spot where the box should be placed with a chalked cross on the floor. When the students moved the box as usual they at once realized the significance of the mark, rubbed it out, put a new cross a short distance from the original and replace the box in its proper place. When the professor reached the point at which to give his demonstration he saw the cross on the floor and, chuckling to himself at his foresight, carefully moved the box of sand over the cross and released the weight. By great good fortune the falling weight missed him but the crash was as satisfying as ever.

Kerr Grant never minded these displays of student high spirits and allowed his final lecture of the year to become an increasingly riotous entertainment at which it became the custom to call upon him to recite Kipling's "If". It appears that in a lecture in 1928 he quoted a couple of lines from this poem, and, in response to shouts for more, promised to recite the whole of it at the end of the year. Not expecting this to be remembered he was surprised in the event by a chant of "we want 'If'" which stopped only when he began the first of many annual recitations of the poem.

His very last lecture was an event which, by all accounts, will never be forgotten by those present. He was driven in a small sports car into the lecture threatre to be received with fireworks, whistles and cheers. Showers of paper planes and dried peas fill around him pigeons were released in the theatre, flour bombs fell and bouquets were presented. The general mayhem was interrupted for 'If' which now had an added verse

If you can find a way to smash the atom
And yet not build the bits into a bomb
If you can say, "Well, I a democrat am",
And yet see something human in a com.
If in the Brave New World's big University
You sometimes find your week-end papers stiff
Perhaps twill help you overcome adversity
If thinking of this day you think of If.

And so Sir Kerr Grant went into retirement. Not completely for in 1951 he gave the Presidential Address to A.N.Z.A.A.S. at the Brisbane meeting. It was a review of the major developments in physics since the turn of the century. He also retained a connection with his old department by taking the Honours Students for German classes, and to within a few years of his death he regularly attended the annual dinner of the students Science Association where, of course, he was always called upon to recite 'If'.

We now turn back to 1922 when R. S. Burdon was appointed a lecturer at Adelaide University after serving for some years as a demonstrator in Natural Philosophy at the University of Melbourne, where, under Professor Laby's direction, he studied binocular vision in relation to radiography [Burdon 1919]. He remained at Adelaide University until his retirement in 1958, becoming successively senior lecturer and reader in physics.

During this time he carried out a fine series of researches on the spreading of one liquid on the surface of another, particularly upon mercury, and upon problems of the precise measurement of the surface tension of mercury. In the first of these papers [Burdon 1926] he says that the investigation was suggested by Kerr Grant, and concludes with an acknowledgement of the assistance of a young graduate M. L. Oliphant. The general conclusion of this paper was "that very minute variations decide the spreading or otherwise of water on mercury, but further shows that the number of ions present is an important deciding factor".

The next paper [Burdon and Oliphant 1927] was on "The problem of the surface tension of mercury and the action of aqueous solutions on a mercury surface". It reviewed the very discordant measurements of the surface tension of mercury and concluded that "it may be said to be improbable that agreement as to the absolute value of this quantity will ever be reached by mere repetition of measurements" and suggested that the need was for an understanding of why different methods of measurement gave different results. It also gave an account of further work on the spreading of liquids on mercury showing that the presence of ions was a determining factor. In Burdon's own copy of this paper is an annotation "Work with apparatus in Figure 1 by M. L. Oliphant". this was the apparatus used for liquid spreading experiments.

Oliphant [1928] continued with a study of the selective adsorption from gaseous mixtures by a mercury surface newly formed in the mixture. It was found that carbon dioxide was readily absorbed on to a fresh mercury mercury surface to form a monolayer, and that such layers might well account for the discrepancies in measured values of the surface tension of mercury.

Mark Oliphant joined the physics department as a cadet, that is as an assistant allowed time for academic studies, and graduated in 1923. Two years later he came under the spell of Rutherford who visited Adelaide and wrote of this event [Eve 1939] "We were met at the port by Professor Kerr Grant, Professor and Mrs Osborne and Professor and Mrs. Robertson, all of who I had met before. We had lunch at the Grants and my wife left that afternoon by rail for Melbourne and Sydney hoping to catch the boat for New Zealand at the latter place. Actually she failed to do so and spent the next four days in Sydney with the Gordon Craigs. Stayed at the South Australian Hotel, where rooms had been reserved for us, and found many letters awaiting me for plans in the West of Australia and New Zealand. Gave my first lecture in the evening on the "Counting of Atoms". A good audience and introduced by the Deputy Governor. After dinner went to the hotel with Dr. Mitchell, Vice-Chancellor of the University and talked philosophy till 12.

On the Friday - the 4th - visited Robertson's new bio-chemical laboratory and the new physics and engineering buildings. I gave an informal talk to the people interested in physics - about 200 - on work in the Cavendish laboratory. In the evening gave a second lecture when good speeches were made at the conclusion by Grant and Chapman (Eng.). Attended a reception by Miss Todd in the Adelaide Club.

Saturday the 5th . Answered letters and telegrams and visited Registrar. Went for a picnic with the Osbornes and Grants in a car and had a very pleasant day. In the evening dined with the Vice-Chancellor and a number of friends in the Club.

Sunday - motored by Osborne to see Miss Farr, and on return was taken out by the Vice-Chancellor to lunch at the Barr-Smiths, who have a fine house and garden a few miles from Adelaide. Left by train for Melbourne the same evening and was seen off by a number of friends.

