Lord Rutherford of Nelson, His 1908 Nobel Prize in Chemistry, and Why He Didn't Get a Second Prize

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Abstract. "I have dealt with many different transformations with various periods of time, but the quickest that I have met was my own transformation in one moment from a physicist to a chemist."

Ernest Rutherford (Nobel Banquet, 1908)

This article is about how Ernest Rutherford (1871-1937) got the 1908 Nobel Prize in Chemistry and why he did not get a second Prize for his subsequent outstanding discoveries in physics, specially the discovery of the atomic nucleus and the proton. Who were those who nominated him and who did he nominate for the Nobel Prizes?

In order to put the Prize issue into its proper context, I will briefly describe Rutherford's whereabouts.

Rutherford, an exceptionally gifted scientist who revolutionized chemistry and physics, was moulded in the finest classical tradition. What were his opinions on some scientific issues such as Einstein's photon, uncertainty relations and the future prospects for atomic energy? What would he have said about the "Theory of Everything"?

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1. Introduction

I feel as if I am experiencing "magic" — being here in Christchurch at the 100th anniversary of Rutherford's Nobel Prize in Chemistry. This year, Rutherford is "$1/\alpha$ years old," and α was indeed his scientific sweetheart. Christchurch is his university town and the place where he met his lifelong sweetheart, Mary Newton. He was very devoted to his university, even though he couldn't visit it so often. New Zealand is far, very far. It has taken me more than 24 hours to get here. In his day, it was not a question of a day or two but weeks to get here from Europe! "Within an hour or so of his death he said to his wife: 'I want to leave a hundred pounds to Nelson College. You can see to it'", and again loudly: "Remember, a hundred to Nelson College." He hardly spoke after that, and on Tuesday evening, 19 October, he died peacefully" [1].

I have always been fascinated by Rutherford. He came from a poor scientific environment and yet rose to occupy "the highest position in the British Empire" [2]. A self-made man, and not just a product of a flourishing environment. An exceptionally impressive physicist — detector constructer, experimentalist, theorist and Nobel Laureate in Chemistry.

2. "Humble Beginnings"

Rutherford's birthplace, near the city of Nelson, is a tourist attraction in New Zealand. There is a small statue there of a schoolboy, and an inscription at the site that reads:

"This site is a tribute to one who rose from humble beginnings in rural New Zealand to world eminence. It is also to show New Zealand children that they too can aspire to great heights."

This is of course true not only for children from New Zealand but for all children, provided there are mechanisms to give them a chance to "rise to world eminence".

In Rutherford's family, there were Mom and Dad plus seven sons and five daughters. The living conditions were modest. However "our" Rutherford was exceptionally talented. "Although mathematics was his strong subject, he had no difficulty in obtaining scholarships and prizes for Latin, French, English literature, history, physics and chemistry"[1]. Not only was he good in calculating (remember his scattering formula), but was also excellent in inventing and constructing apparatuses. This ability was essential for his success as an experimentalist.

It was fortunate that Rutherford got a chance, through prizes and scholarships, to pursue an academic career. There were scholarships to bring "able young men" to British Universities, and Rutherford was granted such an award. When his mother came to tell him of his good fortune, he was digging potatoes. He flung away his spade with a laugh, exclaiming: "That's the last potato I'll dig."

3. A Rising Star in Cambridge (1895-1898) and His α's

In October 1895, we find the 24-year-old Rutherford in Cambridge, England. He is welcomed to the Cavendish Laboratory by its leader, Joseph John Thomson (1856-1940). Thomson, who later received the 1906 Nobel Prize in Physics, is generally called J.J. Herein, I shall take the liberty of doing likewise.

Rutherford's exceptional talents are quickly recognized, and he becomes somewhat famous in Cambridge. He is invited to give talks at several distinguished gatherings, even at the Royal Society. He demonstrates his magnetic detector for sensing electrical waves at what were (by the standards of the time) large distances. In his letters to his future wife, he reports on his successful presentation: "No one but myself made any remarks, as it was rather beyond most of them". His success continues, as he notes "My blushing honours are lying thick upon me."

Rutherford is much more interested in basic science than in industrial applications and taking patents. Therefore, after the discovery of the Röntgen rays, called X-rays in the English-speaking world, Rutherford changes his research orientation and starts working with J.J., as he explains in a letter to his mom in July 1896:

"I have been working pretty steadily with Professor J. J. Thomson on the X-rays and find it pretty interesting ...

The method is very simple. A little bulb is exhausted of air and an electrical discharge sent through. The bulb then lights up and looks of a greenish colour. The X-rays are given off ... Aluminium allows the rays to go through easily ..."

This is typical of Rutherford. His letters to his mom and wife are often full of information on scientific issues. He often congratulates himself; for example, in 1896 he writes to his future wife:

"...I am working very hard in the Lab. and have got on what seems to me a very promising line — very original needless to say. I have some very big ideas which I hope to try and these, if successful, would be making of me. Don't be surprised if you see a cable some morning that yours truly has discovered half-a-dozen new elements, for such is the direction my work is taking."

If you think Rutherford is bragging too much, you should keep in mind that such comments are a source of enormous joy to a mother and a sweetheart. Rutherford often informs his mother of his financial successes and sends her copies of his diplomas. Again, a mother who has had to feed many mouths appreciates that sort of thing. In fact, his letters to colleagues have a different style. What the letters have in common is that they frequently convey his enormous self-confidence, enthusiasm and dedication to his work, expressed in a custom-tailored language for the receiver. His letters reveal him as a man with a great deal of social awareness as well, far from the sterotype of the absent-minded professor. He cares about people and has an eye for details. He reports, sometimes in detail, how people look or behave, the color and style of ladies' dresses, etc.

