A COLLECTION OF PAPERS IN THE LIFE OF JOHN PERCIVAL VISSING MADSEN

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INTRODUCTION

This second edition of "A collection of papers in the life of John Percival Vissing Madsen is based on a microfiche copy of the original edition held by the University of Sydney which was copied in 1970.

The papers in this collection have been selected to indicate the full extent of the activities undertaken by J.P.V. Madsen and the influence which they have had on Australian science & engineering.

Detailed histories of the Radio Research Board & the Radiophysics Division (History of the Radiophysics Advisory Board) of C.S.I.R.O have been prepared & published by 1971 which are particularly valuable in meeting the need for a proper record of the development of Radar in Australia & of the vital role played by Sir John.

The biographical memoir by Sir Frederick White has been written for the Records of the Australian Academy of Science, where the originals of Sir John's scientific papers have been placed for preservation.

The selection & preservation of these papers has been made by R.W. Madsen based on the personal reminiscenses & initial guidance of his grandfather, who recognized the useful purpose which biographical & historical records serve.

JOHN PERCIVAL VISSING MADSEN - by Sir Frederick White

John Percival Vissing Madsen was born at Lochinvar, Patterson River, New South Wales on 24th March, 1879. He died in Sydney on Saturday, 4th October, 1969 at the age of 90. He was the eldest of the family of four sons and two daughters of Hans Frandsen Madsen and his wife Annie (nee Bush).

John Madsen's life long interest in science and technology was evidently inherited from and inspired by his father. Hans Madsen, born in Denmark, who migrated to Australia in 1864 and, while working as a miner, became one of the first pupils of the Ballarat School of Mines. He was educated as a surveyor and followed this profession in many centres in New South Wales as an employee of the Surveyor-General. He had a keen interest in astronomy; in 1886 he contributed a paper to the Journal of the Royal Society of New South Wales on the polishing and figuring of 18" glass specula by hand and experiments with flat surfaces.

John Madsen received his early education at Sydney High School and was Dux of the school before leaving to begin his studies at the University of Sydney. Here he read physics and mathematics and graduated B. Sc. in 1900 with first class honours in these subjects and the University Medal for mathematics. A year later he graduated B. E., again with first class honours and the University Medal. In his later life when he was a senior member of the University he strongly advocated and indeed initiated the practice, which became common, of students taking the double degree in science and engineering.

His success in his University studies and the wide range of his interests clearly equipped him for a career as a University teacher. The opportunity came to him in 1901 when he was appointed Lecturer in mathematics and physics at the University of Adelaide. He had already had some experience in teaching for, while still a student and presumably to earn some money, he had acted as Junior Demonstrator in engineering and in physics in the University of Sydney.

He was certainly fortunate in his first appointment. W. H. Bragg, after a brilliant University career in Cambridge had been appointed to the Chair of Physics in Adelaide in 1886. Madsen joined the staff in 1901 and continued his association with Bragg until he left to become the Lecturer in Electrical Engineering in his old University in Sydney in March 1909. His period in Adelaide was therefore spent in close association with Bragg before the latter left in 1908 to become the Cavendish Professor of Physics at the University of Leeds.

Madsen and Bragg became close personal and life-long friends; in this period together each made major contributions to the physics of radio active substances. In later years when Madsen visited England he renewed this friendship and indeed stayed with Bragg in the Royal Institution.

W. H. Bragg began in Adelaide his studies of radio activity and x-rays that started him on his distinguished life as a physicist. In 1912 Bragg published his book "Studies in Radio Activity" and recounts in his first chapter how his interest in these phenomena was stimulated by the task of preparing the Presidential Address to the Physics Section of what was then known as the Australasian Association for the Advancement of Science. This he presented in Dunedin, New Zealand, in January 1904.

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These were the earliest days of the growing knowledge of radioactivity, the nature of the radiations from radioactive substances, of x-rays, and of the electron. Bragg says he "was encouraged to review the researches of Lenard on the passage of cathode rays through matter, the work of J. J. Thomson on the electron and the properties of the new radiations which had been investigated by Becqueral, the Curies, Rutherford and others".

There was at that time considerable doubt as to whether the γ rays from radioactive substances and x-rays were of the same nature as the α particle and the β particle. Bragg's earliest publications in 1904 were concerned with the properties of α particles. The experimental work in Adelaide in which Bragg and Madsen collaborated was concerned with the nature and distinguishing features of these different radiations.

Even three weeks before he died Madsen's memory of this period with W. H. Bragg in Adelaide was quite clear and, while then in hospital, he recounted to me his rememberances of early incidents in this association. It must have been not long after Madsen joined the staff that Bragg brought to his notice some of the published papers of Ernest Rutherford, presumably those in which Rutherford had described his early work on radioactive substances.

Madsen told me that on arrival in Adelaide he was given a very small room (which he shared with the cleaner) opposite the Professor's study. Bragg came there one day and presented these publications and asked Madsen to read them. Bragg told Madsen that he had ideas as to how the experiments described might be improved and extended and he wondered if Rutherford would mind his doing so. Bragg and Madsen agreed that it would be proper procedure to write to Rutherford and this Bragg did. According to Madsen's story and, as might well be expected, he received a very encouraging reply.

About that time Sir George Stokes had put forward his ether-pulse theory to account for the properties of x-rays. Bragg had considerable doubts as to the validity of this idea and advanced his neutral-pair theory which accounted for, in his view, the indifference of the x-ray to electric and magnetic forces. The joint work of Bragg and Madsen was concerned with the elucidation of this problem.

When Bragg went to Leeds he began a regular correspondence with Madsen which is of intense interest to the history of science of that time. One part of this is worth a mention.

Madsen had already begun the experimental investigation of the scattering of β particles by matter and this work was published in the Philosophical Magazine in 1909. It was about this period that Rutherford began his consideration of the structure of the atom and Bragg was evidently in a position to know of Rutherford's ideas as well as of Madsen's experimental work.

In a letter to Madsen from Leeds in March 1909, there is a passage which refers to this and to the steps that Bragg took to make Rutherford aware of the work in Adelaide. Bragg's letter contains the following passage:

> "How do you like Rutherford's new atom? The situation is rather funny now. Crowther and Barkla were just now arguing in the Phil. Mag. about the x-ray scattering and its relation to J. J.'s theory: and Rutherford brings forward a theory which cuts the ground from under the feet of all of them if it is true. Rutherford's theory touches your β ray work very nearly and indeed the law of scattering of the β particle is very much to be determined in order to test his theory. Knowing that you were working away at this and

having your last letter explaining what you had got I thought it best to show it to Rutherford. I think if he went at it hard he would with all his opportunities get ahead of you. He is a very generous chap and always ready to give everyone all he can so I thought that if I told Rutherford exactly what you were doing and had done, he would take you in, so to speak. Your results agree with his theory very well and you will see in his paper that he has made special reference to what you have published."

In the Philosophical Magazine for May 1911 Rutherford published his famous paper on "The Scattering of the α and β particles by Matter and the Structure of the Atom".

Rutherford's postulate that the atom consisted of a central nucleus surrounded by "a sphere of electrification" of opposite sign led him to calculate the distribution with angle of the α and β particles scattered by a single atomic encounter. The very accurate experiments of Geiger and Marsden completely confirmed this theory. As Rutherford pointed out the law of scattering should apply equally for the β rays. Experiments by Crowther in England and by Madsen in Adelaide were relevant in this connection but in neither case did these scientists have the benefit of the theory to aid in the design of their experiments. Rutherford believed the work of both to support his theory but called for further experimental tests.

The work of Bragg and Madsen in Adelaide was in the front line of experimental investigation of these phenomena at that time. In 1907 Madsen was awarded his D. Sc. by the University of Adelaide for the thesis entitled "The Ionisation of Gases after their Removal from the Influence of the Ionising Agent". His examiners, Professors T. R. Lyle and J. A. Pollock of Melbourne, deemed this thesis "very meritorious" and "well worthy of the D. Sc. degree". The substance of this paper was published in the Transactions and Proceedings of the Royal Society of South Australia in 1908.

It is characteristic of Madsen that in seeking the approval of the University for the subject of his thesis he said in writing "I wish it to be clearly understood that I am indebted to Professor Bragg for the suggestion of the subject of the thesis and for many valuable suggestions during the course of the work."

Madsen was destined not to continue his researches in radioactivity and on the electron. In the early part of the 20th century Adelaide was separated by a great gap from the active centres of research in England. Letters and publications took a long time to arrive and even Bragg's voluminous and friendly correspondence with Madsen was not an adequate bridge.

Thus, although Madsen was at that time on the threshhold of being one of the leading workers particularly as to the nature of γ rays, he abandoned these researches when he went to Sydney. This was perhaps inevitable and, looked at in retrospect and particularly from the point of view of his later contributions to science in Australia, not altogether to be regretted.

In Adelaide Madsen was already beginning to turn his attention to the teaching of engineering and this became his absorbing preoccupation when he took up his new post of Lecturer in the Department of Engineering in his old University of Sydney in March 1909.

The Engineering School had been established in 1881 with the appointment of W. H. Warren as Lecturer and later as the first Professor of Engineering in 1884. When Madsen returned the school was already of considerable size with some 90 to 100 under-graduates. In this rapidly developing department he obviously played a leading role in the progress of the teaching of electrical engineering as is clear from his promotion to Assistant Professor in 1912 and to full Professor in 1920. Madsen thereby became the first Professor of Electrical Engineering in any Australian University. Dr D. M. Myers has contributed the following account of Madsen's resourcefullness in building up his new department.

"In this capacity, Madsen refused to accept the low level of finance as an excuse for inactivity in research and he set about establishing in his department the research activities which were to develop in a spectacular manner for years to come. A facet of his character which endeared him to his colleagues was his determination to provide them with the facilities they needed in spite of formidable financial and other obstacles. Much of the sophisticated equipment developed in his department had its origins in 'Madsen's junk heap', a remarkable collection of scrap machinery and components which had been begged, borrowed or stolen from a variety of sources. If a stock-taking had ever been required, it would have been an auditor's nightmare as the only record was in the ample filing system of Madsen's mind. On many occasions he proceeded unerringly through the vaults of his department to find just the piece of equipment needed to fill an urgent need, and it is impossible to over-estimate the saving in time and labour resulting from his propensity for collecting."

A further contemporary picture of the Madsen of this period is given by the following extract from the Engineering Year Book of 1926:

"It was not until the beginning of Third Year that we met Professor Madsen and his subject of Electrical Engineering, which is rather a pity, as his untiring energy was what really instilled into our minds the true idea of efficient work. He is one of the busiest men in the School, and consequently one of the hardest to find when you want him - always conferring with mechanics or contractors, inspecting St. Paul's Oval or at a meeting. Yet his lectures are more effective than any others we get, due probably to his clear and concise idea of the usual pitfalls for young students of electricity and the saving grace of first principles as opposed to details. A regular bogey-man at exam. times, he demands a very high standard from his "studes" - and usually gets it. To him alone, we owe whatever slight conception we have of the importance of filthy lucre and "corsts" in engineering undertakings.

Professor Madsen is chiefly noted for a quite distinctive gait, and for a small cardboard case, which ever and anon is brought forth from the depths of his coat pocket, only to disappear again in the twinkling of an eye."

Five years after his appointment to Sydney the great war of 1914-1918 broke out. Madsen was appointed as Chief Instructor and Officer Commanding the Engineer Officers Training School at Roseville, New South Wales. At the end of hostilities, the Secretary of the Department of Defence, in writing to thank the University for Madsen's services, said:

"This gentleman's high technical and professional attainments coupled with the wholehearted energy which he brought to bear on this important work has enabled this department to send forward highly trained Engineer Officers to the front."

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Sir Walter Bassett met Madsen for the first time when he was attached to this school; he has contributed this note of his experience.

"Following preliminary training early in 1915 at the Engineers' Depot in the Domain, Melbourne, I was fortunate to be posted for further training to Madsen's Officers' Training School, at that stage in Moore Park, Sydney.

Madsen made a splendid Commandant for such a School. He was well equipped as a teacher and made full use of his prowess. In addition, he was skilful in helping us by making us each in turn take a class for some small section of work, while he listened in and commented when necessary.

There was nothing of the professional "military" man about him. He maintained a mixture of hard discipline during work periods, and at other times a smiling ease and warm friendliness.

Apart from school technical work he was a tiger for regular physical exercises. The principal daily exercise was a pre-breakfast five mile run in Moore Park, a run which inevitably ended with the field widely spread out, but with Madsen himself, at 36, up near the leaders, and still smiling.

He naturally enough developed a well trained school, and one with a fine spirit."

It would be true to say that Madsen's greatest national service to Australia was made possible by his very active co-operation with the Council for Scientific and Industrial Research after this body was founded by the Commonwealth Government in 1926. The history of the founding of CSIR has been comprehensively recorded elsewhere. The need for a national institution for scientific research had been widely discussed following Federation. The new Commonwealth first set up the Institute of Science and Industry, but later replaced this by the Council for Scientific and Industrial Research with wider powers.

The Council met for the first time from the 22nd to the 25th January, 1926; prior to the second meeting, Madsen, by correspondence and discussion with the Executive Committee of the Council, had put forward two proposals and had been given power to make preliminary investigations of these proposals prior to reporting to the second meeting of the Council which occurred between 23rd and 25th November of that year.

At that meeting and subsequently the Council discussed the programme of research to be undertaken and the minutes reveal a wide array of proposals largely concerned with the problems of the primary industries of Australia. However, Madsen as an engineer and physicist had other ideas.

On the 25th November, 1926 he attended a meeting of the Council, not then being a member of it, and proposed the founding of a Radio Research Board and later, at the same meeting, made proposals for the maintenance of the standards of weights and measures for the Commonwealth. These events mark the beginning of two major interests that Madsen pursued effectively in collaboration with CSIR and in which he maintained a very close personal interest throughout the remainder of his life.

Engineers throughout Australia were conscious, in an environment of growing industrial activity, of the need for properly maintained standards of weights and measures and their interest was stimulated by the powers given to the Commonwealth, under its new constitution, to legislate in this field.

All industrial, engineering and commercial activities, whether these be concerned with the buying and selling of goods or land or with engineering construction and even involving the simple transactions of the grocer and the butcher, depended vitally on proper and accurate measurements. Scientific investigations are frustrated if measurements made cannot be interpreted with accuracy throughout the scientific world.

This was of course generally understood. The National Physical Laboratory had been founded in the United Kingdom in 1900 while the Bureau of Standards in the United States of America was founded in 1901. The primary question in Australia was whether this country was also in need of a comparable institution to maintain the primary standards of mass, length, time and the multitude of others that are derived from these.

The history of the events that cleared the way for action to be taken for the maintenance of Australian standards of weights and measures is complex; the most significant events are as follows.

The first was that in the framing of the Science and Industry Research Act 1926, the Government had given power to CSIR to undertake "the testing and standardisation of scientific apparatus and instruments and the carrying out of scientific investigations connected with standardisation of apparatus, machinery, materials and instruments used in industry".

Thus CSIR had to consider the actions that it should take to fulfil its obligation under this Act.

Secondly, it became clear to the Executive Committee that the State Governments, hitherto responsible for the supervision of legal measurements, wished some action to be taken. In September 1936 a conference of Commonwealth and State Ministers resolved that if the Commonwealth Government enacted legislation covering the establishment and maintenance of Commonwealth standards of weights and measures the States would co-operate fully in regard to the uniform adoption of such standards throughout Australia.

In 1938, some twelve years after Madsen's initial proposals to the Executive Committee, positive action was possible; with the concurrence of the Minister, approval was given for the establishment and staffing of the National Standards Laboratory. Madsen was asked by the Executive Committee of the CSIR to supervise the construction of the building and the initial allocation of work to the various sections of the scientific staff employed and to assist generally in the development of the whole project. He arranged for the appointment of heads of sections and organised for them specialist training abroad particularly at the National Physical Laboratory at Teddington in England.

The Executive Committee of CSIR had at that time the policy of establishing its laboratories, wherever possible, within the grounds of the Australian Universities. Madsen, through his University connections, obtained, on behalf of CSIR, the concurrence of the University of Sydney to build its new laboratory in the grounds of that University. This planning and action was overtaken by the outbreak of war in 1939. Indeed some of the senior officers sent overseas were at the National Physical Laboratory in England during the early part of the war.

The building was completed in 1939 and the National Standards Laboratory began active operations. But the stress of war required a rethinking of the immediate work for this institution. With the considerable growth in the Australian munitions manufacturing industry there was a call for a service to this industry particularly by supplying tools and gauges to control the dimensions and accuracy of the munitions output. As a result the National Standards Laboratory in collaboration with the Munitions Supply Laboratories in Melbourne quickly expanded existing facilities for providing this service. Particularly in the early stages of this endeavour Madsen, as the representative of the Executive Committee of CSIR, played an important role as a stimulator and a co-ordinator.

When the war ended the staff were able to resume their rightful role as originally planned. Before many years had passed the National Standards Laboratory became the custodian of the legal standards of physical measurement for Australia and, with the passage of the National Standards Weights and Measures Act, and the setting up of collaborative arrangements with the State Weights and Measures Authorities, the original concept that Madsen had in presenting his ideas to the Executive Committee of CSIR in 1926 began to be realised.

Madsen's proposal to the CSIR in 1926 that a Radio Research Board be formed to encourage research in the Universities received the wholehearted support of the Council. Madsen's efforts in this direction were supported by the then Director of Posts and Telegraphs and Secretary of the Postmaster-General's Department, H.P. Brown. The funds needed were provided both by the CSIR and the Post Office. This meant that the Board could get under way and by 1929 had already appointed its first investigators.

Once the Radio Research Board had money to support its research activities a steady and increasing stream of scientific publications began to appear, many of which were published in special bulletins of the CSIR entitled the "Radio Research Board Reports". Support was given initially to research activities in the Universities of Sydney and Melbourne. When this work first began, the original radio broadcasting system of Australia had not long come into existence and, as a result, there was considerable interest in the spacial distribution of the signal strength of the broadcast transmitters. One of the first papers published under the auspices of the Board was on the field intensity measurements around some of the broadcasting stations that then were in operation (1930).

In 1930 the investigation of the distribution of atmospherics and thunder storm activity began with these researches located mainly in Melbourne University.

Another theme was soon to become one of the principal interests of the scientists working under the Radio Research Board. Early in the 20th century, as a result of Marconi's successful transmission of radio waves across the Atlantic, the existence of ionized layers in the upper atmosphere was postulated by Heaviside and Kennelly. In 1925 Appleton and Barnett performed the now famous first experiment giving direct proof to the existence in the upper atmosphere of ionization layers capable of reflecting radio waves. This experiment initiated widespread interest in the use of radio methods for the investigation of the upper atmosphere and, to the scientists of the Radio Research Board, the opportunity of making similar investigations in the southern hemisphere had immediate appeal. The first measurements of the heights of the Heaviside layer over Australia were recorded in 1930. From then on there gradually developed comprehensive studies of the ionized layers over Australia and the effect of these layers on the nature of the down coming signals reflected from them. These studies were important for two reasons. They were of practical interest to those who had the responsibility for the development of communications by radio over long distances but they were, in themselves, of intense interest as providing a means for the measurement of the characteristics of the upper atmosphere. The level of ionization and its variations with time were determined, the pressure and temperature of the atmosphere at these levels found, and the atmospheric constituents ionized by the sun's radiation identified.

New techniques were devised for the continuous automatic observation of the changing conditions aloft so that by 1939 a considerable volume of information of this nature had accumulated.

The work of the Radio Research Board prior to the outbreak of war in 1939 contributed considerably not only to the knowledge of radio propagation in a wide variety of conditions but also had added to the knowledge of the upper atmosphere which was also being gained in the United Kingdom, the United States and elsewhere. The Australian researches ranked equally with those overseas.

This, in itself, is a tribute to Madsen's imaginative approach to the possibilities presented by the Radio Research Board in the encouragement of this type of science for this country.

However, the presence of the Board had another important effect on the growth of Australian science. Although it was the practice after a time of the Board to employ some full time scientific leaders the Board devoted its funds mainly to the support of the research workers of the electrical engineering and physics departments of the Universities. It became possible for those students wishing to undertake post graduate studies to do so in the fields of interest to the Radio

Research Board. Many scientists now in prominent positions in the Universities of Australia, in CSIRO, in the departments of Government such as that of Civil Aviation and in private industry, gained their initial experience as research scientists through the help given by this Board. Madsen, as Chairman and his associates through the financial aid continuing year by year given to the Universities at a time when research funds were otherwise very limited created lively schools of upper atmosphere geophysics and radio science. This was in fact Madsen's original objective and he fortunately lived to see the extraordinary influence it had on Australian physics.

In the University of Sydney it was the Department of Electrical Engineering that became the centre of the researches financed by the Board. Here the senior members of the Board's staff had their laboratories to house their equipment and the students supported by the Board. Madsen's personal influence was considerable for he not only had an intimate knowledge of the programme but exerted his skill to assist his colleagues. Although his senior colleagues were responsible for initiating and carrying out their own researches Madsen throughout continued his interest and afforded them his active assistance.

With the outbreak of war in 1939 the scene of necessity changed. Although many of those concerned with these researches were diverted to other work, the Board successfully developed its activities to be of value to the fighting services. Under war time conditions radio communications became of paramount significance and it was of vital interest to the fighting services to be able to foretell the conditions for successful radio communications particularly when this had to occur over areas of the globe occupied by the enemy.

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The Radio Research Board created an Australian centre for the forecasting of radio communications conditions. This centre, based principally on Sydney University, collaborated with similar groups in the United States and England and throughout the war provided important data of this nature to the fighting services.

At the termination of hostilities the Board resumed its peace time role of supporting University physics and electrical engineering and this still continues. With the increasing finances made available to it the CSIRO, by the Postmaster-General's Department, the Overseas Telecommunications Commission and the Australian Broadcasting Control Board, it became possible to support a wide range of researches in many of the Universities of Australia. Today grants are given to the majority of the Australian Universities and the variety of research investigation has increased with a corresponding output of valuable scientific results.

Throughout the pre-war period, during the period of hostilities and for many years afterwards Madsen continued his role as Chairman of the Board and as an enthusiastic stimulator of University research through the Board's agency.

The importance of Australian contributions to radio and upper atmosphere research were recognised when the International Union of Radio Science held its 10th General Assembly at Sydney University in 1952. Madsen was elected President of URSI for this meeting and this was certainly a compliment to him since it was the first time that an International Union had met in this country.

The secret development of radar in Great Britain and the vital part it played in the air defence of that country is one of the great stories of the last war. The full story of radar research and development in Australia and its use in the south west Pacific area of operations has not yet been published; when it is Madsen will figure as a principal leader in this effort.

The idea of using the reflection of radio waves from aircraft to detect their presence in the sky approaching Great Britain was an adaptation to this purpose of the techniques which had been so successfully used in upper atmosphere radio science. As a result of the experience of the scientists of the Radio Research Board there were many in this country capable of taking up these studies when the war-time need arose.

In February 1939 the United Kingdom Government invited Australia to share its secret knowledge of R. D. F. which became known later as radar. When this invitation arrived it was to Madsen that the Executive Committee of CSIR turned for advice and help. In consultation with the Government and the leaders of the fighting services, it was decided that CSIR should set up the Radiophysics Advisory Board to bring about a proper contact between the scientists and the services and to be responsible for recommending the principal decisions regarding research, development and production. Madsen was invited to be its first chairman.

The need for a special secret radio laboratory immediately became evident and it was Madsen who proposed that this be built as an additional wing to the partially completed building of the National Standards Laboratory in the grounds of Sydney University. Indeed under the impact of the urgency of war this laboratory, which became known as the Division of Radiophysics of CSIR, was completed before its sister institution the National Standards Laboratory.

The scientists of this Laboratory played a conspicuous part throughout the war in the development of the special radar systems to meet the needs of the fighting services in this theatre of operations. Through the Radiophysics Advisory Board, and to safeguard the secrecy of these activities, arrangements were made with the Postmaster-General's Department for the production of radar equipment for service use.

As the war progressed, although secrecy was still maintained, a widening circle of scientists, engineers and industrial firms were brought into this effort and as a result a considerable number and a wide variety of specialised equipment was designed and produced.

With the arrival of the US forces in Australia, and particularly when the Japanese campaign in the Coral Sea began, attention was turned to the design of portable air warning equipment suitable for the very mobile operations that ultimately took the American and Australian forces from New Guinea to the north of the area and ultimately to Japan. Many sets of the light weight air warning equipment were made. They were manned principally by the personnel of the Royal Australian Air Force and played a conspicuous part in the northward island hopping advances under General MacArthur.

These were extremely strenuous days for Madsen since, as chairman of the Radiophysics Board, particularly in the early phases of these operations, he had the direct responsibility to see to it that the ideas of the scientific staff were properly aligned to the needs of the fighting services and, moreover, that production arrangements to supply the services with equipment were adequate. Neither of these requirements were particularly easy.

He resigned as Chairman of the Radiophysics Advisory Board in 1942 when it became evident that it was the production of equipment rather than scientific research that was of paramount importance to the services.

It was Madsen who conceived the need for the closest possible liaison between Australia, Great Britain and the United States. He went overseas on several occasions to initiate a very comprehensive liaison arrangement that was to bring about the exchange of information essential to progress in war time science at a time when this was the only method of exchanging scientific and technical knowledge.

Madsen's enthusiasm for the part Australia could play in the scientific war effort commanded respect overseas. He renewed his past personal friendship with W. H. Bragg and met many of the leaders of the British radar effort. In particular, since he and Tizard were of such similar personalities, they became firm and close friends seeing much of one another in the Athenaeum in London. He was shown most of what was being done in Britain and arranged for intelligence of this great effort to be available to his colleagues in Australia.

Similarly, with the help of the Australian Minister, R. G. Casey in Washington, he established a close liaison between the U. S. A. and Australia. His anxiety about the situation in Singapore led him to initiate active support there from Australia. This was cut short by the Japanese invasion of that part of the world. By good fortune he left Honolulu only a few hours before the Japanese attack.

When the war ended Madsen's desire still further to support research in the Universities did not by any means abate. In 1944 he conceived the idea of forming another body to support research, this time principally in the field of electrical engineering. He sought and obtained the co-operation of the Electrical Supply Association of Australia, an Association representative of all the power generating authorities throughout the Commonwealth. This Association provided the necessary finance to support an Electrical Research Board which was founded and began work in 1944. Although of more recent origin than the Radio Research Board, the

Electrical Research Board has been able greatly to stimulate research in many fields in a number of Universities.

Madsen's success as a Professor of Electrical Engineering can be attributed mainly to his firm belief that progress in electrical engineering had its origin in physics, a veiw not always held by engineers at the time of his appointment. This is amply shown by his continuing interest in the physics of the upper atmosphere which he described in the University of Queensland's Macrossan lecture in 1935 and in the emphasis he placed on the need for the scientists of the National Standards Laboratory to devote a considerable proportion of their time to research.

He maintained a continuing interest in the life of scientific societies; he was a Fellow of the Institution of Engineers, Australia, and of the Institute of Physics (Australian Branch). He was President of the latter body in 1945 and Chairman of the Australian National Research Council in the same year. Madsen was elected a Fellow of the Australian Academy of Science in 1954 shortly after the founding of that body. He regularly attended the congresses of ANZAAS.

In addition to all his other activities in association with CSIRO he served as a member of the Advisory Council from 1949 to 1955 and was a member of the N. S. W. State Committee.

Madsen retired from his Chair in the University of Sydney in 1949 at the age of 70; he had served much longer than usual to maintain his activities during the period of the war and for some years thereafter. He was Dean of Engineering in 1942, Chairman of the Professorial Board and a Fellow of the Senate of the University. When he retired after just on 50 years service to his University he was made a Professor Emeritus.

The award to Madsen by his own University of an honorary Doctor of Science degree gave him enormous satisfaction. Dr C. McDonald on this occasion made the following remarks:

> "The conferring of an honorary degree on a man of distinction is always a happy occasion, but when the recipient is an alumnus of the University which grants it, the honour falls on him with greater grace, for the University, though a loving mother, demands the most rigid standards of achievement from her own children."

He immediately joined the board of directors of an important company concerned in the manufacture of communications equipment, and he became very active in the company's interests, maintaining this connection until not many years before his death.

His efforts in the interests of science and of Australia were recognised by the award to him of a knighthood by His Majesty the King in 1941.

Madsen started his career in Adelaide by making distinguished personal contributions to the early studies of the structure of the atom and radioactivity. In other circumstances, if he had been living in England for example, he might well have continued this work and joined the ranks of the atomic physicists. To follow this career with distinction in Australia in 1909 was clearly almost impossible; the pace set by Rutherford and others was too fast to permit anyone living so far away as Australia to participate.

Whether or not Madsen made a deliberate decision to abandon this life of personal research cannot now be decided but for a man of his character it is not improbable that he saw in the University of Sydney an immediate opportunity of a different kind. At the University the electrical engineering department was there to be attended to and Madsen threw himself into this with enthusiasm. In Sydney University, as the first Professor of Electrical Engineering, he built up a distinguished department in that subject.

His energetic interest in scientific affairs was not satisfied by the University scene. By 1926 his abilities as a determined planner and administrator had matured. Many of his closest friends were involved with the new Council for Scientific and Industrial Research and through this body Madsen saw the opportunity to play his part in a wider national scene. He was the creator and mentor of Australia's National Standards Laboratory and its associated activities. His Radio Research Board brought University research in upper atmosphere geophysics and radio science to its present high level and laid the firm foundation for further advances particularly in radio astronomy. Through the Electrical Research Board he encouraged further research in the Universities.

Madsen's whole life was dedicated to science and engineering. Even his opponents who feared his determination, diplomatic skill and enormous energy never attributed any other motive to him than that of wanting to further the progress of science in the way that he felt it should go.

He served his country in the first world war in the training of army engineers and made a much wider contribution in the second war through his active chairmanship of the Radiophysics Advisory Board.

He was a keen tennis player and for many years he relaxed by beach fishing on the south coast of New South Wales. It was here that he took his young family and later went with close friends. He delighted to expound his theories of time and tide to account for good or bad catches. Beach fishing had in his view to be subject to scientific analysis.

At his home in Roseville he had an excellent workshop where, in his limited spare time, he practised the craft of his profession of engineering. Metal and wood working gave him joy for he admired the skills of these, the craft that supported more sophisticated engineering.

Despite his boundless energy and devotion to the cause of science, his home became a focal point for the widespread family of which he was a member. They, and many other close friends, regularly enjoyed the warmth of his hospitality, and he was never too busy to give advice and guidance to those who sought it, even on matters far from the realms of science. His loyalty to his friends and colleagues was perhaps the foremost of his many human attributes.

He attracted close personal allegiance from those who found him stimulating and encouraging. Their achievements he relished and admired and were of importance to him but he was not much concerned with those who were not of this group. His strength was that in all his endeavours he had clearly planned objectives which he followed with determination and skill.

In his last days when it was evident to him that his time had expired he assisted others in the important task of recording the history of those activities in which he and his colleagues had played a direct part over so many years. When he died few of those of his contemporaries remained who had passed with him through the seventy years of initial growth of scientific research in physics and engineering in this country. His passing certainly marked the end of an epoch in the history of Australian science.

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1. W. H. Bragg and J.P.V. Madsen
"The Quality of the Secondary Ionization due to β Rays"
Trans. Royal Society of South Australia. 31, 300, 1906/07

2. W.H. Bragg and J.P.V. Madsen
"An Experimental Investigation of the Nature of γ Rays, No. 1"
Trans. Royal Society of South Australia. 32, 1, 1908

3. J.P.V. Madsen
"The Ionization Remaining in Gases after Removal of the Influence of the Ionizing Agent"
Trans. Royal Society of South Australia. 32, 12, 1909

4. W.H. Bragg and J.P.V. Madsen
"An Experimental Investigation of the Nature of γ Rays No. 1"
Phil. Mag. Vol. 15, 663, 1908

5. W.H. Bragg and J.P.V. Madsen
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9. J.P.V. Madsen
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10. J.P.V. Madsen
"The Ionosphere and its Influence upon the Propagation of Radio Waves"
Macrossan Lectures, University of Queensland, 1935.

The Published and Other Scientific Papers of Sir John Madsen

B.Sc., B.E. (Syd.), D.Sc. (Adel.)

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The originals of these papers ~~are~~ will be held by the Basser Library of the Australian Academy of Science

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i)	On the absorption of alpha rays, and on the classification of the alpha rays from radium	W.H. Bragg, Phil. Mag., Dec. 1904.
ii)	On the ionization curve of radium	W.H. Bragg, A. Kleeman, Phil. Mag. Dec. 1904.
iii)	On the alpha particles of radium, and their loss of range in passing through various atoms and molecules	W.H. Bragg, R. Kleeman, Phil. Mag. Sept. 1905.
iv)	On the ionization of various gases by the alpha particles of radium	W.H. Bragg, Phil. Mag., May, 1906.
v)	On the ionization of various gases by the alpha particles of radium - No. 2.	W.H. Bragg, Phil. Mag., March, 1907.
vi)	The influence of the velocity of the alpha particle upon the stopping power of the substance through which it passes.	W.H. Bragg, Phil. Mag., April, 1907.
vii)	A comparison of some forms of electric radiation	W.H. Bragg, T.R.S.S.A., May, 1907.

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viii)	The nature of Rontgen rays	W. H. Bragg, T.R.S.S.A., June, 1907.
ix)	The ionization curve of methane	W.H. Bragg, W.T. Cooke, Phil.Mag., Sept., 1907.
x)	The experimental investigation of the nature of gamma rays	W.H. Bragg, J.P.V. Madsen, Phil. Mag., May, 1908.
xi)	The ionization remaining in gases after removal from the influence of the ionizing agent	J.P.V. Madsen, T.R.S.S.A., April, 1908.
xii)	Secondary gamma radiation	J.P.V. Madsen, Phil.Mag., March, 1909. ✓
xiii)	The scattering of the beta rays of radium	J.P.V. Madsen, T.R.S.S.A., April, 1909.
xiv)	Radioactivity as a Kinetic Theory of a Fourth State of Matter	W.H. Bragg, Weekly evening meeting, The Royal Institution, Jan. 27, 1911.

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xv)	The quality of the secondary ionisation due to beta rays.	W.H.Bragg, J.P.V.Madsen, Phil Mag., October 1907.

Part 2. Correspondence in the period 1908-1911 – *attached*.

i) Letter to 'NATURE' Nov. 19, 1908 by J.P.V. Madsen on "The nature of gamma rays".

ii) Letter from W.H. Bragg, March 2, 1909.

iii) Letter from W.H. Bragg, April 29, 1909.

iv) Letter from W.H. Bragg, May 18, 1909.

v) Letter from W.H. Bragg, August 1, 1909.

vi) Letter from W.H. Bragg, Oct. 6, 1909.

vii) Letter from W.H. Bragg, Dec. 12, 1909.

viii) Extract from a letter by W.H. Bragg to Rutherford, Feb. 12, 1911.

ix) Letter from Rutherford to J.P.V. Madsen, March 8, 1911.

x) Description and interpretation of Madsen's experiment by W.H. Bragg – "*Studies in Radioactivity*".

Part 3. Various papers published after 1911.

i)	'Studies in Radioactivity'	W.H. Bragg, Macmillan, 1912, pp. 85, 116
ii)	'The Life and Work of Sir William Bragg'	John Murtagh Macrossan lecture 1950 Sir Kerr Grant
iii)	Presidential address to Electrical Association of N.S.W., 1914	J.P.V. Madsen
iv)	'Australian Standards'	J.P.V. Madsen, The Institution of Engineers, Aust., Paper no. 4, Vol. ix, 1928.
v)	The Ionosphere and its influence upon the propagation of radio waves	John Murtagh Macrossan lecture 1935 J.P.V. Madsen

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(a) Corrections to Field Strength Measurements with Loop Antennae
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H.C. Webster

THE UNIVERSITY, LEEDS.

My dear Madsen

Just a line to report progress.

I have accepted, with Rutherford's approval,
an offer from the Chininfabrik Braunschweig
to supply 10 mmg now & 20 in May
at £16.5. a mmg. It seems an
awful price, but Rutherford says it is
right. I am thinking of making a small
cup with two divisions in it, one to hold the
10 the other the 20; & the radium must be
put into 2 separate receptacles that will
fit into the cup side by side, so that I can
send you the 10 now in the cup & let the
20 follow. The activity is guaranteed 90%.

Yrs WHB.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE.]

An Electromagnetic Problem.

In the application of general principles to special cases it is sometimes found that the result is a seeming paradox, which is not always easy to remove. Such problems, although involving no new principle, are nevertheless of considerable interest, and after attaining their satisfactory solution we often realise that we did not before appreciate the full import of the general law.

The following question has been discussed with considerable interest among some of the writer's friends, and therefore it seemed not improbable that other physicists might be interested.

If two spheres of positive electricity are near together and are suddenly released, it is clear that their potential energy decreases as they separate and goes over into kinetic energy of motion. This kinetic energy is, of course, the energy of the magnetic field which results from the motion of the charges.

It seems possible, however, to arrange a system so that this magnetic field shall vanish because of symmetry, and the question then presents itself, Where is the energy? Suppose we have a sphere of positive electrification placed as the water is in a soap bubble, and capable of expanding under the mutual repulsion of its parts. The potential energy of the electricity certainly decreases as the sphere expands, and *if the electricity be considered continuous* there is certainly no chance for a magnetic field, as is easily seen from consideration of symmetry. If the sphere be allowed to expand, where does the energy go? The obvious answer is that the electricity is not continuous, but exists as discrete particles, *i.e.* as electrons; but if we try to escape the difficulty in this way, it is equivalent to admitting that the electrical laws, together with the conservation of energy, *require in themselves* the discrete structure of electricity. If, on the other hand, we say that the electricity is associated with matter, *i.e.* with ponderable mass, and the energy appears as ordinary mechanical energy of motion, then we are admitting that the electrical and energy laws *require the association of electricity with matter.*

There seem to be no other solutions to the problem than those above given, and if we admit either of them we reach a conclusion which certainly is striking when we consider that we have only used the general laws of electricity and energy.