Many years later Sir Mark Oliphant [1972] wrote of how this visit affected his career, "In September, 1925, the Rutherfords visited Adelaide, where I was working as assistant to the Professor of Physics, Kerr Grant. Rutherford gave a talk in the Department of Physics, Kerr Grant. Rutherford gave a talk in the Department of Physics on the work going on in the Cavendish Laboratory. This fascinated me, and I determined that would work under him if this were at all possible. At that time, members of the University as humble as I were, not introduced to such illustrious visitors. In 1927 I was able to convince the Commissioners for the Exhibition of 1851 that I should be awarded an overseas scholarship. Professor Kerr Grant was abroad on sabbatical leave, and had just visited the Cavendish. He wrote a letter urging me to endeavour to go to Cambridge, where he had found a more lively atmosphere than in any other physical laboratory in England. I had already telegraphed to Rutherford and had received a reply saying that he would reserve a place for me. I had also been accepted by Trinity College as a Research Student. So I set out convinced that I had made the right decision."

No doubt an important factor in convincing the Commissioners was the work done with Burdon, and the high opinion which Burdon had of his younger collaborator. This respect and admiration was, I believe, mutual. When Oliphant left Adelaide he took with him the manuscript of the paper referred to above, to show to Rutherford who communicated it to the Philosophical Magazine.

The further career of Sir Mark Oliphant is too well known to be detailed here. Suffice it to say that in recent years he has been able to renew contact with his alma mater, and it has given much pleasure to many to see His Excellency the Governor of South Australia attending colloquia in the Physics Department.

Returning to Burdon's researches, he next made a very careful determination of the surface tension of mercury in a silica apparatus using the sessile drop method of Quincke [Burdon 1932]. The very elegant apparatus in which the mercury drop was formed and measured was "made by the Thermal Syndicate under instruction from Dr M. L. Oliphant", and is now preserved in the Physics Department. With this apparatus the surface tension of mercury in vacuum was measured and found to be the same as that of a newly formed surface in air. Also the temperature coefficient of the surface tension was measured up to 230řC. Experiments on the action of gases on the surface of mercury did not lead to positive conclusions, but this matter was taken up again in a paper on the adsorption of gases [Burdon 1935]. This contains more very nice experimental work and showed that "adsorbed CO_2 or H_2 to the extent of a monomolecular layer is retained by the mercury surface on evacuation. The absorption is readily observed when the mercury surface is formed in a gas, but not when the gas is admitted to a surface which has been formed in a vacuum. Though the mercury surface, from its uniformity and definite area, should be ideal for quantitative work on gas-adsorption on a metal, the phenomena observed are at present too complex to be embraced in a single theory".

There followed some papers on the spreading of liquids in which Kerr Grant, W. P. Allen, G. R. Fuller and E. S. H. Gibson appeared as co-authors, and then in 1940 Burdon published a Cambridge Physical Tract entitled "Surface Tension and the Spreading of Liquids" which summarized his own work, and that of others, in this field. A second edition appeared in 1949.

The immediate post-war years saw a large increase in student numbers with the normal intake supplemented by large numbers of returned members of the forces. Consequently teaching duties were heavy but Burdon supervised a post-graduate student, G. M. Ziesing, who carried out another series of measurements of the surface tension of mercury by the Quincke method, using the silica apparatus [Ziesing 1953]. He noted an error in the formula that had commonly been used to calculate the surface tension from the dimensions of the drop, and paid particular attention to the optical fringes observed above the drop, which affected the measurements. The final result is probably one of the most reliable determinations of the surface tension of mercury, and its temperature coefficient, ever made.

Burdon was awarded the D.Sc. degree of the University of Adelaide in 1935. I think there is no doubt that had he been able to work in the conditions now usual in physics departments, where opportunities for research and the provision of funds are almost taken for granted, he would have achieved much more. As it was he produced, in difficult circumstances, an admirable body of work, and a record of distinguished teaching.

The name of G. R. Fuller has occurred earlier in this account. He graduated in the University of Adelaide in 1924 and served it for all his working life, primarily as an outstanding teacher, whom many students will recall with gratitude and respect. He was a notable cricketer and had played a leading part in the introduction of baseball into south Australia. On his retirement in 1963 Mr. C. A. Appleby had the happy idea of producing a presentation volume containing photographs, lists of all the first year students who had attended Mr. Fuller's first year lectures, and tributes and greeting from friends and former students. This collection leaves no doubt of the great esteem in which he was held by all who knew him. He was one of the best liked and most respected members of the Physics Department, and indeed of the University.

With the retirement of Kerr Grant in 1948 seventy four of the seventy five years I have allowed for this story have been completed. With the appointment of his successor L. G. H. Huxley, and the post-war improvements in staff-student ratios, and financial support for research, the Physics Department developed rapidly into a well balanced teaching and research organization. Huxley was fortunate in finding in his new department a group of enthusiastic and very able young men anxious to embark on research careers and follow his lead into two particular fields. There were R. W. Crompton and D. J. Sutton who began work on electronic and ionic diffusion in gases, and G. J. Aitchison, W. G. Elford, A. A. Weiss and D. S. Robertson who began studies of the ionosphere and of the upper atmosphere by radar observation of meteor trails. Both of these projects continued to develop most successfully and are still in full flight. And so 1949, the last year of my record, saw the birth of an activity such that the following years, and, no doubt, the years to come, will provide ample material for some later chronicler. But now, with a salute to that first three quarters of a century, I put down my pen.

4 ACKNOWLEDGEMENT

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