What Rutherford discovers in Cambridge is that X-rays make ions. By charge separation, he discovers that there are two kinds of rays, which he calls alpha rays and beta rays, and embarks on closer studies of their properties, especially the lesser-known and more-energetic alpha rays.

Getting a good permanent job in academia is difficult even for a person of Rutherford's calibre. Rutherford, as he writes in several of his letters, is not interested in going to a science's barren soil and starting to build research facilities. He is a man of action working in an exploding new area of research – radioactivity – a field of international knife-sharp competition that attracts leading scientists. He can't afford to waste any time.

4. At McGill (1898-1907) and the Transmutation of Elements

Late in 1898, Rutherford, at the age of 27, becomes Macdonald Professor of Physics at McGill University, Montreal, Canada. He considers himself, as he states in a letter to his mom,

"extraordinarily lucky to start so well, for not 1 man in 10,000 ever gets the opportunity ...".

The working conditions at McGill are fine, thanks to very generous donations by a philanthropist, Sir William C. Macdonald (1831 - 1917), who years later remarked that all his expenditure was fully justified by Rutherford's results alone.

At McGill, Rutherford is the successor of a famous man who had decided to return to England, and who according to Rutherford, "was considered a universal genius" by the locals. (I have seen that this gentleman later received three nomination to the Nobel Prize in Physics.) There is a general unhappiness about his departure. When a scientist laments about how sorry they all are to have lost him, J.J. declares "I don't see why you should be, you got a better man anyway."

Rutherford's work at McGill is outstanding. His sensational finding is that atoms are not necessarily eternal; they can transform into one another: transmutation of elements. He proposes the "genealogical tree" of the uranium family where he even has to postulate the existence of a yet unseen intermediate state in the chain. This is no less than a revolutionary idea.

The great authority of the time, William Thomson (Lord Kelvin, 1824-1907), and his co-writer, Peter Tait, had reported that:

"the inhabitants of the earth cannot continue to enjoy the light and heat essential to their life for many million years longer, unless sources now unknown to us are prepared in the great storehouse of creation".

Rutherford applies his findings in radioactivity and discovers that the sun will shine much longer. He writes to his wife,

"My attendance keeps up steadily and all sorts of people turn up to hear them. In my lecture tomorrow I am expecting a large audience as I am dealing with questions of the effect of radioactivity on the age of the sun and earth ... I have had a round of visits during the week – dinner, lunches, teas...."

He is now a Celebrity. He makes headlines in the newspapers, such as "Doomsday postponed". There is a great deal of demand on his time. He is frequently the guest of honour at important events, gets prizes and medals, is elected into distinguished societies, such as the Royal Society, and is offered “a year’s salary for 10 lectures” to be given at Yale and so on. He makes his Mom happy by writing to her:

“If you get the August number of Harper Magazine you will see a photo of my noble self....”

Having been informed that the 1904 Nobel Prizes in Physics and Chemistry have been awarded to John W. Strutt (Lord Rayleigh) and William Ramsay, he writes in a letter to his wife:

“I think they are a very good selection. I may have a chance if I keep going, in another 10 years, as there are a good many prominent physicists like J.J. and others to have their turn of spending the money. It is just as well too that I have got something worth having to look forward to ...”

Rutherford hardly ever made any errors. Here he makes two at one swish! It took only 4 years, not 10, and it wasn’t physics but chemistry.

5. Nominations to Nobel Prizes in Physics and Chemistry

In order to be eligible for a Nobel Prize in physics or chemistry, the candidate must have been nominated for the year in question. All that is required is just one valid nomination, i.e., a nomination by a person who has been invited to nominate.

Rutherford is nominated to the Prize in 1907 and 1908. In 1907, he has 7 nominations to the Physics Prize and one to the Chemistry Prize. In 1908, he receives 5 nominations in Physics and 3 in Chemistry. This amounts to a total of 16 nominations for the 2 years 1907 and 1908. 13 of these 16 nominations come from Germany, 2 from Sweden and 1 from Canada. His nominators for the Physics Prize in 1907 are:

- Adolf von Baeyer (1905 NLC)
- Hermann Ebert
- Vincenz Czerny
- Emil Fischer (1902 NLC)
- Philipp Lenard (1905 NLP)
- Max Planck (later 1918 NLP)
- Emil Warburg

NLC/NLP stand for Nobel Laureate in Chemistry/Physics. All of these nominations come from Germany and are written in German. His nominator to the Chemistry Prize is Svante Arrhenius, Sweden (see Appendix B at the end of this article). In 1908, his nominators to Physics Prize are:

◦ Arrhenius, ◦ John Cox, ◦ Lenard, ◦ Planck, ◦ Warburg.

The only “newcomer”, Cox, is a professor at McGill.

He is nominated to the 1908 Chemistry Prize by

◦ Arrhenius, ◦ Oskar Widman, ◦ Rudolf Wegscheider

the first two from Sweden and the latter from Austria.

Most of the above nominations are short letters of a few lines. Some of the nominators attach a list of references, but others take it for granted that Stockholm knows Rutherford’s work. They state that he deserves the Prize for his work on radioactivity. Let me give a few examples. Lenard writes that he would like to nominate Rutherford for his work on radioactivity and (my translation):

“especially for the first proof of the chemical transformation of an element/the radium/ Phil. Mag. Nov. 1904.”

