SOME PERSONAL RECOLLECTIONS OF RUTHERFORD, THE MAN

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CHADWICK

It is unfortunate that Chadwick is not speaking at this session. Of all living men he knew Rutherford best, as a physicist and as a man.

Those who have read Chadwick’s paper ‘Some Personal Notes on the Search for the Neutron’, will know that he not only tells the story of great events succinctly and well, but tells it in beautiful prose.

Hence, first of all, I wish to read a few paragraphs from rough notes which Chadwick had prepared when planning what he would have said today, had his health allowed him to write a lecture and deliver it.

Ernest Rutherford was fortunate in his parents, for although they were poor in ready money, they were rich in personal integrity, and in the physical and mental welfare of their children. Ernest inherited from them their steadfast character and, above all, that fortunate combination of parental genes which endowed him with most unusual ability.

In fairly comprehensive notes on his association with Rutherford, Chadwick has written:

I entered the University of Manchester in October, 1908, when I was not quite 17. I had intended to read mathematics, in which I had shown some ability at school, but by some mischance, I found myself enrolled to study Honours Physics. Rutherford, was of course, a man beyond contact with First Year. Fortunately, it so happened that one of the staff who should have lectured to us on Electricity and Magnetism in our second year, took up a post in London, and Rutherford deputized for about a month while a new lecturer was appointed. This was more than 60 years ago, but I still remember the enthralling and stimulating experience of listening to Rutherford. He left it to us to read the books and the formal presentation of Electricity and Magnetism, but he filled in the background. From the purely teaching point of view he was perhaps not remarkable; but it was the first time in my course that I realized what physics was about.

In our third year we were given the alternatives of (1) some elementary
research, or (2) continuing a formal course on Electrical Engineering from its physical aspect. I chose (1) and was given a simple task by Rutherford himself. I was terrified of him... I think that he began with rather a poor opinion of me. But, as I lost my awe of him, his opinion began to improve. He recommended me for studentships or fellowships to allow me to continue in research. He must have made a strong recommendation to enable me to be awarded an 1851 Exhibition which enabled me to go to work under Geiger at the Physikalisch-Technische Reichsanstalt Charlottenburg, at the end of September, 1913. I became a civilian prisoner of war until the end of the 1914–1918 war.

On my return to England in December 1918, I naturally visited Rutherford as soon as I had recovered sufficiently. I found him engaged upon the artificial disintegration of nitrogen and other work. He told me about the nitrogen results and showed me the apparatus. He was full of good spirits.

As I had nothing in view, and was not fit to take up a regular position, even if I had been able to find one, Rutherford offered me a temporary job as part-time demonstrator in the elementary laboratories. This helped me greatly, providing a little money, which I needed, and time to recover.

A few weeks after his election to the Cavendish Chair, in April 1919, Rutherford suggested that I should go to Cambridge with him, to help in the transfer in the research work on radio-activity, etc. . . .

I was offered the Wolleston Studentship in Physics by Gonville and Caius College, of £120 a year, and entered as a Research Student in October 1919. When I got to Cambridge I was surprised to find that Rutherford had already put the Vienna radium into solution and had partly fitted up the radium room.

I was, of course, in the same position as other research students, but Rutherford put me in general charge of the radium room . . .

Rutherford discussed with me from time to time the work of the Laboratory and consulted me on some matters. For example: should the main work of the laboratory be on the properties and possible structure of the atomic nucleus? He sometimes said, and had said in public, that this should be left to the next generation, and said privately that he thought that he had done enough for one man. My reply was: 'Who is going to lead us, if not you who has shown the way and is our natural leader?' I realized, of course, that he had really made up his mind, and that he was perhaps feeling out what I thought. He began also to consult me, sometimes, about the admission of research students. I suggested about 6 to 8 students from the
Commonwealth. This had clearly been in his own mind, but he was quite pleased that I suggested it independently.

In 1921 I was elected a Fellow of Gonville and Caius College, I think largely because I was of some help to Rutherford . . .

Sir Wm. M'Cormick, Chairman of the Advisory Council of D.S.I.R., used to visit the Cavendish once or twice a year. I generally accompanied Rutherford when he took him round the laboratory.

Then in 1923 I believe, M'Cormick sought me out. He said that he thought Rutherford had too much to do, what with University duties, external lectures, rapid growth in number of research students, etc. Would I be willing to help Rutherford in looking after research students and research work? He suggested a position as Assistant Director of Research with a stipend of £500 which D.S.I.R. would provide—he would arrange matters with the University. I was naturally delighted. So this was fixed up . . .