The writer does not state the above as a fundamental paradox, but only as an interesting problem.

D. F. COMSTOCK.

Institute of Technology, Boston, Mass., November 3.

The Progress of Aviation.

I have read with great interest the article on the above subject by Prof. Bryan in NATURE of October 29.

May I be permitted to direct especial attention to the necessity for finding the displacement of the centre of pressure on all kinds of surfaces and at all angles therein referred to? The paper by Prof. Bryan and Mr. Williams on the subject of longitudinal stability, and Captain Ferber's article in the *Revue d'Artillerie* (November, 1905), both assume the truth of Joëssel's law. There is, however, every reason to suppose that there is a certain critical angle below which Joëssel's law ceases to be true, the displacement decreasing with the angle instead of increasing.[1]

Consequently, the numerical conclusions arrived at from the stability formulae of Captain Ferber and Prof. Bryan may be very wide of the mark.

I hope to experiment in this direction myself, but my time is very limited. There can be no doubt whatever that a thorough investigation as to the centre of pressure would be of the greatest practical use.

HERBERT CHATLEY.

32 Britannia Road, Southsea, October 31.

[1] Spratt-Moedebeck's "Pocket-book of Aëronautics" (1901); Wilbur Wright, Smithsonian Report, 1902, pp. 133–148 (*Journal of Western Society of Engineers*, December, 1901); Turnbull, *Physical Review*, vol. xxiv., No. 3, 1907.

I agree strongly with all that Mr. Chatley has said. It cannot be too emphatically pointed out that the object of our stability investigations was to show that the subject is capable of being treated mathematically, and that, *given the requisite experimental data*, the conditions of stability of any system of planes or surfaces can be calculated out in the form of numerical results. The cases in which this was done were intended merely as *examples* illustrative of the general method, and for this purpose Joëssel's law furnished the simplest assumption available at the time. It will be noticed, too, that arbitrary values were assumed for the moments of inertia of the systems. To draw inferences from the results of examples worked out with this object would be an unfortunate mistake.

It is to be regretted that want of time has prevented my attempting to work out any examples based on the Turnbull results, though the idea suggested itself when I saw the paper in the *Physical Review*. The theory of stability has thus been somewhat at a standstill. Those who, like Mr. Chatley and myself, would like to see that theory advanced are prevented from doing this by pressure of other duties, while those who have the necessary time and money have been mainly occupied of late in breaking records. Mr. Lanchester's theory of stability starts from so different a standpoint that it must be discussed at a future time.

G. H. BRYAN.

Potato Black Scab.

The discovery this autumn of black scab in the potato crop in two localities in co. Down was the means, through the Irish Department of Agriculture, of supplying me with excellent material of diseased tubers for examination. I have kept the resting "spores" of the chytridian fungus *Chrysophlyctis endobiotica*, Schilb., causing the disease, under varied conditions of temperature, nourishment, moisture, and light; and have succeeded in causing the "spores" to germinate, especially by cultivation in potato juice. Each "spore" proves to be a zoosporangium, full of zoospores or zoogonidia, seen in active swarming motion before rupture of the sporangium. The zoospores, 1.5–2 μ in diameter, escape through a slit-like opening in the wall of the sporangium 30–60 μ in diameter, and have the usual characters of a chytridian zoospore.

Since the publication of Schilbersky's short preliminary account in 1896 in the *Berichte der deutscher botanischen Gesellschaft*, and Potter's account of his discovery of the pest in Cheshire in 1902, we have learnt nothing of the life-history of this injurious fungus.

T. JOHNSON.

Royal College of Science, Dublin, November 17.

The Nature of γ Rays.

Experiments by Prof. Bragg and myself upon the secondary kathode radiation which proceeds from matter through which γ rays are allowed to pass, taken in conjunction with the similar result announced by Mr. Cooksey in NATURE of April 2 (vol. lxxvii., p. 509) for X-rays, support the theory of the material nature of X and of γ rays originally advanced by Prof. Bragg.

The modification of the ether-pulse theory recently advanced by Prof. Thomson may possibly furnish a partial explanation of these effects, but in the light of some experiments which I have lately carried out upon the secondary γ rays, even this modification seems quite insufficient. A brief summary of these results is appended.

(1) The γ rays of Ra, and probably of Th, appear to consist of two distinct homogeneous bundles, the value of λ/Δ (where λ is the absorption coefficient and Δ the

density of the material) for the soft set being approximately four times that for the hard.

(2) For each set of rays the value of λ/Δ is constant, and practically independent of the nature of the absorbing material with which λ is measured, provided that in the case of the soft rays secondary effects be excluded.

(3) Secondary γ radiation appears on both sides of a plate which is penetrated by a stream of γ rays. There exists a marked lack of symmetry between the amount of secondary radiation which proceeds from the two sides.

(4) A lack of symmetry exists in the case of some substances between the quality of the radiation on the two sides.

(5) The last results seem very difficult to reconcile with a pulse theory. On the "material" theory propounded by Prof. Bragg no such difficulty arises.

(6) The secondary γ radiation appears to be derived from the primary by a process of scattering, this process generally involving a reduction in the subsequent penetrating power of the ray affected.

(7) There appears to be reason to believe that the distribution of the scattered radiation depends to some extent upon the hardness of the radiation which is scattered, also upon the nature of the material in which the scattering is produced. The softer radiation appears to be turned back to a somewhat greater extent than the hard. Materials of high atomic weight seem to be able to produce more complete scattering than those of lower atomic weight.

(8) The absorption of γ radiation which has already passed through a thickness of one substance by screens of a different substance may not in all cases give a true measure of the absorption of the original radiation which has been effected by the first screens.

J. P. V. MADSEN.

University of Adelaide, October 1.

[As there are few opportunities in Australia for an investigator to place his views quickly before a scientific public, we print the above letter, but with it the correspondence must cease. The subject is more suitable for discussion in special journals devoted to physics than in our columns.—ED. NATURE.]

The Origin of Spectra.

THE very interesting observation of the anomalous dispersion of luminous hydrogen in the neighbourhood of the Hα line recorded by Messrs. R. Ladenburg and Stanislaw Loria in NATURE of November 5 (p. 7), and the known absence of the phenomena in ordinary hydrogen, show conclusively that *the spectrum lines of a substance are not free periods of the atoms in their normal state, but only of those systems produced somehow by the agency which gives rise to the spectra.*

The figure 1/50,000 as the number of electrons per atom of course means that in the gas under experiment only one atom in 50,000 was emitting the Hα line at any one time. The very important remark is made that the anomalous dispersion in the neighbourhood of the other lines of the hydrogen series "is expected to be much smaller than that at the Hα line." If this be so, it will show that at any given time different numbers of atoms are producing the different lines, that is to say, that the spectrum is not produced *in toto* by each atom. Each atom (or rather the system emitting the lines) may, for instance, only be emitting one line at a time. These results are the same as those I have deduced from Prof. R. W. Wood's work on the anomalous dispersion of sodium vapour. Sodium vapour shows anomalous dispersion in the neighbourhood of all the lines of the principal series, which "is very strong at D_1 feeble at the first pair of ultra-violet lines λ 3303, and almost imperceptible at λ 2852." It is also, Wood states, stronger at D_2 than at D_1. This shows that the number of atoms emitting D_2 at any time is greater than the number emitting D_1, and both these are much greater than the numbers emitting the higher members of the series. We note that there is no anomalous dispersion in the neighbourhood of the lines of the subordinate series of the sodium spectrum, showing that heat alone does not produce those systems which vibrate with the periods of the subordinate series, which agrees with the facts that these series do not appear in the absorption spectrum of sodium vapour or in the Bunsen flame spectrum of sodium.

It thus seems probable that different series of lines in a spectrum are produced by entirely different vibrating systems, while any system possibly only emits one line at a time of its own particular series, depending upon the manner in which it has been struck. It is evident that the different vibrating systems obtained, and their relative proportions, may be expected to vary with the nature of the electrical discharge producing the spectra, and hence the variation of the spectra under different conditions. This may, perhaps, on the modern views, be regarded as the same idea put forth many years ago by Sir Norman Lockyer in his dissociation hypothesis.

I make these observations in order that those working on the subject from the theoretical side may the better see the phenomena to be explained, which are quite different from ordinary dynamical vibrating systems.

In conclusion, I should like to direct attention to the importance of extending Messrs. Ladenburg and Loria's work. By examining every line in the spectrum of an element we could, for instance, say whether a line was faint because very few systems were emitting it, or whether its faintness must be attributed to the fact that the vibrations producing this line have only a very small amplitude.

ALBERT EAGLE.

Imperial College of Science and Technology,
London, November 9.

A Gall-producing Dragon-fly.

WHEN looking through Dr. C. Houard's new work on galls ("Les Zoocécidies des Plantes d'Europe et du Bassin de la Méditerranée," tome I.), I was surprised to find on p. 240 an entry:—"Minime borselette Q. ped. *Lestes viridis*, Van der Lind."

A gall-producing dragon-fly was quite new to me, but on looking up the subject I found a series of very important observations on the oviposition and larva of the species in question by the Abbé Pierre and M. de Rocquigny-Adanson, in the *Revue scientifique du Bourbonnais et du Centre de la France*, xv. and xvi. (1902–3), and the *Annales et Bulletin de la Société entomologique de France* for 1904. As these seem to have been entirely overlooked in England, I think it may be useful to epitomise them as briefly as possible.

The eggs of *Lestes viridis* are laid on the branches of a great variety of deciduous trees and shrubs, but always close to, or overhanging, water, and therefore probably most often on alders or willows. These result in the production of small galls, which are sometimes extremely abundant, and which are thus described by Pierre:—

"Un bourrelet mesure de 1 mm. ½ à 2 mm. de longueur, sur ½ ou 1 mm. de largeur. Deux bourrelets sont associés en chevron et forment un angle d'à peu près 90°, ouvert vers le bas du rameau. Le sommet de l'angle présente une pellicule corticale plus ou moins arrondie, formant clapet au dessus de l'ouverture par laquelle de 1 à 4 œufs ont été insérés sur chaque bourrelet. Enfin les chevrons distants de 2 mm., sont associés en série longitudinale, de telle façon qu'une même génératrice du rameau soit sensiblement bissectrice de tous les angles."

The emergence from the eggs and the structure of the larva are equally curious. The new-born larva, or "pro-larve," as Pierre calls it (*Ann. Soc. Ent. de France*, 1904, pp. 477–84, pl. iv.), resembles a coleopterous pupa, being enclosed in an outer membrane which leaves it only the power of leaping. If these young larvæ do not fall into the water on emerging from the egg, they leap about, sometimes for several hours, until they succeed in reaching it. After reaching the water the pro-larva rests on its back for two hours, and then casts the skin, a process occupying from three to thirteen minutes. The larval development of *Lestes viridis* has been compared by M. Giard to that of the crickets. A similar structure of the newly emerged larva has also been noticed in *Epitheca bimaculata*, another dragon-fly.

I may remark that *Lestes viridis*, though common on the Continent, is an insect of great rarity with us, and not firmly established in the list of British species.

W. F. KIRBY.

ROSEHURST:
GROSVENOR ROAD.
LEEDS.

March 2.

My dear Madsen

Just a note to acknowledge the receipt of the cheque. My word! you are a lucky chap. I have seen Rutherford about it: & he says, as I expected, that the only thing to do is to write to Giesel which I will do at once. I will write you a letter about Bragg & very soon. I am so glad your work is going on well.

My wife and I are so dreadfully sorry about the little baby that did not live. My wife was so distressed when I told her about it. Do tell her how sorry we are about it. My wife says only a woman can realise what it means.

I hope the rest of the family is well & happy.

Kindest regards

Yrs ever
WHBragg

I will write again as soon as I hear from Giesel. I shall be delighted to see Dinsa

THE UNIVERSITY,
LEEDS,

April 29. 1909

My dear Madsen

I told you I would write after the meeting of the Physical Society. Well, I went up armed with every weapon I thought might be needed; but there was hardly any argument. There was a good attendance, and Lees made the only sensible comment. He said that what was now wanted was greater precision: some absolute standard of hard and soft. Of course I agreed [illegible] anything and said that I thought the determination of the speed of the cathode rays which each X ray gave rise to was the first and most important determining factor as representing the energy. There might be a "quality" in addition. Barkla was not there; but his representative Sadler called attention to the fact that

~~Those~~ in our figures for the absorption by two tin foils the figures

	Sn	Cu	Zn	Al
Emergence	176	140	39	185
Incidence	122	119	15	60

& four tin foils

Emergence

Incidence

May 1. I had to stop here last week and was too late for the mail: now I can go on. But now I have not the paper from which I was quoting, as I am writing at home and the paper is at the University and I must post tonight. But if you will look at the paper (Glasson's & mine) you will see what I am going to tell you. Sadler [illegible] several of the figures had constant differences e.g. 140 − 119 = 21, 39 − 15 = 24 and some more from the figures for the four tin foils. I hinted that either I had got a constant error or else there was some addition to the emergence, or else there was some new radiation playing up with the experiments! Well that was about all, except that one or two made friendly & complimentary remarks. I had a long talk to Sadler afterwards and found him much more amenable and quite friendly. He admits that the old form of the pulse theory has gone

6 U 11

The University, Leeds.

May 18

My dear Madsen

The radium for you has been posted and I hope will
arrive safely. It was registered: and I would have insured it
but there are no insurance terms to Australia. I do hope
you will find it all satisfactory.

I had rather a bother with the cup. The makers of the radium
(Chemiefabrik Braunschweig) refused to have anything to
do with the cup: and I had to make it here. I did not know
the dimensions very well, but I calculated that if 30 mmg were
spread over 1 cm² or thereabouts your self absorption of β rays would
be 15% which I thought a fair compromise. So I used a platinum
cup made in the town here and fitted into a brass turned
in my own shop: making the whole thing rather big and loose
so that the radium people might pack it to suit. But they
returned it: I think They do not like putting it in such an
arrangement and I am not sorry myself that it should go
out to Australia in a glass tube. Unpack it carefully.
The glass tube is not likely to crack, but suppose it did!
I think you might undo the last little square box on a
clean sheet of glass so that if there had been an accident by
any chance you could have everything in the one spot. I made
the cup flat because the radium would be arranged more
economically that way: and I am sending it on in the hope you
will be able to use it or alter it. I dare say you could get to it

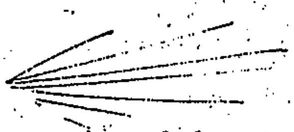
The University, Leeds.

made a little shallower – it is platinum of course.

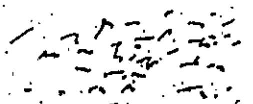
How are you getting on? How do you like Rutherford's new atom? The situation is rather funny now. Crowther & Barkla were just now arguing in the same Phil. Mag. about the X ray scattering and its relation to J.J.'s theory: and Rutherford brings forward a theory which cuts the ground from under the feet of all of them if it is true. Rutherford's theory touches your β ray work very nearly: and indeed the law of scattering of the β particle is very much to be determined in order to test his theory. Knowing that you were working away at this and having your last letter explaining what you had got I thought it best to show it to Rutherford. I thought if he went at it hard he would use all his opportunities get ahead of you: he is a very generous chap and always ready to give everyone all he can. So I thought that if I told Rutherford exactly what you were doing and had done, he would take you in so to speak: your results agree with his theory very well, and you will see in his paper that he has made special reference to what you have published. If you have anything more, now or in the future, I should write to him direct or at least through me if you prefer, and I know he would like to hear from you and build in anything you had to give.

You may have seen that C T R Wilson has given a paper at the R.S. on a method of making visible the tracks of ionising particles. He is very ~~excited~~ excited about it: has been working at it two years and just been successful. He flashes the rays (α β γ or X) through the gas & takes an instantaneous picture of the fog caused by simultaneous expansion. The ions have not had time to spread and so you see the tracks. The plates I believe are not as

fine as the real thing which they say is gorgeous, especially for
the α particles. My boy has seen them. CTR sent me two
photos which Rutherford has just now or I would send them to you.
The α particle is like this :-



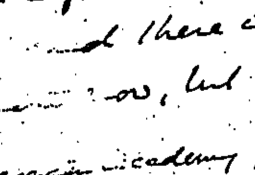
The shorter paths are of α particles that are not in the plane of the
cell & have hit the walls I suppose. They are beautifully defined.
The X rays are is "rather an effort" as my schoolboy Bob says. It
is like this



can't be anything else but the track of the cathode rays in the gas!
The γ rays have not been photographed: but to the eye CTR says they show
fine delicate straight lines right across the chamber which are no
doubt the β rays from the walls.

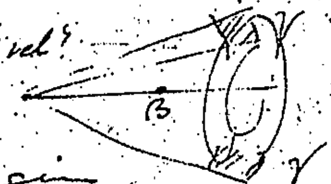
I am reading a paper in the RS next week: just explaining
the transformation of energy of the X rays: trying to account for the
expenditure in secondary and in cathode rays. It has been
awfully hard because it is quantitative and there is so much
to be taken account of. It is only approximate now, but I think it
breaks the ice.

Sommerfeld has just carefully worked out (Bavarian Academy) what sort of a γ ray
the electromagnetic theory gives from the starting of a β ray of different
speeds. He gets lots of dissymmetry for he finds that suppose the
β ray goes off from RaC with a speed of 9.10 of light the γ ray goes out
practically in a hollow cone, the
dotted curve shows the intensity



PTO

in different directions: of course if the β ray began & ended
in a certain small time the γ ray energy will be confined also
between two spherical surfaces, which are not quite concentric. Thus
the γ ray is like a spreading ring: the β ray lags behind of course.
The semi-∠ of the cone is 15° for a 9·10[10] vel?
& 5° if the β ray gets up to 99%.



But this while it gives dissymmetry gives
no clue at all as to how γ ray energy, which is ever widening gets
back into one electron again. I have written to ask him & he is
bound to reply, I think, that the γ ray has a bigger action, or else that
there is a storing of energy.

I do hope you are all well. I am so glad to get something off
to the R.S: because it has been such a long job & the result seems so
small for the labour which is great. Still it is a start in this line: & the
X ray apparatus is now so good that consecutive readings differ by
less than ½ % : it has come out real well. I have got quite a lot
in hand: ~~[illegible]~~ I had a Royal Institution discourse, & I have done the
R.S paper & a long paper for Armstrong for Science Progress. Then I have
a book (200 pages) to do for Macmillan who asked me some months ago,
& I have promised to write the article on radioactivity for Thorpe's new edition
of his dictionary. We are all well: summer has come in beautifully
& the country is gorgeous. May it keep so! Many very kindest
regards to you old chap. & remember me to your wife & the University(?) people
Pollock Woolnough Vonwiller(?) & so on
& [illegible].
I will pay for the cup & send
back the rest of the money. Goodbye W.H.Bragg.

Bolton Abbey
Wharfedale
Aug. 1. 1909

My dear Madsen

I was glad to have your jolly letter
of June 10th. I saw Rosevelt on the
same line as Duramunne; I was not
there two or three times to my brother's
house? I am glad you are settled and
are all well. Doesn't it take a long
time rearranging all the work and
getting things going one's own way? I
like your idea of the cornets experiment
and with your consent I will use it in a
public lecture if I can.

I hope you are getting on with your
B ray experiment. I want you to get
those results out soon. There is a man
at Manchester, W. Wilson working at
B rays also: I know he is getting unorthodox
results which will rather run contrary to

r Schmidt & others. I believe it is not
actually the same experiment as yours,
but you must not let things go on too
long. By the way Rutherford said to me the
other day that if the B rays went forward drops,
then a very thin sheet should show them
nearly all going forward, since of course there
would be little to turn them back. I don't
remember that we actually attended to
this point; but I must look up the figures
I wonder if they show it. I had Rutherford
staying here for two days and it was great
fun: he & his wife came. We have [illegible]
a jolly old farmhouse overlooking Bolton
woods and with the moors at the back: a
glorious place altogether. We have enjoyed
it awfully even though it has rained most
days & just now does not seem able to leave
off. The moors belong to the Duke of Devonshire
and he & the Prince of Wales are coming down to
shoot next week. The heather is just coming
out. Well, Rutherford and I talked hard,
culminating on the last evening: then we both

enough to publish. I am working it with electroscopes, and I find that if you keep two going, one as a standard and reckon all the other readings as ratios to the standard you get marvellously consistent results even when the coil is not behaving.

Dr R. T. Beatty is working in my lab this summer. He is trying to find the velocity of the cathode rays due to the secondary Rö rays by a direct magnetic method: so as to check Glasson's result. He uses his [illegible] He uses my electroscope, you remember it. He uses my big coil, 20" spark & a great X ray bulb.

Kleeman is also here doing a diffusion of ions experiment. Another of my demonstrators is proving the absurdity of H W Schmidt's "reflection" effect, a fact he has done so. I tell you I have had a shot at it long ago, but the methods are different. Then is tackling N R Campbell's anomalies of the absorption by solutions.

I have a Norwegian called Vegard coming here to work for a few weeks and I am going to tackle it with him.

Geiger at Manchester has pretty well cleaned up the α ray problem. The particles do after all run right out in speed, but they get awfully scattered towards the end, so that Rutherford lost them by the photographic method. Also the scattering α √atomic wt.

I put one of my demonstrators on the question I was last doing in Adelaide, viz the cathode rays made by primary X rays. He got the whole thing in working order after great labour, and then had to go to London without getting at much. I started the next day and got the results at once, reaped the fruit of his labours! But of course I will publish the two names. I think there is going to be something to publish viz that the cathode rays produced in a substance are proportional in number to the absorption of the X rays, and that the X rays do not ionise the gases directly at all. You know I got this roughly in Adelaide, but not nearly good

got excited and stamped about the room
at intervals, to the amusement of our wives.
He is very sympathetic to the material theory.
He really had not gone into it properly and I
had to a lot to tell him which was new to him
both of the work of others and of ourselves. At
one time he broke out with conviction "The old
pulse theory (pause...), the old pulse
theory of Bragg's, is as dead as mutton!" And
he won't believe in J.J.'s energy blobs: no one
does, I think. H. A. Wilson said to me that
J.J. ought to be stopped by somebody. Rutherford
quite understands now all our points.
We talked a lot about Barkla's recent work,
which of course is awfully good. It is really
simple on the whole, and seems just
ripe for an explanation. We both agreed
that it was something jolly simple if only we
could hit it: and told me to hurry up or
he would be having a shot himself. He was
really awfully interested about it. The point
is that each metal, at any rate from
Cr to Zn has a special secondary homogeneous
[illegible] that this can be excited by the

radiation from any heavier atom and not by that
from a lighter. You will have read it of course.
I don't mind telling you the theory I am testing.
I am trying to find whether there is any connection
between the velocity of the cathode ray and the
power it has of exciting X rays in a given metal.
Suppose for example that the rays that best
excite X rays in Cu are faster than those that
excite X rays in Fe, & that when they get too slow they
don't have much effect. Then e.g. you will
have cathode rays which act well on Fe and not
at all well on Cu. Then all Barkla's results are
explained. The rays from Zn (say) fall on Cu:
they break up: cathode rays appear. These knock
about losing speed (it is certain now that this happens)
until they get to the right speed for Cu: then off come
the characteristic rays in quantity, and in all
directions and unpolarised. But of course the Cu
rays cannot excite X rays in Zn, because the cathode
rays cannot rise in speed. In other words Barkla's
homogeneous secondary is really tertiary. But I have
to test this theory; and I am only telling you: it
may come to nothing of course. A man called
Thirkill of Clare College Cambridge is coming

soon; I don't know what I'll put him
on to yet. My senior demonstrator
Shorter is doing initial recombination
especially of CO.

I have got a very nice house in
Leeds now, with a gorgeous billiard room!
and we are furnishing hard. Now
I must stop. Remember me very
kindly to my friends; David and Pollock,
Woolnough and Warren, Madsen, if
you see him. And write to me. I am
trying to keep you posted up, you see! I wish
I had Glasson's results as he gets them:
I want them: I shall have to repeat some
of them, if I don't hear. He was good enough
(for private information only)
to send me one paper (unpublished). By
the way I am going over Barkla's polarisation

is nearly finished.

Kindest regards, old chap: we had
great times together. I tell you, we made
people look into things again: Kleeman
says they thought X rays were about
played out — at Cambridge, until we
revived it all.

My wife sends her regards to you and yours.

W H Bragg.

I have not too much time for long
letters now, with all the racket of rearrangements.
Would you let Glasson have a look at this?

H.A. Wilson believes in the old pulse theory
and that heaps of pulses at last start the particle off.
But he has not really worked it out at all. He
is going to McGill, Montreal: & Barkla takes his
place at King's College.

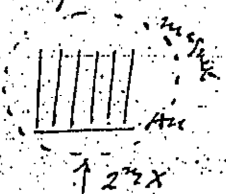
Leeds. Oct 6 1909.

My dear Madsen

I got your letter yesterday and am answering it at once. Besides I want to tell you how things are going generally. First I will take the contents of your letter. You say you are trying to "derive a polar diagram of the intensity of scattered β rays". Quite right: what is wanted is a "polar diagram" for every sort of ray and every sort of atom. You don't say whether you are using γ or β as the primary rays, but it would be valuable in either case. By the way, talking of the intensity of emergence and incidence β rays produced by γ's, the ratio of emergence to incidence should tend to very large values when the plate is very thin, if all the rays go straight forward. Can this be shown experimentally? We got very large values I know. But could the point be made quite clear, for it stands somewhat in contrast to a probable effect of cathode and X rays. (I see I am losing my arranged sequence already). Kaye has recently shown that when cathode rays fall on thin sheets the ratio of the emergence X rays to the incidence X rays is generally > 1 and is > 3 for aluminium. His paper is coming out in the Camb. Phil. Soc. Proc. I have seen the proof. I asked Kaye to send you a copy. Kaye was here half a day lately, and we got on splendidly together. I think this experiment converted him finally to the material theory, in spite of his being J.J.'s private assistant. He says he has shown the result to several, and no one can explain it on the pulse theory. Sometimes he starts with one foil & then goes on to two and three and so on: but he has not done many experiment altogether. He finds that R (emergence/incidence) grows a little with the thickness of the foil and then of course diminishes. I think this means that the X ray turns into the cathode ray at the moment of being swung round in the atom: and not that there is a chance of any cathode ray as it flies being turned into X, [without going out of its line of flight]. For then R should become enormous when the layer is very thin, since there are far more cathode particles going forwards than backwards in a thin sheet. In fact does a pair get stripped in its flight without the -ve losing its direction, and a -ve pick up a positive only in the act of turning? We want to settle this: and we ought to find the distribution or "polar diagram" of cathode rays due to cathode rays, X due to cathode, and cathode due to X. Kaye is trying to do the second of these: you are doing the first: very likely we shall do the third here. And the comparison ought to show something! By the bye one of my demonstrators, Keene, who has gone to Birmingham lately wrote asking me to suggest a job and I told him to try the second of the above, the same as you are undertaking. This was before your letter came of course. But don't worry! & his method is quite different, he is first making his R rays from X rays, you make them direct and he has not started yet and won't for a while I should think. Kaye quite sees all our points: he says the resemblance between the scattering of cathode rays and of X rays "is getting exciting." "So far as one could judge in the thin leaf experiments" he writes to me" by the phosphorescence of the glass walls of the tube, R for the secondary cathode rays seemed to follow any variation of R for the X rays: you could generally tell

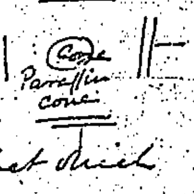
from the look of the tube whether R. for the X rays was going
to be considerable." I expect he is at it now, and that I shall
hear from him shortly. To go back to your letter. You mention
Kleeman's "polarisation". But he uses a wrong term here: he
means distribution, and what he found was that R ($\frac{\text{[illegible]}}{\text{[illegible]}}$ [illegible])
for secondary γ rays was considerable: I think I am right: he
never touched polarisation in Barkla's sense.

Dr Beatty has just left me to go back to Cambridge to keep
his terms. His work came on with rather a rush just at the
end and I think he was sorry to leave it. Still he got out
same results. I asked him when he came to confirm Glasson's
results by finding the velocity of the cathode rays due to the
various homogeneous radiations, using a magnet. It turned
out to be a very difficult experiment: and at one time he got
rather sick of it. He could find hardly any influence at all due
to the magnet: he had a little set of slits over some Au foil &
tried to turn the cathode rays to one side. Finally
it appeared that the effect only was plain
when the pressure was down to less than
1 cm of Hg. Also he got to drawing a number of
curves showing the relation between pressure & ionisation
and then found that they showed him the penetration of the
various radiations in the chamber. They seem to indicate a
very soft X radiation from gold capable of crossing only a few
cm of air. He showed that Cu rays actually do produce K rays
in Ag: an effect which I think Sadler is trying to show is impossible.
He wants to prove that X rays only excite cathode rays in metals whose
homogeneous radiation is softer than their own. I think it is



all rubbish of course. Also he showed that the secondary X rays excited in Au by Cu sec^y were slower than those due to Ag sec^y but he did not get good quantitative results before he had to stop. I think he was very well satisfied with his summer's work. Kleeman did not get on with his own exp^t: and then I asked him to find the ionisation in different gases due to X rays, by passing the X rays first through gold, then card & subtracting; and he is getting on very nicely. He finds the ~~relative~~ ionisation in different gases due to the effect of the soft secondaries obtained in this way follow nearly the values for α β or γ rays.

Vegard has been testing the polarisation. He uses an apparatus which I designed to show the effect securely: it has four ionisation chambers symmetrically placed, and the whole thing can be turned round of course.



I wanted him to see whether that which causes X rays is polarised as well as that which ionises the air and so is the subject of Barkla's experiments. He found it was: so polarisation must be accounted for on the material theory. He passed the X rays into the four chambers sometimes → Au, Al, sometimes → Al, Au and compared results. In the latter case he had a crowd of cathode rays, of course, and they showed the polarised effect i.e. different amounts of them were caused by the rays travelling in the two directions. He is still investigating the polarisation question with different forms of anticathode.

Kleeman has been and is doing the relative ionisations of different gases by the cathode rays. He passes X rays into a chamber through a → Au, card screen: then from outside he reverses it to → card, Au. The increase in the latter case is due to soft radiation from the Au. Heger's figures would the same as for γ rays, only they rise rather quickly for the heavy atoms. I think Ether is 1·23, C_2H_5Br is 1·70 and CH_3I is 3·00. I think however that he has a little soft X radiation with a range of only a few cm in addition to his cathode rays, and these this may heighten the Br & I figures. You will see though that the figures are not enormous as for X rays, & fit in very nicely with the idea that the Br & I are great manufacturers of ~~X~~ cathode rays: & that is where the big ionisation came from.

For myself I am trying to collect ~~the~~ figures connecting the amount of cathode rays produced from each metal or substance with the absorption of the X rays in that substance, & showing the proportionality which exist pretty completely I think. I want to include Br & I if I can get suitable films. I am not sure I can. But I have got As and can get Sb. I can practically show I think that Br does produce clouds of cathode particles: I am also finding the absorption of all the cathode rays by Al foils.

Crowther must have had lots of soft radiation made in the ethyl bromide in his chamber & the reason why in spite of this his ionisation was proportional to the pressure must find some other explanation than that the ionisation by cathode rays or other soft radiation is negligible.

I have a man Thirkill from Clare College Cambridge who is doing Helium ionisation constants by α rays. I never did it properly in Adelaide, only the argon.

~~B~~ Now I think I have told you most of the doings here. You could see W. Wilson's paper on β rays in the Roy. Soc. Proc. also Eve's in the Phil. Mag. on γ rays confirming our results.

I have not heard of anything more particular. I believe J J had a paper at Winnipeg in which he used the neutral pair idea to explain some vacuum tube phenomena.

What cells have you got? I got 500 from Klingelfuss in Basle (Switzerland). They are test tube cells, coated, with 1st class porcelain insulation. They are small but doing well. I have a glorious air pump: Gaede's double rotary. A rotary oil does the 1st pumping down to about ·01 mm of Hg: then a rotary Hg pump completes the job: all driven by a little motor. You just switch on the current & go off & do something else until the tube is ready. I find that X ray expts are quite easy if only you use a separate standard ionisation chamber all the time & work by comparison with it. E.g. the standard chamber gives 110 in a certain time, & the main one 172 then the current is called 172/110 = 1·56. I don't use a watch: just read the zeros, turn on the current a convenient time & turn it off again. Beatty's electroscope is very sensitive, but tricky. For many expts I use the ordy electroscope: not even the tilted one. An inch each way is quite big enough & allows the use of a less special microscope. If you want a sealed chamber to hold a vacuum & easily take down, try this:-

pour in melted ½ rosin & beeswax round the joint. It is quite airtight. To take off warm with a flame, it is very quickly done.

I was called in as an expert last week to adjudicate on the claims of a man for a fellowship at Trinity College, Cambridge. I felt such a duke. Soddy is going to stay a night with me week after next. Now I must stop: this letter is all shop, meant to tell you what is doing so far as I know. I will write a more human one presently.

Kindest regards to yourself & Mrs Madsen.

Yrs always W H Bragg.

I will see about the film

Leeds. Decr. 12.

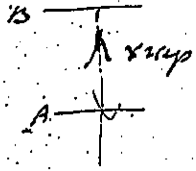
My dear old chief:

I have been a round of labs lately, and have seen many people, pretty well all the men whose names we have discussed so often, so I guess I may as well write to you about it all while it is fresh.

The points we used to talk about are very much to the fore and for your satisfaction and mine I may as well say at once that we have always been on the right track so far as I can judge. This is for your private ear! The neutral pair theory may or may not be absolutely true: but I think nearly everyone thinks that its promulgation was absolutely justifiable at the time, and that it has led to several discoveries and encouraged several successful researches, which it alone prompted. Some, including Rutherford, have actually said as much to me, very positively: and wherever I go I find the theory and all our experiments treated with great respect. Also the newest work still fits in, and indeed strengthens our arguments. You would see Stark's work in the Phys. Zeit. of Nov 22 (? I think, or thereabouts) in which he finds the X rays from a C plate struck by cathode rays to be much more intense, and much more penetrating in the forward than in the backward direction. I spoke to you before about Kaye's work in the Camb. Phil. Soc. Proc: which covered part of the same ground. You would also see Sadler's letter

* When I told Boltwood this he said he did not think J.J. could have ... explained it if he wanted it for his theory! Then ca[illegible]

in a recent "Nature". I saw him yesterday at Liverpool and had a long talk with him about it, and saw his apparatus. He is quite clear that the different homogeneous 2ry X radiations cause cathode radiation from various screens; the vel[y] of which is quite independent of the nature of the screen but is (or rather the absorbability is) a linear function of the atomic wt of the radiator. He says there is little of it from a screen in which the radiator is unable to excite the 2ry X radn which is characteristic of the screen: But there I am not sure that he has got his theory quite right, and I am going into the question. There was a point about which he was mixed and I tried hard to make him see it, but I had to give it up. He thought that if the ionisation between two plates A & B was propl to the distance AB, then there was no cathode radn from A or B: which it means is that the plate A contributes as much cathode radiation to the space between A and B as would a block of air below A, the screen A being taken away.



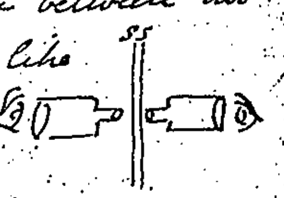
I dined in hall at Trinity with J.J. the other day: but we did not talk much science. Only I asked him as we walked home what he thought of the "light quantum" of the Germans, and of their practically abandoning the ether for the corpuscular theory of Newton (Einstein & Stark in the recent Phys: Zeit). He said it would not work at all. How could one explain reflection and refraction at the same.

* When I told Boltwood this he said he did not think J.J. would have much worry in explaining it if he wanted it for his theories! They say J.J. has a new theory every week.

surface? For myself I cannot see how they are going to explain the unique velocity of light in space. J.J. is much puzzled over a fact that he has recently discovered: he finds the velocity* of the canal rays to be independent of the potential on the tube; its value is 3×10^8 cm/sec, the same as δ rays: and he imagines, I think, that the atom emits a doublet which subsequently breaks up into +α δ −α, and that it is a sort of trigger action. I don't know exactly how he explains all the X ray things: Glasson says he heard him say at a lecture that the X rays store up energy in the atom until the emission of the cathode ray takes place, but as you know there is any amount of argument against this theory.

Kaye is a great friend: he took me all round the Cavendish explaining everything. Beatty is continuing an experiment begun in Leeds: which is much the same as Sadler's. J.J. himself is at these canal rays: most of the others were on experiments which do not closely concern us. At Manchester they were all on radioactive work. There was a Russian trying to find whether the absorption by β rays depends on constitutive influences of the molecule. Of course he got the negative: some of my own students have found the same; I cannot think what big mistake S.J. Allen has made in the Physical Review. I am sending a letter to the Review

Some one else is trying to measure the absorption of β rays of different speeds, if I remember right: but he was only starting. Boltwood is at the quantities of helium from all the different radioactive products. He is such a nice fellow. Geiger has been doing the timing of the α particles ~~arc~~: he has some emanation between two fluorescent screens very close together like this, so that when an atom goes off its α particle is bound to hit one of the two small portions of the screen which are in view of the two microscopes. The observers register by keys pressing on the paper of the same chronograph. Then they don't get flashes anyhow, but in a sort of sequence: which actually emanat I believe they get two close together, and one a little later like this, ... :



The Morse code, they call it! Isn't it extraordinary? Curiously enough they don't get it with Th. B&C, which you would rather expect.

I have not got many results to chronicle myself. I have been so busy getting things straight. But as opportunities served I have been going on with the conversion of X rays into cathode rays, and my results are becoming more consistent. I want to measure also the absorption of cathode rays of various speeds, and to trace the exact connection between the speed of the particle in the X ray tube and that of the 2nd cathode ray: I am getting a new workshop, and have taken a man from the Cambridge Scientific Inst. Co.