Planck nominates him for his experiments and research on radioactivity and adds (my translation)

"for having to some extent swept away the blanket of darkness that still enwraps the nature of these processes."

Wegscheider, from Vienna, writes (my translation):

"This Rutherfordian idea is of such importance to chemistry that I have no problem with recommending him to the Chemistry Prize, even though he is a physicist."

The longest nomination letter comes from John Cox at McGill, and is dated February 8, 1907. The letter arrives after the deadline (January 31, 1907) and therefore is not valid for 1907, but is saved as a nomination for 1908. Cox writes:

"Gentlemen,

In response to the invitation which I had the honour to receive from you to propose a candidate for the Nobel Prize in Physics for the year 1907, I beg leave to suggest the name of my colleague Professor Ernest Rutherford, one of the Macdonald Professors of Physics in McGill University.

I regret that I did not observe with sufficient care at the time that such proposals should be made before February 1st. But it is almost certain that Professor Rutherford's name will have been brought before you from other quarters; so that I deem it well to forward herewith a partial list of his scientific work, which may help to support other proposals even if this one should be excluded by the date.

Professor Rutherford is leaving us in the autumn to occupy the chair of Physics in the Victoria University, Manchester, England. It would indeed be a satisfaction to his friends here, if he should receive so great an honour while still a member of the University where during nine years he has completed so many researches.

I have the honour to be, Gentlemen, with the highest respect,

Obediently Yours
John Cox
Macdonald Professor of Physics and Director of the Macdonald Physics Building."

John Cox, who is 20 years older than Rutherford, had been one of the two "head-hunters" who had interviewed Rutherford for the professorship at McGill. Eve tells us that Cox, before Rutherford's arrival, had remarked to him that he was feeling rather dispirited because there seemed nothing new going on in Physics. The main things, he said, had all been found out, and the work which remained was to carry on a great number of experiments and researches into relatively minor matters. When Rutherford got going, Cox was ready and glad to sing another tune. Cox is now a loyal supporter of Rutherford. The scientists at McGill are worried that Rutherford's revolutionary ideas about the transmutation of elements might turn out to be wrong and bring discredit on the University. Cox, the Director of Physics, rises to defend Rutherford and predicts that "some day Rutherford's experimental work would be rated as the greatest since Faraday ..." [1]

Returning to the nominations to the Chemistry Prize, the one by Oskar Widman differs from the others as he proposes that Rutherford should share the Prize with his former research student (postdoc in modern terminology), Fredrick Soddy, while all the other nominators opt for an undivided award to Rutherford. (Widman was a member of the Nobel Committee for Chemistry during 1900-1928. We will meet him again in the next section.)

You may wonder about J.J., who had always been very supportive of Rutherford. Why doesn't he nominate his great student? Actually, he does, by submitting a nomination in 1908, which, however, arrives too late and is therefore invalid for that year, but is saved for the 1909

Prize. By then, however, Rutherford has received the 1908 Prize, thus making J.J.'s nomination invalid! The rules did not allow the nomination of a person who had received the Prize within the previous two years! Thus Rutherford had no nominations from England or France, where his work was very well known and where there were qualified nominators, among them several Nobel Laureates.

6. Deliberations on the Nobel Prize to Rutherford

Rutherford is nominated for his work on radioactivity, the essential issue being the decay of radium. The Nobel Committee for Physics, in its 1907 report to the Academy, brushes him aside quickly by stating:

"...his observation of the decay of a chemical element (radium) should be awarded with the Chemistry Prize rather than the Physics Nobel Prize. Therefore, we deem we should not suggest him as a recipient of this year's Nobel Prize in Physics."

In other words, radium is a chemical element and that's chemistry. This matter is not trivial. The 1904 Nobel Prizes in Physics and Chemistry were awarded respectively to John William Strutt (Lord Rayleigh) and William Ramsay. Both of them received the Prize for the discovery of chemical elements. Strutt was a physicist and Ramsay a physical chemist.

The Nobel Committee for Chemistry, in its 1907 report to the Academy, states that:

"Rutherford has been nominated for his studies of radioactivity, by seven nominators to the Physics Prize and by one nominator to the Chemistry Prize. This is understandable, taking into account that Rutherford uses physical methods while the results, so far as they are concerned with chemical elements, must be considered to be of fundamental importance also for chemistry."

The Committee then opts for a wait-and-see strategy.

In 1908 the Nobel Committees for Physics and Chemistry meet and decide that Rutherford's work is more relevant to chemistry than to physics. Svante Arrhenius (see Appendix A) is worried that Rutherford might actually fall between two stools at the Academy's plenum, where the final decision is made. There, the objection could be raised that he is not a chemist, and the physicists have already opted for someone else. He writes to the Academy proposing that "if the Academy should decide that it is not appropriate to give him the Chemistry Prize, he should be awarded the 1908 Physics Prize".

Contrary to the Physics Committee, the Chemistry Committee takes Rutherford's candidacy very seriously. Their report to the Academy contains about 15 pages on him! Here Rutherford's competitors are the almost-40-years-older Sir William Crookes (1832-1919) and, to a lesser extent, Rutherford's former research student, Fredrick Soddy (1877-1956).