I was the first Assistant Director of Research in the University. There are now many.

But the point of this story is that from this time I could not only relieve Rutherford of much tedious work, but I could, and did, have some say in the admission of research students . . . and also in the tasks which were assigned to them . . .

**Personal recollections**

I come now to my own part in today's celebrations. It will be largely a rambling account of some memories of Rutherford, without sequential order or rigid division into the many facets of the personality of one whom I loved as much as I revered for his greatness. For some there is no foundation but my own memory, which suffers from all the defects and omissions of that fickle record. From my arrival in Cambridge, accompanied by a young wife, the Rutherfords were extremely kind to us, and our relationship grew to have much of that between parents and children. We accompanied them on holidays, alone or together, and it was at these times of special privilege that we learnt much about them as human beings, and came to feel for them both a deep and abiding affection.

In appearance, Rutherford was more like a successful business man or dominion farmer than a scholar. Indeed, he reminded me strongly of the general storekeeper in a small country village in South Australia where I spent part of my childhood. When I knew him he was of massive build, had thinning fair hair, a moustache and a ruddy complexion. He wore loose, rather baggy
clothes, except on formal occasions. A little under six feet in height, he was noticeable, but by no means impressive. Indeed, in most ways he was a very ordinary man.

It seemed impossible for Rutherford to speak softly. His whisper could be heard all over a room, and in any company he dominated through the sheer volume and nature of his voice, which remained tinged with an antipodean flavour despite his many years in Canada and England. His laughter was equally formidable. He appreciated greatly an off-colour tale provided that it was humorous. I recall how he revelled in the many apocryphal stories about King Edward VIII and Mrs Simpson in the months before the abdication.

Rutherford was a singularly inspiring lecturer when speaking of his world of science, despite the frequent interpolation of Er! Er!, as he gathered his thoughts together. He so obviously cared deeply about his work, rousing his audiences to similar enthusiasm, and young physicists among them to emulation. He spoke of the particles emitted in radioactive transformations with the same pride and affection as a man speaks of his children—indeed, he had given them their names. He enjoyed the experimental demonstrations with which he illustrated his lectures, showing his pleasure as his audience clapped and his lecture assistant sighed with relief that the experiment had worked. As chairman of a meeting at which others spoke, Rutherford never displayed boredom or irritation, and would say a few words of kindness and encouragement to the young and inexperienced. His grasp of the essential points made by a speaker on a subject quite outside Rutherford’s own area of knowledge, was astonishing.

Rutherford disliked a discursive approach to a subject, whether in writing or in speech. He once remarked to me that no thesis submitted for a Ph.D. should exceed 80 to 90 pages, in which compass a research student should be able to convey all that was worth recording of what he or others had done and thought about his part of physics.

Two unusual habits of Rutherford are worthy of mention here. He appeared to possess no fountain pen. He wrote slowly and laboriously with an old-fashioned steel-nib pen, or more often with a short pencil. He carried in his waistcoat pocket several pieces of pencil, not more than two inches in length and often shorter, with very blunt points. When necessary, he fumbled for one of these, which he held in an awkward manner between thumb and forefinger. Sometimes the pencil was so blunt that the words or figures he produced were all but indecipherable. However, with such a pencil he did arithmetic rapidly and with surprising accuracy. Mumbling to himself, he would use what appeared to be gross approximations in order to reduce multiplication or division to simple addition and subtraction, remembering to correct the final result by
the necessary percentage. The answer he obtained was invariably within the overall accuracy of the experiment.

Rutherford smoked interminably, usually a pipe and only occasionally a cigar or cigarette. His pipe tobacco was reduced to tinder dryness by being spread on a piece of newspaper in front of the fire, or on a sheet of paper placed on top of a hot water radiator in his office or laboratory. When he lit his pipe it produced sparks and even flame, like a volcano. A result of this was that his waistcoat was peppered with small holes, and he often had to brush red hot grains of tobacco from the papers before him on the desk.

Rutherford read very widely and retained an enormous amount of the knowledge he gained in this way. While this reading was omnivorous in his younger days, towards the end of his life he preferred biography, not by any means confined to the lives of scientists. He learned much of notable men of the past. He knew surprising details of the life and work of the great experimental scientists, and of Captain Cook, the outstanding navigator who discovered New Zealand and Australia for Britain.