Dec 17. Just heard that my man can't come for family reasons: what a nuisance! I have a second string in the shape of a Dutchman from Kamerlingh Onnes's lab. in Leyden.

I have been much concerned to find you anything new in the way of foils, but I can get nothing that we did not have in Adelaide. The only thing is I can get real copper foil not Dutch metal and I have got a packet of that to send you. There is nothing else.

Have you heard of the new Snook apparatus for X rays? It has a [illegible] induction coil, a real transformer with alternating primary and a commutator in the 2ry that is mechanically reversed at the proper time. The voltage is 70.000 to 100.000 & you can get up to 60 milliampere, perhaps more, but no tube will stand this for more than ½ second: that is enough to take a photo thro the human body. The 2 KW-size is £140! & the 4 KW is £170.

Now I must stop. My kindest regards to your wife. I hope you are all well & flourishing.

Yrs. always
W.H.Bragg.

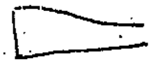
Parts of letter W. H. Bragg to Rutherford

Rosehurst,
Grosvenor Road,
Leeds.

Feb. 12th 1911

My dear Rutherford,

I got your letter of yesterday just now: and I have your letter of Thursday also.

I am delighted to hear how things are coming out: and I agree with all you say. Madsen's original experiment on the scattering of β rays (Dec 09. Phil Mag) showed quite clearly that the distribution of scattered rays amongst themselves was not at first a function of the thickness of the plate, for those rays well deflected. I have always held that the meaning of that was that they had suffered but one deflection that counted, and I think this makes everything much clearer as well as more interesting. As you say Crowther's and Schmidt's results fall into their places very nicely. Mind you, there is for aluminum absorption a bend in the curve at the top, you get that don't you? Madsen did, and Schmidt also I think. This bit is the one I mean . Your opinion of Crowther's paper agrees with mine: do you know, Crowther is tackling the more difficult problem before the simpler. The rays that are deflected through small angles - only have had or some of them have had a complicated history, their deflection being often the average of a larger number of small deflections. But the thing to go-for is the ray that has had but one serious deflection, and that is to be found deflected through a large angle, or turned right back, i.e. through more than 90°. The curve of reflected rays in relation to thickness of plate can surely be pushed back to the origin, so many things point to it: and then you have the effect of an infinitely thin layer, say one atom thick. Then you <u>must</u> have single deflections only: and there is your chance of comparing theory & experiment.

University Library

Cambridge

15th June 1966

Sir John Madsen,
c/o Radio Physics Laboratory,
C.S.I.R.O. University Grounds,
Sydney.

Sir,

I have the honour to acknowledge the receipt of the work mentioned below, which you have been good enough to send as a present to the Library, and to convey to you on behalf of the Library Syndicate the best thanks of the University for this addition to our Collection.

Your most obedient Servant

F. J. Norton, Under-Librarian,

for the Librarian

A letter of Lord Rutherford.

U.L.C. 122

17, Wilmslow Road,

Withington.

March 8th, 1911.

Dear Mr. Madsen

I saw Bragg yesterday and he was telling me about your work on the large scattering of β particles for different materials. As I have been working at this problem theoretically for the past few months, it may be of interest to you to give an account of the relations that should hold experimentally on the theory.

In the first place, the theory of small scattering as developed by J.J.Thomson is fairly correct as far as it goes; but it takes no account of large scatterings which we know from your work, and that of Geiger and Marsden on the α particles, must always be present. The model atom of J.J.T. only admits of comparatively small scattering, so I have made calculations on an atom which consists of a central point charge, either positive or negative, surrounded by a uniform spherical dsitribution of electricity opposite in ~~amount~~ sign. One may suppose provisionally that this sphere has a diameter of the same order as that of the atom as ordinarily understood. I will give in the accompanying ~~paper~~ abstract the main deducti-tions from the theory which I find, as far as experiments has gone, fits in well with the observed facts. I find that the large scatterings due to the central charge really control the scattering phenomena, although a small scattering becomes important when the probability of a deflexion through any given angle is greater than one half.

I gave an account of my paper yesterday to the Manchester Literary and Philosophical Society, and will publish it shortly in the Philosophical Magazine. Dr. Geiger is testing for me the correctness of the main assumptions, using the α rays and the scintillation method. As far as he has gone, he has found an extremely good agreement between the experimental and theoretical distribution of α particles for thin metal foils and it seems to me probable that the theory is a fairly correct expression of the facts, at any rate for small thicknesses of matter, where the probability of a given large deflexion is comparatively small. On the theory, the laws of the scattering are independent of the sign of the central charge, and I ha have not so far been able to settle this question with certainty. I have calculated approximately the magnitude of the central charge, and it corresponds for the atom of gold to about 100 unit charges; the magnitude of the charge is proportional to the atomic weight, at any rate for substances heavier than aluminium. At the same time, it is quite possible that the charge may ultimately be found to be twice as great as that mentioned.

It is interesting to note that the main conclusions deduced by Crowther or small scattering can be explained equally well on my theory of large scattering, and in fact, I am confident that his results are mainly due to this effect. I also feel sure that his curve for aluminium of variation of scattering with thickness is wrong in the initial parts. The curve should be much more nearly a straight line.

I may mention that the theory of large scattering will hold equally well if instead of one large central charge one supposed the atom to consist of a very large number of smaller charges distributed throughout the atom. It can be shown, however, that on this view the small scattering should be much greater than that experimentally observed. It is consequently simplest to consider the effect of a single point charge.

I understood from Bragg that you have found some interesting relations between the scattering for different materials. You will see from the theory on the assumption that the central charge is proportional to the atomic weight, that the fraction of α particles deflected through an angle is proportional to nA^2 where n is the number of atoms per unit volume, and A the atomic weight. This weight ought to hold for very small thicknesses, but I can easily see that this relation will be somewhat departed from for thicknesses where the probability of a large deflexion exceeds 1. It is evident in such a case that the theory must be modified, probably by a mixture of the theory of large and small scattering.

I am writing thus fully as I had intended to test my theory by experiments with β rays along very similar lines to that which I understand you are doing. I shall be glad, however, to leave the matter to you if you will be able to get through the work in reasonable time. I shall be very glad to hear from you how your ~~results~~ results are going.

Yours sincerely,

E Rutherford

Give my remembrances to Professor Pollock. I am hoping to visit Australia at the time of the Brit meeting

Abstract of theory.

Nomenclature.

Ne = central charge on atom.

E = charge on scattered particle

m = its mass

u = its velocity.

t = thickness of matter

n = number of atoms per unit volume.

ϕ = angle of deflexion

b = perpendicular distance from centre of atom on direction of motion of entering particle.

If we suppose the central charge positive, an α particle directed straight to the centre of the atom will be turned back at a distance $b = \frac{2NeE}{mu^2}$; b is an important constant.

It can easily be shown that in order to suffer a large deflexion an ordinary α or β particle should approach within 10^{-11} or 10^{-12} cms of the central charge. In this region, the forces may be supposed to be entirely due to the central charge, and to vary inversely as the square of the distance. The path of the particle is consequently a hyperbola, and the value of the deflexion ϕ can be shown to be $\cot \phi/2 = \frac{2p}{b}$

Since the chance of a large deflexion is proportional to the number of atoms traversed, the chance of passing within a distance p of the centre is $\pi p^2 n t$

From this it follows that the fraction of the particles scattered through the angles~~is~~ between ~~phi + d phi~~ ϕ and $\phi + d\phi$ is equal

$$\frac{\pi}{4} b^2 n t \cot \phi/2 \operatorname{cosec}^2 \phi/2 \, d\phi.$$

The fraction scattered through an angle greater than ~~phi~~ ϕ is equal to $\frac{\pi}{4} b^2 n t \cot^2 \phi/2$ (1)

The general data available shows that the value of Ne is proportional to the atomic weight A. It is consequently seen from the formula (1) that the fraction of particles scattered is proportional to (1) thickness, ~~(2) A nA2~~ supposed small (2) nA^2 (3) $1/(mu^2)^2$)

Leaving out the small part of the cross section of the atom where large deflexions are produced, the average angle of scattering due to my atom is $\frac{3\pi b}{8R}$ or three times that due to J.J.T's atoms with corresponding constants.

For heavy atoms like gold, the corpuscular scattering is small compared with that due to the ~~small~~ electric field of the atom. It can easily be shown that the fraction of a particles falling on a unit area of a screen at a constant distance from the centre of the scattering material varies as $\operatorname{cosec}^4 \phi/2$

where ~~phi~~ ϕ is the angle of deflexion of the particle. Geiger finds this relation to hold quite closely for thin foils over the range examined, viz. from 30° to 150°, where the number of particles varies [in a ratio of] nearly 300 times.

I think there is no doubt that the large scattering is proportional to thickness. The proof of this will show conclusively that large scattering is not due to accumulative small scattering.

E R

STUDIES IN RADIOACTIVITY

BY

W. H. BRAGG, M.A., F.R.S.

Cavendish Professor of Physics in the University of Leeds; formerly Elder Professor of Mathematics and Physics in the University of Adelaide

MACMILLAN AND CO., LIMITED
ST. MARTIN'S STREET, LONDON
1912

are more diffused. Even when the screen is a layer of paraffin 2 mm. thick, the faster get through, and though they are more diffused in this case they still have a definite line of movement in continuance of the old. When the layer of paraffin is 8 mm. thick, the rapid rays can no longer cross it and stop at a depth of 2 mm.; the less rapid penetrate in the order of their velocity and come to a sudden end, which is marked by a maximum of impression upon the plate (Curie, p. 53). This is all very like the effects of the α ray.

Madsen describes a striking experiment which supports

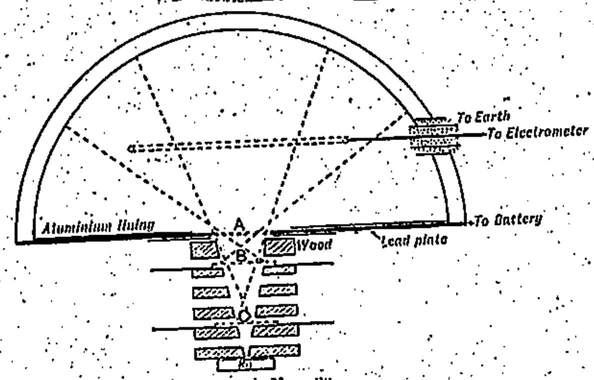


FIG. 38.

the same idea (*Phil. Mag.*, Dec., 1909). His apparatus is shown in Fig. 38. A hemispherical ionisation chamber is made of wood lined with aluminium foil: the purpose of this arrangement is to avoid scattering at the walls of the chamber as much as possible. The radium is placed at the bottom of a conical hole cut in a block of wood as shown, and at *A*, *B*, and *C* are slides by which absorbing screens may be introduced. The hemispherical form gives an equal path in the chamber to every ray that gets through, and an equal record of its presence there.

When the screen is at *A*, all the β rays which get through it make their way into the chamber: when it is

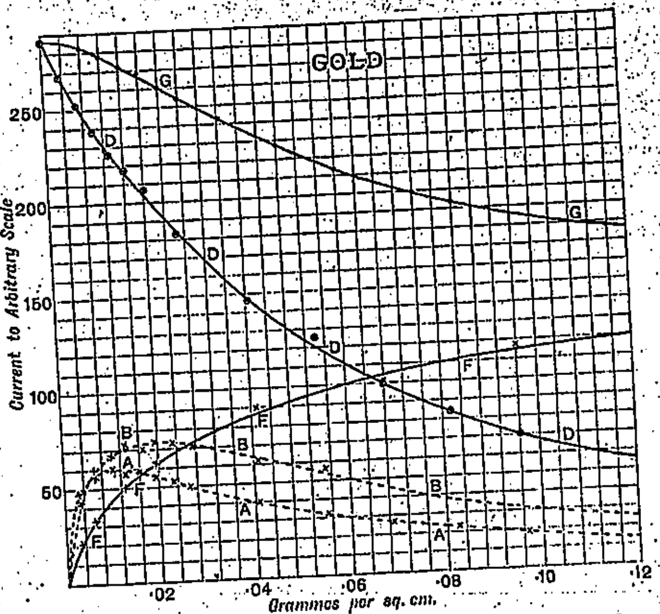
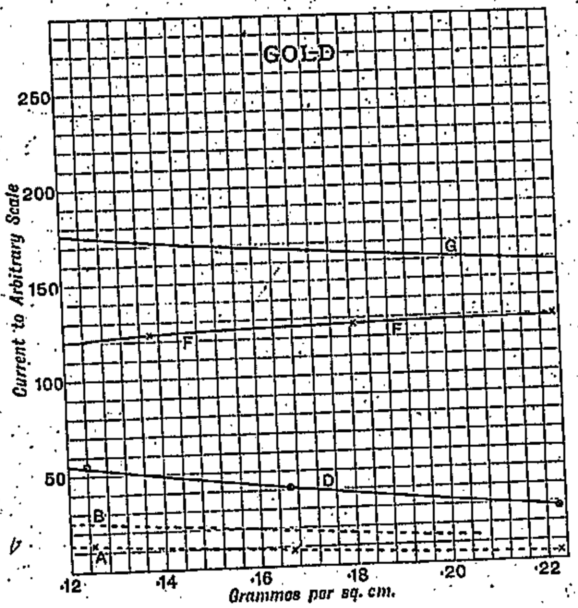


FIG. 30.—Cathode ray current from

at B only such rays get in as emerge from the screen at less than about 60° to the normal: and when it is at C, the entering rays are limited to those that make an angle of less than 30° to the normal. By subtracting the ionisation in the C position from the ionisation in the B position for all thicknesses of screen, and then again the B values from the A values, Madsen obtained measures of (*a*) such rays as are scattered more than 30° and less than 60°, (*b*) such as are scattered more than 60° and less than 90°. Let us call these quantities the less scattered and the more scattered radiations; they are represented by the ordinates of the curves A and B in the figure, which are taken from Madsen's paper. Now it appears that for small thicknesses of screen the ratio of the more scattered to the less scattered is constant, and this holds up to a thick-



gold screens of varying weight.

ness of 0·04 mm. of Al, and proportionately less for gold. This is what we should expect if those particles which have been turned through more than 30° from their original direction have as a rule suffered no more than one deflection. For then, if a screen of 0·02 mm. of Al has been used and the quantities of more and less scattered radiation have been measured, the addition of a second screen of the same thickness will deflect from the primary pencil further quantities in the same proportion and will not interfere appreciably with the ratio between the quantities already deflected.

We may draw the same conclusion from the way in which such curves as *A*, *B*, and *F* (Fig. 39) approach the origin. These were obtained by Madsen by the use of absorbing screens of varying thickness down to the thinnest that could be obtained. They make a finite angle with the axis of x, and are of the type of the curve P in Fig. 41, not of Q. There is no sign even for the thinnest leaf used (about 0·0001 cm. Al) of any point of inflexion on the curve, so that the tangent to the curve at the origin is to all appearances more inclined to the

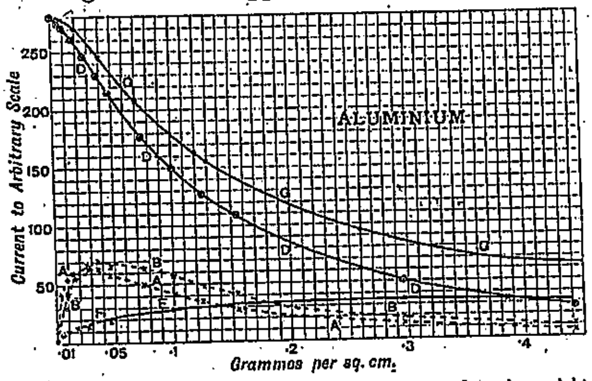


FIG. 40.—Cathode ray current from aluminium screens of varying weight.

axis of x than the tangent at any other point. This means that for the very thinnest films the fraction of the rays scattered bears a definite ratio to the mass per sq. cm. of the plate. The slopes of such curves at the origin are relative measures of the rays scattered by sheets so thin that no β particle can have had more than one encounter in crossing the sheet. That is to say, they represent the results of the encounter of the single β particle with the single atom, showing the probable chance of deflection in each direction for each kind of atom investigated.

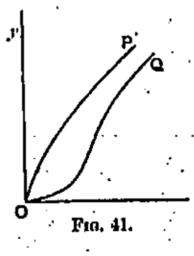


FIG. 41.

The results for any given case may conveniently be represented by drawing radii from a point representing the atom, each of a length proportional to the chance of deflection into the direction in which it is drawn. The extremities of these radii will lie on a surface, the form of which will represent the scattering effect graphically, and the form will vary with the nature of the atoms and the speed of the β ray. The surface is one of revolution, the axis of which is the original direction of the β ray. A section through the axis will therefore express the facts completely, and such a section may be called the "deflection oval." It is a proper object of experiment to determine the oval in all possible cases, for as the result we gain knowledge which will be of service in the inquiry into the nature of the atom. Moreover, when we have learnt the probable results of an encounter between a β ray of given velocity and an atom of given nature, so far as deflection goes, we are so much nearer to being able to calculate the results when a pencil of β rays falls on a plate which is an aggregate of atoms. When the simpler problem has been solved, we shall be in a position to approach the more complex—and this is the right way to proceed.

It seems now to be clear that in much work on the β rays, the opposite procedure has been followed and the complex problem has been the first to be experimentally attacked. Measurements have been made on the "reflection" from, or "absorption" by, thick plates, in which every source of complexity occurs, variety in the speed of β rays, accumulation of scattering at multitudinous encounters, loss of speed, and continual alteration of scattering coefficients and other constants and so forth. A theory is required as a guiding line through the maze, and it is of necessity an approximate one and of limited application. All that the theory can do is to arrive by rough analysis at the probable consequences of the encounter between the single β ray and the single atom, and this we see can be obtained by direct experiment, provided of course that we are right in the interpretation of Madsen's results.

We have yet to take into account the loss of speed of the particle in passing through matter, an effect of great importance in experiments with thick plates, and we shall see presently how we may investigate this point without interference from the phenomena of scattering, just as Madsen's experiment gives the scattering without interference from the effects of loss of speed. The two effects, together with the chance of conversion into X or γ ray form, fill up the history of the particle.

There is yet much information to be desired on the subject of the form of the deflection oval. We know, however, that the lighter the atom the more eccentric the oval, the heavier atom being more capable of swinging round the β ray which tries to pass by. This is in agreement with the results of Eve, McClelland, and others who have allowed β rays to fall upon thick plates of various substances and have found the returned radiation to increase with the atomic weight of the material of the plate.

Density of material is a matter of no consequence in such experiments, for an electron acts only on one atom at a time; if the material composing a plate could be compressed into smaller volume there would be no change in the returned radiation.

inversion of the plates A and B did not alter the quantity of γ rays that were active; the rays had to pass in each case through the same materials, and undergo the same absorption before entering the chamber.

When the plates A' and B' were transposed, the current in the chamber was 44 per cent. greater with the lead uppermost, which showed that the incidence β rays from Pb were much larger than the incidence rays from Al. We conclude that the emergence and incidence radiations are unequal, either in the case of Al, or of Pb, or of both metals.

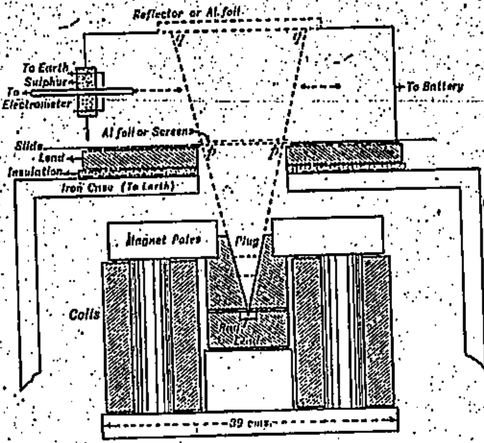


FIG. 45.

The apparatus employed by Madsen and myself in the more complete investigation is shown in Fig. 45. It is taken from a drawing in the original paper (*Trans. Roy. Soc. of South Australia*, xxxii, May, 1908, and *Phil. Mag.*, Dec., 1908). The radium was placed at the bottom of a conical hole made in a massive lead block. Plugs of various materials and thicknesses were turned to fit the hole, and could be used to investigate the effects of partially absorbing the γ rays by different substances.

The γ rays passed up between the poles of a powerful field magnet, which turned aside all β rays from the stream. It is to be remembered that a pencil of γ rays always contains β rays arising from the action of the γ rays on the last material through which they have passed, or the next which they are about to enter, and it is impossible to remove these β rays by a screen, since the interposition of material will only be the occasion of fresh secondary radiation which will take the place of that which it has intercepted. Nothing but a strong magnetic field and a special arrangement of the apparatus can even approximately remove the β rays from a space through which the γ rays are passing. It is to be remembered also that the air itself absorbs γ rays with a consequent production of β rays, so that on this account alone it is impossible to provide a space where γ rays are present without β rays.

A thick iron case was placed round the magnet and the γ rays passed up through a circular opening cut in the top of it. The iron prevented the stray lines of magnetic force from entering the ionisation chamber, and there distorting and altering the paths of the β rays inside it. On top of the iron case was a thick lead screen, intended to assist in preventing stray γ radiation from entering the chamber except through the opening provided. Above this was the ionisation chamber made of thin zinc. Sufficient openings were left at the top (*qq*) and at the bottom (*pp*) of the chamber to allow the rays to pass through without touching the zinc, and the openings could be closed by suitable screens of various substances. When the screens were made of the thinnest Al leaf supported on fine Al wires, the secondary β rays in the chamber were reduced to a minimum, though they were far from being negligible.

In the case of each substance investigated, measurements were made of the ionisation current under three different arrangements, namely :—

(*a*) when the screens *pp* and *qq* were of the thinnest Al foil;

(*b*) when *pp* consisted of a plate of the given substance just thick enough to give the full amount of emergence β rays;

(*c*) when a thick plate of the same substance composed the screen *qq*.

The differences between *b* and *a*, and between *c* and *a* were taken as measures of the emergence and the incidence β radiations respectively. The results are given in the following table, in which the two sets refer to soft and hard rays respectively. In the former case the γ rays were unscreened except by the walls of the capsule containing the radium, which were of light materials a millimetre or so in thickness. The hard rays were those left after passing through a thick lead plug inserted in the conical hole and were mainly composed of the more penetrating constituents of the original bundle of γ rays. The units are arbitrary.

TABLE XIX.—*Comparison of Emergence and Incidence β Rays.*

	Soft γ rays.		Hard γ rays.	
	Incidence.	Emergence.	Incidence.	Emergence.
C	170	2,280	58	1,150
Al	280	1,810	120	705
S	340	1,575	154	685
Fe	487	1,350	163	560
Cu	558	...	202	523
Zn	618	1,160	224	485
Sn	1,051	1,170	333	303
Pb	1,723	2,001	407	470

These figures show the existence of large dissymmetries in various cases which are far beyond the reach of experimental errors, though the latter are considerable. There are difficulties of interpretation, for it is evident that $b-a$ (the emergence radiation) is generally under-estimated, since the screen *pp* stops a certain amount of

β radiation which is made in the lead just below it and in the air also, and which is reckoned in a but not in b. The screen also cuts down the γ rays themselves to some extent. And again the screen qq not only gives rise to the true incidence radiation but also turns back some β rays striking it from below, and this is most serious when the substance of the screen is of high atomic weight. It is difficult to allow for all these sources of error. They are almost necessary consequences of the very penetrating nature of the γ radiation which cannot be altogether limited to the pencil used in the investigation. It is difficult to purify the pencil from β rays and also to keep the ionisation chamber from being affected by secondary radiation springing up in surrounding objects where they are struck by escaped γ rays. The whole experiment is worth repeating on a still more massive scale, when the errors might be sensibly reduced.

From these results we can draw the general conclusion that the emergence radiation is greater than the incidence, particularly in the case of the substances of small atomic weight. The increase of incidence radiation with atomic weight is in agreement with earlier proofs of the same principle (Eve, *Phil. Mag.*, Dec. 1904; McClelland, *Trans. Roy. Dub. Soc.*, March, 1905). The relative amounts of incidence β rays from different substances when exposed to β and to γ rays are not very different, as may be seen from the table given by Eve (*loc. cit.*):—

TABLE XX.—*Comparison of Secondary β Rays due to Primary β and Primary γ Rays.*

Radiator.	β and γ rays.	γ rays.
Pb	100	100
Cu	67	61
Brass	58	59
Zn	57	...
Al	30	30
Glass	31	35
Paraffin	12	20

Madsen and I next proceeded to measure the quality of the secondary β rays in terms of their penetrating powers. When the thickness of the screen *pp* is gradually increased from the smallest value possible, the β radiation increases rapidly at first but reaches a maximum when the screen is so thick that β rays from its lowest stratum are unable to make their way through it, or indeed a little before this point if account is taken of the absorption of the primary γ rays. The results of experiments of this kind in which Pb and Al screens have been used are shown in Figs. 46 and 47. From these curves we can obtain an approximate

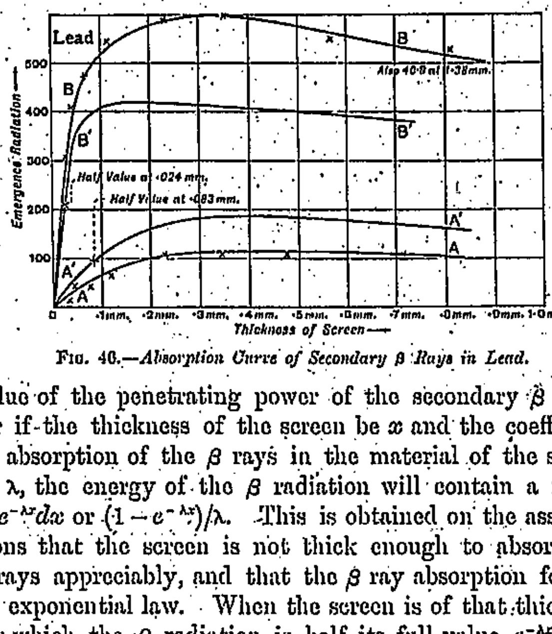


FIG. 46.—*Absorption Curve of Secondary β Rays in Lead.*

value of the penetrating power of the secondary β rays; for if the thickness of the screen be x and the coefficient of absorption of the β rays in the material of the screen be λ, the energy of the β radiation will contain a factor $\int_0^x e^{-\lambda x}dx$ or $(1-e^{-\lambda x})/\lambda$. This is obtained on the assumptions that the screen is not thick enough to absorb the γ rays appreciably, and that the β ray absorption follows an exponential law. When the screen is of that thickness for which the β radiation is half its full value $e^{-\lambda x}=1/2$ and $\lambda x = 0{\cdot}7$.

In Fig. 46 the curve marked *A* shows how the emergence β radiation from Pb increases with the thickness of the

Pb screen at pp, when the γ rays have been sifted of their less penetrating constituents by a lead plug 1·6 cm. thick placed in the conical opening above the radium. The rays which are left after penetrating this amount of lead have a mass absorption coefficient in lead of about 0·037 (McClelland) or 0·041 (Soddy and Russell), the initial coefficient of absorption being about fifty per cent. greater. The β radiation is shown by curve A to rise to half its full value when the thickness of the lead screen is 0·083

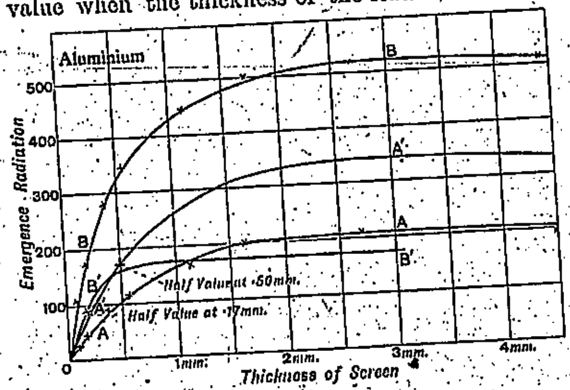


FIG. 47.—Absorption of Secondary β rays in Aluminium.

mm., so that the space absorption coefficient of the radiation is $0·7/0·0083 = 84$ cm.$^{-1}$. Similar results were obtained for Sn, Cu, and Al, and all are set out together in the following table, in which the last column gives also the values of the absorption coefficients of the primary β rays of radium in these substances, as given by McClelland and Hackett (*Trans. Roy. Dub. Soc.*, March 22, 1907).

TABLE XXI.—*Showing quality of Secondary β Rays due to Primary γ Rays to be the same as that of the Primary β Rays.*

I. Substance.	II. Thickness of screen giving half value in mm.	III. λ calculated from II.	IV. λ for β rays.
Lead	0·083	84	93
Tin	0·141	50	52
Copper	0·137	51	55
Aluminium	0·50	14	14

Since the figures in the last two columns agree so closely, we conclude that the secondary β rays, no matter in what substance they arise, have the same penetration as the primary β rays. It is true that hard γ rays were used in these experiments, while the values of the absorption coefficients of the β rays refer to rays of the usual quality belonging to RaC. The allowance to be made for this difference is uncertain; but it cannot be great, for the value of λ varies rapidly with the speed of the β particle, and there is room for considerable alteration of the values of λ in the third column of the table without thereby making much change in the corresponding velocities.

The curves marked B in Figs. 46, 47, exhibit the results of measurements of the emergence radiations when the lead plug had been removed, and the γ rays were therefore of a less penetrating character. Comparing them with the A curves, we have an opportunity of judging the effect of varying the quality of the γ rays. We see that the B curves rise much more quickly to their maxima, and indeed in the case of lead the total ionisation in the chamber begins actually to decline when the lead screen is only half a millimetre in thickness. This peculiar behaviour of the lead is due to the fact that the softer constituents of the γ rays are absorbed with especial rapidity by substances of large atomic weight. A lead screen "hardens" a heterogeneous beam of γ rays far more than a screen of aluminium. This is in agreement with the rapid decline of the absorption coefficient of the γ rays of radium as they pass through greater and greater thicknesses of lead: a decline which is not manifested with corresponding clearness in the case of the lighter atomic weights. As an example, we may take the following figures due to McClelland (*Phil. Mag.*, July, 1904).

TABLE XXII.—*Mass Absorption Coefficients of γ Rays.*

Substance.	Thickness of screen.			
	0·25 cm.	0·05 cm.	1·0 cm.	1·5 cm.
Pb	0·050	0·040	0·042	0·037
Al	0·038	0·038	0·038	0·038

The heterogeneous γ rays causing the effects which are represented by the B curves contain both hard and soft rays, though there is no clear line of distinction between them. It is possible to separate out the effects of the soft rays in the following way.

The effects of the hard radiation which has passed through the Pb plug is shown by the curve A. If the plug had not been there, the effects of this radiation would have been greater by about two-thirds, a result easily calculated. The curve A' is obtained by increasing the ordinates of A by two-thirds of their values, and the ordinates of A' are subtracted from those of B. We thus obtain B', a curve which may be taken to represent roughly the quality of the β radiation due to the less penetrating γ rays. The radiation now rises to half value when the lead screen at pp is only 0·024 mm. thick, which is not much more than a quarter of the corresponding value for the hard rays. The more penetrating constituents of the γ rays of radium give rise to secondary β rays which are four times as penetrating as those due to certain of the less penetrating portions of the same radiation.

The results of this investigation upon the relation between the secondary β ray and the γ ray to which it is due may therefore be summed up in the following statements:—

(*a*) The velocity of the β ray depends on the quality of the γ ray, increasing with the penetrating power of the latter.

(*b*) The velocity is independent of the nature of the atom in which the β ray arises.

(*c*) The emergence β radiation is generally greater than the incidence, particularly in the case of the light atoms.

It is possible to put the last statement in a different form, which throws some light on the manner in which the β ray begins its motion away from the atom. It is clear that the β ray continues the motion of the γ ray to a greater or less extent, and we should like to know the exact amount of this tendency. We can imagine the chance that the secondary β ray will leave the atom in any specified direction to be expressed as a function of the angle which that direction makes with the direction of the γ ray. We shall no doubt be able eventually to determine this function by experiment, and we shall have to use thin sheets of absorbing material for the purpose, for the same reason as in the case of β rays (p. 88). With thick sheets the results must be complicated and difficult to interpret, since it is then necessary to take into account the production of β rays in each stratum crossed by γ rays and their subsequent scattering and slowing down. Work of this kind has scarcely been attempted. The results given in Table XIX. can be employed only in forming an estimate of the relative numbers of β particles that go forwards and go backwards respectively from the atoms struck by the γ rays, the terms having reference to a plane perpendicular to the direction of the exciting rays. It appears from calculation that they must nearly all go forward, and it is easiest to assume this as a hypothesis and see how closely it explains the experimental results. We shall also be obliged to make certain other assumptions.

We must assume some relation between the "absorption" of γ rays and the quantity of β rays produced. The simplest supposition is that the two are always proportional to each other; that is to say if a certain percentage of a γ ray stream disappears in passing through a plate, the same quantity of β radiations makes its appearance no matter of what substance the plate is composed. As a matter of fact, it will appear later that probably the whole of the disappearing γ ray energy reappears as β ray energy, the material in which the β rays arise being simply the cause of a transformation of energy; but we do not assume so much as this at present.

Next let us suppose ourselves to be using γ rays of great penetration, which Wigger, McClelland and others have shown to be absorbed fairly strictly according to a density law: which means that screens of equal weights absorb equal amounts no matter what the material of the screens; lead only and substances of the largest atomic weights have a little more absorbing power than the rest.

Again, let us assume that the β rays are also absorbed according to a density law. In doing so we make a considerable departure from experimental results; but it is easy to allow for this error afterwards.

Finally, let us assume that the β ray when first produced continues exactly in the line of motion of the γ ray.

We proceed to compare the quantities of β radiation which should emerge from the "emergence" sides of two plates of different materials. Let these be represented by AD and $A'D'$ in Fig. 48, and let BC and $B'C'$ be corresponding strata of equal weight; in fact, let $AB/A'B' = BC/B'C' = CD/C'D' = \rho'/\rho$, where ρ and ρ' are the densities of the two plates respectively. Let the plates be crossed by equal pencils of γ rays as shown by the dotted lines in the figure. Since the same quantity of γ radiation is absorbed in BC and $B'C'$, the same quantity of β radiation takes its rise in each. And, since the strata CD and $C'D'$ are of equal weight, the same fraction of this β radiation passes out of each plate. Integrating for all effective strata, the whole emergence β radiation should be the same for each plate and so for all plates, presuming of course that the γ stream issuing from the plate is always the same.

If we now take into account the fact that the absorption coefficients of the β rays are not all equal, but diminish considerably in the case of the lighter atomic weights, then the emergence radiations should decrease as the absorption coefficients and the atomic weights increase. H. W. Schmidt (*Jahrbuch der Rad. und Elek.*, vol. v., 4, p. 486) gives the following values of the absorption coefficients of Ur β rays :—

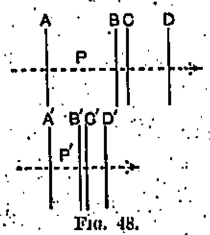


FIG. 48.

Al 5·66, Fe 7·32, Cu 7·39, Zn 7·31, Sn 7·95, Pb 9·12.

Crowther (*Phil. Mag.*, xii., p. 379, 1906) finds the values to be

C 4·4, Al 5·26, Fe 6·4, Cu 6·8, Zn 6·95, Sn 9·46, Pb 10·8.

If we take into account also the somewhat high absorption coefficient of Pb for γ rays, we see that the relative values of the figures in the last column of Table XIX. are quite in agreement with what we should expect. The lightest atoms give the largest emergence radiation, but lead has a rather high value which breaks the general rule.

The whole of this comparison is of course approximate only; the assumptions made are many and the method of calculation is a rough one.

Let us now consider the β rays appearing on the incidence side. Of those originating in BC and continuing at first the direction of the γ rays, a certain fraction, say p, is returned from the material in front, CD. The values of p for different substances have been measured by Eve, McClelland, and others. Its meaning, as already mentioned, is anything but definite, but is clear enough for present purposes. In the case of the other stratum, $B'C'$, the amount returned is p'. The same fraction of the returned portion emerges from the plate in each case, and integrating for all effective strata the incidence radiation of each substance should be proportional to its corresponding constant, p. In other words, the incidence β radiations should bear nearly the same relations to each other whether β rays or γ rays are the primary radiation. This has already been proved experimentally by Eve and McClelland: see the table on p. 119. The experimental fact is now a deduction from the hypothesis which we have assumed.

In this comparison of the incidence radiations, we ought no doubt to make the same allowances for the want of accuracy of some of the assumptions as we did in the case of the emergence rays. The absorption coefficients of the β rays in C and Al are less than in the heavier atoms, and on that account the experimental values of the incidence radiations for those substances should be somewhat greater than the calculated. But it is scarcely worth while to look carefully into these sources of error and others which are also present, such as the variations in quality of returned β radiations. We do not know them with sufficient accuracy to make proper allowance for them; it is clear only that they cannot interfere with the general agreement between theory and experiment. We can conclude that the secondary β radiation, at least when originating in the lighter atoms, starts off almost entirely in the direction of the primary γ radiation to which it is due. In the case of the heavier atoms this may not hold so well.

There is one apparent discrepancy in the figures of

Table XIX. which must not be overlooked in the attempt to give a general explanation. In some cases, the emergence radiation appears to be a little less than the incidence. This is probably due to experimental error and to defects in the arrangements and the calculations, for which insufficient allowance has been made. Some of these have been mentioned already.