Crookes, who is nominated primarily for his life-work by William Ramsay and Silvanus Phillips Thompson, is a remarkable scientist. He has discovered thallium in 1861 and electrons (cathode rays) in the second half of the 1870s, using discharge tubes. The Committee prefers recent discoveries. Therefore, Crookes' recent discovery of uranium-X in 1900 is considered to be the most relevant one.

Soddy has worked with Rutherford at McGill, 1900-1902, and has written a number of seminal papers with him. As mentioned before, he has been nominated "internally" by Committee member Widman to share the Prize with Rutherford.

The central issue, in the case of the 1908 Prize, is "emanation", i.e., a chemical element giving birth to something else. The Chemistry Committee's report on Rutherford is much too long to be reproduced in this paper. Therefore, I will only give a few excerpts from it, marked by bullets below. The Committee says: (again my translation):

• Rutherford's publication of the discovery of thorium emanation predates that of Crookes' discovery of uranium-X.

(Here, I should add that this statement is not quite correct.)

• Rutherford has done both experimental and theoretical work.

• His experimental work concerns the study of transformation of radioactive elements and the genetic relationships between them.

• Rutherford's theoretical work contains the formulation and development of the so-called decay hypothesis, for describing the transformation of elements and deducing the laws that govern them.

• Rutherford has found the most exact method to compare the intensity of the emitted radiation, whereby radiation phenomena can be studied quantitatively.

• It is due to his work in 1899 that the radiation emitted by radioactive materials could be classified into the categories which he has called alpha rays and beta rays. In addition, he has called the radiation discovered in the following year, by Villard, gamma rays.

• Alpha rays were less known than beta rays until Rutherford discovered their vital role in radioactive phenomena, and found that they carry the largest portion of the emitted energy in the form of ionising rays, much more so than beta rays.

• He has shown that alpha rays are deflected by both electric and magnetic fields, and that they are positively charged. He has proposed that alphas are doubly-charged helium atoms.

• Rutherford has insisted on the material nature of the emanation process, and has done experiments to verify his hypothesis.

Here I would like to add a short aside, as the latter point was a matter of much dispute. As an example, one of the greatest authorities of the time, William Thomson (Lord Kelvin), declared that radium receives its energy by absorption of ethereal waves. You may have read in your textbooks that Michelson and Morley had discovered in 1887 that there is no ether. That is a widely propagated misconception. Ether was alive until a much later date, but that is not a subject that will concern us here. I would only like to quote what Rutherford said about ether:

"With regard to the question 'What is Electricity?' so often asked the scientist by the layman, science cannot at present venture an adequate answer. ....Attempts have been made to explain electricity as a manifestation of the universal medium or ether ...Even if we may ultimately explain electricity in terms of ether, there remains the still more fundamental problem, 'What is ether?' An attempt to explain such fundamental conceptions seems of necessity to end in metaphysical subtleties."

These words were uttered in 1905, almost two decades after the Michelson-Morley experiment, and by one of the greatest scientists of the time.

Returning to radioactivity, some other leading scientists attributed the emanation to some kind of "storable energy". This state of affairs was highly convoluted, and it took Rutherford's genius to sort it out.

The Chemistry Committee's report continues on and on about Rutherford's ingenious experiments and his deep insight regarding what was going on in the complicated chain of the emanation processes. Here are some more extracts:

• Rutherford had even predicted the existence of a not-yet-observed intermediary state in order to get a comprehensive description of the emanation chain.

• Research on radioactivity had, in just a few years, led to a large number of surprising observations, which appeared to be incompatible with previously undisputed doctrines. The mysterious transformation of one chemical element into another one appeared to be contrary to chemistry's underlying hypothesis of immutability of elements. And where did the enormous energy released in these processes come from?

• Rutherford had thus shaken the foundations of chemistry by replacing its assumption of the immutability of chemical elements with a new and more general hypothesis. The report describes the theory of Rutherford and Soddy, along with their introduction of the exponential decay law, lifetimes, etc.

• The theory had gained ground quickly. The half-lives were found to vary over a large range, from a few seconds to several thousand million years.

• Although the details were not yet well known, there could be no doubt that the disintegration hypothesis had been an exceptionally fruitful working hypothesis.

• Evidently, the acquired knowledge about radioactivity was not the work of just one person. Many people had been involved. However, Rutherford's share is of such importance that he is an undisputable leader in this field. More so as time has gone by, and his followers have confirmed the results of his research. He undoubtedly deserves the Nobel Prize in Chemistry.

• A more difficult question concerns whether any of Rutherford's collaborators should share the Prize with him.

• He has had a large staff of assistants, and about half of his articles on radioactivity have been signed by two authors.

However, a closer study of his work shows that most of his assistants had helped him with limited particular tasks; their contribution has been secondary when compared with Rutherford's. The only exception is the case of Soddy, who not only was a collaborator of his on some of his most important experimental studies (1902-1903), but also participated in the formulation of the theory of disintegration of elements. Naturally, the question of their individual contributions in formulating this theory cannot be assessed by outsiders. It is remarkable that none of the foreign nominators have suggested that Soddy should share the Prize with Rutherford.

Finally, the Committee argues against honouring Soddy together with Rutherford, because a shared Prize could easily be misinterpreted as an underestimation of the eminent importance of Rutherford's work for chemistry and more generally for modern natural sciences, especially since the Chemistry Prize, up to now, has only been awarded to one laureate at a time.

In fact this tradition was kept until 1929 when, for the first time, the Chemistry Prize was jointly awarded to two people. In contradistinction in physics, from an early date there were joint and divided awards. The first one had been given already in 1902 to Lorentz and Zeeman.