Whatever their interests, colour, creed or social standing, Rutherford enjoyed the company of his fellows. He would talk to anyone without any trace of either condescension or subservience in manner or words. He never forgot to thank personally the technicians who had assisted with a lecture he had given. He realized the difficulties of students who came from abroad, whether of language, of background in physics, or of fitting into a new and strange environment. He helped students who found themselves in financial difficulties, though sometimes repayment was long delayed. Lady Rutherford told me that he could never resist a personal appeal for funds in support of any charity, and that often she had to step in to prevent him from giving away far more than they could afford. His charity was always private.

Rutherford's goodwill extended to all mankind. He often discussed with me how the extreme poor of India or Africa could be helped, especially by the application of natural knowledge through science and technology. Both he and Lady Rutherford saw the necessity to limit the population, and particularly the rate of growth of population, to keep demand within the capacity of the world's resources, and this long before this problem was recognized generally. However, he continued to believe that there was much good in the colonial system, and much that the richer nations should contribute towards the betterment of the way of life of colonial peoples before they could govern themselves. We had many strong arguments about such questions, he accusing me of deriving all my ideas from the *New Statesman*—which was not so far from the truth in the years before the Second World War!
Education, Rutherford believed, should be directed to enabling a man to seek out and pursue goals which he set for himself. Completely happy in his own work, he did not believe that anyone, other than a man himself, could make the choice of work in which he would find satisfaction. He subscribed whole-heartedly to an opinion expressed by Bertrand Russell, that the world would be an infinitely pleasanter place if men would but learn to seek their own happiness, rather than the misery of others.

At home

The Rutherfords lived at Newnham Cottage, a low house in Queen’s Road with a fine old garden, which belonged to Caius College. It was encircled by a wall of dirty Cambridge brick. One entered through a heavy door, and walked along a covered, tiled way to the house itself. There was a very fine drawing room, dominated by a concert-size grand piano. This room looked over the garden in which Lady Rutherford took great pride. Rutherford’s study was to the left, immediately after entering the house. Like the desk, the room was littered with books and papers in a manner which I was taught at school meant an untidy mind. Occasionally, when it became too covered with such materials for any item to be identified without a prolonged search, Lady Rutherford would tidy it all up, arranging everything with meticulous care. It is largely owing to her efforts that Rutherford’s letters and papers were so carefully preserved.

Lady Rutherford had a short, dumpy figure, and many who met her found her aggressive and opinionated. Though she was apt to correct abruptly any lapse in pronunciation, especially of botanical terms, and to call every man ‘Mister’, regardless of his rank, her outward manner concealed a woman of great warmth of character, who was the helpmate of Rutherford in all that he did. She was very fond of her grandchildren when they had passed beyond the infant stage. Keenly interested in music, she played the piano well, and would listen after dinner to any concert of note from the B.B.C. However, after a few moments Rutherford would move to his study to work or to read. He did not have any appreciation of other than loud, martial music, to which he could stamp his feet or attempt to sing, considerably off key.

The garden at Newnham Cottage was Lady Rutherford’s continuing delight, but her gardening was subject to sudden changes of interest and enthusiasm. What gave her great pleasure in one season because of its flowers or foliage, would be thrown out ruthlessly next, because its autumn colouring was poor. During one autumn she devoted an enormous amount of her own
energy, and that of her younger friends, to establishing a rock garden, with almost every plant suitable for such a habitat. She then went off to New Zealand, returning one evening in the early spring. Promptly, she went to inspect the rock garden by the light of a torch. That was the end of her interest, which was transferred to the establishment of a new shrub which she had seen abroad.

I have vivid memories of being one of a small group of research students which cut a large branch from the fine old walnut tree which dominated lawn and garden. This was about twenty feet above the ground, and the ladder by which we reached it was none too stable. Lady Rutherford shouted directions, most of which we found necessary to ignore in the interests of our safety. When at last the large branch crashed to the ground, she was most upset because it did not fall exactly where she wished.

The Rutherfords occupied separate bedrooms, and there were no overt acts of affection between them. Yet they were devoted to one another. Lady Rutherford understood little or nothing of her husband’s work, but she was very proud of the honours which were showered upon him, and reacted violently to any criticism. She treated him in all ordinary matters as she would a child, still attempting to correct his faults when eating, for instance. I never heard him retort impatiently or angrily, as would most men when treated in that way. When, rarely, Rutherford caught a cold or influenza, she nursed him with loving care. Lady Rutherford’s concessions to the ills of the body were confined almost completely to periodic bouts of dieting to reduce her weight.