Some of the parallel laws have been proved by Sadler for the β rays due to X rays (*Phil. Mag.*, March, 1910). Barkla has shown that when primary X rays of sufficient

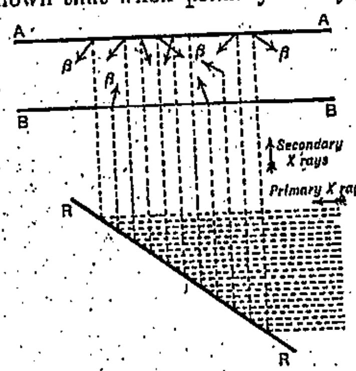


FIG. 40.

penetrating power fall upon plates of various substances, most conveniently those between chromium and tin, there is a strong secondary X radiation which is homogeneous and characteristic of the substance. The great variety in the quality of these radiations is shown by the following list of mass absorption coefficients in aluminium given by Barkla and Sadler (*Phil. Mag.*, May, 1909): Cr 136, Fe 88·5, Co 71·6, Ni 59·1, Cu 47·7, Zn 39·4, As 22·5, Se 18·9, Ag 2·5. With this range of quality, it is possible to make a searching test of the principle that the speed of the secondary β ray depends on the quality of the radiation but not upon the atomic weight of the substance.

The method will be understood from the accompanying diagram (Fig. 49) of the essential features of the apparatus. The secondary rays characteristic of some radiator R enter the ionisation chamber AB through a thin Al sheet stretched across an opening in B. After crossing the chamber they strike the opposite wall A. The β rays from both A and B contribute to the ionisation in the chamber, the former being usually in greater quantity by far. The plate B can be moved so as to make the depth of the chamber equal to any desired value. When it is large and the β rays from the walls cannot cross the chamber, the

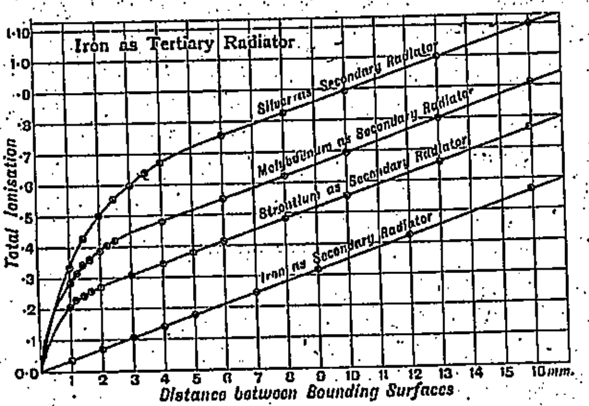


FIG. 50.

ionisation current increases uniformly with the width. But when B is pushed so closely up to A that the β rays cannot complete their paths within the chamber, the current falls off at an accelerating rate as the depth diminishes. Figs. 50 and 51 are taken from Sadler's paper (*Phil. Mag.*, March, 1910).

The abscissæ in these figures are the distances between the two plates of the ionisation chamber: the ordinates are the observed ionisation currents. The curve marked "silver as secondary radiator" refers to experiments in which the X rays used were the homogeneous rays emitted from silver when irradiated by the primary rays from the X ray bulb. Let us refer to them as Ag X rays. These rays were passed into the chamber AB (see above) through the thin Al wall in B and fell upon A, which was in this case an iron plate—the "tertiary radiator" of the figure. The curve shows that beyond a certain point the observations when plotted lie on a straight line. Sadler assumes that the increasing values of the current are now

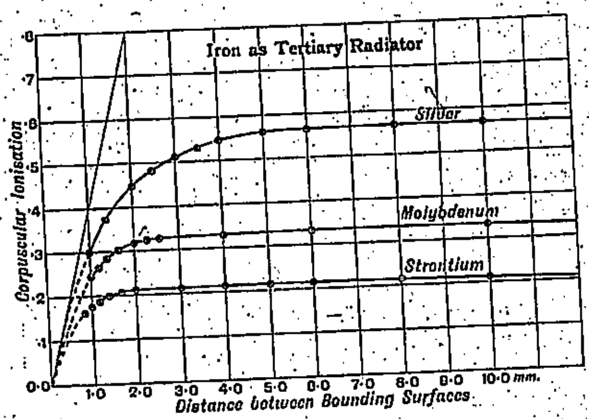


Fig. 51.

due entirely to the increasing width of air which is submitted to the direct action of the X rays crossing the chamber, and that a straight line drawn through the origin parallel to this straight portion of the curve will represent the direct effects of the X rays at all pressures. If the ordinates of the straight line through the origin be subtracted from those of the curve, the remainder can be ascribed to the action of the β rays from the walls. The curve thus obtained is given in the "silver" curve of Fig. 51. Sadler finds this curve to be very nearly of the form $y = A(1 - e^{-\lambda x})$, and he takes the value of λ so found to be a measure of the absorption coefficient of the β rays in air.

Some of Sadler's results are not in complete agreement with those of other observers. But as regards the relative penetrating powers of the β rays excited in different radiators by X rays of different qualities, his methods seem quite valid and his conclusions have been confirmed by others. Sadler puts his results into the form of a table, which is here reproduced:—

TABLE XXIII.—*Values of the Absorption Coefficient* (λ) *in Air of the Cathode Rays due to X rays of Various Qualities.*

Tertiary Radiator.	Radiators which act as the source of homogeneous secondary X rays.									
	Ni	Cu	Zn	As	Se	Sr	Mo	Rho	Ag	Sn
Iron . . .	38·0	37·0	35·8	30·2	20·4	21·5	15·5	10·0	8·84	6·41
Copper . .	...	...	36·2	30·4	...	20·8	15·2	10·8	8·81	6·07
Silver . .	...	...	35·4	30·2	...	21·2	15·4	10·3	8·78	6·03
Aluminium	...	...	...	29·6	...	20·0	15·2	...	8·00	6·54

These results show very clearly that the same principles hold in the case of the β rays due to X rays as were found by Madsen and myself in the case of the β rays due to γ rays. The penetrating power of the β ray, and its speed, depend upon the quality of the exciting ray and not upon the nature of the atom in which it is excited.

Beatty has also done independent work in this direction (*Proc. Camb. Phil. Soc.*, xv., p. 416, 1910); he used only one metal—silver—as the source of the β rays, but so far as they go his results, like Sadler's, are quite in accord with the principles we have stated.

It will be observed that the methods employed in the investigations with X rays are different in character from those used with the γ rays. This is necessarily the case. The β rays due to γ rays are so penetrating that they only spend a fraction of their range within the ionisation chamber as it is usually constituted, and it is practically impossible to vary the pressure of the air or the depth of the chamber so as to include the whole range; we cannot therefore find the form of the whole of the absorption curve in air. We must vary the thickness of the chamber wall through which the β rays enter, and so find the absorption curve in the material of the wall. In the case of the β rays due to X rays, the thinnest metal leaf absorbs completely all but the fastest, and the only way is to find their absorption in the gas of the chamber. Beatty does this by varying the pressure, Sadler the depth of the chamber. This latter method was first used by Townsend some years ago (*Proc. Camb. Phil. Soc.*, x, p. 217, 1899). Townsend's rays were heterogeneous, and his results therefore of less value than those of later date, but it is apparent from his figures that the penetrating power of the β ray is independent of the nature of the atom in which it arises.

The relations between the directions of the β ray and the exciting X ray have been investigated by Cooksey (*Nature*, April 2nd, 1908), who showed that the same want of symmetry of the β rays existed as had previously been found in the case of the γ rays. He found the emergence β radiation to be 50 to 90 per cent. greater than the incidence in such cases as he examined. He used heterogeneous X rays. He afterwards repeated the experiments with X rays of various qualities (*Nature*, Dec. 2nd, 1909), and showed that the dissymmetry increased with the penetration of the X ray. Beatty found the following values for the ratio of the emergence to the incidence β radiation (*Proc. Camb. Phil. Soc.*, xv., 6; p. 492, 1910):—

TABLE XXIV.—*Ratios of Emergence to Incidence β Radiation.*

I. Radiator.	II. Ag.	III. Cu.
Fe	1·02	...
Cu	1·01	...
Se	1·10	1·08
Ag	1·20	...
Sn	1·303	1·310
Al	1·435	1·42

The first column gives the metal used as the source of secondary X rays, and the radiators are arranged in the order of the penetration of the rays which they emit. Those from Fe to Sn give their characteristic radiations; Al merely scatters primary rays which are harder than any of the secondary X rays. The second column gives the values of the ratio of emergence to incidence β rays where silver is the substance in which the β rays are excited. The third column gives the corresponding values for copper.

The following values of the ratio were found by Porter and myself, using Sn X rays (*Proc. Roy. Soc.*, 85, May, 1911):—

TABLE XXV.

Metal in which β rays were excited.	Ratio.
Al	1·80
Fe	1·50
Ni	1·50
Cu	1·50
Sn	1·30

These figures give an idea of the amount of the dissymmetry. It is much smaller than in the case of the β rays excited by γ rays.

Not only do the experiments with γ rays and with X rays establish separately the principles stated, but also we find further confirmation when we take the two sets of results together; for the X rays and the γ rays may be considered as extremes in the matter of quality, and we find accordingly that the velocity of the β ray due to the γ ray is much greater than that of the β ray due to the X ray.

We may make a final statement of the conclusions to be drawn from all these experiments as follows:

1. The speed of the β ray due to the γ or X ray depends only on the quality or penetrating power of the exciting ray. The speed and penetration of the former increase with the penetration of the latter. The speed depends neither on the intensity of the γ or X ray stream, nor upon the nature of the atom in which the β ray arises.

2. The initial direction of the movement of the β ray is more or less in continuation of that of the γ or X ray, this effect being most pronounced when the exciting ray is penetrating and the atomic weight small. In the case of hard γ rays and light atoms, the continuance is almost complete; in the case of soft X rays and heavy atoms, it is very small.

We can now proceed to consider the form which these conclusions would lead us to assign to the γ and the X ray.

PART TWO. CHRONOLOGY.

I. J.P.V.M.'s academic career and appointments.

2. Overseas trips.

2) J.P.V.M.'s OVERSEAS TRIPS.

1903;

Travelled to England and the U.S. visiting the principal universities and electrical works,meeting some of the leading scientific men of the era, including Lord Kelvin and J.J.Thomson.

July 1927--February 1928;

This was a private trip which took in many official duties. His itinerary included Italy, Switzerland, Germany, France, U.K., U.S. and Canada.

In Italy he attended the International Electrotechnical Commission, where he met Mussolini.

In the U.K. he established contact with the leading men in British Radio Research and together they planned the future course of radio research in Australia. He also visited The National Physical Laboratory and the equivalent bodies in Washington, Canada, Germany gathering the necessary information to set up a Standards Laboratory in Australia.

In Washington he attended the Second General Assembly of U.R.S.I. and also the Communications Conference of the International Union of Broadcasting Organisations.

J.P.V.M!s wife Maud travelled to Italy and Britain on this trip.

December 1939--January 1940;

J.P.V.M. returned to England to establish a plan of collabor- -ation with Watson-Watt's radar research team.

April 194I-- December 194I;

J.P.V.M. travelled to the U.S., Canada and Britain to establish on behalf of the Commonwealth, facilities for scientific liason to assist the allied war effort.

1948;

J.P.V.M. led a Commonwealth scientific delegation to India.

1949,195

As a director of the local Philips concern he visited the company's operations in Holland and Britain.

Sir John Percival Vissing MADSEN

Academic Career and Appointments

Academic Career

1900	Graduated B.Sc., University of Sydney - 1st Class Honours in Mathematics and Physics; University Medal for Mathematics
1901	Graduated B.E., University of Sydney - 1st Class Honours and University Medal in Civil Engineering and University Medal on Graduation
1906	D.Sc., University of Adelaide

University Appointments

1899	Junior Demonstrator in Physics, University of Sydney
1900	Assistant Instructor in Drawing, University of Sydney
1901-02	Lecturer in Physics and Mathematics, University of Adelaide
1903-08	Lecturer in Electrical Engineering, University of Adelaide
1909-12	P.N. Russell Lecturer in Electrical Engineering, University of Sydney
1912-20	P.N. Russell Assistant Professor of Electrical Engineering, University of Sydney
1920-49	P.N. Russell Professor of Electrical Engineering, University of Sydney
1942-49	Dean of the Faculty of Engineering and Fellow of the Senate, University of Sydney
1947-49	Chairman, Professorial Board, University of Sydney
1935	Macrossan Lecturer, University of Queensland

Appointments under Council for Scientific and Industrial Research

1927-58	Chairman, Radio Research Board
1927-45	Chairman, Standards Committee
1945-	Chairman, Commonwealth Committee on Standards and Testing
1939-41	Chairman, Radiophysics Board
1941	Member of Radiophysics Board
1943-48	Deputy Chairman, Radio Propagation Committee of Radio Research Board
1948-	Chairman, Radio Propagation Committee of Radio Research Board
1943	Member of Council for Scientific and Industrial Research

Other Appointments

1915-18	Chief Instructor and later Officer commanding the Engineer Officers' Training School
1914	President of Electrical Association of N.S.W.
1912-16	Consulting Elec. Engineer to W.C.I.C. (Water Conservation & Irrigation Commission)
1919-	Foundation Member of Institution of Engineers, Australia
1936-49	Fellow of Institute of Physics

1941	Knight Bachelor
1946	President, Institute of Physics
1946-66	Chairman, Electrical Research Board
1937-	Fellow of Australian National Research Council
1946-47	Chairman, Australian National Research Council
1947-	Foundation Member, National Association of Testing Authorities
1948	Chairman, National Association of Testing Authorities
1948	Leader of scientific delegation sent by Commonwealth Govt. to India
1949-63	Director, Philips Electrical Industries
1952-	Chairman, Australian National Committee for Radio Science

PART THREE. THE EARLY YEARS.

1. A biography of H.F.Madsen.
2. Three letters of personal recommendation to Sydney University in support of J.P.V.M.'s application for the position of lecturer in Electrical Engineering.
3. The official appointment to the lectureship with an appropriate condition to conduct outside consulting work.
4. The historical perspective in science:
   (i) The life and work of Lord Rutherford.
   (ii) The work of Sir William Bragg.
5. A letter of appreciation from the Federal Government to Sydney University for J.P.V.M.'s war services in training Australia's military engineers during the First War. (1914-18)

HANS FRANDSEN MADSEN

Born at Janderup, Denmark, 25th February, 1843.

Died on 22nd January, 1937.

Arrived Melbourne, Victoria, January 1864, by sailing vessel. Journeyed to Bunniyong, 7 miles from Ballarat, and obtained employment at a mine (Garibaldy).

In 1874 joined as one of the first pupils, a School of Mines which was started in Ballarat under Mr. John Phillips. Six months later Mr. Phillips went to New South Wales as a surveyor and took H.F. Madsen as his Assistant. Went to Tamworth and Orange districts.

Sat for Examination for Licensed Surveyor in February, 1876, and passed third out of fifteen. Then obtained appointment as Draughtsman in Lands Department.

Later received appointment as Licensed Surveyor in Maitland District (Surveyor General at that time was Mr. Adams). Took as pupil and assistant John Bush. Married Annie Bush 27th May 1878, at Gresford. Later went to Lockinvar and then to Bimble, in Castlereagh district; later appointed to Staff of Detail Survey at Sydney, being one of the three first - the others being Messrs. Foate and Scrivener. In 1888 appointed second-in-command. In 1897 appointed to position in Goulburn district with Head-quarters at Braidwood. In 1896 went to Young district.

In 1909 returned to Sydney Office where remained until 1913, when he retired at the age of seventy years.

Issue -

Four Sons: Professor J.P.V. Madsen, George (deceased), Sidney and Frank

Two Daughters: Regine (spinster), Mrs. Gladys Fisher.

Wife predeceased him in 1929.

6 -

BIGGEST NOT BEST.

Telescopes for Mars

ATMOSPHERIC OBSTACLES

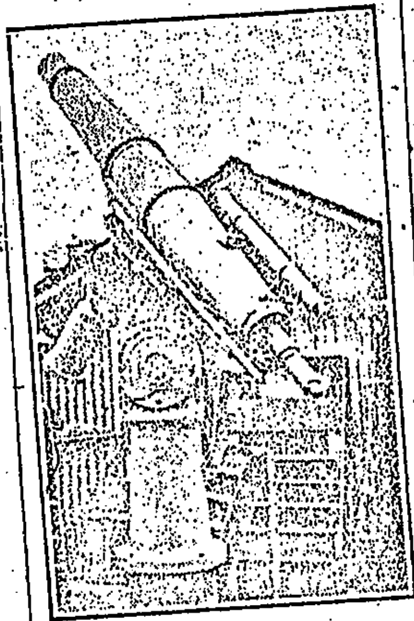
The public, no doubt, wonders why a telescope sufficiently powerful has not been built to enable the observer to obtain an image of Mars sufficiently large for him to get a much closer and clearer view than those already obtained.

The trouble, as Mr. Walter Gale points out, is that the most powerful telescopes are of little value in observing the planet. In his observatory Mr. Gale employs two types of telescope, in one of which the image is formed by the rays passing through a compound lens, and in the other by reflection from a parabolic surface of silvered glass.

The 18in. Equatorial Reflecting Telescope, through which Mr. Walter Gale is putting Mars under the third degree.

Each type has its special advantages, but for the amateur the great light grasp, purity of image, convenience and low cost are overwhelming arguments in favor of the reflector. With an instrument of this form of 8¼ inches aperture Mr. Gale discovered in 1892 the small dark spots upon Mars which have since become famous as the oases of the planet.

It is true that the reflector is more sensitive to atmospheric disturbances



Another of Mr. Gale's instruments at Waverley—the eight-inch Equatorial Refracting Telescope by Grubb.

than the refractor, but in any case the best seeing conditions are essential to successful observation, as well as a trained eye.

The fine 8-inch equatorial refractor by Grubb, which for many years did excellent service in the hands of the late John Tebbutt, is one of the telescopes employed by Mr. Gale, while an 18-inch reflector constructed many years ago by Mr. H. F. Madsen, has recently been erected. With this latter telescope the tiny moons of Mars were revealed in 1892, and may again be seen during the coming weeks.

Unfortunately the larger the telescope the fewer are the nights that it can be used to advantage, for every imperfection of the atmosphere is increased by the very power of the instrument. Thus a large telescope is often a disappointment to the visitor, who expects to see much more than the night will permit to be revealed.

Experience and a night of good seeing conditions will, however, convince anyone of the value of large telescopes, and leave lasting memories of some of the most beautiful and impressive sights in the heavens.

THE UNIVERSITY,
ADELAIDE.

Mr J. P. V. Madsen was appointed in 1901 to the post of Assistant Lecturer in Mathematics and Demonstrator in Physics in this University. In 1902 the Council of the University established a four years course leading to a diploma in Electrical Engineering. Mr Madsen was then appointed Lecturer in Electrical Engineering and placed in charge of the new course.

The details of the course and the design of the Electrical Engineering laboratories have been left entirely to him, and he alone is responsible for the excellence of the present

arrangements. He has spared neither thought nor labour to make the best of the sums available for equipment; and has made his students and assistants as enthusiastic as himself.

He has been in charge of the practical work of all the students in Physics, and has fulfilled in the most satisfactory way his duties as demonstrator. He has very much improved and added to the list of experiments, and increased the efficiency of the laboratory arrangements. Under his care the students have made excellent progress.

Since he has always been a loyal

4

and willing colleague and I cannot but say that for my own sake I shall be very sorry if this testimonial assists his departure from Adelaide

W. H. Bragg. M.A. M.I.E.E.

Elder Professor of Mathematics and Physics in the University of Adelaide

THE UNIVERSITY OF ADELAIDE.

Mr. J. P. V. Madsen

B.Sc., B.E., P.N. Russell Gold Medallist, Sydney, was appointed Assistant Lecturer on Mathematics and Physics in this University in 1901 and in 1903 he was promoted to be Lecturer in Electrical Engineering. His appointment to the latter office was made in 1902 when he had leave of absence granted to him for the purpose of acquainting himself on the spot with the latest advancements in the technical and applied branches of Electricity in England and America. Besides greatly benefitting in that way Mr. Madsen has found time to enlarge his practical experience at the Electrical Works in this City and he is exceptionally skilful in handling machinery and apparatus.

Mr. Madsen did good work in organizing this School of Electrical Engineering. He has proved himself a successful teacher and lecturer and has the credit of getting his students on and of inspiring them with his own enthusiasm.

Mr. Madsen is an able and hard working man of unimpeachable character, and if he leaves us we shall part

with

THE UNIVERSITY OF ADELAIDE.

with him with great regret. There can be no doubt that he is well qualified for the Lectureship in Electrical Engineering in the University of Sydney for which he is a Candidate.

[signature]

Chancellor of the
University of Adelaide.

4th August 1904

TELEPHONE Nº
[illegible]9.

LONDON OFFICE:
49, QUEEN VICTORIA STREET, E.C.

THE ELECTRIC LIGHTING & TRACTION Cº OF AUSTRALIA LTD.

LIGHT AND POWER STATIONS:
ADELAIDE.
PORT ADELAIDE.
GEELONG.
MELBOURNE.

ENGINEER AND MANAGER:
FRANCIS W. CLEMENTS.

ALL COMMUNICATIONS TO BE ADDRESSED TO THE SECRETARY.

31 Queen Street,
Melbourne, July 21st. 1904.

J.P.V. MADSEN, Esq.,
University,
ADELAIDE.

Dear Mr. Madsen,

As I understand that you are about to apply for the position of Lecturer in Electrical Engineering to the Sydney University, I have much pleasure in testifying as to the experience you have gained in connection with our Adelaide undertaking.

Prior to your taking up the position of Assistant Engineer on the Company's Adelaide staff you had the opportunity of watching and studying the erection of a large and modern electric power station suitable for supplying a city of 150,000 inhabitants, and were thus enabled to obtain a good insight into actual work and the practical applications of the very thorough theoretical electrical engineering knowledge you possessed.

Sometime ago the Company was able to retain your services as an Assistant Engineer on its staff and during the period of your appointment you have had still further opportunity of coming into intimate contact with the working and daily routine of a power station; you have been engaged in carrying out practical tests of various descriptions on steam plant, electric generating plant, mains, meters and the like, and have been most useful in carrying out tests on consumers' premises in connection with the application of electric motive power to various industries. The practical knowledge thus

J.P.V.MADSEN, Esq.
ADELAIDE.

Date 21/7/04.

gained, taken in conjunction with your undoubtedly high theoretical attainments and your University experience, should in my opinion eminently suit you for the position for which you are applying.

Wishing you every success,

I remain,

Yours very truly,

THE ELECTRIC LIGHTING & TRACTION COMPANY
OF AUSTRALIA, LIMITED

F. W. Clements

Engineer and Manager.

A

UNIVERSITY OF SYDNEY.

8th September 1908.

SIR,

I have the honour to inform you that you have been appointed by the Senate to the office of P.N. Russell Lecturer in Electrical Engineering in this University, your appointment to take effect from 1st March next; and that the appointment is subject to the following conditions:

(1) The duty of the Lecturer in Electrical Engineering is to deliver the lectures prescribed by the Senate.

(2) The hours of attendance will be those prescribed by the Senate.

(3) The Lecturer in Electrical Engineering will take a part in the University Examinations of students.

(4) The engagement may be terminated by six months' notice on either side, in accordance with Chapter xxvi., Section 1, of the University By-laws.

(5) The engagement will, under any circumstances, expire on the 31st December, 1915, under the provisions of Chapter xxvi., Section 2, of the University By-laws.

(6) The salary of the Lecturer in Electrical Engineering is at the rate of Five hundred Pounds per annum and he is permitted to carry on a certain amount of consulting practice, provided that, in the opinion of the Senate, such consulting practice does not interfere with his University duties.

Kindly acknowledge the receipt of this letter.

I have the honour to be,

Sir,

Your obedient servant,

Robert A Dallen

Acting – Registrar.

To J. P. V. Madsen Esq. D.Sc., B.E.

The University

Adelaide S.A.

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Acting Registrar.

To J. P. V. Madsen Esq., D.Sc., B.E.

The University

Adelaide S.A.

The Brilliance of Lord Rutherford

By SIR JOHN COCKCROFT

THE President of the Royal Society, in his anniversary address on St. Andrew's Day, told the Fellows of the Society of the plans which are being made to commemorate the name of Lord Rutherford.

When Rutherford came to Cambridge in 1895 from New Zealand to work with the Cavendish Professor, J. J. Thomson, he was living in a scientific world which believed that the atoms of the material world were unchangeable and indestructible. But the foundations for this belief were being undermined, first by Roentgen's discovery of X-rays in 1895, then by Becquerel's discovery in 1896 of the similar radiations emitted from uranium, and even more so by J. J. Thomson's discovery of the electron in 1897 which showed conclusively that the chemical atom was not the smallest unit of matter. So it was natural for the young and energetic research scholar to enter this new field, and he quickly established a great reputation. 'We've got a young rabbit here from the Antipodes', wrote a Cambridge resident, 'and he's burrowing mighty deep'. Rutherford soon found out that the radiations thrown out by uranium consisted of two quite different forms . . . one of them behaving like J. J. Thomson's electrons, which he called the beta rays, and another radiation which he called the alpha rays. These alpha rays were to be one of the most important tools of his later life.

Lord Rutherford: one of the last photographs of him

He took the problems of these radiations with him to McGill University in Montreal, where he was appointed MacDonald Research Professor of Physics in 1898. He collected round him an able band of research workers, including Frederick Soddy. In the next five years Rutherford and his school proved conclusively that the heaviest elements were spontaneously changing by throwing out Rutherford's alpha and beta rays. The alpha rays were shown to be atoms of the light element helium and the beta rays were shown to be electrons. By these processes the heaviest element, uranium, was transformed first through three lighter elements into radium—which Madame Curie had discovered—and from that by nine more changes into stable lead. A similar process of radioactive change was found to be occurring in members of the thorium family. These changes could not be speeded up by any known physical process, and the amount of energy which was released in the process was astoundingly large. Rutherford said that there was 'reason to believe that an enormous store of latent energy was resident in the atoms of radioactive elements . . . energy which was derived from the internal energy of atoms. There seemed to be every reason to believe that the atomic energy of all the elements was of a similar high order of magnitude'. By 1905, then, the doctrine of immutable atoms had been overthrown and the possibilities of atomic energy were dimly seen.

The next great phase of Rutherford's work was carried out in Manchester University, where he moved in 1907. At this time the structure of atoms was uncertain. They were no longer thought of as minute billiard balls, and speculation on their structure was very free, one school considering them to be rather like minute plum puddings with electrons as currants embedded in a sphere of positive electricity.

Rutherford started by working on the nature and properties of the helium atoms which he had found to be shot out of radioactive elements. In the course of the experiment he noticed that these high-speed atomic projectiles could be deflected slightly by collision with atoms of a gas or in passing through thin metal foils. One day when he was discussing in the laboratory the great magnitude of the forces required to deflect such very high-speed particles—they would cross the Atlantic in a fraction of a second—he turned to a young student, Marsden, and said, 'What about trying whether you can get alpha particles reflected from a solid metal surface'. To Marsden's surprise he found that a few of these projectiles did in fact bounce back. This was even more surprising to Rutherford: he said that it was as surprising as if a fifteen-inch shell had bounced back from a sheet of tissue paper. He puzzled over these results for nearly two years and finally, by remarkable insight, concluded that the atom must be like a miniature solar system—a central electrically charged sun, the nucleus, with electrons circulating round it like planets. This picture was confirmed by a series of beautiful experiments. Rutherford believed in the motto written above the entrance to McGill Physics Laboratory: prove all things.

From this discovery it was seen also that the properties of the different elements were determined solely by the nature of the central nucleus. The central nucleus could carry any number of units of positive electrical charge between one and ninety-two and for each unit of charge on the nucleus, one negatively charged electron could be attracted as a planet. The chemical properties depend on the electrons and so in turn on the nucleus. Many of you will remember that the work of the chemists had enabled them to arrange the elements in what is called the periodic table. In the top row you have only two elements: hydrogen (the lightest of all elements) on the left, and helium on the right. The next row starts with lithium at the left-hand side and works across, through beryllium, boron, carbon, nitrogen, oxygen and fluorine to neon. In the next row you start with sodium and work across to argon. The properties of the elements repeat themselves in passing down from one row to another. This was now all explained by the planetary atom of Rutherford, for the electrical charge of the nucleus increases steadily from one to ninety-two as we work through successive rows of the periodic table. Successive shells of electrons are filled, one shell to each row of the table. The Manchester work of Rutherford not only gave us a picture of the incredibly minute world of the atom, but it explained at once the chemical regularities of the elements.

Already, Rutherford's discoveries were sufficient to have placed him amongst the immortals, but one last great period of work was still to come. He moved to Cambridge in 1918 and became the fourth of the illustrious line of Cavendish Professors. He was experimenting again with his alpha particles, shooting the high-speed helium atoms into nitrogen gas in a sort of nuclear billiards to see how the atoms were knocked about. To his surprise another kind of atomic particle appeared and it turned out that these were hydrogen atoms. Again Rutherford's remarkable intuition led him to the correct conclusion. His helium atoms were entering the nitrogen nuclei and knocking out hydrogen atoms, thus transforming nitrogen into a form of oxygen, which is three units of mass heavier. The rapidly growing school of the Cavendish Laboratory now concentrated on this problem. When I first worked in the laboratory in 1922, Rutherford used to shut himself up for an hour or so every day in a darkened room with selected research students, looking for a minute at a time through a microscope at the faint scintillations of light produced when the nuclear fragments hit a zinc sulphide screen. With this remarkably simple apparatus the controlled transmutation of matter was achieved for the first time.

These experiments were trying and difficult, and it was characteristic of Rutherford that he encouraged 'his boys', as he called us, to develop new methods which in the end produced a new branch of science—nuclear physics. New apparatus producing high voltages and long sparks was brought into or built in the laboratory, and by these means copious streams of high-speed hydrogen atoms were produced to take over the work of transmutation from Rutherford's alpha particles. At the same time, other groups working in cellars and dim corners were developing new methods of recording the impact of high-speed atomic particles. This work bore fruit in that *annus mirabilis* of 1932 when Chadwick discovered the neutron, Walton and I transmuted the light elements with hydrogen atoms, and Blackett and Occhialini showed how radiation could be transformed into matter. The discovery of the neutron by Chadwick led in 1938 to the discovery of the fission of uranium by neutrons and from here to the final achievement of the release of nuclear energy. These discoveries, with all their far-reaching consequences, rest therefore on the foundation of Rutherford's work, though at the time of his death, in 1937, he himself thought that the outlook for gaining useful energy from atoms did not seem promising.

Rutherford's scientific work was well summed up by his friend, Sir James Jeans. Jeans said: 'Most of his investigations were key investigations . . . each brilliant in its simplicity of conception and far reaching in its consequences. In his flair for the right line of approach to a problem, as well as in the simple directness of attack, he often reminded us of Faraday. Voltaire once said that Newton was more fortunate than any other scientist could ever be since it could only fall to one man to discover the laws which govern the universe. Had Voltaire lived in a later age he might have said something similar of Rutherford and the realm of the infinitely small, for Rutherford was the Newton of Atomic Physics'.

In considering the technological consequences of Rutherford's work we might again think of Faraday. In 1831 Faraday discovered that a moving magnet will produce an electric current in a coil of wire, and with that observation opened the way to the development of electric power which has transformed our way of living and working and enormously increased man's productivity and standard of life. But it was not till forty-eight years later that a dynamo lit Edison's first practical electric light, and two more years before the first central electricity station came into use. No one living in 1831 could have predicted the full consequences of Faraday's work, and I do not think that anyone living today can predict the full technological consequences of Rutherford's work. If Rutherford were alive today he would be thrilled by the sight of the powerful atomic research piles at Chalk River and Harwell, generating energy, quietly and safely, producing the radioactive isotopes which are helping the biologist to understand the world of living matter and providing for physicists new and powerful tools of research. We are only beginning, however, to see our way to applying nuclear energy to the development of electrical power.

What sort of man was Rutherford to have achieved so much? Needless to say he was a man of great intellectual power, but Rutherford was much more than this. He was a man of wide reading, shrewd in all practical things, a great judge and leader of men, and a man of profound wisdom, much sought after for his counsel in the larger world. For five years he served the Royal Society as its President; he did much to encourage the application of science to industry, and in particular to encourage the development of the Department of Scientific and Industrial Research to its present status in our country.

Rutherford was not one who journeyed in strange seas of thought, alone. He was a man of exuberant vitality; he loved to have young men about him, sharing his enthusiasms, generating their own ideas by the intense cross-fertilisation of discussion, producing results which no one man, however great, could have realised. Those who worked with Rutherford caught to some degree this infection and way of working. During the war you could see this spirit of the Cavendish burning fiercely in huts and stables on the Swanage headland and Hampshire coast, generating the micro-wave radar which contributed so much to our victory. Today you can still see the influence of Rutherford in the work of his students.

In the last decade of his life Rutherford came to dominate the scientific world as no other scientist has ever done. We can say of him, rather as Planck said of Clerk Maxwell, by his birth and early training he belongs to New Zealand, by his personality he belongs to the British Commonwealth; by his work he belongs to the whole world. The Royal Society propose to commemorate his name by providing for Rutherford Scholars and Rutherford Lecturers who, like Rutherford, will carry the torch of learning between our member nations. There can be no more fitting memorial.—*Third Programme*

Psychology and the Future

The last of eight talks by SIR CYRIL BURT on 'The Study of the Mind'

IN this final talk I want to sum up the main conclusions emerging from our previous discussions. What, if anything, has the psychologist discovered? And how are those discoveries likely to affect our everyday life? In short, what progress has psychology made, and what advances may we expect in the near future?

Let us begin with the more practical problems first. The most conspicuous achievements of the scientific study of the mind are to be seen in the field of child psychology. For this there are obvious reasons: first, it is easy through the schools to get large numbers of children for observation and experiment; secondly, with children it is far easier to control environmental conditions, to carry out a given line of treatment, and to follow up their after-histories; thirdly, problems of childhood are far simpler in themselves; and, finally, teachers and education authorities have been the first to welcome psychological assistance. As a result, the systematic study of mental growth and maturation, of intelligence, memory and manual skill, of mental work and mental fatigue, of motivation of different stages of child life, and, above all, of the mental differences between individuals, has had a profound effect on the methods of child training and education.

Industrial psychology is a much younger branch; but its growth has been still more rapid. It started with an extension of the methods of child psychology to vocational guidance and selection. During the first world war, the investigation of hours and conditions of work in munition factories, of the lay-out of tools and the construction of machines, of time-and-motion study (as it is termed), of incentives, morale, and management, developed with surprising speed; and what was attempted with such success in time of war was applied to a still wider variety of problems during the interval of peace.

Soon after the outbreak of the second war the advice of psychologists was sought by the navy, army, and air force. The testing and allocation of recruits for the three fighting services, the study of innumerable psychological questions as they cropped up—in connection with military training, military equipment, military and civilian morale, and so-called psychological warfare—all this revealed the advantages to be gained by joining scientific advisers or investigators with professional experts in each particular field; and the analysis of the data thus secured has greatly increased our understanding of the human factor in both military and civilian undertakings. Above all, it has emphasised that need to discover, as early in childhood as possible, those whose innate gifts of ability and character will fit them for posts of responsibility and leadership.

The attempt to solve these more practical problems plainly requires a basis or background of theoretical knowledge. We cannot offer sound advice in regard to methods of education until we have first investigated the nature of the learning process. We cannot construct tests of innate 'intelligence' until we have first demonstrated that there is such a thing, and discovered whether (or in what sense) it is really innate. We cannot make systematic studies of the individual mind until we have achieved a clear scientific conception of the structure

Recollections of Lord Rutherford

At Manchester

By SIR CHARLES DARWIN, F.R.S.

AT Montreal Rutherford had made his first great discoveries of the natural transmutations of the radioactive elements and of their characteristic radiations. When he came to Manchester in 1907 he continued to follow up these Montreal discoveries. A good deal of the new work was connected with tidying up the relationships of the various families of radioactive elements, but undoubtedly the most exciting work was in connection with the radiations.

All through his life Rutherford showed what I should call an almost personal affection for the alpha-particle, which is a helium atom moving at a very high speed, and I think this was because he saw better than anyone else that in it he had much the most powerful probe there could be with which to discover how the atom is constructed. It was with alpha-particles that the work was done in Manchester—the work which led to what was undoubtedly the greatest discovery in the physics of this period, the discovery of the nucleus of the atom. When an alpha-particle goes through a sheet of gold-leaf it is scattered off the straight line, and a study of this scattering suggested that something very curious was happening to a few of them. The alpha-particle was occasionally thrown so wildly off its line that it could not be a cumulative effect that had done it. It must be a single event, but it took Rutherford to perceive this.

I myself went to Manchester in 1910 to work in the laboratory, but I was in a somewhat exceptional position there because my training had been mathematical, not experimental, so that though I was in the middle of this business I was hardly concerned directly in any of the experimental work, but more with the mathematical aspects.

I count it as one of the great events of my life that I was practically in at the birth of the nucleus of the atom. I remember very well going out to supper with Rutherford one Sunday evening along with three or four of the other workers of the laboratory. I think we arrived a bit before supper, and I remember sitting in Rutherford's study, and his saying 'You know I've just been looking at this scattering business. The forces from the atom working on the alpha-particle must be enormous'. And then he went on to describe how it all worked out. One characteristic of this conversation appealed to me particularly. According to his theory the alpha-particle in going past the nucleus describes a hyperbola, and the orbit is not difficult to work out for a professional mathematician, but Rutherford did not do it that way. He recalled from his school days a certain special property of the hyperbola, one which I certainly had not remembered, and got it all out from that.

This idea of the structure of the nucleus led on very quickly to the idea of atomic number, the importance of which we all accepted in Manchester long before it was fully established elsewhere. But it was firmly established by other work also done in Rutherford's laboratory in Manchester a year or so later, in particular by Moseley's work on X-rays and by Behr's theory of the structure of the atom. I think most people would agree that the discovery of atomic number has been the most important advance in our knowledge of the nature of matter since the discovery of the atomic theory by John Dalton, the Manchester schoolmaster, a century before.

Perhaps I have not managed to give you much of a picture of what life was like in the laboratory, but I can assure you that it was very stimulating. I particularly remember the way we used to assemble for tea every day, with Rutherford sitting on a stool on one side of a laboratory table and the rest of us standing on the other, while we all ate biscuits, and made wild speculations in physics or discussed the state of the world.