What about Sir William Crookes? The Chairman of the Chemistry Committee, Otto Pettersson, writes a report to the Academy proposing that the 1908 Prize be awarded to Crookes, on the grounds of his seniority and that he deserves the Prize. The 37-year-old Rutherford could wait a little and yield the Nobel rights to the 76-year-old Crookes. Finally, however, Pettersson decides to support the decision of the other members of the Committee based on "the exceptional importance of Rutherford's discoveries".

Rutherford "eclipses" his competitors. He is judged to be an epoch-maker, a solid, precise scientist and an undisputed leader. He does systematical work, carried all the way to completion, and draws (theoretical) conclusions out of the results. His work has had a huge impact on the progress of science.

We don't know what went on at the Academy when the case of Rutherford was brought up by the physicists and chemists. No minutes are taken on such occasions. The outcome was what we all know: Rutherford is awarded the 1908 Nobel Prize in Chemistry:

"for his investigations into the disintegration of the elements, and the chemistry of radioactive substances".

Rutherford's Nobel Lecture can be found in [3]. He talked primarily about his α particles. As I quoted in the Abstract of this paper, in his short after dinner speech at the Nobel banquet Rutherford said:

"I have dealt with many different transformations with various periods of time, but the quickest that I have met was my own transformation in one moment from a physicist to a chemist."

In a letter dated 24 December 1908, Rutherford writes to his mom:

"I am sure that you have all been very excited to hear that the Nobel Prize in Chemistry has fallen my way. It is very acceptable both as regards honour and cash. ... We have just returned from our journey to Stockholm, where we had a great time — in fact, the time of our lives."

7. Rutherford the Nominator

As a Nobel Laureate, Rutherford was automatically invited to nominate Nobel Prize candidates. His nominees in physics were

- 1912: John H. Poynting
- 1918: Charles G. Barkla (1917 NLP)
- 1919/22: Niels Bohr (1922 NLP)
- 1924/26/27: Charles T. R. Wilson (1927 NLP)
- 1929: Owen W. Richardson (1929 NLP)
- 1930: Chandrasekhara V. Raman (1930 NLP)
- 1935: James Chadwick (1935 NLP)
- 1937: John D. Cockroft and Ernest T. S. Walton (both 1951 NLP)

Here, NLP stands for Nobel Laureate in Physics. We see that Rutherford did extremely well in suggesting suitable candidates. Except Poynting, they all got the Prize, most of them in the very same year that Rutherford nominated them for the first and thus the only time. It appears as if Barkla got it even the year before! In fact Rutherford's nomination of Barkla was the only nomination Barkla ever had. As this nomination is particularly interesting, I will return to it later.

Concerning Poynting, Rutherford nominated him for his contributions to experimental and theoretical physics, gravitation, the pressure of light and transfer of energy in the electromagnetic field. Information on his other nominees is easily found by going to the internet site http://nobelprize.org/.

A great scientist whom Rutherford surely would have nominated was Henry Moseley (1887-1915), who had worked with him in Manchester. Rutherford thought very highly of him. Moseley was nominated to both Physics and Chemistry Prizes in 1915 by Arrhenius. Unfortunately, later that year he was killed in the war.

Rutherford's nominees in Chemistry were:

- 1912: William Henry Perkin, Jr.
- 1918/1919/1922 Fredrick Soddy (1921 NLC)
- 1935: Fredrick Joliot and Irene Joliot Curie (both 1935 NLC)

Here, again, NLC stands for Nobel Laureate in Chemistry. In 1922, Soddy was awarded the 1921 Nobel Prize in Chemistry. In addition to the above three nominations from Rutherford and the one by Widman that I discussed above, Soddy had only one more nomination (from Wilhelm Schlenk in 1918).

8. Manchester Period (1907 - 1919) - the Discovery of the Nucleus and the Proton

Already in 1901, Rutherford writes from McGill to J.J.:

"I think you know fairly well my position here. The laboratory is everything that can be desired, ... (I) greatly miss the opportunities of meeting men interested in physics. ...I think that this feeling of isolation is the great drawback to colonial appointments, for unless one is prepared to stagnate, one feels badly the want of scientific intercourse."

So when the opportunity arises, for a professorship in Manchester, Rutherford takes it. Here, he is, in his own words, very fortunate to find a most competent assistant, Johannes (Hans) Geiger (1882 -1945) whom he praises in several of his letters:

"He is a very excellent experimenter and is a great assistance to me"

"I have never worked so hard in my life ... Geiger is a good man and worked like a slave".

Rutherford and Geiger succeed in counting alpha particles one by one, thus enabling Rutherford to determine their charge. Geiger would fire alpha particles through thin metal foils and measure their, what we would call, scattering angle. In a letter in 1911 to Otto Hahn (with whom Rutherford corresponded frequently), Rutherford writes:

"I have been working recently on scattering of alpha and beta particles and have devised a new atom to explain the results, and also a special theory of scattering. Geiger is examining this experimentally, and finds so far it is in good agreement with the facts. I am publishing a paper on the subject to appear shortly."

This alludes to the famous Rutherford model of the atom, with a compact nucleus inside, and to his scattering formula.

During his Manchester period, Rutherford makes another striking discovery. On bombarding nitrogen with his beloved alpha particles, he discovers a new particle, which he calls the proton. He publishes this epiphany just before leaving Manchester in 1919.