On holiday

When first I knew them, the Rutherfords had a holiday cottage in the Nant Gwynant valley of North Wales, on a hillside above and between the small lakes, Llyn Dinas and Llyn Gwynant. Its windows looked across the valley to the rugged, bare outline of Snowdon. In winter the valley was cold and lonely, the slopes covered with rocky outcrops and yellow-brown, frozen grass, and sometimes with snow, but there remained an unearthly beauty. In spring the grass sprouted green again, foxgloves of many colours flowered around the stone walls and screes, and lambs, strangely white beside their grimy mothers, appeared overnight. In summer the vale could be very hot, but the weather could change rapidly and rain was seldom far away.

The stone walls and floors of Celyn were always damp, and even in summer the bedclothes felt clammy. A good fireplace heated the large living room where Rutherford spent most of his time in cold or wet weather. He wore plus-fours and a cloth cap when out of doors. On a nice day he could be persuaded to
go for a walk, but he soon became hot and perspired freely. When he demanded a rest, and sat on a rock or wall, he was often breathless and irritable. Rutherford had absorbed much of the folk-lore of the valley. He knew a great deal of the history of the dying slate quarries, and was entranced by a narrow gauge railway track which ran through cuttings and tunnels above the road to Beddgelert.

He must have obtained such knowledge from reading, or discussion with the few local inhabitants, for he never walked far enough to find out for himself.

The Rutherfords' daughter, and only child, Eileen, who was married to Ralph Fowler, mathematician and theoretical physicist, died suddenly following childbirth, on 23 December 1930. Rutherford was greatly upset, and he lacked the support of his wife who was on a visit to New Zealand. For some years at this time, Miss Eileen de Renzi, a niece of Lady Rutherford, lived with them at Newnham Cottage, serving as secretary to Rutherford and companion to his wife. Early in the New Year of 1931, Rutherford, Miss de Renzi and I went to Celyn, where he submitted to attentions from Miss de Renzi and me which he would have brushed off at another time. It was singularly unfortunate that the blow of his daughter's death should coincide with Rutherford's elevation to the Peerage, but in some ways it was a blessing that the stream of congratulations was sent on to Celyn and dealt with by him. Many he answered at once, by hand, while others were kept till he returned to Cambridge. The honours which Rutherford received, and were his due, gave him great pleasure. Despite his sadness, this occasion was no exception, so that his voice reflected the proud acknowledgments of his friends as he read to us particular telegrams and letters. At that time, of course, elevation to the Peerage was rare among men of science.

The journey from Cambridge to Celyn was long and tedious, the hillside too steep for Lady Rutherford’s gardening recreation, walking too strenuous and Celyn too primitive and damp for ageing bones. So, in 1935, following several journeys of exploration, a spot was found on the Wiltshire Downs, where a cottage was built to Lady Rutherford’s specifications. It was in the corner of a large dairy farm, appropriately called ‘New Zealand’, near the tiny village of Upper Chute, not far from Andover. The few acres acquired covered a gently sloping area, the bottom part covered with old oaks, amidst which could be traced the outline of the foundations of a brick building, said locally to be the remains of an ancient chantry, or chapel endowed by its founder for the saying of masses for the repose of his soul. The bricks seemed to me to be too modern to have formed part of such a building, but the legend attracted Lady Rutherford, who called the new holiday home ‘Chantry Cottage’. The main accommodation was again a relatively large living room, with a fine brick fire-
place at one end. Wood for the fires came from the trees below, giving a cosy and homely atmosphere in an otherwise centrally heated house.

A settled pattern of life was soon established at Chantry Cottage. Breakfast, a simple meal, was at 8 a.m., at which time Rutherford was usually rather taciturn, though not ill-tempered. Consequently, there was little conversation, other than Lady Rutherford’s occasional admonition: ‘Ern, you’re dribbling’, or: ‘Ern, you’ve dropped marmalade down your jacket.’

Toast was made at the embers of a cheering fire of twigs and small wood. Breakfast over, Rutherford moved to a comfortable chair beside the fire, where he browsed in the Times and the Manchester Guardian, or read the mail which had been sent on from Cambridge. During this process he thawed, and soon we would become embroiled in an argument about the Prime Minister, Stanley Baldwin, whom he admired, in discussion of a letter from Niels Bohr, or of the book which he was reading. He read much about the history, archaeology and legend of the area, and spoke fascinatingly of the ancient pathways along the ridges, one of which passed close to the cottage, or of the British earth-work ‘forts’ not far away.