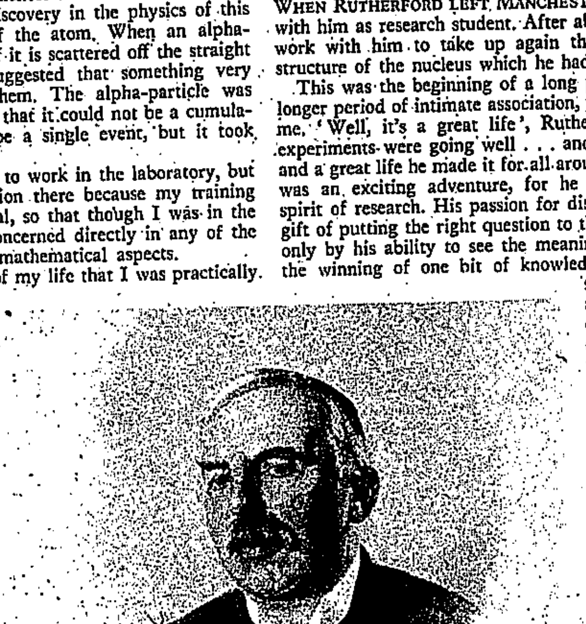
At Cambridge

By SIR JAMES CHADWICK, F.R.S.

WHEN RUTHERFORD LEFT MANCHESTER for Cambridge in 1919 I went with him as research student. After about a year there he invited me to work with him to take up again the assault on the problem of the structure of the nucleus which he had begun in Manchester.

This was the beginning of a long period of collaboration and a still longer period of intimate association, years of the happiest memories for me. 'Well, it's a great life', Rutherford would often exclaim when experiments were going well . . . and sometimes when they were not: and a great life he made it for all around him. Working with Rutherford was an exciting adventure, for he was the very incarnation of the spirit of research. His passion for discovery dominated everything. His gift of putting the right question to the test of experiment was matched only by his ability to see the meaning of the experimental result, and the winning of one bit of knowledge became at once the stepping-stone to the next. In him, thought and action were fused together into one tremendous urge. Anyone who ever worked in his laboratory will recognise the words 'Get on with it' with which he would stimulate his students, sometimes in cheerful encouragement, sometimes in not so cheerful admonition. By 'getting on with it' Rutherford meant, and demanded, an intense single-minded effort, a complete concentration on the job to be done. 'So-and-so will never make a physicist', he might say, 'I don't believe he loses much sleep over his problems'. But few could live up to Rutherford's standard in singleness of purpose or capacity for work.

Looking back at Rutherford's life one thinks that his great discoveries follow one upon the other as naturally as the links in a chain. The first is a revolutionary explanation of the behaviour of radioactive elements showing that one atom changes spontaneously into another with the emission of an enormous amount of energy in the form of radiation. Then, using the alpha-radiation to probe into the inside of the atom, he disclosed the broad picture of its structure as an extremely small heavy nucleus surrounded by a cloud of electrons. The problem of the constitution of matter was now resolved into two distinct parts, the problem of the



Lord Rutherford, who died ten years ago: a portrait by James Gunn
National Portrait Gallery

configuration of the electron cloud and the problem of the structure of the nucleus. It is amazing that one man could so transform physics by his own effort, a man with no great mathematical equipment, good but not remarkable even in experimental technique. Nor had he an acute or subtle mind; no, his mind was like the bow of a battleship—there was so much power and weight behind it, it had no need to be as sharp as a razor. He brushed aside all irrelevancy and went straight to his mark.

And what of Rutherford the man? It was natural enough that his genius should command respect and admiration but equally marked was the loyalty and affection he incited in his colleagues and students. His friendliness, transparent honesty and fair dealing endeared him to us all, and even his foibles were those of a frank, simple and vigorous spirit. He carried around with him an atmosphere of cheerfulness and good will, and the memories he has left behind are all happy ones.

The Workings of Genius

By Professor NORMAN FEATHER, F.R.S.

IF I HAVE ANY TITLE to speak of Rutherford, it is, I imagine, as a representative of the young men who were fortunate enough to come under his inspiring leadership in the Cavendish Laboratory during the last years of his life. It was, indeed, a great experience, but I do not propose to speak of it now. I prefer to take a broader theme.

For Rutherford in Cambridge was already a national figure, and many there will be who met him in those years—men who are not professionally physicists—who will retain vivid memories of his force of character, his robust simplicity, his zest for life. They will remember him as lacking all outward show of subtlety; and they may well think it slightly incredible, looking back, that they had known in him the man who had so changed the scientist's picture of the world that it could never again be the same. And I must admit that we students at times were incredulous too. But Rutherford's scientific intuition was something which we accepted, something which we counted upon, yet something we did not altogether understand. Possibly the workings of genius are always of this sort, but in Rutherford's case I think we can come a little closer to an understanding just because he was primarily an experimenter. His genius lay in never missing an implication in the result of an experiment, and his experiments, and the comments which he made on them, are an open book for all.

Let me take you back one stage farther than Sir Charles Darwin has done. I have in my possession some scraps of photographic plate, each about the size of a thumb-nail, on which more than forty years ago Rutherford obtained the first clear-cut evidence of the deflection of alpha-particles in a magnetic field. The deflection is shown by the doubling of a faint trace in the photographic image. On other scraps of plate there are the slightly blurred traces obtained with alpha-particles which had passed through a thin sheet of mica only one-three-thousandth of an inch thick—the first observation of the scattering to which Sir Charles has referred.

Here is the gist of Rutherford's comment on these seemingly unrelated observations: 'If the alpha-particles', he said, 'are deflected out of their path in passing through one-three-thousandth of an inch of solid matter, if they are deflected by an amount which I find it difficult to produce over several inches of path in a vacuum, using the strongest magnetic field available, then there must exist within the atoms of matter something akin to magnetic or electric fields thousands or even millions of times stronger than anything which can be produced in the laboratory'. You will see how direct is the approach, how apparently inescapable the conclusion.—'*Science Survey*' (*Home Service*)

News Diary: November 19-25

Wednesday, November 19

M. Ramadier, the French Prime Minister, resigns. 500,000 French workers on strike

Lieutenant Philip Mountbatten created Duke of Edinburgh, Earl of Merioneth and Baron Greenwich of Greenwich and invested with the Knighthood of the Garter

Select Committee appointed by House of Commons to consider the provision to be made for Princess Elizabeth and the Duke of Edinburgh on their marriage

Foreign Ministers' Deputies fail to agree on agenda for conference on Germany

Railway companies ask for troops to help in speeding up turn-round of wagons

Thursday, November 20

Princess Elizabeth and the Duke of Edinburgh married in Westminster Abbey. (See pages 936-937)

British Government announces that it cannot allow a United Nations Commission to exercise power in Palestine until the Mandate has ended. Representatives of Muslim States criticise partition plan sponsored by the United States and Russia

Paymaster-General states that a new system of allocating priorities of steel is to be introduced

The new wage agreement for miners unanimously approved by a delegate conference

M. Blum agrees to form new French Government. The French President appeals for a 'return to work'

Select Committee set up by House of Commons to inquire into Budget incident

Friday, November 21

M. Blum fails to obtain vote of confidence from the French Assembly

Mr. Marshall, United States Secretary of State, arrives in England to attend Council of Foreign Ministers

Temporary housing programme discussed in House of Commons

General Bradley to succeed General Eisenhower as Chief of Staff of U.S. Army

Saturday, November 22

M. Robert Schuman (M.R.P.) forms new Government and receives vote of confidence from French National Assembly by 412 votes to 185

Marshal Sokolovsky, Commander of the Russian Zone of Germany, delivers attack on the British and American administration of their zones at a meeting of the Allied Control Council in Berlin

End of general strike in the Italian province of Apulia

Sunday, November 23

Mr. Molotov arrives in London to attend Foreign Ministers' Conference

New French Cabinet completed with a larger proportion of M.R.P. Ministers. M. Bidault retains his post as Foreign Minister

Minister of Food announces in a speech at Dundee that the Government is again attempting to reach a trade agreement with Russia

Mr. Herbert Morrison states that our key production figures are the most hopeful since the war

Monday, November 24

United States Senate begins debate on the Interim Aid Bill to help France, Italy and Austria

Soviet delegate accuses Britain of obstructing United Nations plan for Palestine

National Assistance Bill receives unopposed second reading in Commons. Minister of Health draws attention to the need for special homes for old people

Prime Minister discusses international relations with Mr. Mackenzie King, General Smuts and the High Commissioners for the Dominions

Coal output reaches above 4,250,000 tons for third successive week

New French Cabinet holds its first meeting

Tuesday, November 25

C.G.T. presents new French Government with demand for higher wages. Extension of French strikes. Railway workers instructed by their union to start a total strike

The Conference of Foreign Ministers on Germany and Austria opens in London

Persia rejects Russian protest at Majlis' refusal to ratify oil agreement

Anglo-Swedish financial agreement signed

Jet-propelled Meteor aircraft flies from Edinburgh to London at 617½ m.p.h.

More rioting in southern Italy

HONI SOIT

24.7.35

W.H. BRAGG'S THEORY.

[illegible]

The [illegible] University from Sydney High School, Professor J. P. V. Madsen, B.Sc. (Syd.), B.E. (Syd.), D.Sc. (Adel.) graduated B.Sc. in 1900 with first-class honours and the University Medal in [illegible] and high first-class honours [illegible] in 1901 he graduated B.E. with first-class Honours and the University Medal. Also in 1901 he received the first award of the P. N. Russell Medal for a Post-Graduate Thesis.

On obtaining his degree, he was appointed lecturer in Physics and Mathematics in the University of Adelaide, and from 1903 to 1909 held the lectureship in Electrical Engineering in the same University. While in South Australia he acted as Assistant Engineer to the Adelaide Electric Light Supply Company, and was thus able to keep in touch with the practical development of electrical engineering. In association with Professor (afterwards Sir William) Bragg, Professor Madsen did a considerable amount of research work dealing with the effects of radiation independently to investigate the scattering effects of other radiation produced by radium.

In 1909 he was appointed P. N. Russell lecturer in electrical engineering at Sydney, and from 1912 till 1920 was assistant professor. During this period Professor Madsen acted as consulting electrical engineer to the Water Conservation and Irrigation Commission of N.S.W., and was responsible for the initial development of one of the first important electrical innovations in the form of rural distribution.

From 1915 till 1918 his services were retained by the Commonwealth Defence Department as officer in charge of and chief instructor to the Engineering Officers' Training School of Australia. [illegible] were detailed [illegible] engineering [illegible] as well as [illegible] from [illegible] in Expeditionary Forces or [illegible] from all States within the Commonwealth.

In 1920 he was appointed Professor of Electrical Engineering.

* Professor Madsen in 1926 acted upon an advisory committee appointed by the Government to consider upon the future control of broadcasting in Australia. This report, adopted almost entirely, forms the basis of the existing [illegible].

In 1926 Professor Madsen was appointed chairman of the newly formed [illegible] Research Board of Australia, a position he still holds. [illegible]

[illegible]

* [illegible]

[illegible]

Study of Research.

In [illegible] an interview on Saturday, Professor [illegible] lecturer in Physics at the Adelaide University, referred to [illegible] Professor Bragg [illegible]. Professor Bragg's [illegible] in Adelaide and, after he went to England, [illegible] experiments with [illegible] X-rays [illegible]

[illegible]

Bragg's Theory.

[illegible]

New Appointment.

[illegible]

FAMOUS SCIENTISTS.

PROFESSOR BRAGG AND HIS SON.

The Barnard gold medal [illegible] five years by the trustees of the [illegible] University, New York, for [illegible] has been awarded to Professor W. H. Bragg [illegible] and W. L. Bragg [illegible] the highest [illegible] Professor Bragg was at one time lecturer in mathematics and physics at the Adelaide University. His son, after having attended St. Peter's College, proceeded to England and is a Fellow of the Trinity College. Their researches have been [illegible].

Study of X-rays.

The report of the National Academy of Sciences in connection with the awarding of the medal contained the following:— "Your committee [illegible] the medal [illegible] William Henry Bragg [illegible] in the University [illegible] and [illegible] W. L. Bragg [illegible] Professor at the University of [illegible] [illegible] indicated in [illegible]. The doctrine of atomism, [illegible] by Leucippus, Democritus, and Lucretius, and raised to the dignity of an exceedingly fruitful hypothesis by Dalton and the modern schools of chemists and physicists, is now approaching the long sought stage of verification and demonstration. Since the time of Dalton a multitude of investigators have contributed [illegible] towards the attainment of this advanced stage, but progress has been [illegible] cumulative and rapid during the past quarter of a century. The [illegible] importance of the several fields of research in which the atomic structure of matter is now being established is sufficiently indicated by the fact that four preceding awards of the Barnard medal have been made for researches in these fields. But this importance is now emphasised [illegible] by the recommendation that the next award of the Barnard Medal be made to Messrs. W. H. and W. L. Bragg, father and son, for highly meritorious work in the same fields. About three years ago [illegible] Laue and his collaborators of the [illegible] of Munich produced some remarkable [illegible] by passing a narrow beam of X-rays through a crystal of zinc blende. These [illegible] of the [illegible] The bearing of [illegible] [illegible] Messrs. Bragg have [illegible] X-rays are [illegible] [illegible] Messrs. W. H. and W. L. Bragg [illegible]

The University of Sydney.

May 7th/ 1918

Dear Sir.

I have much pleasure in sending you a copy of a letter which has been received from the Department of Defence in reference to the service which you have rendered to that department as Officer Commanding the Engineer Officers Training School at Roseville.

The letter was placed before the Senate at its monthly meeting held yesterday.

Yours faithfully,

[signature]

Warden and Registrar.

Commonwealth of Australia,
Dept. of Defence.
April 9th/1918.

Copy.

Dear Sir.

With further reference to your letter of the 6th February last, and this office letter of the 8th ult., relative to Major Madsen, I am directed to inform you that as a result of the discontinuance of further training at the Engineer Officers Training School, Roseville, and the closing of that establishment it is now possible to entirely release Major Madsen from military service.

The Minister desires me at the same time to again express his warm appreciation of the action of the University authorities in making available the services of Dr. Madsen as Chief Instructor and, latterly, Officer Commanding the Engineer Officers Training School. This gentleman's high technical and professional attainments coupled with the whole-hearted energy which he brought to bear on this important work has enabled this department to send forward highly trained Engineer Officers for the front, and it is confidently felt that the achievements of these officers on the field will disclose that Major Madsen's important work in military training has been fulfilled with ability and distinction.

Yours faithfully,

T. Trumble,

Secretary.

The Warden and Registrar,
The University of Sydney.

PART FOUR. UNIVERSITY LIFE.

1. The students' viewpoint.
2. A lecture by J.P.V.M. on 'The Life and Work of Micheal Faraday.'
3. The citation for J.P.V.M.'s Doctor of Science (Honoris Causa) degree.
4. Press cuttings relating to the early years, knighthood, the knighthood and wartime radio location.
5. J.P.V.M.'s influence on the course structure in science and engineering.
6. J.P.V.M.'s work and reputation are recognised by the University's Senate and Professorial Board.

Extract from The Engineering Year Book 1926 - Sydney University

PROF. J.P.V. MADSEN, B.E., D.Sc.

It was not until the beginning of Third Year that we met Professor Madsen and his subject of Electrical Engineering, which is rather a pity, as his untiring energy was what really instilled into our minds the true idea of efficient work. He is one of the busiest men in the School, and consequently one of the hardest to find when you want him - always conferring with mechanics or contractors, inspecting St. Paul's Oval or at a meeting. Yet his lectures are more effective than any others we get, due probably to his clear and concise idea of the usual pitfalls for young students of electricity and the saving grace of first principles as opposed to details. A regular bogey-man at exam. times, he demands a very high standard from his "studes" - and usually gets it. To him alone, we owe whatever slight conception we have of the importance of filthy lucre and "corsts" in engineering undertakings.

Professor Madsen is chiefly noted for a quite distinctive gait, and for a small cardboard case, which ever and anon is brought forth from the depths of his coat pocket, only to disappear again in the twinkling of an eye.

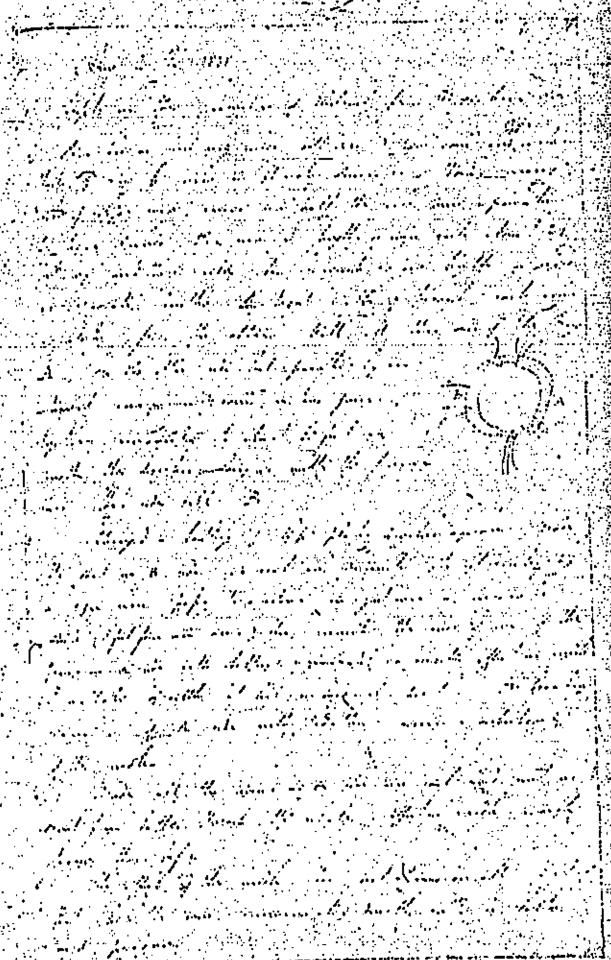
1. Experiments on the production of Electricity from Magnetism, etc., etc.

2. Have had an iron ring made (soft iron), iron round and $\frac{7}{8}$th inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round, one half the coils being separated by twine and calico—there were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call B.

3. Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated and settled at last in original position. On breaking connection of A side with Battery, again a disturbance of the needle.

4. Made all the wires on A side one coil and sent current from battery through the whole. Effect on needle much stronger than before.

5. The effect on the needle then but a very small part of that which the wire communicating directly with the battery could produce.



Facsimile and Transcript of the page of Faraday's Diary recording the Discovery of Electro-magnetic Induction.

THE LIFE AND WORK OF MICHAEL FARADAY

and Applications of his Discovery of Electro-magnetic Induction.

PROFESSOR J. P. V. MADSEN, D.Sc., B.E., M.I.E.AUST.*

"The world has seen no greater experimental philosopher than Michael Faraday." The particular event of importance which we celebrate to-night is what Faraday described in his original notes as "Experiments upon the production of electricity from magnetism." These experiments showed that electrical currents were induced in electrically conducting circuits when they were moved relatively to magnetic fields. One of the immediate results of this discovery was the recognition of an effective means of utilising "the principle of transformation of energy from mechanical to electrical form." Previously, such a transformation had been demonstrated by frictional apparatus, but up to the present day this method has not been developed beyond laboratory equipment capable of dealing with extremely small amounts of energy.

The converse transformation of energy from electrical to mechanical form had been demonstrated by Oersted and Ampere in 1820, and, in 1821, Faraday had performed an experiment which showed how this principle could be applied to the production of the electric motor.

A century has elapsed since this discovery by Faraday was made known, and during this period the progress of mankind and of our modern state of civilisation has been profoundly influenced by its results; at the same time, the stimulus which it has given to research in physical science and its application has lead to a truly wonderful development.

By accepting Faraday's principles, Maxwell, Kelvin and Hertz extended and developed scientific knowledge, while, at the same time, from the application of these principles there arose the modern developments with which we are now so familiar—the generation and distribution of electrical energy, its application to mechanical purposes—lighting, heating, telegraphy and telephony, radio transmission and reception, chemical and medical technique.—

In addition to his work as a physicist, Faraday did quite as notable work as a chemist. The liquefaction of chlorine in 1823, his discovery of benzene, and his discovery of the fundamental laws of electrolysis, did almost as much for chemistry as his discovery of the principle of electro-magnetic induction did for physics.

Faraday gave his discoveries freely to the world and looked for no material reward. Apart from his scientific work, the world has gained much that he bequeathed in his character, example, ideals, clearness of thought and expression.

In tribute to his memory it is appropriate on such an occasion as this that we should review his life story.

To follow the career of the blacksmith's son through a life of unremitting perseverance, to appreciate his mode of thought, his failures, his successes, his passion for truth, is in itself a privilege and an inspiration.

For much of the information contained in this address, the author is indebted to the following works:

The Life and Letters of Faraday, by Dr. Bence Jones, and *A Tribute to Michael Faraday*, by Rollo Appleyard.

It is noteworthy that 22nd September, 1831, was Michael Faraday's 40th birthday. In that same year, James Clerk Maxwell was born, and the British Association for the Advancement of Science held its first meeting.

Michael Faraday was born on 22nd September, 1791, at Newington, near what was once the village of Walworth in South London. James, his father, was a blacksmith, and Margaret, his mother, was a farmer's daughter.

In 1796, through distress and force of circumstances, Faraday's family was forced to move to the north side of the Thames, where Michael received his early training at a local day school.

At the age of 13 he entered the employment of Mr. Riebau, a newspaper agent and bookbinder. It was his duty to carry round the news sheet of the day, waiting until each subscriber had perused it. After a year's trial he was apprenticed for a period of seven years as a bookbinder.

During his apprenticeship he took advantage of the opportunity afforded for reading the material which passed through his hands, and in this manner gained a little knowledge of the elements of chemistry and physics. He attended occasional lectures and gained some instruction in drawing and perspective.

His father died in 1810, and, in 1812, at the termination of his apprenticeship, he entered the service of Mr. De la Roche as a journeyman bookbinder.

In this year he was taken by Mr. Dance, one of his master's customers, to a series of four lectures by Sir Humphrey Davy at the Royal Institution, and he subsequently ventured to write to Sir Humphrey offering his services as an assistant, at the same time sending him a carefully prepared set of notes of his lectures, admirably put together and bound. This volume is now in the archives of the Royal Institution.

He received an encouraging reply from Sir Humphrey, who was struck by his zeal, power of memory and attention.

In 1813, at the age of 22, he was appointed an assistant in the laboratory of the Royal Institution, at a salary of 25 shillings per week, with living accommodation.

Almost immediately he was offered by Sir Humphrey an opportunity to accompany him on a lecture-tour of the Continent. This he accepted readily, as up till this time he had not been more than twelve miles from London.

They traversed France, Italy, Switzerland, Germany and Flanders, and came in contact with many notable scientists, among them Ampere, Guy Lussac, Volta, and De la Rive.

Upon his return to England, in 1815, Faraday received promotion, and for the next five years devoted himself principally to chemical work. He delivered lectures regularly at the City Philosophical Society, and as the result of much careful thought and preparation became a skilled experimenter and an accomplished speaker.

He married Miss Sarah Barnard in 1821, and in the following year was appointed Superintendent of the house

* Professor of Electrical Engineering, University of Sydney.

and the laboratory at the Royal Institution, while still acting as chemical assistant.

In 1824, he was elected a Fellow of the Royal Society.

In 1825, he was appointed Director of the Laboratory under the superintendence of the Professor of Chemistry. Upon the death of Sir Humphrey Davy, in 1829, he took over the whole responsibility of the work of the Royal Institution.

From a very complete set of notebooks and diaries, together with the three volumes of the *Experimental Researches*, which Faraday left on record as a statement of his scientific work, it is possible to gain some information in regard to his researches.

In 1821, he commenced his electro-magnetic experiments.

It is rather important that we should know something of the knowledge which existed at that time concerning the subject.

In 1791, Galvani had commenced to divert attention from electro-static considerations. Between 1796 and 1800, Volta extended the idea of current flow, and, in 1820, Oersted demonstrated the fact that an electric current flowing through a wire would deflect a magnet.

Almost immediately Ampere had shown that mechanical forces were exerted between neighbouring wires which carry currents, and had developed their laws of action. He had put forward the conception of a magnet as an assemblage of closed electric circuits each carrying current.

It was at this stage that Faraday became seriously interested in the work. In 1821, he had succeeded in making a wire carrying an electric current rotate in the earth's magnetic field.

It is on record that Faraday "danced about the revolving metals," his face beaming with joy as he exclaimed, "There they go, there they go, we have succeeded at last." He further celebrated the occasion by taking his assistant to the theatre. Faraday was indeed very human.

Faraday now appears to have concentrated upon the idea of deriving a current from a circuit under magnetic influence, and with this object in view he carried out many experiments intermittently over a period of nearly 10 years.

Most of these experiments proved complete failures. We know now that this was because of his error in assuming that such effects would be obtained under steady current conditions. Success came eventually when he abandoned these conditions and investigated momentary effects.

It was on 29th August, 1831, that Faraday tried this memorable experiment.

Having wound two independent and insulated circuits on an iron ring, one was connected to a suitable battery, the other to a galvanometer. No effect was experienced while the steady current passed, but upon making and breaking the electrical circuit, induced currents showed their presence in the galvanometer circuit by the transient deflection they produced.

Faraday had discovered the principle which has been used ever since in transformers, and modern achievement now provides for transformation of electrical potential to values approaching one million volts and capacities of the order of many thousands of horse power.

As a result of this success Faraday almost immediately devised further experiments illustrating the same principle. For example, a permanent magnet was thrust into a solenoid connected to a galvanometer. During the movement of the magnet in and out of the solenoid the effects of transient induced currents were observed.

Finally, within a very short period, Faraday inserted a copper disc between the poles of a large permanent magnet, and arranged two spring contacts, one pressing against the axis, and one against the perimeter. On rotating the disc, a steady electric current was obtained in a galvanometer connected to the two springs, and at that moment electrical engineering may be said to have sprung into existence.

Faraday's success was due very largely to his conception of "lines of force" as a convenient method of interpreting the attractions and repulsions of magnetic poles. The distribution of iron filings in the neighbourhood of magnets or of conductors carrying current undoubtedly suggested this idea to Faraday, and his genius enabled him to proceed therefrom to imagine physical lines of magnetic force communicating stress from one part of a medium to another.

Instead of dealing with the problems of the attractions and repulsions which magnetic poles exerted upon each other in terms of action at a distance, Faraday conceived a picture which enabled him to visualise the processes by which these forces were communicated from the one pole to the other. He pictured the medium surrounding the magnetic pole as being thrown into a peculiar condition of magnetic stress which could be expressed in terms of his "lines of force."

The Law of Electro-magnetic Induction which expressed the results arrived at from many of his experiments could be stated in the now familiar form:—When lines of magnetic force and electrical conductors are in relative motion, an electro-motive force is set up in the conductors equal to the rate at which the lines of force are cut.

The means available to Faraday would not enable him to verify the quantitative nature of this law except approximately. Our knowledge to-day is largely based upon the perfect exactness with which this law is found to apply.

Taking Faraday's Law of Electro-magnetic Induction as a basis, the engineer has been able to make rapid progress in the development of machinery for the generation and application of electricity.

In the construction of electrical generators he has been concerned primarily with the production of relative motion between magnetic fields and conductors. From the earliest days it became apparent that rotary, rather than reciprocating, motion lent itself best to the solution of the problem. In some cases the conductors have been caused to rotate about an axis, while the magnetic field was kept stationary; in other cases the magnetic fields have been rotated while the conductors remained stationary.

In the earlier stages the fields produced by permanent magnets were used, but it was soon found more economical to use electromagnets for this purpose.

The advent of the steam turbine made it possible to introduce much higher values of relative movement than had been used previously with the slower speed reciprocating engines. Modern development has reached the point where generators of the capacity of 100,000 horse power are now produced.

The transmission of such large amounts of energy over long distances is effected economically by high voltages up to values of 200,000 volts, and in the design of transformers for this purpose, the original principle, as illustrated in Faraday's ring experiment, is adhered to rigidly.

In addition to his work on electro-magnetic induction, Faraday's researches led him into investigations into the behaviour of electrically-charged bodies, the effects which such charged bodies produce upon one another, and the influence upon these effects of the medium surrounding these bodies.

In much the same way as he had pictured the medium in the neighbourhood of the magnetic pole as being thrown into a state of magnetic stress, which could be expressed in terms of magnetic "lines of force," so also in dealing with the effects of electrical charges Faraday pictured the medium surrounding these charges as being thrown into a condition of electrical stress. He was able to represent this electrical stress in terms of electrical lines of force radiating from charged bodies.

He found that the medium surrounding the charged bodies had considerable influence upon the forces which existed between these bodies, and this property of the medium he called the "Specific Inductive Capacity." We still retain this term and many of us will appreciate it as that property which influences the capacity between conductors.

From Faraday's diary of March, 1832, we read, "The lines or directions of force between two electrical conductors oppositely electrified may be called electric curves in analogy to magnetic curves. Do they not exist also in the electric current wire?"

By means of these conceptions Faraday brought the ideas of electric and magnetic forces into harmony with the ideas of stress and strain. He admitted that his doctrine of "lines of force" was speculative, and we may well quote his own words: "It is not to be supposed for a moment that speculations of this kind are useless, or necessarily hurtful in natural philosophy. They should ever be held as doubtful and liable to error or change, but they are wonderful aids in the hands of the experimentalist and mathematician; they lead on, by deduction and correction, to the discovery of new phenomena, and so cause an advance in real physical truth, which, unlike the hypothesis which lead to it, becomes fundamental knowledge not subject to change. . . Though I value them highly when cautiously advanced, I consider it an essential character of a sound mind to hold them in doubt."

In 1835, as a mark of the nation's appreciation, Faraday was granted a pension of £300 per annum, King William IV taking a personal interest in the matter. In 1841, he established the Juvenile Lectures at the Royal Institution, which are still carried on.

During this period he suffered from ill health and was forced to relax. However, in 1846, he performed a very remarkable experiment which was first described as "the magnetisation of light." A natural counterpart to this experiment has quite recently been discovered in the propagation of radio waves through the earth's magnetic field.

Over a period of his later years Faraday took a considerable interest in submarine telegraphy.

He suffered over a long period from ill health. In 1858, at the request of Queen Victoria, he took up residence at one of Her Majesty's houses on Hampton Court Green.

He was forced to relinquish work entirely in 1865, and died on 25th August, 1867.

We cannot close this account of Faraday's lifework without some reference to aspects other than purely scientific.

Commencing with an extremely elementary education, he paid the closest attention to self instruction. He was a great letter-writer; many of his letters to his mother and friends have been preserved and are most interesting, not only from the nature of their contents but also from their style and composition. He paid minute attention to such matters. His success as a lecturer was not achieved without the same careful thought and study. At one stage of his career he writes:—

I always find myself obliged, if any argument is of the least importance, to draw up a plan of it on paper, and fill in the part by recalling there to mind, either by association or otherwise; and this done, I have a series of major and minor heads in order, and from these I work my matter. Now, this method, unfortunately, though it will do very well for the mere purpose of arrangement and so forth, yet it introduces a dryness and stiffness into the style of the piece composed of it; for the parts come together like bricks, one flat on the other, and though they may fit, yet they have the appearance of too much regularity . . . I would, if possible, imitate a tree in its progression from roots to trunk, to branches, twigs and leaves.

His lectures at the Royal Institution would in themselves have made fame. His series of lectures to "Members of a Juvenile Auditory," given at Christmas over a period of nineteen years, have created a tradition which is still followed.

He exercised great care in writing up his notebooks and diaries, many of which were embodied in his "Experimental Researches." Faraday rendered great public service during his life. He was consulted by Government Departments on such matters as explosives, mine explosives, lighthouses—in connection with the replacement of oil-burning lanterns by electric machinery; cable insulation, and many other matters.

Faraday took a keen interest in music and art. He made many close and lasting friendships, and was regarded affectionately by all with whom he came in contract.

Faraday belonged to a small isolated sect known as Sandemanians after their founder. His religion concerned him seriously but was reserved for his own intimate thoughts, from which even his wife was to some extent excluded. His religious and philosophical views were kept rigidly separated.

He was a keen advocate of the teaching of science in schools. It must be remembered that in his time science was almost completely neglected in the public schools. Faraday, in evidence before a Royal Commission in 1862, claimed that the proper teaching of science "trained the mind to ascertain the sequence of a particular conclusion from certain premises, to detect a fallacy, to correct undue generalisation, and to prevent the growth of mistakes in reasoning."

It is difficult thoroughly to appreciate the greatness of Faraday's work, covering as it did the realm of chemistry, electricity, and magnetism. The connection of these subjects with Light, Heat, Gravity, Cohesion, etc., and the elucidation of the fundamental principles involved, was the great problem which he constantly faced. His conviction that some fundamental connection existed between them caused him to devise the innumerable experiments which he carried out. If we bear this in mind it may help us to understand how he maintained his undaunted efforts; how, in spite of many failures, he was able so often to emerge triumphant at last.

Finally, may we ask whether our present situation in regard to social problems is any more advanced than the state of affairs which existed in the field of Physical Science before Faraday made his illuminating discoveries. Is it not possible for us to hope that corresponding research may bring about enlightenment upon fundamental laws which may govern social and economic relationships, that another Faraday may arise in another field?

THE UNIVERSITY OF SYDNEY.
SYDNEY.

Presentation of Emeritus Professor Sir John Percival Vissing Madsen, B.Sc., B.E.(Sydney), D.Sc. (Adelaide), formerly Peter Nicol Russell Professor of Electrical Engineering, for the Degree of Doctor of Science (Honoris Causa), by the Deputy Chancellor, Dr. C. G. Macdonald, on Wednesday, 5th May, 1954.

Mr. Chancellor,

The conferring of an honorary degree on a man of distinction is always a happy occasion, but when the recipient is an alumnus of the University which grants it, the honour falls on him with greater grace, for the University, though a loving mother, demands the most rigid standards of achievement from her own children.

John Percival Vissing Madsen is one of the best scholars this University has produced. Mathematician, physicist, engineer, he won the University medal for mathematics in his science course and another University medal on graduation in engineering. In 1920 he was appointed Peter Nicol Russell Professor of Electrical Engineering and after some twenty years of professorial service he became Dean of his Faculty and a Fellow of the Senate. From 1947 till his retirement he was Chairman of the Professorial Board, the highest academic post of any serving professor.

Whereas some great scholars exercise all their influence within the cloisters of the University, allowing their students after graduation to disseminate their learning vicariously, this is not true of John Madsen. If we could use an intellectual Geiger counter we should find evidence of his activity in every corner of the Commonwealth. When in the early days of radio boys of all ages were convinced that the strange noises issuing from their crystal sets came from China or Russia, it was John Madsen who determined to explore the atmosphere and the ionosphere in an attempt to increase our knowledge of the propagation of radio waves. To this end he founded the Radio Research Board of Australia, a body whose record of fundamental scientific investigation is not inferior to that of similar bodies in the United Kingdom and in the United States of America.

The next great chapter in his life was his association with Australia's contribution to research into radar, that discovery which perhaps more than any other decided victory for the Allied Forces in the Second World War. Appointed Chairman of the Advisory Committee of the Radiophysics Laboratory of the Council for Scientific and Industrial Research, he with his large team of young scientists poured into the pool of radar investigation Australia's goodly share of fundamental and applied research.

Many other achievements lie to his credit. It is enough to mention the formation of the National Standards Laboratory, his work on the Council for Scientific and Industrial Research, his Chairmanship of the Australian National Research Council and his Chairmanship of the Electrical Research Board of the C.S.I.R.O. Already in 1941 he had been honoured by his King with the order of knighthood.

In these exciting and dangerous times when, almost literally, we see men of science

> Rift the hills, and roll the waters, flash
> the lightnings, weigh the sun,

is it any wonder that this University should wish to honour one who has brought to her much honour by his offerings to Science ?

Mr. Chancellor, I present Sir John Percival Vissing Madsen, Knight, Doctor of Science, Bachelor of Engineering, Fellow of the Institute of Physics, Member of the Institution of Engineers, Australia, for admission to the Degree of Doctor of Science, honoris causa.

C. S. McDonald

Deputy Chancellor.

TELEPHONE: 660 0522.

The University of Sydney

SYDNEY, N.S.W. 2006

IN REPLY PLEASE QUOTE: HMC/JD

9th October, 1969.

Miss P. Madsen,
1 Wandella Avenue,
ROSEVILLE. N.S.W.

Dear Miss Madsen,

The Chancellor and Fellows of the Senate have asked me to write and convey to you and all members of Sir John's family their very sincere sympathy.

The Senate at its meeting on 7th October placed on record its deepest appreciation of Sir John's services to the University. He will be remembered by all who knew him as a lovable man with a great intellectual capacity and a very fine personality.

Yours sincerely,

H. McCredie,
Registrar.

TELEPHONE: 660 0522.

The University of Sydney

SYDNEY, N.S.W. 2006

IN REPLY PLEASE QUOTE: RBF/JR

22nd October, 1969

Miss P. Madsen,
1 Wandella Avenue,
ROSEVILLE. N.S.W. 2069

Dear Miss Madsen,

At its meeting on 20th October, 1969 the Professorial Board was informed of the recent death of your father, Emeritus Professor Sir John Madsen, and a statement of appreciation of his services was read out by Professor W.N. Christiansen to the members of the Board and incorporated in the Minutes. The members of the Board stood briefly in silence as a mark of respect.

I thought you might like to have a record of this statement and I am therefore enclosing a copy.

Yours sincerely,

H. McCredie,
Registrar.

Encl.

TELEPHONE 68 0522.

THE BASSER COMPUTING DEPARTMENT

SCHOOL OF PHYSICS, UNIVERSITY OF SYDNEY

Sydney, N.S.W. 2006

28th October, 1969

Mr. J.A. Madsen,
43 Outlook Drive,
Eaglemont,
VICTORIA. 3084

Dear Mr. Madsen:

As Acting Dean of the Faculty of Science, I have been asked by the Faculty to convey to you and other members of your family, its deepest sympathy and condolences for the loss of your father, Sir John Madsen.