9. Return to Cambridge, 1919 - 1937

In 1919, Rutherford returns to Cambridge. Now a Super-Celebrity, he has been appointed to succeed J.J. as Director of the Cavendish Laboratory. He continues his work on protons by shooting alpha particles at light atoms. His technical assistant, G. R. Crowe, has witnessed Rutherford's active engagement in the experiments and his sense of humour. Rutherford checks Crowe's setup by asking several questions (Did you do this or that...), and declares:

"Crowe, my boy, you're always wrong until I've proved you right! Now we'll find their range."

This concerns the range of protons, which were knocked out of the light atoms.

Rutherford predicts the existence of the neutron, deuteron, tritium and helium-three. In 1921, he sets out to discover the neutron, but doesn't succeed.

Further honours are bestowed on Rutherford, and he makes the transition from Super-Celebrity to Hyper-Celebrity. Nonetheless, he writes papers with his fellow researchers and makes further discoveries until the end of his life.

10. A Second Prize to Rutherford?

Usually, Nobel Laureates are not nominated for a second Prize, though there are some exceptions. Einstein, for example, was never nominated after 1922, the year in which he received the 1921 Prize.

Rutherford had received the 1908 Prize in Chemistry and subsequently had made stunning discoveries in physics. So, one might have expected that he would be nominated to the Physics Prize. After all Marie Curie had been awarded both Prizes.

The archives reveal that Rutherford was actually nominated for a second Prize, a Prize in Physics, but only by three people. These were:

- The (Theodor) Svedberg: 1922/1923
- David S. Jordan: 1924
- Johannes Stark: 1931/1932/1933/1935/1937.

Just for completeness, I should add that he also received a nomination to a second Prize in Chemistry. That came from the 1911 Nobel Laureate in Physics, Wilhelm Wien. This nomination was marked as invalid on the grounds that the discoveries for which he was nominated fell outside the realm of chemistry.

His first nominator, The (Theodor) Svedberg is a distinguished member of the Academy (see Appendix B at the end of this article). He nominates Rutherford in 1922 for his atomic model. The hottest candidates that year are Einstein and Bohr, who have respectively 17 and 11 nominations. Svedberg wants Rutherford to be awarded the Physics Prize before Bohr, his argument being that Bohr is nominated for his atomic model which is based on Rutherford's model.

The Committee, in its 1922 report to the Academy, argues against Svedberg's proposal, on the grounds that:

"giving Rutherford a Prize in Physics would imply that the 1908 decision to award him the Prize in Chemistry was wrong, because the methods used in these discoveries are similar, and the Bohr model of the atom is superior to Rutherford's".

As an aside, I would like to mention that Niels Bohr (1885-1962) had gone to Cambridge in 1911 to do experimental work with J.J., but left the following year to work with Rutherford in Manchester. One of the 11 nominations of Bohr came from Rutherford. The letter shows Rutherford's great appreciation of his former research fellow. The outcome in 1922 is that Bohr gets the 1922 Nobel Prize in Physics and Einstein the 1921 Prize, which had not yet been awarded.

In 1923, Svedberg repeats his nomination, adding another superb discovery of Rutherford's: the proton. This means that the matter has to be considered more seriously. Svante Arrhenius is charged to look into it and produces a report to the Academy, in which he, on general grounds, argues against a second Prize to Rutherford. His report includes the following statements (my translation):

- There is very little sympathy for giving the same person two Nobel Prizes.
- None of Rutherford's countrymen have nominated him for the Prize.
- Sir Ernest's meritorious contributions are so great and widely known that his standing and possibilities to do research would hardly be affected by a second Prize.
- He already occupies the highest position in the British Empire.

For the 1924 Prize, Rutherford receives a nomination by David S. Jordan from Leland Stanford, Jr. University. Retired by then, Jordan had been a professor of natural sciences, an ichthyologist, and the first president of Stanford. He submitted a few more nominations after 1924 but did not repeat his nomination of Rutherford. In his 1924 nomination, he writes:

"..the work, following on his previous discovery of the nuclear character of positive electricity, is a most remarkable and extremely important line of research, and taken with the high degree of excellence of all his later work, makes him appear to me as a most suitable candidate for the prize."

There are no further nominations until 1931, when Johannes Stark (Nobel Laureate 1919) nominates Rutherford for his work on alpha rays and atomic structure. He writes (my translation):

"Gentlemen, I am afraid you might be offended if I were to justify to you in more detail the fundamental importance of the studies carried out by Rutherford. I consider it my scientific duty to inform you and your Nobel Foundation that scientific justice and fairness require that you urgently award him the Nobel Prize in Physics."

The response of the Committee to this nomination is strange, to say the least. In 1931 the

Committee writes, in its report to the Academy:

"With all due respect for the importance of Rutherford's work, the Committee is of the opinion that these lie so close to the work for which he has been given the Chemistry Prize that the awarding of a further Prize is not justified."

Stark repeated his nomination four times (1932, 1933, 1935 and 1937), i.e., until Rutherford passed away.

Was Rutherford disappointed for not getting a second Prize? We don't know, but I don't believe so, as I will explain later.

The case of Marie Curie is different. I will not go into it in any detail but would like to remind you that in 1903, the Prize was divided into two halves. One half went to Becquerel, "for his discovery of spontaneous radioactivity" while the other half was further divided between Pierre and Marie Curie, "... for their joint researches on the radiation phenomena discovered by Professor Henri Becquerel". Pierre Curie died in 1906. The Chemistry Committee felt that Marie Curie's Prize in Physics did not give her the recognition she deserved. It was she who had discovered the chemical elements radium and polonium; therefore, she deserved the 1911 Nobel Prize in Chemistry. Marie Curie had a total of three nominations in physics and two in chemistry.