If it was reasonably fine, by Lady Rutherford’s standards, which were not always ours, she led us outside to ask advice about the development of her garden—advice which she invariably ignored—to dig holes, cut branches from trees, or shorten the growth of climbing roses. Although there was solid chalk beneath a very thin layer of topsoil, she insisted upon planting rhododendrons, which promptly yellowed and died. I had to plant water-loving species around a small pond among the trees, and since she demanded adequate root room, digging the holes in the foul-smelling, glue-like mud was not the best of tasks.

Later in the morning Rutherford and I would cut wood with a cross-cut saw, or chop up smaller stuff with axe and tomahawk. Each of us had been used to such tasks in our antipodean boyhood, so we got on well. He grunted as he sawed and, during frequent rests, he sat on a log and yarned about the past or the problems of the day. After lunch, Rutherford would doze before the fire, and later we might go for a walk or visit one of the neighbours. He liked to discuss farm management and policy with farmers in the district, or naval strategy with a retired petty officer who lived nearby.

Meals were cooked on a flimsy paraffin stove which was often my job to persuade to work. After dinner we sat near the fire, round the one paraffin lamp in the room, reading or talking, Lady Rutherford frequently finding some sewing or mending to do. Gossip ranged widely, Rutherford often reminiscing about events in which he had played the major role, about people he had known, or he would recall the latest scandal surrounding the royal interest in
Mrs Simpson. Rutherford revelled in pomp and ceremony, especially if he was at the centre, and spoke with boyish pleasure of all that had happened, Lady Rutherford intervening occasionally to put him right on dates or persons present. Such memories had nothing of boasting—they were expressions of great appreciation and pleasure.

It was to Chantry Cottage that the Rutherfords invited their friends, though all menfolk did not appreciate the tasks they were expected to perform. It brought them great happiness, and Rutherford returned to the Laboratory refreshed by an atmosphere not unlike that of his childhood and youth. To one who knew the completeness of his immersion in his work while in the laboratory, his ability to put it aside and relax utterly while on holiday seemed remarkable. Moreover, he urged his colleagues and students to do likewise, often telling one who was obviously tired to go off for a complete break.

I have heard it said that Lady Rutherford expected him to do too much in the garden there, and that this contributed to the strangulated hernia which led to his death. In my experience, he did nothing which he did not want to do, and I never saw him over-exert himself in the least. He puffed and blew at times, but he did this when he got up from his easy chair to put fresh wood on the fire!

Mother

Rutherford had a great love for his mother, to whom he wrote regularly until her death in 1935. It was clear from all that he said that she was the dominant parent so far as the children were concerned. She endeavoured to awaken in them an interest in literature and learning, and a recognition that success came only from hard work. Despite her great age, ninety-two years when she died, and his own maturity, Rutherford was upset greatly by her death, and for a time would sit immobile in deep reverie. He soon recovered, but never completely. He was to survive his mother by only two years.

Working with Rutherford

Following the work of Cockcroft and Walton, which showed that the light elements could be transformed by bombardment with protons of relatively low energy, Rutherford asked whether I would work with him in this field. Till then, my research in the Cavendish had been with low energy beams of positive ions, and Rutherford thought that this experience would enable me to change course rapidly.

Naturally, I accepted eagerly this opportunity and privilege. We decided not to duplicate the equipment of Cockcroft and Walton, but to aim for
greater intensity in a bombarding beam accelerated to lower energies, which should enable us to measure the energies of product particles from light elements with greater accuracy. The equipment was set up in the room next to that in which Rayleigh had determined the ohm, and where Rutherford and Chadwick had done most of their work on artificial disintegration with alpha-particles. With the enthusiastic and skilful help of Rutherford's technical assistant, George Crowe, the apparatus was assembled rapidly, using whatever bits and pieces were available in the laboratory, in the usual Cavendish manner. It often gave trouble. The resultant delays irritated Rutherford, but he remained singularly uninterested in finding the money with which to buy more reliable components. However, he was extremely pleased when things went well, giving us a triumphant feeling of something accomplished. At various times we were joined in this work by P. Harteck, A. E. Kempton, B. B. Kinsey and Miss R. Maasdorp.

Rutherford's participation in the experiments was limited to discussion of what to do next, and deep interest in the results. He gave us a completely free hand in the design of experiments and running of the equipment, but kept us on our toes all the time. Usually he came to see us twice each day, late in the morning and shortly before six o'clock in the evening. Sometimes, he would turn up at other times, uncannily aware that something interesting was happening. This was when things were almost bound to go wrong. With Rutherford looking over the operator's shoulder, impatiently awaiting the outcome of an observation, silly mistakes were apt to be made. On two occasions, Rutherford pushed something through the thin mica window through which the products of transformations emerged, creating panic as air flowed into the vacuum and we rushed to shut off and cool down the oil diffusion pumps. He apologized profusely, but disappeared for days while we cleaned up and got going again.