I understand that the requirement for the Honours degree in Electrical Engineering which called for the completion of a physics/maths science degree, was due to him. This arrangement has resulted in closer ties between the Faculties of Science and Engineering in this University than in other Australian universities. As part of the overall structure of the degree, it has contributed to the particularly high regard in which it is held throughout the world.

At its meeting recently, the Faculty heard an address of appreciation of his career and services to Australian science. I myself have had occasion to consult him on several occasions, and found his advice helpful and to the point. I am sure that he is well remembered by his former colleagues and students, and by younger members of staff who have had contact with him, and that his passing is most deeply felt by them all.

Yours sincerely,

John M. Bennett

TELEPHONE 68 0522

THE BASSER COMPUTING DEPARTMENT

SCHOOL OF PHYSICS, UNIVERSITY OF SYDNEY

Sydney, N.S.W. 2006

28th October, 1969

Mr. J.A. Madsen,
43 Outlook Drive,
Eaglemont,
VICTORIA. 3084

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Yours sincerely,

John M. Bennett

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Emeritus Professor Sir John Madsen

On 4th October, 1969 Emeritus Professor Sir John Percival Madsen died at the age of 90 years. Sir John Madsen was on the teaching staff of this University for 40 years, from 1909 to 1949. After graduation at the University of Sydney in Science and Engineering he worked under Professor Bragg in the Physics Department of the University of Adelaide. In 1909 he was appointed as a Lecturer in Electrical Engineering at Sydney and in 1920 was appointed as the first Professor of Electrical Engineering. He was made Dean of the Faculty of Engineering in 1942, Fellow of the Senate in 1944 and Chairman of the Professorial Board in 1947. He held these positions until his retirement in 1949. He was knighted in 1941.

Australia has had world-wide recognition of its work in radio science, and Madsen can well be called the father of radio research in this country. He was responsible for setting up the Radio Research Board in Australia in 1927. The team of scientists and engineers that he gathered around him rapidly became well known for its important discoveries. It is no exaggeration to say that this group put Australia on the map in the field of physical research.

Madsen's influence is still strongly felt through his students and through the research organizations which he set up - the National Standards Laboratory and the Division of Physics of C.S.I.R.O. As an engineer-physicist himself he insisted on the inseparability of science and engineering and was responsible for the very strong emphasis on physics in the engineering courses in the University of Sydney. As a leader of Research he had a flair for choosing profitable fields of investigation and for choosing good research staff. He was content to direct the research group and practically never added his name to the list of authors of any paper that originated in his group. His determination and organizing skill was such that those who knew him only by reputation regarded him with considerable awe and even fear. Yet he was a very down-to-earth and approachable person who was regarded with affection by most of his students.

Madsen's whole life was dedicated to science and engineering. Even his opponents who feared his determination, diplomatic skill and enormous energy never attributed any other motive to him than that of wanting to further the progress of science in the way that he felt it should go. He was one of the great men of this University and of Australia.

W. N. Christiansen.

SIR J. MADSEN RETURNS

Radio-location Work

Sir John Madsen, professor of electrical energy at the University of Sydney, whose name has been associated with the development of radio-location, returned to Sydney from England yesterday.

He was knighted last June after his researches in Australia and England, which led to the adoption of radio-location, as a counter to the night bombing menace. In this work he was associated closely with Mr. R. A. W. Watt, director of communications in the British Air Ministry.

Mr. Watt first demonstrated radio-location in 1935 and on the outbreak of war a team of brilliant scientists, including Sir John Madsen, worked on the invention in England until it was developed into a highly efficient means of detecting the approach of enemy aircraft or ships.

Sir John Madsen left for Melbourne last night to confer with the Federal Government.

RADIO-LOCATION

Jobs For Young Australians

Sir David Rivett said last night that hundreds of young men would be required to maintain and operate new radio-location equipment in Australia.

All Australian Universities had agreed to train the operation staffs, and it was proposed to develop a six months' intensive training, both theoretical and practical, for them, said Sir David in a broadcast talk.

Selected undergraduates could enlist for national work for which their special training had fitted them, and recruits would also be taken from technical colleges. Any excess of trained people not required in Australia would be welcomed in other parts of the Empire.

Although the "radio-location" of raiding enemy aircraft was only announced recently, Sir David explained that investigation began in 1935. Early in 1939, the Australian Government was invited to take part in researches, and a board to direct operations was founded that year, with Sir John Madsen as chairman. Since then, investigations had been directed by the Council of Scientific and Industrial Research, and construction by the Postmaster-General's Department.

KNIGHTHOOD

PROFESSOR SIR JOHN MADSEN

THE UNION RECORDER cordially congratulates Professor Sir John Madsen, Professor of Electrical Engineering at this University, on his having had conferred on him by His Majesty the King the honour of Knight Bachelor. As Chairman of the Radio Research Board and Chairman of the Radio Research Committee—both activities of the Council for Scientific and Industrial Research, Sir John had rendered very valuable assistance to the Commonwealth Government in matters connected with the war.

Sir John Madsen was one of the first in Australia to realize the importance of the scientific teaching of communication engineering, and particularly radio engineering. Realizing the increasingly important part that radio must play in the community, he was largely responsible for persuading the Commonwealth Government to begin a programme of radio research into fundamental problems. Some time before the outbreak of war it became apparent that a new field of great importance to defence, and in which radio played an important part, was opening up. As a result the Commonwealth Government set up, built, and staffed the Radiophysics Laboratory under the aegis of the Council for Scientific and Industrial Research, and arranged that the policy of this laboratory should be governed by a new board—the Radiophysics Advisory Board—with Sir John again as Chairman.

Over thirty years ago Sir John Madsen, from difficulties in reconciling results obtained from allegedly standard instruments, realized with great force the necessity for having available in Australia some authoritative centre charged with the responsibility of maintaining the standards of physical quantities, and able to make them available as required. He preached this doctrine for many years, and was mainly responsible for advocating the establishment of the National Standards Laboratory. Sir John was Chairman of the Standards Committee responsible for the initiation of the engagement project which resulted in the engagement of the initial staff, the purchase of equipment, and the erection of the building in the grounds of this University. The building was begun shortly before the war, and the laboratory has turned all its activities to work directly concerned with defence. It is now playing an important part in this sphere.

THE EARLY YEARS

Dr. J. P. V. Madsen, D.Sc. (Adelaide), B.Sc. and B.E. (Sydney), who has for some time held the position of assistant professor in electrical engineering at the Sydney University, has been elected as the first professor in electrical engineering at that University. Dr. Madsen's University record at Adelaide and Sydney is a fine [illegible] of honours. These include the Stow prize for physics, 1897; the Levi scholarship for physics and chemistry, 1898; the [illegible] scholarship for physics, 1899; [illegible] medal and first-class honours on graduation [illegible] and B.Sc. [illegible] and the P. N. Russell medal for post-graduate thesis in the same year. In 1900 he became junior demonstrator in physics at Sydney University. In 1901 he accepted a post as lecturer at Adelaide. In 1909 he went back to Sydney as lecturer in electrical engineering, and in 1912 he was appointed assistant-professor. For six months in 1907 he was assistant engineer to the Adelaide Electric Supply Company. During 1912-16, as consulting electrical engineer to the New South Wales Irrigation Commission, he had the design and lay-out of the generating station and distributing system for the Murrumbidgee irrigation area. He has had a general consulting practice from 1910 on, and in [illegible] he visited the principal universities and electrical works in England and America. During the war he volunteered for active service, but was retained as O.C. and [illegible] instructor to the Commonwealth Engineer Officers' Training School. Dr. Madsen has done a great deal of research work, the results of which have been published in the "Transactions" of the Royal Society of South Australia, and in the "Philosophical Magazine," &c. In several cases his co-investigator was Professor W. H. Bragg. His principal subject has been radio-activity in its various aspects.

HONOUR FOR SCIENTIST

Degree For Sir John Madsen

An honorary doctorate of science will be conferred on Sir John Madsen, chairman of the Australian Radio Research Board, at the University of Sydney today.

The ceremony at which [illegible] science and [illegible] degrees will be conferred, will be held in the Great Hall at 3 p.m.

Sir John Madsen will give an address.

The degree Sir John will receive is in recognition of his contributions to science in Australia.

Sir John was Professor of Electrical Engineering at Sydney University from 1920 to 1939 and for shorter periods was Dean of the Faculty of Engineering, chairman of the Professorial Board, and a Fellow of the Senate. He is a Sydney University graduate.

In 1927 he founded and became chairman of the Australian Radio Research Board, which established a reputation for fundamental research equal to that of similar bodies in Great Britain and the U.S.A.

It was this board which provided a nucleus of trained scientists to form the Radiophysics Laboratory of C.S.I.R.O., set up during the

PROFESSOR SIR JOHN MADSEN

war. Its establishment followed a visit to England by Sir John Madsen to confer with Allied defence authorities on the initiation of similar radar research in Australia, and it has since achieved a high international reputation.

The importance of Australian contributions to radio science were recognized when the Union Radio Scientifique Internationale (U.R.S.I.) held its 10th general assembly at Sydney University in August, 1952. This was the first time an international scientific body had met elsewhere than in Europe or the U.S.A.

As a member of the Council for Scientific and Industrial Research, Sir John Madsen also [illegible]

PART FIVE. THE RADIO RESEARCH BOARD.

I. History of the R.R.B.

2. Sir Edward Appleton's letter acknowledging J.P.V.M.'s pioneering efforts.

3. Press reports on J.P.V.M.'s 1935 Macrossan lecture, which summarised the R.R.B.'s findings to that time.

4. Three letters from Lord Rutherford acknowledging research findings for publication. The reference to the transfer of Kapitsa's laboratory to Russia from England is significant in view of the fact that Kapitsa was prominent in the production of Russia's atomic bomb completed in 1949 and the H- bomb in 1953. Kapitsa trained and worked with Rutherford from 1921 to 1934.

Radio Research Board

Sir John Madsen, who had been Chairman of the Radio Research Board since it commenced operation in 1927, resigned from that position last year.

The opportunity was taken to make some revision in the membership and functions of the Board. The Board members are now:

Professor L. G. H. Huxley (Chairman), University of Adelaide.
Dr. F. W. G. White, Chairman, C.S.I.R.O.
Professor H. C. Webster, University of Queensland.
Mr. E. Sawkins, Assistant Director-General, P.M.G. Department.
Mr. N. J. McCoy, P.M.G. Research Laboratories.
Mr. T. Housley, Overseas Telecommunications Commission.
Mr. D. McDonald, Australian Broadcasting Control Board.
Group-Captain J. W. Reddrop, Department of Air.
Dr. J. L. Farrands, Department of the Army.
Commander J. R. McMurray, Department of the Navy.
Mr. W. F. Evans (Secretary), C.S.I.R.O.

The function of the Board is to encourage radio research in the universities of Australia by making grants-in-aid.

The early work of the Board contributed materially to understanding the propagation of radio waves of medium frequencies and associated problems of sky wave interference and fading.

The major research sponsored by the Board is investigation of the ionosphere. The work of Australian scientists in this field has received world-wide recognition. During the war, the Board's predictions of ionospheric behaviour contributed substantially to methods of forecasting communication conditions for the Allied Armed Forces. Such forecasts are now the function of the Ionospheric Prediction Service of the Department of the Interior.

The Universities of Queensland, Adelaide and Tasmania are receiving grants from the Board. Professor Webster and his colleagues in the University of Queensland have for some years been investigating irregularities in the ionization of the upper atmosphere and sporadic E. In Adelaide, Professor Huxley and his staff are interested in meteor astronomy, laboratory investigations of electrons in gases related to the phenomena in the upper atmosphere, and the measurement of upper atmosphere winds obtained from drifting meteor trails.

Professor Newstead has recently been appointed to the Chair of Electrical Engineering in Tasmania, and will be developing a programme of research under the auspices of the Board.

Two laboratories, one at Sydney and one at Camden, New South Wales, directly concerned with the work of the Radio Research Board have been reorganized.

During the past few years Dr. G. H. Munro and his colleagues have made many contributions to the knowledge of the structure of the ionosphere. In future, the group of workers led by Dr. Munro will be attached to the Electrical Engineering Department of the University of Sydney; the University will receive a grant from the Board to support this work.

It has previously been announced that C.S.I.R.O. has formed a new section, to be known as the Upper Atmosphere Section. The Officer-in-Charge is Dr. D. F. Martyn. The section will be financed by C.S.I.R.O. from its general funds. This new arrangement will permit Dr. D. F. Martyn and his colleagues to widen their interests in the physics of the earth's atmosphere, which is an aspect of geophysics to which they have already made substantial contributions.

Sir John Madsen

Early in 1958 Sir John Madsen retired from the Radio Research Board after a period of thirty years as its chairman. He has been associated with many projects for the advancement of science, but his guidance of the Board has been one of the longest and most fruitful of his many activities.

Many of the techniques of radio propagation were still unknown in 1926, and development of long-distance communication and broadcasting was still empirical. However, in England and U.S.A. a more fundamental scientific approach was evolving, with spectacular results. At this time problems limiting full use of the medium were assuming importance in Australia. The first research projects in this field were started in the Universities of Sydney and Melbourne and were financed by the broadcasting companies.

When the Postmaster-General's Department entered this field, a stimulus was given to the work. At this time a Radio Research Board was formed in the United Kingdom under the auspices of the Department of Scientific and Industrial Research. This suggested to Madsen, then Professor of Electrical Engineering, University of Sydney, the value of a similar body in Australia. In September 1926 a conference was convened by the Council for Scientific and Industrial Research to discuss formation of a Radio Research Board. The Board came into being in 1927, with Madsen as chairman.

Young scientists were recruited in Australia and England, and active research programmes

sponsored by the Board were soon under way at Sydney and Melbourne Universities. The work was strongly supported by the P.M.G.'s Department and the Armed Services.

It is interesting to note that in line with present-day trends, the initial programme was established on a three-year basis. From the beginning it was emphasized that the Board's projects should be on fundamental problems, and that information obtained would be made freely available by publication. The work of the Board soon achieved world-wide recognition, and valuable contributions were made to knowledge of the upper atmosphere, and aspects of broadcasting and long-distance radio communication.

Although in 1939, when war was imminent, Radio Research Board trainees formed a valuable nucleus enabling the C.S.I.R.O. Radiophysics Laboratory to undertake essential radar work, the Board's investigations into the upper atmosphere continued. Early in the war, when the need became obvious for accurate predictions of radio propagation conditions for the Armed Services, Madsen diverted staff to participate in this work. The Australian contribution in this field was of major importance. In the post-war period, when prediction work had become a routine service, it was at Madsen's insistence that Radio Research Board scientists were released to resume their fundamental investigations. This resulted in a further period of fruitful research on upper atmosphere conditions, and enabled Australia to continue as a leader in this field. When earth satellites were launched, he strongly supported investigations on the use of radio transmission from them to enable knowledge to be extended of the high atmosphere. His unerring sense of what was worth investigating and his untiring efforts to obtain support contributed much to the success of the Board's work. His own personality stimulated the interest of scientists in this field of research. Sir John has also been largely responsible for co-ordinating the work of the Australian universities and government research establishments, and for maintaining close working relationships between the various scientific groups.

The papers published in scientific journals by Radio Research Board workers and collaborators reached the impressive total of 136 during Sir John's chairmanship. This in itself is a tribute to his able guidance.

SIR EDWARD APPLETON
PRINCIPAL AND VICE-CHANCELLOR

THE OLD COLLEGE,
SOUTH BRIDGE,
EDINBURGH, 8.

22/Sept/60.

My dear John,

I want you to know that I have seen that nice reference to you in the October issue of the Australian Journal of Science: I was delighted to see this tribute to your pioneer, outstanding, service to the Radio Research Board. My warm congratulations on something which I hope will please you as much as it does your friends & admirers.

I went to U.R.S.I. for a few days & made the inevitable speeches. As David Martyn will tell you, I could have read a paper, but I wanted the youngsters to perform. Martyn & Munro were both well to the fore, because you have plenty going on round Sydney.

We do not forget the gracious hospitality of your home, offered to us in 1952. And we hope we may be allowed to send our love to your daughter, the perfect hostess.

We are just off for 2 weeks of holiday. I got a bad ankle – knocked it & then neglected it. London didn't do it any good with all the standing. But now, with rest, it is on the mend. We go to Nairn tomorrow.

I manage to work a bit on the ionosphere, particularly on the subject of the anomalous equatorial (magnetic equator) belt which I described in Nature in 1946. The I.G.Y. results are most useful, as exhibiting this anomaly.

But of course, I have much to occupy me in the University. I calculate I've made 12 speeches this summer, to one of which Fred White replied!

With all good wishes

Yours ever

E.V.A.

J.P.V.M.'s MACROSSAN LECTURE 1935.

DATE 20/ 1935.

ER-MAIL, BRISBANE

RADIO RESEARCH IN IONOSPHERE

Important Work in Progress

MACROSSAN LECTURE

"There still remains a tremendous field for research, and one from which there will be results of the greatest importance; several investigations of great interest are in progress at present," said Professor J. P. V. Madsen at the conclusion of his second John Murtagh Macrossan lecture at the Teachers' Conference Hall last night. Professor Madsen, who is Russell Professor of Engineering at the University of Sydney, and chairman of the Radio Research Board, Commonwealth Council for Scientific and Industrial Research, devoted his two lectures to the ionosphere and its influence upon the propagation of radio waves.

He paid a tribute to the physicists carrying out the investigations of the board.

After reviewing some of the work covered in his first lecture, Professor Madsen described the methods which radio-physicists had used in the examination of the upper atmosphere. He explained the famous interference experiment of Professor E. V. Appleton, Wheatstone Professor of Physics, King's College, London University, and the pulse of echo experiment devised by American physicists. This experiment, he said, showed that there existed not merely one layer from which radio waves were reflected, but a region extending between the height of 60 miles and 200 miles, in which there occurred several layers from which, under suitable conditions, reflections could occur.

The lowest region was known as the Kennelly-Heaviside and the uppermost, as the Appleton, while between them there existed what were termed intermediate layers. These layers owed their reflective properties to the fact that they were intensely ionised. This effect was produced by the sun's radiation during [illegible] and it was reduced considerably at night in the absence of [illegible]. This accounted for the variations experienced in radio transmission.

LOCAL APPLICATION

For example, in the case of 4QG, during daylight, the sky ray was absorbed owing to the intense ionisation which extended between the Appleton region and ground. The listener then received his broadcast only by the ground ray, which weakened very rapidly as one got beyond, say, 100 miles from Brisbane. After sunset the sky ray penetrated to the Appleton layer, and could be reflected there. Transmission could then be picked up from 4QG almost throughout Australia, except for an area known as the fading area, which extended over a distance of between approximately 80 and 220 miles from Brisbane.

Professor Madsen gave an account of investigations carried out by the physicists of the board in Australia.

Professor R. W. H. Hawken presided.

SCIENCE AIDING BROADCASTING

Atmospherics and Radio Waves

The two John Murtagh Macrossan lectures for 1935 are being given by Professor Madsen, Russell Professor of Engineering in the University of Sydney, and the first was delivered before a distinguished audience in the Teachers' Conference Hall last night, the subject being "The Ionosphere and its influence upon the propagation of radio waves."

The lecturer showed how the Radio Research Board had followed two main lines of research—atmospherics and radio propagation—and how valuable the information it had gained had been to the Commonwealth Government in defining its broadcasting system.

Professor Madsen, who is chairman of the Research Board, which was established by the Council of Scientific and Industrial Research in 1922, said that in the investigation of atmospherics it had given particular attention to their effects on broadcasting. The second question—radio propagation—included investigations into the causes of fading and the relative advantages of different wavelengths for broadcasting. There appeared to be considerable promise that the work on atmospherics might be of value in meteorology, particularly for aviation, where information about weather changes was required at comparatively short notice.

TEMPERATURE VARIATIONS

The radio investigations which had been begun almost 10 years ago by Professor Appleton, of King's College, London, had shown that radio provided a method by which information might be obtained about the physical constitution and characteristics of the upper atmosphere, regions between 60 and 200 miles from the earth's surface.

The lecturer detailed the information obtained about temperatures and wind velocities at heights of 10 to 15 miles by the use of manned and pilot balloons, and observations upon [illegible] clouds. At these heights the atmospheric temperature reached values as low as minus 55 degrees [illegible], and remained constant at that low value up to the greatest heights reached by pilot balloons.

Observations upon the occurrence of dead areas in the transmission of sound waves, together with information gathered from the study of meteors, showed that a rise in temperature was indicated at heights of approximately 25 miles. Further observations upon noctilucent clouds suggested that at a height of 50 miles the temperature had fallen again to values as low as minus 100deg centigrade, and that it then proceeded to rise until at heights of 60 miles it was at approximately normal ground temperature. Beyond that height, spectroscopic determinations indicated that the temperature rose to as much as 1000 degrees centigrade, at midday in summer, at heights of the order of 150 miles.

The result of these and other investigations left little doubt that that line of work would be pursued internationally, and that it afforded the opportunity for gaining information which could not be obtained by other methods. Nature, in fact, had provided a full scale laboratory in which the physicist was able to carry out experiments by means of radio waves.

Dr. J. J. C. Bradfield presided.

THE IONOSPHERE AND RADIO

Science for the Man in the Street

It did not follow that because he would speak of the ionosphere, and use a few technicalities and scientific terms, he would be "up in the clouds" all the time, beyond the reach of the man in the street, while delivering the John Macrossan lectures, said Professor Madsen, of Sydney, in reply to a question yesterday. He would certainly "come down to earth," and there was a good deal to interest the radio-minded public in his subject, "The ionosphere and its influence upon the propagation of radio waves."

There was definite proof, he said, that at night if 4QG, as an example, were picked up, say, at Rockhampton, there would be received the effect of a wave which had been reflected through the ionosphere at a height of 60 miles from the earth. If one were very much closer than Rockhampton, for instance, one might not get such good reception at night. The reason was that in that case one was getting both the reflected ray and a ground ray, which produced interference with one another.

One part of the programme of the Radio Research Institute of Australia had been to investigate such phenomena to see whether the range of reception might be extended. The first thing necessary scientifically was to thoroughly investigate the reflected ray. Valuable information had been obtained about the constituents of the upper atmosphere, or ionosphere. The investigations had been also found to be associated with the conditions occurring near the earth's surface, as, for example, changes in barometric pressure. Much interest had been centred in such investigations at present both in England and America. Experiments in radio phenomena had indicated very high temperatures at 150 miles above the earth. The lectures would deal with research in Australia particularly.

Starting with the idea of improved transmission, it was hard to say what would be the effect on commercial wireless. Improvements in local broadcasts and oversea communication could be brought about only by careful and intensive scientific investigation of the conditions affecting [illegible].

PRIME MINISTER,

CANBERRA.

7th May, 1958.

My dear Sir John

I have just heard that you have asked to be released from the responsibility which you have borne for over thirty years as Chairman of the Radio Research Board of C.S.I.R.O. I would like you to know how grateful I and all members of the Government are for the long and distinguished service you have given to the Commonwealth in this office and in so many other ways. Your name will always be honourably associated with the development of radio research in this country and with those outstanding improvements in radio communication which have been of such significance in both peace and war.

In your retirement, you will, I know, carry with you the gratitude of a host of your fellow countrymen and their good wishes for your future happiness.

With my warm personal thanks,

Yours sincerely,

(R.G. MENZIES)

Sir John Madsen.

C and Telegraphic Address:
"UNIPHYSICS"
Tel. W 3211
W 2148

DEPARTMENT OF PHYSICS

The University of Adelaide

Your Ref.
Our Ref.

4th July, 1958

Sir John Madsen, Kt.,
Wandella Avenue,
ROSEVILLE, N.S.W.

Dear Sir John,

At its meeting yesterday, I was asked by the Radio Research Board to convey to you, the founder and first Chairman of the Board, its deep sense of gratitude to you for your great work in fostering so successfully during thirty years the prosecution of research into the ionosphere, radio wave propagation and related studies, within the Universities and by the Board's Officers.

The record of the Board under your Chairmanship has been outstanding not only for the calibre of the scientific work that it has made possible but also because it gave initial encouragement and training to many men who later achieved positions of responsibility in the community.

I cannot do justice to the expressions of goodwill that were made spontaneously by members of the Board but I can convey the general good wishes of them all.

Yours sincerely,

L.G.H. Huxley.

(L.G.H. Huxley)
Chairman
Radio Research Board

...and Telegraphic Address:
"UNIPHYSICS"
Tel. W 3211
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Yours sincerely,

L.G.H. Huxley

(L.G.H. Huxley)
Chairman
Radio Research Board

MINISTER IN CHARGE OF THE
COMMONWEALTH SCIENTIFIC AND
INDUSTRIAL RESEARCH ORGANIZATION:
CANBERRA, A.C.T.

5th May, 1958

Dear Sir John,

The Chairman of C.S.I.R.O. has told me that you have resigned from the Chairmanship of the Radio Research Board.

It is now many years since I was first associated with you as Minister-in-Charge of C.S.I.R.O. but I have clear recollections of the magnificent work you did before and during the war. To you more than to any other we owe the development of radio research in Australia and we owe much to you also for the consequences of this for the country.

I am deeply grateful for the continuing responsibility you have accepted for guiding the activities of the Radio Research Board following your retirement from the University of Sydney.

In your retirement, you can carry with you my own personal thanks, those of all your colleagues in C.S.I.R.O. throughout the years, and the many others in science and industry who are conscious of the magnificent service you have rendered to the Commonwealth.

With all good wishes,

I am,

Yours sincerely,

R G Casey

(R.G. CASEY)

Sir John Madsen,
1 Wandilla Avenue,
ROSEVILLE. N.S.W.

Cavendish Laboratory,
Cambridge.

3rd December, 1935.

Dear Madsen,

I have just received your letter and the paper from Martyn and Pulley. I have read it through and it seems to me a very interesting discussion of the state of the upper atmosphere. I am communicating it at once to the Royal, but it will have to go to a referee whom I hope will act promptly.

Of course I am not an expert in these fields, but it seems to me that the paper has great merit, and in any case may lead to a valuable discussion with regard to the interpretation of the electrical state of the upper atmosphere.

I am glad to say we are all very well, but I have been kept extraordinarily busy. As you may have seen, we have had to deal with the transfer of the Kapitza apparatus to Russia which has involved negotiations with our own and the Soviet Government, the Royal Society, the D.S.I.R., and the University, not to mention the Managing Committee of the Mond Laboratory! It looks as if the proposal will go through, and we are preparing to send off some of the apparatus within a week or so when the first payment is made.

With kind regards,

Yours sincerely,

Rutherford

The Russian business is now through & the first batch of apparatus has gone off.

Cavendish Laboratory,
Cambridge.

14th June 1937.

My dear Madsen,

I have received safely the paper of Godfrey and Price, which you sent me, and I have had time to glance through it. It seems to me an excellent piece of work. I am communicating ~~with~~ the Royal Society, who, I trust, will arrange for its early publication. I will see that the proofs are sent to Piddington.

I am very interested to hear of the good progress of your Council in promoting scientific work along so many lines: in particular, I was glad to learn that they have formed a Radio Research Board in New Zealand, and I hope the new Professor in Christchurch, White, will take an active part in its work.

I am naturally very interested also to hear that you have got an annual grant of £30,000 for five years to encourage research in Australian Universities. This cannot but prove a wise move in develping the scientific resources of your country. We are ourselves here considering the possibility of giving more help to the Universities to tackle some of the bigger problems which are outside their financial possibilities. I hope something will come of it.

I shall of course want to know whether you have any luck in starting a National Physical Laboratory at Camberra. Incidentally, I am pleased to hear that Briggs will be able to obtain some financial support for his researches. He is a genuine researcher who keeps in the background, but I consider him one of the best men you have in Australia: so help him all you can.

You may have heard that I am going to India in November with a British Association party, to take part in the Jubilee of the Indian Science Congress. We leave in November for Bombay, and hold most of our meetings in Calcutta. I hope that we shall get a fair number of

(Temp change & Radiation in the upper atmosphere)
~~Temp gradient in the upper atmosphere~~

scientific men to go from this country, for I think it important to show our interest in the development of scientific work in India.

I am glad to say that we are all well.

Yours sincerely,

Rutherford

Cavendish Laboratory,
Cambridge.

31st July 1937.

Dear Madsen,

I have just received your letter and the copy of the letter for Nature which is sent in by Martyn and others of your group of workers.

I have heard the subject of their letter mentioned from time to time as a possibility, but it is very interesting to see the excellent relation between the radio observations and the disturbances in the sun. Unfortunately, Appleton is away on holiday for a week or two, so I have not had a chance to show him the letter and discuss the matter with him. He is an expert on the evidence in this type of problem.

The only trouble I have is that the letter is rather long for Nature, owing to the fact that so many points are introduced and briefly discussed. If I might make a suggestion, I think it would be better in a future letter to concentrate on the main question and to leave out some of the details for subsequent publication in the ordinary way. Gregory tells me that he is deluged with letters, and, while he is anxious to publish as representative a number as possible, there is a limit to his space. However this is a small matter, and I should like to congratulate you all on the success that is attending your radio work. I hope that you will keep closely in touch with the corresponding work in this country. I was wondering whether you are in contact with the latest developments in connection with air defence, but I suspect that you will be, through the Australian authorities. My friend Wimperis is, I believe, visiting New Zealand and Australia shortly in connection with the Air Ministry. I hope you will have an opportunity of meeting him. He is a thoroughly sound fellow and a good friend of mine. We have played many a game of golf together.

Yours sincerely,

Rutherford

PART SIX. KNIGHTHOOD.

I. The official invitation.

2. Sir David Rivett's wry comments.

3. J.P.V.M.'s description of the dubbing.

4.

CONFIDENTIAL.

Government House,
Canberra,
28 MAY 1941

Dear Sir,

It has been ascertained that His Majesty The King would be pleased to approve of your appointment as

a Knight Bachelor

I am therefore commanded by the Governor-General to request that you will indicate, by telegram, whether such an honour would be acceptable to you.

In conformity with the necessity for secrecy at this stage, would you please confine your telegram to one of the following examples:—

Military and Official Secretary
Canberra

Gratefully accept
(signature)..........

or

Military and Official Secretary
Canberra

Beg to decline
(signature)..........

In the latter event it is customary to follow the telegram with a letter expressing the reason for declining the honour.

Until notification of the award of the honour appears in the daily press, you are enjoined to treat the foregoing information as strictly confidential.

Yours faithfully,

Captain, R.A.N.

Military and Official Secretary.

To

Professor John Percival Vissing Madsen,
University of Sydney,
SYDNEY.

A letter to his daughter

COMMONWEALTH OF AUSTRALIA

AUSTRALIA HOUSE
STRAND · LONDON
W.C.2.

PLEASE REPLY TO THE OFFICIAL SECRETARY AND QUOTE

TELEGRAPHIC ADDRESS: "CROTONATE, ESTRAND, LONDON"
TELEPHONE: TEMPLE BAR 1567

July 26. 41.

My dear Phyl.
I received last week a cable of congratulat[ions] from Roger and judging by it the M.H.O appeared in good form. Since I wrote to you last I have been duly "dubbed" or accolated by His Majesty. You may be interested in the detail. The first thing was to obtain a suitable dress for the occasion morning dress with a top hat. You cant buy clothes without coupons so you borrow or hire. I could find no suitable victim from whom to borrow so I loaned the outfit from Messr. Moss. who do these things very well. James the Tasmanian representative in this building was also being Knighted & kindly offered to take me along. So we went in good style with the Tas. flag mounted on the radiator. About 200 were to receive decorations & these were drafted into separate rooms for marshalling. We of course were among the first group. We formed up in appropriate line after receiving instructions in regards to detail an eventually after arriving before His Majesty ones name was called. You then turn

left, bowed, stepped forward one pace, knelt on one knee
on a stool - was tapped by the King with his sword on each
shoulder and then stood to attention - The King
then shook hands & said several short words of congratulation
you bowed turned and made way for the next man
We then made back to Australia H. & had several drinks
and having changed went on with our job.
I have now made almost all essential senior contacts
have met the respective ministers Lord Beaverbrook,
Moore-Brabazon, Anderson and Alexander the
First Lord of Admiralty as well as Lord Hankey.
After them I have been meeting the Directors of Research
& their staffs in the various ministries.
All have been exceedingly good & we anticipate
no difficulty in our work.
I spent a day at Christchurch last week and
also a short time at Dover.
I am living with Sir William Bragg at the
Royal Institution in Albemarle St near
Piccadilly. Bragg has the whole of the top floor
and as his daughter is in the country he has
only himself & a Secretary Miss Deighton to
occupy this very large area. They are both away
over the weekend. Bragg even more so. and
a small staff is maintained permanently.
Bragg's son in law also stays there. We
breakfast together, are all away at lunch &
dine in when we feel inclined. this in my case
being only once or twice a week. I have a
wonderful bedroom - bathroom - dressing room

COMMONWEALTH OF AUSTRALIA

PLEASE REPLY TO THE OFFICIAL SECRETARY AND QUOTE

AUSTRALIA HOUSE
STRAND · LONDON
W.C.2.

TELEGRAPHIC ADDRESS: "CROTONATE, ESTRAND, LONDON"
TELEPHONE: TEMPLE BAR 1867

in fact a complete suite with a very large drawing
room as well if you had any use for it.
The basement forms an official public shelter so
there is good protection. At present with no raids
I am sleeping upstairs a reserve bed is ready
however on the ground floor should I require it.
This is only 5 mins from the Athenaeum. So
I have fallen on my feet in regard to accomodation
We are now into our suite of offices in Aus. House
5 rooms self contained + well situated.
The team are now hard at it and much work
is coming in. Webster this week and is up at
Glasgow. Mrs. Nicholes has got a job in the main
office on "decipher" cable work. So far have not
seen a plane, heard a gun or a bomb in London
and have only heard the air-raid siren, once when
living at Dover. Although damaged severely in
places London appears to go on much the same as ever
and the people show very little signs of the times
they have been through. You will probably have
heard from the Duncans by now as they should have
arrived in Sydney. Burgmann tells me his wife
[illegible] + come across now that she has heard.

than Mrs Nicholls has come. I also believe that
a typist is to be sent from Australia to work with
Munro at Washington. I sent back from
N.Y. to your account Commercial Bank of Sydney
Roseville Branch about £[redacted] - you might see whether
it has been duly credited to your account & let
me know next letter. Food is just fair not
much variety & butter & sugar scarce, also fruit.
They seem to do better in the country than in London.
Cigarettes are not over abundant but enough to go
round. Whisky pretty dear but still one
would last a long time on what there is.
Bergman & Webster are living at London House which is
quite up to one our best University Colleges and it would
be hard for them to have better quarters.

I think this is about all the news so
with kindest regards
Your affectionate Dad
J

Monday 26 just received another cable from
Roger OK.
Herewith photos which may interest you, Tom Nicholls re.
taken after the big event. J

Sydney [illegible] 1941

RADIO WEAPON

To Defeat Night Raiders

KNIGHTHOOD FOLLOWS

ANNOUNCEMENT that J. P. V. Madsen, Professor of Electrical Engineering at Sydney University, had received a knighthood in the King's Birthday Honors list, came as no surprise to his close colleagues.

It is surmised that reason for this distinction was Sir John's part in evolving a radio weapon to defeat night air raiders over Britain.

Nature of this weapon has not been disclosed. It remains a closely-guarded secret.

What can be stated is that Sir John as far back as 1927 was instrumental in interesting the Commonwealth Government in the necessity of research into the radio propagation problems, with the result that a Radio Research Board, under his chairmanship, was founded.

Sir John collected in Sydney a team of research workers, whose experiments have become world-famous in the past three or four years.

Research was particularly directed into the vagaries of radio waves in the upper atmosphere, with result that valuable new knowledge was gained about workings and temperature of the atmosphere, in which new-type bombing planes operate.

With outbreak of war, Sir John switched over to activities of a secret and highly confidential nature. He spent some time in England working in collaboration with British scientists on the problem of the night raider.

Scientific Teaching

A man with brilliant academic qualifications, Sir John entered Sydney University from Sydney High School. He graduated B.Sc. in 1900 with first-class honors and the University Medal in mathematics and first-class honors in physics.

A year later, he took his Bachelorship of Engineering with first-class honors and the University Medal. He received the first award of P. N. Russell Medal for a post-graduate thesis.

Next he was appointed lecturer in physics and mathematics at Adelaide University, and from 1903-9 was lecturer in electrical engineering.

In South Australia, he was also assistant-engineer to the Adelaide Electric Light Company.

In 1909, he became P. N. Russell lecturer in electrical engineering, and from 1912-20 was assistant-professor.

He acted as consulting electrical engineer to the Water Conservation and Irrigation Commission of N.S.W., and was responsible for the initial developments of the first important electrical innovations in rural distribution.

In 1915, his services were taken over by the Commonwealth Defence Department, when he became officer-in-charge and chief instructor at the Engineering Officers' Training School. Here, he did valuable research into the making of bomb-throwers and trench mortars.

Since 1920, he has been Professor of electrical engineering at Sydney University.

In [illegible], he was on an advisory committee to advise on the future control of broadcasting in Australia. Committee's report was adopted almost entirely by the Federal Government, and it forms the basis of present broadcasting organisation.

Sir John was one of the first men in Australia to realise the importance of [illegible] radio in a scientific way. He

[illegible]

established at Sydney University, in communication engineering, particularly radio communication.

For more than 12 years he steadily [illegible] and personnel to [illegible] fundamental principles of this [illegible]. His work is bearing fruit to[illegible] it is found that a very large [illegible] of his former students hold [illegible] positions in radio-physics.

[illegible] John is retiring socially, but [illegible] his views forcibly at scientific [illegible].

His chief hobby is beach fishing, and each [illegible] he generally takes a long [illegible]. He [illegible]

Academy Elects 64 Fellows

CANBERRA, Friday. — Sixty-four fellows have been elected to the Australian Academy of Science, which received a Royal charter from the Queen during her visit to Canberra last February.