There has never been a case where one single person, on their own, has received two total prizes either in physics or chemistry, or even one in each discipline.

11. Rutherford on the Photon, Atomic Energy, and the Laws of Nature

11.1. The Photon

In a letter dated January 26, 1917, Rutherford nominates Charles Barkla (1877 - 1944) to the Nobel Prize in Physics. Arriving late, this nomination is taken to be valid for 1918. This is the only nomination Barkla ever receives and is sufficient to earn him, in 1918, the Nobel Prize for 1917, which had not yet been awarded. Barkla's "competitors" on the Nobel scene, Einstein and Planck, have each had six nominations in 1918; in 1919, Planck receives the 1918 Prize in Physics. Rutherford nominates Barkla for:

"his important original contributions to our knowledge of the nature of X-rays, and particularly for his discovery of the characteristic X-radiations of the elements.

The proof that each element under certain conditions emits an X-radiation of the element is a contribution that, in my opinion, ranks only second in importance to the subsequent discovery of the diffraction of X-rays by Laue. ..."

(Max von Laue had already been awarded the 1914 Nobel Prize.)

In praising Barkla, at the end of his nomination, Rutherford adds a surprising statement:

"Professor Barkla was throughout a staunch adherent of the view that X-rays were a type of wave motion, and championed this with vigour when a more materialistic hypothesis appeared to be gaining ground."

This means that, in 1917, neither Barkla nor Rutherford believe in Einstein's photon of 1905! However, a nomination letter by Rutherford in 1929, proposing Richardson to the Prize, suggests that he (perhaps) accepts the photon.

11.2. Atomic Energy

Rutherford expresses his opinion on the future use of atomic energy in a talk in 1933 by stating:

"The transformations of the atom are of extraordinary interest to scientists but we cannot control atomic energy to an extent which would be of any value commercially, and I believe we are not likely ever to be able to do so."

How fortunate he was not to know about atomic bombs!

11.3. The Laws of Nature
Rutherford was not so keen on the quantum mechanics of Heisenberg and Schrödinger. On uncertainty relations, he writes in 1933 (the year in which Heisenberg was awarded the 1932 Prize and Schrödinger and Dirac the 1933 Prize):

"While the theory of indeterminacy is of great theoretical interest as showing the limitations of the present wave-theory of matter, its importance in physics seems to me to have been much exaggerated by many writers. It seems to me unscientific and also dangerous to draw far-flung deductions from a theoretical conception which is incapable of experimental verification, either directly or indirectly."

Being a truly great scientist, he would have, of course, in due time accepted the experimental evidence. Rutherford was, as he puts it:

"much amused at various articles ... by writers ... who hold up their hands at the audacity of experimentations .. and sagely reflect how Newton would have sat down and worked out the whole subject and then given a theory. It never occurs to them that it would have wanted half a dozen Newtons to accomplish the experimental work in a lifetime and even they could not have put forward any more plausible theory than we work on today. These dam'd fools ..."

On the nature of our science, he writes:

"There is an error far too prevalent to-day that Science progresses by the demolition of former well-established theories. Such is very rarely the case. For example, it is often stated that Einstein's general theory of relativity has overthrown the work of Newton on gravitation. No statement can be further from the truth. Their works, in fact, are hardly comparable for they deal with different fields of thought. So far as the work of Einstein is relative to that of Newton, it is simply a generalisation and broadening of its basis, in fact a typical case of mathematical and physical development. In general a great principle is not discarded, but is so modified that it rests on a broader and more stable basis".

Here Rutherford is making a very important point which even today (i.e., 85 years later), many people don't seem to understand. They don't trust science because they believe that scientists keep changing their opinions on what is "true" - what was true yesterday is no longer true today. They say physicists have shown that Newton was wrong. Surely, in the future, Einstein's picture of the world will also be dumped into the dustbin of history.

It was typical of Rutherford that "he kept his feet firmly on the ground and avoided the more speculative aspects of physics". I guess he would not have cared at all about the "Theory of Everything" and such other, by their nature, untestable hypotheses. He might have accepted it as a humorous concept, one used in acquiring new knowledge. After all, he had a great sense of humour.

In conclusion, it seems that nobody is perfect, but I venture to say that "our dear Lord" was as perfect as anyone is allowed to be, by the laws of nature. A more perfect person is hard for me to imagine!

12. Rutherford and His Celebrity
Rutherford is remarkable. He seems to violate a conjecture of mine that reads:

$$C|C >= |0 > \tag{1}$$

This equation, expressed in words, reads: Celebrity operator C acting on the state of creativity $|C >$ gives vacuum. In other words, Celebrity annihilates Creativity. Indeed, Celebrity absorbs such an enormous amount of time and energy from its victims that there should be no room left for Creativity. Rutherford is aware of this problem.

He becomes a mini-Celebrity soon after arriving in Cambridge in 1895. He is asked to give demonstrations and talks, and is often invited to dinners and expected to be social and entertaining. Later on, during his period at McGill, he develops into a real Celebrity. He is the "lion of the season," and the newspapers are becoming radioactive. He is often the guest of honour and, as he puts it in a letter to his wife, "It is not altogether pleasant to be talked at, for four solid hours in succession".