If Rutherford appeared just at the end of a run, he insisted that the record be developed as rapidly as possible, barely allowed it to be dipped in the fixing bath, and sat at the table in the next room, dripping fixing solution upon our papers and his own clothes, as he examined the tracing. His pipe dribbled ash all over the wet and sticky photographic paper. He damaged it irreparably with the stump of a pencil from his pocket, with which he attempted to mark the soft, messy material. Searching impatiently for the interesting parts of the long record, he pulled it from the coil in Crowe's hands to fall to the dirty stone floor, trampling on it as he got up in the end. We had then to do our best to finish fixing, washing and drying the paper strips, often damaged beyond repair. When it was possible, we concealed records from him till they had been properly processed and measured up by us, but this was impossible when he
was present while the record was being taken. Once, at the end of a particularly heavy day, when the experiments had gone well, we decided to postpone development till next morning when we were fresh and we could handle the long strip in new developer and fixer without damage. Just as we were leaving Rutherford came in. He became extremely angry when he heard what we had decided, and insisted that we develop the film at once. 'I can't understand it', he thundered. 'Here you have exciting results and you are too damned lazy to look at them tonight.'

We did our best, but the developer was almost exhausted, and the fixing bath yellowed with use. The result was a messy record which even Rutherford could not interpret. In the end, he went off, muttering to himself that he did not know why he was blessed with such a group of incompetent colleagues. After dinner that night, he telephoned me at home: 'Er! Er! Is that you Oliphant? I'm er, er, sorry to have been so bad tempered tonight. Would you call in to see me at Newnham Cottage as you go to the Laboratory in the morning?'

Next day he was even more contrite: 'Mary says I've ruined my suit. Did you manage to salvage the record?'

He drove us mercilessly, but we loved him for it.

In 1933, G. N. Lewis, from Berkeley, visited the Cavendish and presented Rutherford with about half a gram of almost pure heavy water which he had concentrated electrolytically. We made arrangements to recover a small volume of deuterium gas produced from this, after it had passed through the apparatus, and to purify it for re-use. A small portion of the heavy water was converted, by ion exchange, into a solid salt which was spread on our target. Immediately, we obtained exciting results when a beam of deuterium ions fell on this deuterium containing target, even at very low energies. There was a copious emission of two groups of particles which we identified as long range protons and short range tritium ions which originated in the same process and therefore escaped in pairs opposite one another. It was impressive to experience Rutherford's enthusiasm and the approximate arithmetic by which he calculated the range-energy relationship of tritium nuclei from the known range-energy curves for alpha-particles and protons. We were able to show, by passing the particles through a magnetic and an electric field at right angles, that both particles had the same momentum, and we obtained a value for the mass of tritium very close to that now accepted. We showed also that there was a copious emission of neutrons, using a helium ionization counting chamber at high pressure. I managed, with Crowe's help, to split a piece of mica of uniform thickness, and stopping power equivalent to only 1.5 millimetres of air, to cover the window on our equipment. We at once observed an emission of particles
which clearly carried a double charge and appeared to be alpha-particles, in numbers equal to that of the protons or tritons. The equality of fluxes suggested strongly that all three particles originated in the same nuclear process. Rutherford produced hypothesis after hypothesis, covering reams of paper with abortive arithmetic, and finally we went home to think about it.

I went all over the afternoon’s work again, telephoned Cockcroft who had no new ideas to offer, and went to bed tired out. At 3 a.m., the telephone rang. Fearing bad news, for a call at that time is always ominous, my wife, who wakens instantly, answered it and came back to tell me that ‘the Professor’ wanted to speak to me. Still drugged with sleep, I heard an apologetic voice express sorrow for wakening me, then excitedly say: ‘I’ve got it. Those short-range particles are helium of mass three.’

Shocked into attention, I asked on what possible grounds could he conclude that this was so, as no combination of twice two could give two particles of mass three and one of mass unity. Rutherford roared: ‘Reasons! Reasons! I feel it in my water!’