The Academy is the only scientific body to have been honoured with a Royal charter since the Royal Society, London, was founded by King Charles II almost 300 years ago.

It receives a grant of £10,000 a year from the Federal Government to enable it "to promote, declare, and disseminate" scientific knowledge in Australia.

An Academy statement yesterday said that in the first election of fellows it had tried to ensure that all branches of the natural sciences had been properly represented by men of high attainment.

Many first-class Australian scientists remained outside the academy at present, but additional fellows would be elected annually. Fellows had to be British subjects.

In the first election two pioneers of applied science in Australia, Mr. W. S. Robinson, former president of the Zinc Corporation, and Mr. Essington Lewis, former chairman of the B.H.P., had been made fellows.

The statement said the academy's first meeting in April and May this year had confirmed the election of the following officers and council:

Professor M. L. Oliphant, president; Dr. D. F. Martyn, secretary, physical sciences; Dr. A. J. Nicholson, secretary, biological sciences; H. R. Marston, treasurer; Professor T. M. Cherry, Sir Ian Clunies Ross, Professor J. C. Eccles, Professor R. J. W. Le Fevre, Sir Douglas Mawson, Sir David Rivett.

The following had been elected to Fellowship of the Academy:

J. S. Anderson, Professor of Chemistry, Melbourne University.

Dr. F. S. Barnes, Reader in Pure Mathematics, Sydney University; J. P. Baxter, Director and Professor of Chemical Engineering, N.S.W. University of Technology; N. S. Bayliss, Professor of Chemistry, University of Western Australia; A. J. Birch, Professor of Organic Chemistry, University of Sydney; Dr. W. [illegible], Chief, Division of Tribophysics, C.S.I.R.O., Melbourne; Dr. W. R. Browne, Reader in Geology, [illegible] Sydney University; Dr. [illegible], Chief, Division of Animal Health and Production, C.S.I.R.O., Melbourne.

Dr. E. A. Cornish, Chief, Division of Mathematical Statistics, C.S.I.R.O., Adelaide; Dr. [illegible], Director, [illegible] Kanematsu Memorial Institute of Pathology, Sydney.

A. H. Ennor, Professor of Biochemistry, A.N.U., Canberra.

F. J. Fenner, Professor of Microbiology, A.N.U., Canberra; Dr. O. H. Frankel, Chief, Division of Plant Industry, C.S.I.R.O., Canberra.

Dr. A. Gottschalk, Walter and Eliza Hall Institute of Medical Research, Melbourne; H. S. Green, Professor of Mathematical Physics, Adelaide University.

Dr. A. R. Hogg, Commonwealth Observatory, Mount Stromlo, Canberra.

[illegible], Professor of Geophysics, A.N.U., Canberra.

[illegible], Professor of Pathology, Melbourne University.

Dr. [illegible] Mackerras, Director, Queensland Institute of Medical Research, Brisbane; [illegible]

[illegible]

Former [illegible], Division of Animal Health and Production, C.S.I.R.O., Melbourne; [illegible], Adelaide; [illegible] Professor of [illegible], University of Western Australia; [illegible] Waring, Professor of Zoology, University of Western Australia; [illegible] W. Wark, [illegible], Division of Industrial Chemistry, C.S.I.R.O., Melbourne; Dr. [illegible], Assistant Chief, Division of [illegible], C.S.I.R.O., Canberra; W. L. Waterhouse, former Professor of Agriculture, Research, Sydney University; J. G. Wood, Professor of Botany, Adelaide University.

Mr. Essington Lewis, former chairman of B.H.P., and Mr. W. S. Robinson, former president of the Consolidated Zinc Corporation.

PETITIONERS

The above, together with the petitioners for the Royal charter, comprise the complete Fellowship of the Academy at the present time. The petitioners were:

K. E. Bullen, Professor of Mathematics (Applied Mathematics), Sydney University; Sir Macfarlane Burnet, director, Walter and Eliza Hall Institute of Medical Research, Melbourne; Dr. G. [illegible], Professor of Genetics, Waite Agricultural Institute, Adelaide; T. M. Cherry, Professor of Mathematics, University of Melbourne; Sir Ian Clunies Ross, chairman, C.S.I.R.O., Melbourne; J. C. Eccles, Professor of Physiology, A.N.U., Canberra; R. J. W. Le Fevre, Professor of Chemistry, Sydney University; E. S. Hills, Professor of Geology, Melbourne University; [illegible] H. Hoskins, Professor of Physics, Adelaide University; Dr. [illegible] K. Lemberg, Director, Institute of Medical Research, Royal North Shore Hospital, Sydney.

H. R. Marston, Chief, Division of Biochemistry and General Nutrition, C.S.I.R.O., Adelaide; [illegible] Professor of Physics, [illegible], Melbourne; Dr. D. F. Martyn, Chief, [illegible] Radio Research [illegible], C.S.I.R.O., Canberra; Sir Douglas Mawson, Professor Emeritus, [illegible] and Mineralogy, Adelaide University; Dr. A. J. Nicholson, Chief, Division of Entomology, C.S.I.R.O., Canberra; [illegible] Research School of [illegible] Sciences, A.N.U., Canberra; [illegible], Radiophysics, C.S.I.R.O., [illegible]; [illegible] Agricultural Institute, Adelaide; Sir David Rivett, C.S.I.R.O., [illegible] Rosen, Professor of Mathematics, [illegible] University; [illegible] S. Sunderland, Professor of Anatomy and Histology, Melbourne University; [illegible] Zoology, Melbourne University; Dr. R. [illegible] Woolley, Commonwealth Astronomer, [illegible] Mount Stromlo, Canberra.

[illegible]

[illegible] Professor of Mathematics, [illegible]; Dr. C. H. B. Priestley, Meteorological Physics, C.S.I.R.O., Melbourne.

Dr. H. G. Raggatt, Secretary, Department of National Development, Canberra; [illegible], Chief, Division of [illegible], C.S.I.R.O., [illegible], Sydney; [illegible], C.S.I.R.O., [illegible]; W. Roberts, Professor of [illegible], Sydney University; [illegible] Rogers, Professor of Zoology, Adelaide University.

Dr. F. [illegible], Chief, Division of [illegible], C.S.I.R.O., Melbourne.

T. Graham Cole, Professor of [illegible] Geology, University of Tasmania; [illegible] W. [illegible], Professor of Physics, A.N.U., [illegible]; [illegible], Professor of [illegible], Melbourne [illegible].

*

PART SEVEN. THE NATIONAL STANDARDS LABORATORIES.

1. J.P.V.M.'s first proposals for Standards Laboratories in 1914.

2. A brief history and an outline of the work undertaken by the N.S.L. and the Upper Atmosphere Section of C.S.I.R.O.

3. The recommendation from Britain which precipitated the farmation of the N.S.L.

4. A letter from Sir David Rivett resolving a difficult situation.

Part of J.P.V.M.'s Presedential Address to the Electrical Association of N.S.W. in 1914.

THE NEED FOR STANDARDISATION LABORATORIES IN AUSTRALIA.

The matter of Standardisation Laboratories is one which has received a considerable amount of attention in other countries. It is usual for such laboratories to conduct not only the work involved in the maintenance of standards, their continual checking and comparison with those of other countries, but also investigations with regard to their constancy and application. In addition to this, such laboratories usually undertake the testing and calibration of apparatus and material which are used in the country, and, at the same time, conduct investigations in regard to the suitability of different classes of apparatus and material for the special requirements of the country, and under special conditions, such as temperature, etc., under which such materials are most likely to be used. The Bureau of Standards, Washington, established in 1910, has in its custody the standard weights and measures of the United States. The Bureau employs a specially highly-trained staff, and has, during its short life, produced some of the most valuable work. In England, the National Physical Laboratory deals with a similar class of work, and pays special attention to hydraulic, metallurgical, optical, and aeronautical problems. In Germany, the Physicalische Reichsanstalt has become a very important institution, and deals with a very large range of standardisation and testing work, and has devoted special attention to pyrometry and thermometry. The Materials Prufungsant devotes its attention particularly to the testing of raw materials for manufacture, building, etc. Japan has also realised the necessity for establishing a similar institution. The international comparisons effected by these institutions has already had a very important influence on electrical work. It is highly necessary that such institutions should be developed in Australia. There are many difficulties in the way of establishing a Federal institution, and although we must recognise that such an institution must eventually be established, it would seem advisable for the present for the individual States to pave the way by making suitable provisions for State Laboratories. This applies at present particularly to New South Wales, as I am sure we all hope to maintain the lead in electrical development which our State has already established. I am personally of opinion that the prospects of electrical development in this State are sufficiently assured to war-

rant the establishment of such an institution, which shall deal not only with electrical matters but with such questions as those of weights and measures and the testing of material generally.

INTERNATIONAL CO-OPERATION.

With regard to conventions in Electrical Science, the last year has seen a considerable amount accomplished in the direction of international standardisation. The International Electro-Technical Commission met in Berlin, and the decisions arrived at in regard to copper-wire tables, uniform machinery ratings, nomenclature and electro-technical symbolage have already been adopted by different countries. International commissions were also successfully convened at Berlin in relation to illumination, and at Brussels to physico-chemical symbolage.

STEAM POWER PLANT.

Turbine units up to 35,000 K.W. capacity have been built during the last year, and the limits of unit size have been so far removed that it is possible to state that a turbine unit of 100,000 K.W. capacity could be successfully designed and constructed were it necessary. The number of turbine units put into operation during the year is a clear indication of the supremacy of this type in the case of large power units. Reduction gearing for turbines has been satisfactorily developed, still further extending the application of the high-speed turbine. In condenser equipment, considerable advances have been made. The introduction of the hydraulic air pump, in conjunction with such apparatus, has helped in this development. Nor has its influence been confined to surface-condenser work, the jet condenser having been considerably improved since the application of this principle to air removal. Mechanical stokers of the forced-draught type have been developed to such an extent that the limit of capacity lies with the boiler and flues rather than with the stoker.

PRIME MOVERS.

In the matter of generator prime movers the situation of the past few years is practically unchanged. The steam turbine remains unchallenged as the typical large unit of the

standards

For many years after the foundation of the Commonwealth of Australia, the States continued to be the custodians of their legal standards of weights and measures.

The establishment of a National Standards Laboratory was first advocated in 1912 by Sir John Madsen, who was then Professor of Electrical Engineering at the University of Sydney. But it was not until 1937 that the report of a Secondary Industries Testing Research Advisory Committee (of which Sir John was a member) led to the setting up of a National Standards Laboratory within C.S.I.R. It was decided that the Laboratory should consist of the Sections of Metrology, Physics, and Electrotechnology.

In 1938 leaders of the three groups were chosen: Mr. N. A. Esserman (later the first Director of the Laboratory) came from the Munitions Supply Laboratory to take charge of Metrology, and two Sydney University men, Dr. G. H. Briggs and Dr. D. M. Myers, were appointed Officers-in-Charge of the Physics and Electrotechnology Sections. A year later, construction of the Laboratory began in the grounds of the University of Sydney.

When the war broke out in 1939, the three Officers-in-Charge were overseas, where they had been looking at standards research and seeking standards equipment. Fortunately, some equipment was obtained, and when the Officers-in-Charge returned from over-seas it was possible for the Laboratory to commence functioning and devote its entire effort to defence work. The Metrology Sec-tion certified gauges, made micrometers, slip gauges and measur-ing equipment, and provided a calibration service for the Ministry of Munitions and the inspection branches of the armed services.

Optical glass had not been produced in Australia before the war, and the Physics Section was called on to advise on its manu-facture for lenses and prisms for such instruments as telescopes and range finders. The Physics Section became involved in many other problems, ranging from the development of aircraft-spotting goggles to the production of jewelled bearings for instruments.

The Electrotechnology Section worked on "degaussing", a means of neutralizing or counteracting magnetic fields, which was of great interest to the Navy. Another of the Section's projects was concerned with the prevention of deterioration in hot and humid climates of radios and optical and electrical instruments.

After the war, the Sections were raised to Divisional status, and for the first time the Laboratory was able to concentrate on its original objectives. In 1948 the Commonwealth Government passed a Weights and Measures (National Standards) Act which made the Laboratory, on behalf of CSIRO, the custodian of the legal standards of the Commonwealth. In 1961 Metrology and Electro-technology were merged in a new Division of Applied Physics.

The Division of Applied Physics has maintained the standards of length, mass and volume, and all the secondary standards, such as area and density, which are derived from them. Since 1960, when the units of length were defined in terms of the wave length of an isotope of the gas krypton, it has been possible to define the metre accurately to within one part in ten million. Working standards of mass can be compared to a standard platinum-iridium kilogram on a balance accurate to more than one part in ten million.

There have been many useful applications of the metrological work. It has, for example, been largely instrumental in the estab-lishment of an Australian scientific glassware industry. Research

The Division of Applied Physics has developed improved facilities for the accurate measurement of large gears.

STANDARDS ... cont. 2.

[illegible]eters and pyrometers *in situ.* Well-attended courses in temperature control are held for technicians from industry.

Fundamental research includes work on solid state physics, solar physics, physical optics and physics of fluids. The solid state programme is designed for the study of the physical properties of both metallic and insulating substances, and the inter-atomic forces which determine these properties. The solar physics work is aimed at finding out how corona flares and other visible changes in the sun's surface are related to phenomena directly affecting such things as radio communications on Earth.

A Geodetic Base, 50 metres long, for the calibration of surveying tapes to an accuracy of between 2 and 3 parts in one million.

The Division of Physics calibrates mercury-in-glass sub-standard thermometers against platinum resistance thermometers.

upper atmosphere

Australian interest in the upper atmosphere goes back as far as 1927, when Sir John Madsen, then Professor of Electrical Engineering in Sydney University, interested the Commonwealth Government in research on the propagation of radio waves. With the support of Sir David Rivett of C.S.I.R. a Radio Research Board was formed.

Four young physicists from the United Kingdom were recruited, and these, together with two Australian physicists, formed the nucleus of the Board's team. The Board's work grew and proliferated, and some aspects of its work are now centred in CSIRO's Upper Atmosphere Section, located at Camden, N.S.W. Under the direction of Dr. D. F. Martyn, F.R.S., the Section is studying the upper air, at heights above 50 miles, by rockets and other means.

Australian space research is hampered somewhat by lack of suitable rockets, but the United States National Aeronautics and Space Administration (N.A.S.A.) has made available four Aerobee rockets to the Upper Atmosphere Section. Two of these were successfully fired in 1963 from Wallops Island, Virginia. They carried aloft very low frequency radio receivers, built at Camden, to study the properties of such naturally occurring radio waves above the ionosphere. In these experiments a wide variety of long radio waves was found at high altitudes—waves which are not recorded at the ground because of the absorbing properties of the ionosphere.

The Upper Atmosphere Section also studies other natural phenomena, such as the feeble light emitted by oxygen and other atoms at high levels. The spectroscopic study of this light permits determination of the temperature of the high atmosphere and its variations from day to day, and from year to year as the sun-spot cycle waxes and wanes.

This radio receiver, built in the Upper Atmosphere Section, was fired aloft in an American rocket to record radio waves above the ionosphere.

STANDARDS... cont'd →

has led to the ability to produce very true flat surfaces, and this in turn has led to the invention of ingenious techniques for doing such things as sharpening microtome knives and hypodermic needles. It has also been possible to show industry how to make very flat plates for precision condensers. An applied mechanics group in the Division has developed new ceramic machining tools from Australian materials, and has worked on the isolation of vibration.

The Division is also responsible for the maintenance of the standards of electrical and magnetic quantities. It maintains the Commonwealth standard of frequency in conjunction with the Mount Stromlo Observatory, and other standards derived from frequency, resistance, and electromotive force. As part of its service to industry the Division calibrates a wide range of electrical instruments and equipment, including resistors, bridges, potentiometers, capacitors and wave meters.

Fundamental research in electrotechnology has been concerned with the improvement and extension of electrical measuring and standards facilities, the dielectric properties of insulating materials and the microwave spectra of gases. A recent outstanding achievement has been the construction of a capacitor, the value of which can be calculated from its dimensions. With this as a starting point it is possible to determine the absolute value of the ohm.

The Division of Physics is responsible for the standards of temperature, photometry, radiometry, hygrometry and viscometry, and it also maintains the International Temperature Scale. A number of ingenious and novel techniques and instruments have been devised for measuring these quantities. A typical example is a fast, accurate and convenient hygrometer which can be used to obtain relative humidity readings within two minutes. The Division's officers visit industrial establishments to calibrate ther-

A magnetic test bench at the Division of Applied Physics.

ACDR/AS

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH,
314 ALBERT STREET, EAST MELBOURNE, C.2.

Ref. No. ....

Telephone: J4171.
Teleg. Address: Coresearch, Melbourne.

From the:
Chief Executive Officer.

Late fee.

20th May, 1940.

Professor J.P. Madsen,
Radiophysics Laboratory,
University Grounds,
City road,
CHIPPENDALE. N.S.W.

My dear Madsen,

A cable has just come in from the High Commissioner, through the Prime Minister, reading as follows :

"Following for Madsen from Myers. Director of National Physical Laboratories advises establishment of Standards Laboratory as early as possible. Delivery of equipment sufficient for most work in electricity section.

"Director also advises cancellation of my return through America and early direct. Possible to leave by ship departing end of June. Air mail letter following giving summary of position.

"Should appreciate your opinion by cable before receipt of my letter to enable necessary arrangements to be made."

Will you please let me have your advice as soon as possible ? I expect you will have no hesitation in saying that we should accept Darwin's advice.

Every message from Britain now conveys, implicitly or explicitly, an injunction to us to get on our own feet as quickly as possible.

Yours sincerely,

David Rivett

CHIEF EXECUTIVE OFFICER.

ACDR/AS

Ref. No.

From the
Chief Executive Officer.

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH,
314 ALBERT STREET, EAST MELBOURNE, C.2.
Telephone: J4171.
Teleg. Address: Cornsearch, Melbourne.

21st November, 1940.

PERSONAL AND CONFIDENTIAL.

Professor J.P.V. Madsen,
National Standards Laboratory,
c/- Electrical Engineering Department,
University,
SYDNEY. N.S.W.

My dear Madsen,

I have just received and read your letter of November 20th. telling me of your discussion on the previous day with the Chairman concerning N.S.L. matters, and I must say that I found the letter most disturbing.

[redacted]. Your knowledge of the way to handle men, or rather your practice of a method of doing so, is simply splendid. As long as I can stop it, nothing in this world is going to end your directorship of these activities while this war lasts.

You suggest that Admiral Colvin's proposal be taken seriously, but I want to assure you that he himself dismissed it immediately he had made it with the remark that you could not possibly be spared from Sydney; so that's that. I do not intend to interrupt the progress of enquiries into the possibility of getting Martin.

This morning I had a talk with Sir Charles Burnett who was not entirely clear about the project, thinking perhaps that Martin's main duties would just be on the operational liaison side. When I assured him that vastly more was required than that, or rather that something more fundamental and supplementary to the mere operational business was required, he said he fully understood and would support the proposal.

In all these circumstances, you will understand that I am not looking round at the moment for a successor for J.P.V.M.; nor do I believe that it will be necessary to seek one for G.A.J. when April comes along.

With kindest regards,

Yours sincerely,

Daniel Rivett

CHIEF EXECUTIVE OFFICER.

As the Americans say: "this correspondence is now ended."

PART EIGHT. RADIOPHYSICS.

I. A brief history of C.S.I.R.O.'s Radiophysics Division.

2. The purpose of J.P.V.M.'s trip to Britain in 1939.

3. The basic plan of collaboration devised by Watson-Watt and J.P.V.M. to further Radar development in Australia.

Radiophysics

The Division of Radiophysics was established, as an outcome of an approach from the British Government to the Australian Government early in 1939, to carry out research and development in the then highly secret field of radar, and to serve as a centre for this work in the Pacific area in the event of war.

With the outbreak of war in September 1939 the Division developed rapidly and a new wing was added to a building then under construction for the National Standards Laboratory to provide accommodation for the new work. To preserve anonymity and disguise its true purpose this was given the name "radiophysics".

The wartime work of the Division was of great value to the Australian and American armed forces in the Pacific area. The Laboratory developed coast defence radar equipment and fire control devices for anti-aircraft guns, but its most important achievement was the development of light, compact, transportable radar equipment which could be moved by air. Upwards of 150 sets of this equipment were manufactured in Australia and gave sterling service in the island campaigns of the Pacific theatre.

Since the end of the war the Division's peacetime programme has been directed by Dr. E. G. Bowen, who was a member of the original team responsible for the development of radar in Great Britain in the late 1930s. It was concerned initially with obvious applications of the new knowledge and techniques mastered in wartime.

One of these was to the provision of improved navigational aids for aircraft and, in particular, to a device known as D.M.E. This allows a pilot to read his distance in miles to reference beacons on the ground. There are now about 180 ground beacons installed along the Australian civil air routes, and D.M.E. has undoubtedly made a significant contribution to the good safety record of our domestic airline system.

The discoveries, in 1946, that powerful radio waves are emitted from the vicinity of sunspots and, shortly afterwards, of the existence of "radio stars" were some of the pioneering achievements of the Division in opening up the new science of Radio Astronomy, a field in which it has become one of the outstanding world centres, and won for Australia the status of a leading nation.

A number of novel and ingenious devices for studying radio waves of extraterrestrial origin have been developed, including the Mills Cross, the Crossed Grating Interferometer and the Solar Radio Frequency Spectrograph, all of which have since been copied overseas.

In 1961, thanks to the generosity of two American Foundations and the Australian Government, CSIRO was able to build the world's most powerful steerable radio telescope at Parkes, N.S.W. This instrument, which has an aerial 210 ft. in diameter, has already been responsible for some important discoveries. The Division's latest instrumental development is a Radioheliograph, which is due to be completed at Culgoora, N.S.W., by 1965. The construction of this device, which will provide pictures of the Sun's atmosphere by radio waves at the rate of one a second, has been made possible by a generous grant from the Ford Foundation.

A second aspect of the Division's research programme also had its beginning in 1946, following the demonstration by the American scientists Langmuir and Schaefer that snowfall could be induced artificially by cloud seeding. The Division was already using radar for studying water droplets in cloud and, as Australia is chronically short of water, it was decided to undertake a thorough study of the physical processes in the atmosphere which are responsible for the formation of cloud and rain, and of the feasibility of "rain-making". The decision proved a fortunate one and has led to a vast extension of our knowledge of precipitation and allied processes, in particular, of the vital role played by ice forming nuclei.

It has also included a practical attack on the problem of the stimulation of rainfall; the first artificially induced rain ever to hit the ground fell in New South Wales after a cloud seeding experiment early in 1947.

Within a few years, hundreds of single clouds had been successfully seeded, and by 1961 a series of experiments had been initiated to find out whether rainfall in areas on the western slopes of the main dividing range could be increased significantly. These experiments have not yet been concluded but the results obtained so far indicate that worthwhile increases in rainfall are possible in those areas in which cloud and topographical features are favourable.

C O P Y

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH,

314 Albert Street,
EAST MELBOURNE, C.2. Vic.

AGDR:AS

6th December, 1939.

DECLASSIFIED

Professor J.P.Madsen,
Radiophysics Laboratory,
c/- Electrical Engineering Department,
University of Sydney,
SYDNEY, N.S.W.

My dear Madsen,

You may as well have a copy of Mr. Casey's secret cablegram for your files. It runs :-

"For Rivett -
I have investigated radiophysics position thoroughly and will tell you in return. I find that it is possible for Watson Watt to visit Australia briefly, leaving here within month if you wish him to do so. I think it would be very useful but before arranging it glad to have your views."

I received your wire confirming the suggested draft programme which you had given me over the telephone. As we have not yet received Ministerial approval to your visit, I had to make some obvious alterations. I also thought it was as well to give a hint that recasting of the programme was essential and demanded your presence in England. The reply sent reads :-

"For Rt. Hon. R.G. Casey from Rivett -
Radiophysics Board has recommended Professor
" Madsen fly England leaving here December twentieth purpose
" recasting whole Australian programme in light of war
" conditions and experience (stop) if this project receives
" Ministerial approval very desirable Watson Watt be avail-
" able in London for discussions therefore suggest question
" of Watt's visit be considered after Madsen reaches London."

A memorandum is being sent to the Minister recommending that Munro should leave with you. In addition to the official document, I am sending him a personal letter explaining the importance and urgency of the position.

With kind regards,

Yours sincerely,

Sgd. DAVID RIVETT

CHIEF EXECUTIVE OFFICER

C O P Y

DECLASSIFIED

Late December 1939

MEMORANDUM ON RADIOPHYSICS

(Prepared by Mr. R.A. Watson Watt (Director of Communications Development, Air Ministry) and Professor J.P. Madsen in collaboration with Group-Captain Leedham (Deputy Director of Communications Development, Air Ministry) and Messrs. Dixon and Horley of the Radio Communications Directorate, Air Ministry. This memorandum was presented to Sir Philip Joubert de la Ferte and communicated to the Secretary of State for Air, Sir Kingsley Wood. It forms the basis of recommendations from the Air Ministry to the Governments of Australia and New Zealand).

I. INTRODUCTION

PRE-WAR SCHEME.

As one result of an interview between the Secretary of State for Air and the High Commissioners of Canada, Australia, New Zealand and South Africa, a physicist from Australia visited this country to examine our work in Radiophysics. The Australian Government, having received his verbal and written reports, appointed a Radiophysics Advisory Board, under the Chairmanship of Professor J.P.V. Madsen, Professor of Electrical Engineering in the University of Sydney and Chairman of the Radio Research Board of Australia. The Board is constituted as follows :-

Professor J.P.V. Madsen - Chairman.
Admiral Sir Ragnar Colvin.
Lieutenant-General E.K. Squires.
Air Vice-Marshal S.J. Goble (to be replaced by Air Chief Marshal Sir Charles Burnett).
Sir Harry Brown (representing the Postmaster-General of Australia) (to be replaced by Mr. D. McVey).
Sir David Rivett (representing the Council for Scientific and Industrial Research).
Mr. G.A. Cook - Secretary.

The Board decided to set up a preliminary organisation to provide for research, development and possible production in different degrees of military emergency. A radiophysics research building will be completed in March 1940, as a suitably isolated part of a larger group of research buildings. A staff of approximately 12 radiophysicist-engineers has been appointed, the leader of this group being Dr. D.F. Martyn, who is the physicist referred to in the first lines of this memorandum. This initial structure was designed to provide for :-

1. Instruction and training of staff in the technical use of radiophysical equipment.

2. Adaptations of Radiophysics to suit the particular needs of Australia and New Zealand.

3. Research on special parts of Radiophysics decided in consultation with Great Britain.

4. Training of personnel for operating equipment.

5. Assistance to neighbours, particularly New Zealand.

6. Planning for possible production in emergency.

7. Application of Radiophysics technique to the needs of Civil Aviation and industry.

This last consideration was taken by the Board, whose recommendations were accepted by the Government, as justifying a permanent rather than a war emergency organisation in respect of personnel, equipment and buildings.

II. RECONSIDERATION OF SCHEME TO MEET WAR CONDITIONS.

The outbreak of war made it impossible to carry out the details of the original scheme and the Australian Government decided, on the advice of its Radiophysics Advisory Board, to send the Chairman of that Board to discuss with the authorities in Great Britain a scheme more suited to the prevailing conditions.

The results of conferences between Professor Madsen, Mr. Munro, Mr. R.A. Watson-Watt, the Scientific Adviser on Telecommunication to the Air Ministry and Group Captain H. Leedham, Deputy Director of Communication Development, have been referred to Sir Henry Tizard, Scientific Advisor to the Chief of Air Staff and Air Marshal Sir Philip Joubert, and have resulted in the following recommendations :-

1. That the Australian Radiophysics Laboratory shall act as a definite sub-centre to a main centre in Great Britain as regards research, experimental development and possible emergency production in Australia.

2. That to provide for the best utilisation in Imperial interests of the limited number of qualified research workers in Great Britain and Australia, there shall be one general programme of research to be arrived at by mutual consultation, and that specific items of research shall be allocated to the Australian Laboratory subject to frequent revision as required.

3(a) The primary aim in Australia shall be to secure the earliest possible operation of Radiophysics equipment, particularly of existing types suitably modified where necessary.

(b) At the same time steps shall be taken to ensure that the Australian sub-centre can obtain and hold sufficient reserves of essential parts of equipment and the latest information on technical details and manufacturing designs to enable it, in the event of an extreme emergency, to serve as an effective centre of production for the Southern Hemisphere and Singapore.

4. To render 3(a) and 3(b) effective, the British organisation shall provide as soon as possible -

(a) Samples of equipment for instructional and experimental purposes.

(b) Stocks of essential components difficult to produce in Australia.

(c) Detailed drawings and manufacturing designs and instructions.

(for details see appendix to this report).

5. That for effective consultation and interlinkage visits between the Main and Sub-centres shall be a normal part of the organisation. In particular, to take full advantage of the research and development which has already occurred in Great Britain, and to assist the British effort, the Australian Laboratory should detach three or four officers for simultaneous service in Great Britain, each officer specialising in/one major branch of research, for periods between six and twelve months.

To comply with these recommendations it appears desirable that, during the immediately coming years, the Australian Sub-centre shall aim at a scientific and technical staff of the order of 25 officers, and provision made for increasing this to 50 in the event of extreme emergency.

A careful review will be made in order to advise on the stocks of these equipments which should be shipped to Australia at the very earliest date against a possible production programme.

6. The arrangements suggested in this memorandum do not interfere with orders which have already been placed for radiophysics equipment for Australia and New Zealand, which will be fulfilled at the earliest possible date. They provide, however, a plan by which difficulties arising from unavoidable delays in delivery or changes in design will not prevent Australia and New Zealand from obtaining a substantial measure of radiophysics cover.

The experience which will be gained under this plan will be of great value if at any future time it is deemed advisable to develop a more comprehensive scheme to cover other Empire countries.

7. Steps should be taken to ascertain whether the New Zealand Government would be willing to take part in this scheme by close co-operation with Australia, the details of co-operation to be arrived at by consultation between the Australian and New Zealand Governments.

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A P P E N D I X

Specific and Detailed Recommendations regarding Production in Australia.

In general, production would be more economically and more expeditiously undertaken by the large production machine set up in Great Britain, priority of distribution being governed by agreed relative urgency of needs. But international and imperial reasons demand special provision for production in Australia, not solely for her own needs, but for needs which might arise anywhere in the Southern Hemisphere, for example, in Singapore.

This production falls under three heads:-

(a) Improvised production on a small scale to meet training requirements and also in the event of communications with this country being severed at any stage in the War.

(b) Planning for bulk production in the event of that proving to be an ultimate necessity.

(c) Bulk production.

Generally steps will be taken in Great Britain from time to time to assist the Empire countries in their preliminary work while development is proceeding most rapidly in Great Britain. In particular the following immediate measures have been taken to meet (a) -

(i) Air Equipment. Six complete sets of Mark I A.S.V. and three sets of Mark I I.F.F. equipment will be shipped to Australia at the end of January, 1940 - with these sets as models it should be possible after suitable experimental work, to arrange for the production on an improved basis of any air equipment required to meet the special needs in Australia.

(ii) Ground Equipment. Authority will be sought from I.S.C. to ship two complete G.L. Mark I equipments to Australia at the end of March 1940 - one of these models to be used for training purposes and as a prototype for subsequent G.L. emergency development, the second model to be converted in Australia, on data supplied by us, to G.M. type which will then serve as a model on which development may be carried out to provide improvised M.B. type of equipment.

To meet (b) complete working drawings of all types of radiophysical equipment in which Australia is interested will be supplied as soon as these production drawings become available at the various firms in the Radiophysics group. Although costly, it may be desirable to make up by hand-made methods from these drawings one or two sets of each type of equipment in Australia in order to prove the drawings and obtain the measure of the ultimate production problem that arise.

To meet (c) The Australian Government will consult radio and allied firms in Australia as soon as the detailed production drawings referred to above are available, with the object of planning machine tool and assembly capacity to meet a production programme in the event of that policy being decided upon.

The provision of certain types of valves, generators and other components may prove to be a much greater problem than the actual manufacture of the radiophysical equipment itself. A careful review will be made in order to advise on the stocks of these equipments which should be shipped to Australia at the very earliest date against a possible production programme.

PART NINE. THE SCIENTIFIC LIASON MISSION.

I. The recommendations made to the Commonwealth Government for scientific liason with the U.S., Canada and Britain.

2. The Commonwealth's proposal put to the U.S. Secretary of State by R.G.Casey.

3. J.P.V.M.'s anticipation of the future course of the war in asia.

4. A description by J.P.V.M. of his day to day activities in Britain.

5. A letter of appreciation to Sydney University from Prime Minister Curtin.

6. A note from New Zealand recognising J.P.V.M.'s diplomacy.

ACDR/AS M. 2187.

7th Feb., 41

MEMORANDUM TO:

The Hon. Harold Holt, M.P.,
Minister-in-Charge of Scientific
and Industrial Research,
Commonwealth Offices,
MELBOURNE. C.2.

SCIENTIFIC RESEARCH LIAISON OVERSEAS.

Recent events have made it clear that we must now take active steps to develop our contacts with Britain, U.S.A., and Canada in all matters relating to scientific research work on war problems. With our Standards, Radiophysics and Aeronautical laboratories in full swing we are now able to share considerably in physical investigations, and the only way to keep in touch is by personal intercourse between leaders. Traffic in ideas and experimental results (which will not merely be one way) can not now be maintained by correspondence.

Mr. Bruce has recently emphasised the need for better scientific liaison in London and has pointed out that under existing conditions we are not getting anything like as much from British Service work as is Canada. Mr. Casey, too, has drawn attention to the need for Australian representation at Washington and Ottawa.

After much consideration and discussion with the Navy, Air and Army Chiefs, and senior officers in the Departments of Munitions and Supply, it has been decided to recommend that Professor J.P.V. Madsen be invited to take charge of scientific research liaison work overseas, with headquarters in London. We can ill spare him from Sydney, but the need abroad is the greater. He will keep in touch also with Washington and Ottawa and probably cross the Atlantic periodically. If the war continues for some time, he may also need to make short visits back here. This appointment would require an official request to the University of Sydney to free Professor Madsen from his duties there.

It is recommended that Dr. H.C. Webster accompany Professor Madsen as the immediate senior member of the supporting team. Dr. Webster is on the staff of the R.P. Laboratory, having been seconded to us by the University of Queensland for the period of the war. It was previously proposed that Dr. L.H. Martin, of Melbourne, should fill this post, but for various reasons this proposal has been withdrawn.

Mr. F.G. Nicholls, M.Sc., a physicist at present with the Information Section at the [illegible] Office, would go as Professor Madsen's secretary.

Mr. J.H. Piddington, it is suggested, should go across with Dr. Madsen and spend at least three months in Britain, then returning to the R.P. Laboratory with latest advice.

With Mr. Dunsmuir, who is at present at Australia House, this would give us a team of five very competent people, technically well trained in physics and engineering.

Professor Madsen, who suggests that his office be described as that of Director of Scientific Research Liaison (Physics and Engineering), should, through Mr. Bruce, be assured of access when necessary to appropriate Service Ministers, especially the Minister for Supply, in [illegible] would also be fully accredited to the Admiralty, Army and Air Force Research Departments, an arrangement approved by Admiral Sir R. Colvin, Lieut.-General Sturdee and Air Chief Marshal Sir Charles Burnett. It should be easy to arrange that he be given official standing on certain special scientific Defence Committees in England, including the one recently set up under the chairmanship of Sir William Bragg: and he should also be associated with the U.S.A. National Research Defence Committee as intimately as possible.

In America we think that at present the position will be met if Mr. G.H. Munro, who has recently returned from London, be attached to the Australian Legation. Under Mr. Casey's wing, he will quickly make all the desired contacts. Possibly we may find it necessary later to send a more senior officer, say, Dr. C.H. Briggs. Dr. Madsen would keep in close touch with him all the time.

The proposal is that Dr. Madsen, Dr. Webster, Mr. Nicholls, Dr. Piddington and Mr. Munro travel by boat to America, and spend some time at Washington and Ottawa summing up the position there. The first four would then go on to London. A start from Australia is unlikely under two months from now.

This scheme will involve considerable expense. It is recommended that Professor Madsen be paid £2,000 per annum plus a daily allowance of £3 in U.S.A. and Canada and £2 in England. He will have heavy personal expenses in carrying out his duties. The salaries of Dr. Webster (£592 p.a.) and Mr. Nicholls (£492 p.a.) are already provided on our Estimates, but each should be given £1 per day allowance. The same holds for Dr. Piddington (£572 p.a.) for his shorter period abroad.

Mr. Munro's salary is £692 p.a. and his allowance in America should no doubt be greater than that of the officers in London, say, 30/- daily.

Incidentals will include overseas fares, local travelling, typistes, etc. If the general scheme is approved, full details will be provided.

It is unnecessary to cumber this memorandum with a summary of the ways in which sources of information abroad will be tapped. Professor Madsen already knows most of the leaders personally and we know that he will be warmly welcomed and completely trusted. Already he has worked out much detail of his programme, but of course he will require a free hand to develop it as circumstances may demand.

The proposed plan will not interfere at all with existing practices of the Service and Munitions authorities who send technical officers abroad to investigate specific problems for different arms of the Services: nor will it alter in any way the existing arrangements for naval, military and air liaison officers at Australia House. On the contrary, it will be complementary to these in taking charge of research matters which at present receive inadequate attention.

The plan gives the answer to a request recently received from the Admiralty that a permanent senior scientific officer be appointed in London and recognised as the one main channel for all secret research communications. Professor Madsen will arrange with the Navy Office here for the safeguarding of all such interchanges, and the use of established guarded channels.

Your general approval of the plan is now sought. If it be given a more detailed statement will follow.

(sgd.) David Rivett.
CHIEF EXECUTIVE OFFICER.

I entirely agree with the need for action along the lines indicated and give my general approval subject to specific approval of details from time to time.

(sgd.) H.M.H. 10.3.41.

Australian Legation,
Washington, D.C.,
May 15th, 1941.