He then told me that he believed the helium particle of mass 3 to be the companion of a neutron, produced in an alternative reaction which just happened to occur with the same probability as the reaction producing protons and tritons. I went back to bed, but not to sleep. I called in to see Rutherford at Newnham Cottage after breakfast, and went through his approximate calculations with him. We agreed that the way to clinch the conclusion was to measure, as accurately as we could, the range of the doubly charged group of particles, and the energy of the neutrons. I went through our records from the helium pressure chamber, measuring the amplitudes of the most energetic of the helium recoils, and obtaining a maximum neutron energy of about 2 million electron-volts, while my colleagues estimated more accurately the range of the short group. Of course, Rutherford was right. By the end of the morning we had satisfied ourselves that an alternative reaction of two deuterons, produced a neutron and a helium particle of mass 3, the energy released being close to that in the other reaction. The mass of helium three worked out to be a little less than that of tritium.

We all shared Rutherford’s excitement. We had found two new isotopes and measured their masses, and we understood the remarkable deuterium reactions. That evening, I wrote a note describing our work. This was pencilled all over by Rutherford in the morning, retyped and sent off to Nature. Only in the war was I to experience such a hectic few days of work, but at no other time have I felt the same sense of accomplishment or such comradeship as Rutherford radiated that day.
We were running very short of deuterium by this time, so I cabled Cockcroft, who was on a visit to America, suggesting that he try to obtain a further supply from G. N. Lewis. Lewis kindly let him have two gallons of water with 2% concentration of deuterium, for $10. On his return to England he had some trouble in persuading the customs that the cans did indeed contain water! When he asked for a refund of the $10, Rutherford was angry and told him that he should not have spent the money without permission! Harteck concentrated the deuterium further by electrolysis and was able to provide enough deuterium for all users until heavy water became available commercially from Norway.

Each year Rutherford gave one or more of the Friday Evening Discourses at the Royal Institution, and I assisted in the preparation of experimental demonstrations. For his lecture in 1934, Rutherford decided to talk about artificial disintegration, and asked me to help. Crowe, made a model of our apparatus for exhibition on the lecture bench. Crowe and I decided to try to make an actual demonstration of the deuterium reactions. After all, if it was not successful as a working model, it would do very well as a demonstration of the kind of equipment we used. I borrowed transformers, rectifiers and some capacitors from an X-ray manufacturing firm in London, so that we did not need to cart up the heavier items, and we set the whole up on the bench. It was touch and go whether we could get it adjusted and operating before the lecture. In case something went wrong, Crowe had a small radioactive source ready to make the counters operate at the right moment—he was an adept at this kind of innocent deception. However, all went well, and Rutherford was able to demonstrate the actual transformation of deuterons by deuterons to the audience which filled the ancient lecture room. Everyone was delighted, Rutherford most of all. The canal-ray tube glowed, the high voltage sizzled, and the loud speaker connected with the counter and amplifier thundered with rapidly increasing speed as the voltage was raised.

D.S.I.R.

For seven years, until his death, Rutherford was Chairman of the Advisory Council of the Department of Scientific and Industrial Research. I often met him at the railway station in Cambridge after a trip to London, and drove him to Newnham Cottage, sometimes in the evening following a meeting of that Council. He always had something to say about the work of the day. On one occasion, if I remember rightly in 1931, he was very quiet when he got into the car, and when I asked whether the day had gone well, he said that he was worried because members of Council had again attacked him for not relating
the work of the Cavendish more closely to the industrial needs of the nation. Moreover, he had been accused of producing research workers who were of little or no use when faced with ‘real’ problems. On a later such occasion, in about 1935, when he thought that any misgivings should have been laid to rest through Chadwick’s discovery of the neutron and Cockcroft and Walton’s demonstration of transformations produced by artificially accelerated particles, he said: ‘They have been at me again, implying that I am misusing gifted young men in the Cavendish to transform them into scientists chasing useless knowledge.’

Rutherford’s spirits soon recovered. He realized, more than most, the importance of the application of scientific knowledge if Britain was to prosper, but he remained convinced that one of the best training grounds for physicists was the sort of fundamental science pursued in the Cavendish. His faith was demonstrated dramatically after his death, when the needs of war found almost all the men whom he had trained leading such practical developments as radar, atomic energy, and operational research.

I remember accompanying Rutherford on a visit to the Forest Products Research Laboratory, at Princes Risborough. He showed an eager interest in all that was going on, though it was all far removed from his own field of work. He asked penetrating questions about the darkening of timber from oak trees which was produced by a fungus, the fruit of which appeared as a very large shell-like growth from the bark, known as the beefsteak fungus. An apparatus for determining the relative wearing qualities of different timbers for heavy duty flooring, in which feet were imitated by swivelling lasts, soled with brake-lining material, which shuffled for ever across a floor which was a mosaic of many timbers, fascinated Rutherford as ingenious and bound to give valuable answers. He sat and talked with the youngest of research workers as he did in the Cavendish, as eager to learn from them, as they were to hear what he had to say. Remembering the rape of the magnificent timber stands in his native New Zealand he was keen to know what steps were being taken to ensure continuity of supplies of desirable species, especially those grown in Britain. He questioned all workers about their links with industry and with the fundamental biology, chemistry and physics which were the base of their activities.

Science and Society

Rutherford was much concerned about the results of the application of knowledge of Nature in industry and technology. For some reason he liked to discuss this question with me, making gentle fun of what he termed my
'Shavian ideas'. However, in his Norman Lockyer Lecture for 1936, he chose to speak on 'Science and Development'. He stressed the difficulty of knowing what technological changes could come about as a result of any scientific discovery. He observed that scientific advances were as much dependent upon new instruments and techniques developed by industry as was modern technology upon advances in science. Towards the end of the lecture he remarked:

For this reason, it would seem to me desirable for the Government to set up what I may call a 'Prevision Committee' of an advisory nature. The function of this Committee, which would be composed of representatives of business, industry and science, would be to form an estimate of the trend of industry as a whole and the probable effects on our main industries of new ideas and inventions as they arose, and to advise whether any form of control was likely to prove necessary in the public interest. A competent committee of this kind could no doubt have foreseen the coming competition between motor and railway transport, which had such serious effects on the latter, and have advised the Government as to the need of adjustment of competing claims before the difficulties became acute. While all will agree that industry should be alert to take prompt advantage of new methods made possible by the advance of Science, yet it may be important in the public interest to graduate the rate of change to prevent too serious dislocations in the social order. A Committee of this kind would have a difficult and responsible task, but could not fail to be helpful to the Government in advising it of the trend of change for industry in general and to inform it of possible dislocations of industrial life which may suddenly arise from the impact of scientific discovery.

With some slight changes of emphasis these words are even more applicable to the situation today. The advent of nuclear energy, which arose from Rutherford’s own work, and of the computer and automation, is producing profound changes in the relations between science and technology and the society in which they exist. Serious problems face the world, nationally and internationally. It is to be regretted that Rutherford’s wisdom is not available to help find solutions.

The end

Rutherford suffered from a slight hernia at the umbilicus, for which he wore a truss harness. Normally, it did not appear to worry him. He spent most of September, 1937, at Chantry Cottage, where he was his usual relaxed and cheerful self. He had been preparing the Presidential Address which he was to give
to a joint gathering of the Indian Science Congress and the British Association for the Advancement of Science, and had done much reading of material of significance for the occasion. He looked forward to the gathering, for not only would he meet many former students, he would have the opportunity to encourage the pursuit of science in another part of the British Commonwealth of Nations, in which he believed implicitly. As usual, the address was prepared with great care and attention to detail.

What followed is best told by Lady Rutherford, in a letter written from the Evelyn Nursing Home in Trumpington Street, Cambridge, in the late afternoon of Tuesday, 19 October 1937:

My dear Mark,

You will have heard from someone of my husband’s illness. He was seedy—indigestion—on Thursday, doctor next morning, operated that night, Friday, for strangulated hernia. There was no gangrene and they were very pleased, some paralysis of the gut which they thought was got rid of. On Sat. as well as cd. be expected. On Sunday vomiting all day showed there was serious mischief. That night washed our stomach and put permanent tube in by the mouth to keep siphoning all the time. Since yesterday morning he’s had intravenous injection of saline going all the time. Yesterday morning Nourse* and Prof. Ryle, Regius Professor who has been consulting several times a day, decided to get the surgeon down again for a second operation. He is Sir Thos. Dunhill and absolutely first class and charming—a Melbourne man by the way. He talked it over last night after examining Ernest and decided it was no use to operate and practically said that nothing could be done, age etc. were factors. This morning the other two said the same. Today however at 4 p.m. Nourse said he couldn’t see that he was any worse than at 8 a.m. and today he has retained a few oz. more than he has expelled and he has had 6 pints by the vein since 1 p.m. yesterday. He is a wonderful patient and bears his discomforts splendidly, so tired and weary of these interminable days.

There is just a thread of hope!

Love to Rosie.

Yours affectionately,

MARY RUTHERFORD.

Dunhill was Ryle’s choice, an old friend. Great opinion of his diagnosis as well as his surgery.

Rutherford died peacefully that evening.

* Dr. Nourse was the family physician.