Sir,

I have the honour to inform you that my Government has recently given consideration to the necessity for maintaining the closest possible liaison with Great Britain, Canada and the United States of America regarding scientific matters connected with problems of defence.

The Commonwealth Government, which has already established close scientific liaison with the United Kingdom Government, is convinced that the Australian war effort can be substantially increased if the scientific liaison already established by Australia with Great Britain can be extended to Canada and the United States.

In this connection it is understood that, following upon the arrival in North America of a scientific delegation from Great Britain led by Sir Henry Tizard, the necessary steps have been taken to establish full cooperation of this kind between Great Britain, Canada, and the United States.

In the hope that the United States Government may feel able to extend to Australia the facilities for more direct scientific contact which have alread, been granted to Canada, my Government has appointed Professor J.P.V. Madsen of the University of Sydney, to direct Scientific Research Liaison for Australia. Professor Madsen has now arrived in Washington and is ready to proceed with the establishment of the necessary Australian scientific organization in America as soon as the formal assent of the United States

The Honourable
Cordell Hull,
Secretary of State of the United States,
Washington, D.C.

Government to the establishment of scientific liaison between United States and Australia is secured.

My Government, therefore, would be glad if the United States Government could indicate its approval in principle of this proposal, the adoption of which would enable Australia to obtain scientific information far more expeditiously than under the arrangements already existing between Great Britain and Australia.

The Commonwealth Government is, of course, ready to give any necessary undertakings in regard to secrecy and the use of scientific information so obtained and to undertake to place at the disposal of the American Government the results of scientific research carried out in Australia.

As Professor Madson has been instructed by the Commonwealth Government to proceed as soon as possible to Canada and the United Kingdom in order to take any necessary steps to expedite the transmission to Australia of scientific information from these countries, it would be greatly appreciated if an early decision on this matter could be reache

As I have indicated, Professor Madsen is passing through the United States on his way to London, where he will be more or less permaner tly established. The Australian Government, however, proposes, with the agreement of the United States Government, to maintain a permanent scientific liaison officer at this Legation - in the shape of Mr. G. Munro M.Sc. If this appointment meets with the approval of the United States Administration, Mr. Munro would be designated "attache" to this Legation. I am given to understand that this general description is regarded as more appropriate than the more precise description "Scientific Adviser".

I would be grateful to be advised if the above proposals are agreeable to the United States Government.

I have the honour to be,

With the highest consideration,

Sir,

Your obedient servant,

(SGD) R. G. CASEY

Australian Scientific Research
Liaison Office,
Australia House,
Strand,
London, W.C.2.

16th September, 1941.

DECLASSIFIED

My dear Rivett,

I have just received your letters of the 5th and 7th August, and am glad to hear that everything is shaping so well in spite of difficulties.

At this end I have been looking more particularly into matters of general policy, particularly where they concern Australia. As the result of a discussion with Admiral Murray, of the Signal Department, Admiralty, a cable is being sent officially to the Naval Board, Melbourne, indicating that Admiralty have now defined their policy in regard to wavelength, fixing upon values of 1½ m. and 10 cm., and from now on discarding the 50 cm. This fits in admirably with the programme which we have been planning in Australia.

Next, I was anxious to find out what had been done by a certain Inter-Services and Dominions Policy R.D.F. Committee. I found that unfortunately the work of this Committee had been in abeyance for some time due to the transfer of its chairman, Sir Philip Joubert, to Coastal Command work. Sir Frank Smith helped me run this body to earth, and as I made contact with it I was pleased to find that Tizard had taken over the chairmanship. I had a long conference with him yesterday afternoon, and a ring from him this afternoon, when he informed me that matters we are concerned with were discussed by that Committee this morning and will be taken up seriously, probably at a higher level, bringing the High Commissioner into the picture.) What we really want to know is the steps which would be taken in the event of Japan coming into the picture, and the responsibility which Australia might be called upon to carry in such an event, particularly in regard to equipment of ships, aircraft and defended areas in Singapore, Malaya and the Dutch East Indies. I am sure that Australia can render great service in this direction, provided we are given sufficient warning. I am looking forward to a full discussion on these matters, the result of which should be to enable one to obtain a clear set-out of the problem in the first place, and early warning of the requirements necessary to meet the situation should it occur.

In addition to these matters, I am now turning my attention more particularly to an examination of operational research work. This is a new phase of work which has come about through the introduction of R.D.F., and it is in these matters that Tizard has himself been playing a rather important role. Blackett also appears to be taking an active part in it. It involves such problems as operational methods for the employment of aircraft fitted with R.D.F. for spotting ships and submarines. It is tied up also, of course, with normal communication methods established between such craft and suitable bases, and deals with the question of operating a number of such craft at the one time.

It is considered necessary to take up this study from the scientific aspect as well as from the purely Service point of view, and a good deal of economy and increased efficiency is being obtained by such operational research. I propose to devote a good deal of my time between now and November to dealing with this aspect of things, from the point of view of all Services, -

(Sgd.)
J.P.V.M.

Sir David Rivett, KCMG.,
Council for Scientific and Industrial Research,
314, Albert Street,
East Melbourne, C.2.

Australian Scientific Research
Liaison Office,
Australia House,
Strand,
London, W.C.2.

PERSONAL

31st October, 1941.

My dear Wallace,

It has taken me some little time to size up the situation here and decide what my future movements are likely to be, but I now have a fairly clear picture of the whole position. I anticipate leaving here about the middle of November, and will be spending three weeks in America and Canada, flying then to Australia. I am booking through Auckland, and it is highly probable that I shall have to stay there a week. On the other hand, it is quite likely that within the next week or two I may have to alter these arrangements so as to return via Singapore. In any case, however, I expect to be in Sydney somewhere about the New Year, and look forward to seeing you all again. There is little doubt, however, that I shall be called upon to return after a couple of months in Australia, as there is plenty of work here to be done, and at the same time the effort in America and Canada is increasing very rapidly. I expect, therefore, that I shall have to ask the University to consider an extension of my present leave.

Things, of course, are moving very rapidly over here, and I find it hard to keep up with the range of requirements which we are called upon to meet. However, I managed to get a week-end at Cambridge recently, and stayed at Trinity Lodge with Trevelyan. Bragg, Jnr., took me over the Cavendish, and I naturally met a number of very interesting people there, including Eddington, Ashton, A. V. Hill, Ingles, Hardy and others. Next week I am spending the week-end at Oxford with Tizard, and again am looking forward to an interesting time.

My living conditions here have been exceedingly well looked after. I have been staying with Bragg, Snr., at the Royal Institution, where he has a number of private rooms not in use, and, as this is so convenient to the Athenaeum, any other than my working hours are spent between the two places. I also spent a week-end recently with Bragg at his house down at Whitley.

I judge from the newspaper reports that you have been having rather an interesting time with the Senate in relation to law matters.

I am glad to hear that Bailey is taking such an active part in the training of radiolocation personnel for the Services. There are two requests going forward from Army and Navy respectively here, asking for considerable numbers of such men, so I anticipate that during this next year Bailey and Vonwiller will be having a rather busy time. It has been agreed generally here that men trained in this way are to be used for the supply of Services in the Near and Far East, rather than for service in Great Britain. This should be a much more economical arrangement than the one which was suggested previously, in which men were being

Sir Robert Wallace,
Vice-Chancellor,
University of Sydney.

asked for here, while at the same time men were being sent from here almost back as far as they had come.

Earle Page arrived yesterday, and Bruce got together a rather interesting lot of people (mainly Cabinet Ministers) to meet him at lunch - at which I was also present. I am looking forward to having a discussion with Bruce and Page very soon in regard to Australian associations with Singapore and the Dutch East Indies.

I have not heard from any of my own people recently as to how things are going on in the Electrical Engineering Lab., but I expect they should be going quite satisfactorily. I shall be interested to know what has happened in regard to the Chair of Chemical Engineering. I should think that with the material likely to be available from here at the present Gibson's chances should be quite good.

I spent the week-end recently at Bristol, and had the opportunity of seeing Keeble and Ramsay. Both seemed to be doing very well, and are finding excellent opportunities.

I don't know that there is much more that I can tell you. Fortunately I have seen and heard very little of bombs and such like. The weather is beginning to feel quite sharp: in fact, I had the first light fall of snow a couple of days ago.

I hope you yourself have been keeping in good fettle.

Kindest regards,

Yours sincerely,

(COPY)

Prime Minister,
CANBERRA,
21/12/42.

My Dear Vice-Chancellor,

I should like to convey to you the thanks of the Government for the readiness with which your University has met the request of the Council for Scientific and Industrial Research for a continuation of the services of Sir John Madsen in the handling of problems associated with radio-location.

The willingness of the University to allow Sir John Madsen to proceed to America and England to establish Scientific Liaison Offices was greatly appreciated and, now that he has returned from that mission and has rejoined your staff, we are very glad indeed that we can still count on his assistance under a somewhat modified arrangement.

I would like to thank you, too, for providing further facilities for the extension of the Radiophysics Laboratory in the University Grounds.

Yours sincerely,
(Signed) John Curtin.

Sir Robert Wallace,
Vice-Chancellor,
University of Sydney,
SYDNEY, N.S.W.

Pers. Rivett
(N.Z. Trip)

COMMONWEALTH COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH,
314 ALBERT STREET, EAST MELBOURNE, C.2.
Telephone: J4171.
Teleg. Address: Coresearch, Melbourne.
Executive Officer.

13th June, 1943.

Sir John Madsen,
Electrical Engineering Department,
University,
SYDNEY. N.S.W.

My dear Madsen,

I have just received a letter labelled "Personal: Confidential: by British Packet in charge of Master" which was delivered by hand here at the C.S.I.R. Office with a printed form of receipt which I signed!

In such serious circumstances I feel it necessary to quote the letter to you in full. It runs :-

"We have had a visit from Sir John Madsen, which passed off very well. He was helpful in many directions in his own inimitable way. Also his contacts with Ministers etc., were not embarrassing. I must confess that he has a wonderful technique of interesting Ministers.

"We are having a terribly busy time here just now but will try to find time soon to tell you in more detail how things are progressing."

The letter took 15 days in transit, but, in view of its weight, I am not surprised!

With kind regards,

Yours sincerely,

David Rivett

PART TEN. THE ELECTRICAL RESEARCH BOARD.

I. History of the E.R.B.

2. A note from Lord Casey.

PART ELEVEN. OTHER PAPERS.

I. A cable from Philips Holland on J.P.V.M.'s appointment to the local board.

2. A letter from a former student and a personal friend.

3. Press cuttings from June 1941 on the public disclosure of Radar.

THE ELECTRICAL RESEARCH BOARD

In the fourteen years of its existence, the Electrical Research Board has received very substantial grants from electrical supply authorities throughout Australia, all of which are members of the Electricity Supply Association of Australia. The purpose of this report is to give to the E.S.A.A., and through it to the individual supply authorities, an account of the work done by the Board and the achievements which have resulted, directly or indirectly, from its activities.

HISTORY

On 28th November, 1944, Sir John Madsen, Professor of Electrical Engineering in the University of Sydney, was invited to address a meeting of the E.S.A.A. on the subject of research in Universities and the ways in which the electrical supply industries might contribute to, and profit from, such research. Following the meeting, the Council of E.S.A.A. proposed that there should be established an Electrical Research Board, for the general purpose of stimulating electrical research in Australia, and more particularly, of enabling the Universities to expand their research activities so as to ensure a regular flow of properly trained research men into the electrical industries and into the Universities themselves, to take part in the training of students. The co-operation of C.S.I.R.O. was readily obtained, and it was decided that that organization would provide administrative and secretarial facilities; the operating funds of the Board were to be provided on a pro rata basis by the member bodies of the E.S.A.A. A statement of the total contributions up to the present time by these bodies is given in Appendix A, which shows that the funds so far received by the Board from these sources have reached £72,647, whilst Appendix B lists the special contributions, amounting to £42,550, to the high voltage project of the University of Queensland to which private industries made substantial contributions. The amount expended or committed is £109,987; its distribution is shown in Appendix C.

The initial membership of the Board was as follows:

Professor Sir John Madsen, University of Sydney, (Chairman).

Mr. V. J. F. Brain, Chairman, Elec. Authority of N.S.W.

Mr. R. Liddelow, Manager, S.E.C., Victoria.

Dr. F. W. G. White, C.S.I.R.O.

Dr. D. M. Myers, C.S.I.R.O.

Several changes have since taken place. Mr. Liddelow retired from the Board in 1954 and was replaced by Mr. Willis Connolly. Mr. Brain died in 1957, and Mr. P. A. W. Anthony (Southern Electricity Supply, Queensland) was elected to replace him. Dr. Myers joined the University of Sydney in 1949, remaining a member of the Board, and Mr. F. J. Lehany (C.S.I.R.O.) joined the Board.

The conjoint secretaries of the Board are Mr. F. G. Nicholls (C.S.I.R.O.) and Mr. R. C. Richardson (C.S.I.R.O.).

POLICY OF THE BOARD

The functions of the Board were stated in very wide terms, and the Board's policy has been to give them a wide interpretation, avoiding any trend to concentrate on research proposals purely on account of immediate and practical use. In general, the Board's support of research has followed two main lines:

(a) To make grants on an annual basis to Universities to enable them to enrol research students and to provide them with facilities, in cases where the Universities had insufficient financial resources to support the work from their own funds.

(b) To seek out research activities in Universities that commend themselves on account of their quality and the energy with which they are being pursued, and to provide financial assistance to the Universities concerned.

In all cases, the allocation of grants has been based on the inherent quality of the men and of those supervising them, rather than a consideration of the direct usefulness of their work; the Board has never lost sight of the long-term value of increasing the production of first-class men with research training and experience.

GOVERNMENT HOUSE

CANBERRA

Friday, 2nd December 1966.

My dear Sir John Madsen,

I hear that you have resigned from your Chairmanship of the Electrical Research Board and so from your long association with C.S.I.R.O. and C.S.I.R.

I think from memory that we first met in 1939, over the very early Radar (R.D.F.) in the U.K. - and of course I know about the very distinguished service you have rendered over the years in many directions, in respect of National Standards and Radio Physics in the war years, and much else. In short your service to the Commonwealth has been outstanding which is well known to a great many people.

This note is only to send you my thanks and appreciation for what you have done and to congratulate you most sincerely on it.

I'm sure you won't be idle now. I haven't got to tell you that the secret is to continue to be busy in directions of your own choice.

All good wishes to you -

Yours Sincerely

Casey

Sir John Madsen,
1 Wandella Avenue,
ROSEVILLE, N.S.W.

GOVERNMENT HOUSE

CANBERRA

Friday, 2nd December 1966.

My dear Sir John Madsen,

I hear that you have resigned from your Chairmanship of the Electrical Research Board and so from your long association with C.S.I.R.O. and C.S.I.R.

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All good wishes to you -

Yours Sincerely

Casey

Sir John Madsen,
1 Wandella Avenue,
ROSEVILLE, N.S.W.

PHILIPS ELECTRICAL INDUSTRIES OF AUSTRALIA PTY. LIMITED
PHILIPS HOUSE, 69-73 CLARENCE STREET, SYDNEY
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SYDNEY

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TELEGRAMS: "ARGENTA SYDNEY"

YOUR REF.

PLEASE QUOTE IN YOUR REPLY
MANAGEMENT
AEP/MD/2742

5th April, 1948.

Sir John Madsen,
1 Wandella Avenue,
ROSEVILLE. N.S.W.

Dear Sir John,

Further to our conversation of to-day I have pleasure in confirming that the following telegram from Mr. Loupart arrived to-day:

"DELIGHTED HEAR SIR JOHN MADSEN NOW ABLE AND READY JOIN BOARD YOUR COMPANY THUS FULFILLING LONGFELT MUTUAL DESIRE stop WE ALL FEEL THE PROPOSED CLOSE COOPERATION WITH EMINENT REPRESENTATIVE OF AUSTRALIAN SCIENCE WILL BE OF UTMOST IMPORTANCE FUTURE DEVELOPMENT INDUSTRIAL FIELD stop ON BEHALF OF ENTIRE BOARD OF MANAGEMENT I EXTEND HEARTIEST WELCOME TO SIR JOHN WE ARE LOOKING FORWARD TO LONG HAPPY ASSOCIATION stop PROFESSOR CASIMIR JOINS ME IN KINDEST PERSONAL REGARDS - LOUPART"

We of the local organisation are very happy to associate ourselves with the expressions of welcome so adequately expressed by

9 Woodville Ave.,
Wahroonga.
8th October, 1969.

Dear Phyl,

As I sit here tonight over a cup of coffee, my mind has gone back to some of the wonderful days I shared with your father and I thought I should let you know how I felt about him.

Although the difference in our ages was great, it was his ever fresh and youthful searching approach to life that allowed us, or as I thought, to communicate almost as brothers. As you know I first met him through that other wonderful man Tom Nicholls Snr. and we quickly established a friendship which I have always cherished.

I do not know whether you were aware that Sir John made and gave me the first fishing rod I ever owned – it was a metal one with which he had experimented with some of that scrap metal the parson talked about at the service today. And it was he who conferred my degree on me at graduation – I well remember the tremendous wink he gave me when I bowed and doffed my lid to him in front of the assembled multitude in the Great Hall, because we both knew that the very next day our formal robes would be exchanged for more comfortable gear – we were both off to Bawley next morning. And the wonderful sparkling morning at Bawley when I beat him to the best fishing hole on the beach and he said he hadn't worried about it much until he got closer to the hole and saw it was me because he had mistaken me from a distance for "a bloody big Kangaroo"! And my last fishing trip with him was the wonderful week-end with my own father when we taught Harry Messel to catch beach worms.

Phyl, I have so many memories of him which I will never forget and all these were in the latter part of his life – of his younger life I have also shared because of all the other stories I have heard told of him – God was good to have allowed him to have lived so long and that so many of us crossed paths with him over the years. You must be very proud and happy to know the love, respect and admiration in which he was held. I am one who is better for the knowing of him.

He told me dozens of times "Boy, there's not much time on this earth, so fish every tide you can manage". That sums up his philosophy of never letting life go by without making the most and best of it. Trite though it may be, I hope he's found a beach where the tide is always right and fish always on the bight.

Love from me and mine

John Dexter

WARTIME PRESS CUTTINGS ON RADAR.

S.M.H. 19.6.41.

SECRET RADIO DEVICE.

DETECTS ENEMY AIRCRAFT.

Wide British Use.

LONDON, June 18. (A.A.P.)

An amazing system developed by British scientists for detecting the approach of enemy aircraft or ships by means of ether waves has now been officially disclosed.

Because of this system, known as radio-location, it was now virtually impossible for any raider to approach Britain undetected, Air Chief-Marshal Sir Philip Joubert, Officer Commanding-in-Chief, Coastal Command, said yesterday.

Radio-location, he added, was the war's best-kept secret, and one of the most important developments of our war organisation. It could be truly said that the Battle for Britain last autumn was won by fighters and radio-location.

AUSTRALIAN MANUFACTURE.

"Australia and New Zealand are already manufacturing its equipment and training personnel for its maintenance and [illegible]," Sir Philip Joubert said. "But it is of [illegible] [illegible] air, land, and sea strategy that it has come into being without the world knowing of it.

"It is not new to science, but its application to war was not known.

"The man who first applied these scientific facts to the detection of planes was Mr. Robert Alexander Watson-Watt, Director of Communications, Air Ministry. He developed the system from meteorological methods.

"Radio-location was born in March, 1935, when Mr. Watt demonstrated it with an [illegible] lorry on a country road near Daventry.

"A group of brilliant scientists worked on it in the closest secrecy until the [illegible] of 1939, when radio-location emerged as a system for sending out electric or other waves far beyond our shores. Any solid object in the path of the waves, whether ship or plane, sends back the reflection to [illegible].

"The system is not affected by fog, cloud, or by darkness, and keeps up its watch for twenty-four hours every day throughout the year.

ELIMINATES PATROLS.

"Radio-location eliminates the necessity for continuous patrols of fighters," Sir Philip Joubert added, "thus saving petrol, wear and tear on engines, and, of course, obviating immense strain on personnel.

"The development of the system is continuous and rapid. Its organisation throughout the country has made necessary the employment of thousands to staff it. It also [illegible] doubles the usefulness of the Royal Observer Corps.

"It is also used by the Navy and by the Army, but science and manufacture have outstripped personnel. Scientists are constantly evolving improvements, and the electrical radio manufacturers have brought in all their resources for producing radio-location [illegible] production in ever-increasing quantities.

"We have mobilised every available qualified [illegible] and have used women [illegible] but we need immediately for the three Services 18,000 men and 3,000 women. The ultimate need is about twice those numbers."

In answer to a question, Sir Philip Joubert said: "The scientific facts on which radio-location was developed are known to the world, and it could be supposed, therefore, that the Germans had not [illegible] its application, but [illegible] no positive evidence of it. [illegible] there have been [illegible] in our [illegible] Germans. [illegible] have been mainly due to anti-aircraft [illegible] [illegible] could be [illegible] to radio-location."

UNLIMITED [illegible]

The [illegible] [illegible] [illegible] radio-location [illegible] [illegible] [illegible]

[illegible] Beaverbrook said. [illegible]

INVENTOR'S HOPE.

FROM OUR OWN CORRESPONDENT.

LONDON, June 18.

"I am just an ordinary scientist, and all I hope is that many more people will be able to sleep more comfortably in their beds at night-time now that the Air Ministry has released the news," said Mr. Watt.

[illegible]

SIR E. FISK'S STATEMENT.

[illegible]

[illegible]

Anti-[illegible]

Daily Telegraph Service and A.A.P.

LONDON, Wednesday.

Australia and New Zealand are making apparatus for Britain's secret radio weapon which detects the approach of enemy planes and ships.

They are also training men to use and maintain it.

The invention is known as "radio location."

Some newspapers warn against over-enthusiasm about the new device.

The Evening News says:—"With a great flourish of trumpets, but at a discreet distance, the secret radio locator is produced for our inspection.

"Voices full of vague enthusiasm call on us to marvel at its power of detecting things invisible to the human eye.

"Much is claimed for the invention, but the average Briton's applause won't go beyond the bounds of reason.

"Most of us have acquired in the last two years the habit of taking all our claims, especially official claims, with a pinch of salt.

"It will help to remember that the radio detector was expected to mean the end of all U-boats, and that the U-boats are still doing devilish work."

The Yorkshire Post says: "A study of the facts [illegible] will show they are not very [illegible].

"The chief reason for the disclosure is to reinforce the appeal for men and women, with [illegible] radio experience, to join up for radio location work.

"There is some risk that excessive hopes may be raised. The value of radio location is [illegible] question. Its potentialities are [illegible].

"[illegible] a signal to a ground station of the approach of hostile aircraft along a certain [illegible] can obviously give [illegible] [illegible] guidance to fighters and anti-aircraft batteries."

14,000 People Needed

The device has cost millions of pounds to develop. Thousands of men and women throughout the Empire are engaged on its construction and maintenance.

"Radio location combined with British [illegible] won the Battle of Britain," [illegible] the Commander-in-Chief [illegible] of the R.A.F. [illegible] said [illegible].

[illegible] throughout the country [illegible] approximately 10,000 [illegible] will need [illegible].

[illegible] radio location, it is virtually [illegible] for any enemy bomber or [illegible] through Britain without our [illegible].

[illegible]

Australian Part In Invention

CANBERRA, Wednesday.—Professor Madsen, of Sydney University, played a prominent part in evolving the radio weapon to defeat night raiders.

This was the main reason why Professor Madsen received a knighthood in the recent Birthday Honours list announced on June 12.

Professor Madsen spent some time in England after the outbreak of war working with British and other Empire scientists to solve the problem of the night raider.

Sir John Madsen

Several British scientists have been brought to Australia to work in the radio-physics laboratory at Sydney University.

The Minister for Air (Mr. McEwen) said tonight that he felt sure Australian air defences would greatly benefit from this new discovery.

"Results of [illegible] research [illegible] Empire-wide research [illegible] over a long period by [illegible].

"The best brains in the Empire have been devoted to solving the [illegible] dealing with the [illegible].

"Much has been done on this [illegible] in Australia, and the results of Australian research have been [illegible] communicated to the British authorities.

"Australians [illegible] have had the benefit of [illegible] the progress made [illegible] in England [illegible]."

[illegible]

Radio location is a system whereby [illegible] effective [illegible] darkness, are sent out far beyond the limits of British planes.

Planes or ships in the [illegible] immediately cause [illegible] signals to [illegible].

The man mainly responsible for development of radio location is R. A. Watson-Watt, [illegible] scientific adviser on telecommunications to the Air Ministry.

Associated with him in his experiments was Sir John Madsen, Professor of Electrical Engineering at Sydney University.

[illegible] radio location on an [illegible] in [illegible] 1935.

Working in the [illegible], a team of brilliant scientists helped [illegible] with his idea until [illegible] it was perfected.

Now British radio manufacturers are using all their resources to produce radio locators by mass production in ever-increasing numbers.

Call To Technicians

In a radio talk [illegible], the Minister of State [illegible] appealed to the Empire [illegible] for technicians to maintain the radio location [illegible].

[illegible] I am confident we will beat the enemy," he said.

"[illegible] front line of [illegible] battle for the future of the world.

[illegible] into [illegible] location.

[illegible] by means of [illegible].

The sky is [illegible].

[illegible]

RADIO "EYE"

SPOTS RAIDERS

BRITAIN'S SECRET [illegible]

Australian Associated Press

LONDON, Tuesday.

An astounding device which detects the approach of aircraft and ships and is given credit for helping to defeat the German aerial invasion of England last autumn, was described to British listeners to-night.

It is a system of radio location, and its discovery, development and application by scientists and serving officers make an enthralling story.

Air-Marshal Sir Philip Joubert said that the invention was so secret that even in the Services it was known only by three letters but with its use it was now virtually impossible for any raider to approach Britain without our knowing it.

Australia and New Zealand were already manufacturing the equipment and training men for its maintenance and repair, but it was so important to air, land and sea strategy that it came into being without the world knowing of it.

New To War

The idea was not new to science, but its application to war was new. The first man to apply it to the detection of planes was Mr. Robert Alexander Watson Watt, a scientific adviser at the Ministry of Aircraft Production, who had developed the system from meteorological methods.

It is learned that Sir John Percival Madsen, professor of electrical engineering at Sydney University, was associated with Robert Watt in development of radio-location.

Radio location was born in March, 1935, when Watt demonstrated it on an ancient lorry on a country road near Daventry. A team of brilliant scientists worked on it in secret until the middle of 1939 when radio location emerged as a system of sending out electric or other waves far beyond our shores.

"Sees" Through Fog

"Any solid object in the path of these waves, whether it is ship or plane, sent back a reflection to us, and the system was not affected by fog, cloud, or darkness, but kept watch 24 hours every day throughout the year," said Sir Philip Joubert.

"Radio location eliminates the need for continuous patrols by fighter aircraft and thus saves petrol, wear and tear of engines and an immense strain on pilots."

"It is continuous, rapid, and its organisation throughout the country calls for a staff of thousands, [illegible] and manufacture have [illegible] personnel.

[illegible] are constantly evolving [illegible] and the cleverest radio [illegible] are producing radio-[illegible] mass-production in ever-increasing quantities."

Continuation, see "Key to Beat Raiders," Page 2.

SCIENCE FIGHTS RAIDERS

From Page One

"We have mobilised every available qualified radio mechanic and [illegible] women, too, but we need immediately for the Army, Navy and Air Force [illegible] men and women, while our ultimate needs will be about double [illegible].

"The scientific facts which are the origin of radio-location are known to the world, and it can be supposed that the Germans have [illegible] applying it, but there is no positive evidence of that. Our air forces over Germany are still mainly due to sound [illegible].

"Millions have been spent on radio-locators, but the entire cost has already been saved. Its future potentialities are almost unlimited [illegible] when fully applied there need never be another shipwreck and air travel will be [illegible] safer."

Lord Beaverbrook also broadcast a reference to Britain's new weapon and appealed to all listeners throughout the Empire with technical knowledge to give aid to Britain, which needed many mechanics to repair and maintain the apparatus.

"It is radio," said Lord Beaverbrook, "which will destroy the enemy. It is radio which finds the enemy in the darkness, penetrates the clouds, sends the [illegible] fighter to the lurking bomber, and brings him to destruction.

"I call you radio enthusiasts to the front line of human knowledge. Bring your [illegible] your vision to battle for the [illegible] of the world."

A colleague in Sydney revealed to-day that Professor Madsen [illegible] a number of technicians from [illegible] Australian [illegible] to carry out the experiments.

The chairman of directors of Amalgamated Wireless [illegible] declared: "There is no difficulty in making the necessary apparatus, and we have the plant and technicians in Australia to carry out any necessary work."

"I think there will be [illegible] the disclosure that Australia had [illegible] to do with it [illegible] regarded as one of our most closely [illegible] secrets," said another authority.

"Several Australians have been [illegible] a lot of the work has been done at Sydney University."

[illegible]

OUR OWN CORRESPONDENT

NEW YORK, [illegible]

[illegible]

SECRET RADIO RESEARCH

Australia Collaborates With Britain

CANBERRA, Wednesday.

Radiophysical research, with devices of a secret nature, is being carried out in Australia in collaboration with Great Britain.

The Minister for [illegible] and [illegible] Mr. [illegible] [illegible] the Council for Scientific and Industrial [illegible] and the Director-General of Post[illegible].

[illegible] devices of a secret nature.

[illegible] Radio Research Board [illegible]

[illegible] carried out.

SECRET RADIO RESEARCH

Australia Collaborates With Britain

CANBERRA, Wednesday.

Radiophysical research, with devices of a secret nature, is being carried out in Australia in collaboration with Great Britain.

[illegible]

NEW YORK HERALD TRIBUNE

18.6.41

British Reveal Raid-Spotting Radio Secret

Device Warns of Enemy Planes Long Before They Reach Objective

Beaverbrook Asks Technicians to Help

Seeks Volunteers From U.S. and Canada; Attlee and Joubert Join in Plea

By Carey Longmire

From the Herald Tribune Bureau

LONDON, June 18 (Wednesday).—Clement R. Attlee, Lord Privy Seal, speaking in the House of Commons, and Air Marshal Sir Philip Joubert de la Ferte, at a press conference yesterday, revealed what some Britons have suspected but which has never before been officially admitted—that the Royal Air Force possesses a secret radio spotting device which operates amazingly in warning of enemy raiding planes long before they reach Great Britain's shores.

Attlee and Joubert, in an appeal addressed to Great Britain's dominions but plainly aimed at radio technicians in the United States as well, said Britain vitally needed thousands more radio men and women to maintain the radio locators and thus end the German bombings of British cities.

Beaverbrook Asks Volunteers

In a broadcast to Canada and the United States at 2:15 a. m. today Lord Beaverbrook, Canadian-born Minister of State, added his voice to the plan for the enlistment of radio technicians from overseas to assist the hard-pressed British forces radio locator experts. Joubert admitted earlier that the supply of trained British radio men was inadequate to meet the needs of the three British armed services.

"It is the scientists who will save our homes and guard our [illegible]," said Beaverbrook. "How [illegible] In the field of radio devices. These devices locate the enemy arriving by night with his weapons of destruction. [illegible] the radio [illegible] will destroy the enemy airplanes.

"So I appeal to you to come and help us. You the technicians, you who have experience of radio and electrical devices, you who have enthusiasm for wireless development. You will have the opportunity to promote the day of victory."

Attlee, Joubert and Beaverbrook [illegible]

Man, Device Operates

Robert Alexander Watson Watt, forty-nine-year-old British scientist, is chiefly responsible for the development of radio detectors, Joubert said. He is scientific adviser on telecommunications to the Ministry of Aircraft Production. The first experiments with the device were held in March, 1935, in a truck on a British country road, Joubert reported. The principle, he said, was simply that of sending out radio waves unaffected by weather "far beyond our shores." The interference of any strange object, such as an enemy plane, reflects back a signal which gives instant warning of attack and the direction from which the enemy planes are approaching.

Radio location makes it largely unnecessary to maintain great standing patrols, said the air marshal, who last week was named head of the R. A. F. Coastal Command. The locator thus was of "incalculable help" to Britain's sorely overworked fighters in the Battle of Britain last year, Joubert said.

Radio location is used by the Navy and Army as well, Joubert said. The Navy needed immediately 2,000 men and 3,000 women for the radio work; the R. A. F. 4,000 men and 5,000 women, and the Army 4,000 men and 2,000 women. There will also be a civilian force. Volunteers, he said, would get in on the ground floor of a field with great post-war possibilities.

(Continued on page 20, column 5)

British Reveal Raid-Spotting Radio Secret

(Continued from page one)

abilities." He added: "When radio location is fully applied, [illegible] and air navigation in peace there need never be another shipwreck, another Titanic disaster, while many causes of accidents to aircraft will be eliminated."

Best Kept Secret of War

LONDON, June 18 (Wednesday) [illegible] officially today [illegible] of the war with the announcement that radio location, a scientific device which warns of approaching [illegible] miles away, [illegible] against German raiders.

Air Chief Marshal Joubert said that for security reasons the operational methods of the weapon still were a close secret, but that radio location, which started as virtually new, [illegible] works like a [illegible] darkness and fog [illegible] [illegible]

[illegible]

[illegible]

Last fall [illegible] told [illegible] the government [illegible] dominions [illegible] problem of [illegible]

Radio location [illegible] has been [illegible] warfare.

Asked whether the Germans [illegible] knowledge [illegible] the efficiency of [illegible]

"There's no [illegible] that there's a great future in radio location [illegible]"

In [illegible] Lord Beaverbrook, Minister of State, [illegible]

New Military Science Seen

[illegible] according to the [illegible] Lord Beaverbrook.

"The development of the radio [illegible]"

[illegible]

"Credit [illegible] early [illegible] belongs to the Royal Air Force [illegible] Watson Watt, scientific adviser [illegible] to the Air Ministry; Dr. [illegible] of the Air Ministry Research [illegible], Sir Henry Tizard and [illegible] were the [illegible] on the scientific side.

"Backing their faith and vision on the service side in those early days were Lord Swinton, then Air Minister; Sir Cyril Newall, then Chief of the Air Staff; Sir Wilfred Freeman, Air Chief Marshal [illegible] and Air Marshal Sir Philip Joubert."

Appeal by Beaverbrook

Lord Beaverbrook, in a broadcast heard in New York last night by the National Broadcasting Company, said technical developments made progress in wartime, sometimes outstripped all that has gone before and added:

"Inevitably, the progress is made on the battlefront. It is the danger of defeat, the urgency of victory that sends men forward, striving to wrest from nature the secrets that are so hard to obtain, and of all these developments radio, in its many manifestations, takes first place.

"There the [illegible] is strongest, there the [illegible] is greatest. For it is in radio, I am convinced, that we shall find a way to spread the covering wings of science over the multitudes who inhabit our vast cities. It is the scientist who heals our wounds; it is the scientist who will

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protect us; it is the scientist who will save our homes and guard our hearthstones.

"How will they go about it? In the field of radio devices. These devices locate the enemy arriving by night with weapons of destruction. It is radio that will destroy the enemy airplanes. It is radio that finds the enemy in the darkness, that seeks them out through the clouds. Then the watchmen who control the air send the avenging fighters to meet the lurking bombers and bring our enemies to destruction. Fighter meets fighter. Again the watchman is on duty.

"So with a few thousand jewels the fighting power of Britain held the battlefront through the summer of last year. There was radio direction. A few thousand boys who went off to battle there every morning just after the sun had risen [illegible] to admiration and [illegible] I am free to [illegible] with me [illegible] heroes of [illegible] were [illegible] by the radio technicians.

"What can be said, then, in praise of [illegible] the men who [illegible] research, maintenance and [illegible] of radio direction, the direction which sustains the defending squadrons, the Hurricanes [illegible] the direction that gave the warning of the enemy's approach?

"In the New World [illegible] [illegible]

"But [illegible] radio [illegible] is never [illegible] not [illegible] by other devices. The sky is our [illegible] There we keep the [illegible] in the darkness [illegible] the watch [illegible] the presence of the enemy.

"Science has played [illegible] shabby tricks in the past. Now we see with a clear vision, with [illegible] understanding, the powerful benefits, the valuable gifts that radio bestows upon mankind [illegible] all this [illegible] of the war, what will [illegible] unfold for us? What new [illegible] flash? What new [illegible] and [illegible] the minds of all who [illegible] others may live?

"Are you moved by the opportunity? Then let me tell you.

Personnel Demands Growing

"Demands for personnel come to us from the Air Force, the Army and Navy. These [illegible] are always growing. The [illegible] are for men who [illegible] men who [illegible] the men who [illegible] that the technical equipment with which we battle [illegible]

"We have an [illegible] to [illegible] us. We want men of knowledge [illegible] of technical skill [illegible] to take part in the [illegible] and [illegible] of [illegible] I appeal to you [illegible] [illegible]

"Are you in [illegible] whether you have the knowledge and the [illegible] Then [illegible] our representatives all over the world. They have been [illegible] [illegible]

SCIENTISTS TO GO TO BRITAIN

MELBOURNE, Monday.

Several leading Australian [illegible] will [illegible] by the Federal Government [illegible] Australia may be kept [illegible] with [illegible] developments in Britain.

They will include a Director of [illegible] who will have [illegible] Defence [illegible] Admiralty, Army and R.A.F. [illegible]

[illegible] DEFENCE

MELBOURNE, Monday.

To keep Australia more in touch with scientific research on defence and other developments in Britain, the United States and Canada, several leading Australian [illegible] will [illegible] by the Commonwealth Government soon.

There will [illegible] a [illegible] of Scientific Research [illegible] with headquarters in London, and a team of [illegible] distinguished [illegible]. The names of the selected men will be announced soon.

[illegible] to-day, the Minister in Charge of [illegible] and Industrial Research (Mr. [illegible]) said it was proposed that the director would have access to defence service [illegible] in Britain. He would [illegible] to the Australian Army and Air Force [illegible] departments [illegible] in England.