He has much less free time, and life is much tougher. He even has to cancel his private trips to have time to do some work. His letters give ample evidence of this, such as:

> "It is important I should write it up as they are all following my trail, and if I am to have a chance for a Nobel Prize in the next few years I must keep my work moving."

Then there is the Nobel Prize, and he notes, "My correspondence alarms me by its dimensions." Normally, in such a state, one would have no time to do research. But he somehow manages not only to go on, but to make outstanding discoveries. Therefore, in his case, the above conjecture is not quite right and perhaps needs to be "supersymmetrized," like everything else in our field. In other words, it is not the Celebrity but the Super-Celebrity operator that annihilates creativity.

Soon, he becomes that Super-Celebrity and has even less time. He has discovered the nucleus and proposed a new atomic model. In a letter to his mom in 1912, Rutherford hints at the ensuing events:

> "The last month has been filled with congresses and celebrations and I am glad they are now over and I can settle down to three weeks' uninterrupted work before the vacation."

It is hard to imagine that he gets those three uninterrupted weeks. Nonetheless, he manages to make new discoveries, such as the proton.

It may amuse you to know that when Rutherford nominates Soddy to the 1918 Nobel Prize in Chemistry, he sends the nomination to the Physics Committee! And his handwriting shows that he has been in a hurry.

Rutherford, a Super-Celebrity when he moves from Manchester to Cambridge in 1919, turns very soon into a Hyper-Celebrity. Does Hyper-Celebrity definitely kill Creativity?

Rutherford is now under extreme external forces that cost him a great deal of time. He is "everywhere." He is the President of the Royal Society 1925-1930, a Baron, President of the Institute of Physics 1931-1933, etc. Nonetheless, he keeps on working and making new discoveries up until he dies. Eve recounts:

> "On the occasion of one of his discoveries, I said to him: 'You are a lucky man, Rutherford, always on the crest of the wave!' To which he laughingly replied, "Well! I made the wave, didn't I?' and added soberly, "At least to some extent.'"

Perhaps that's the explanation?

13. Final Remarks

Rutherford has a lengthy list of accomplishments, among them:

◦ He identified α particles.

◦ He explained the origin of radioactivity with an extremely bold idea – the transmutation of elements – and gave us the exponential decay law and the concept of half-lives.

◦ He discovered the atomic nucleus.

◦ He discovered and named the proton.

◦ He predicted the existence of the neutron and looked for it. The neutron was later discovered by one of his research students, James Chadwick.

◦ He discovered tritium and helium-3, together with his research students.
◦ He was great at building appartuses and detectors, as well as doing the required theory.

The Empire, in recognition of his services, bestowed upon him Knighthood (1914) and the Order of Merit (1925), made him a Baron (1931) and interred his ashes in Westminster Abbey (1937).

Rutherford was a generous person who gave a great deal of credit to his collaborators, such as Chadwick and Soddy, as well as to many other people. His nominations testify that he played down his own role. Those who knew him seem to have really "loved" him. His research fellows admired him, and several of them rose to great heights in the Society, including Sir Ernest Marsden (1889-1970) in New Zealand and Sir Mark Oliphant (1901-2000) in Australia. They were all very grateful to him.

I guess if he would have wanted a second Nobel Prize, he could have given a slight hint to his distinguished colleagues. Many of his people would have gladly nominated him. Only one person (John Cox) from the British Empire nominated him to his first Nobel Prize, and no one did for a second Prize.

I believe that Rutherford would have loved to be here at this Conference in Christchurch. As you may have noticed, many talks were concerned with one of his domains of expertise, radioactivity. We saw a lot of αs. He would have also enjoyed the talks on geophysical aspects of our science.

What if we would have asked him for his advice? Perhaps, to us theorists, he would have repeated one of his statements:

"Spend more time in thinking and less in doing."

And addressing some of you experimentalists, who have to deal with many co-workers and big budgets, he might have added another one of his statements:

"It is essential for you to take interest in the administration of your own affairs or else the professional civil servants would stop in... and then the Lord help you."

14. Acknowledgements
I wish to thank Stephen Parke and Francis Halzen for inviting me to present this talk at Neutrino 2008.

My most sincere thanks go to Karl Grandin, Maria Asp and Anne Miche de Malleray, at the Center for History of Science, Royal Swedish Academy of Sciences, Stockholm, for their kind and cheerful reception whenever I have visited them to consult original material related to Nobel Prizes.

I am indebted to Arthur Stewart Eve (1862-1941) for his book about Rutherford. I read it when I was a PhD student and re-read it when preparing this talk. It is wonderful.

Appendix A. The Sources of the Presented Material
Many years ago, I became curious about why Rutherford didn't get a second Nobel Prize. I started "digging" in the Nobel Archives in Stockholm. The materials related to the Nobel that I have presented in this article come from the Nobel Archives at "Center for History of Science, Royal Swedish Academy of Sciences, Stockholm". These Archives contain the annual reports that the Nobel Committees submit to the Royal Swedish Academy of Sciences (in this article, often referred to as the Academy). The reports summarize the current status related to Nobel Prizes. They contain information on who are the nominated candidates and what they have been nominated for, as well as the opinion of the Committee.

One should keep in mind that the Committees are expected to propose the candidates to be awarded, but the decision is taken at the Academy's plenum sessions where all of the members are invited to take part. They may express their opinions and, if they so wish, may choose someone not suggested by the Committee. This has happened several times. There are no minutes of Nobel deliberations at Academy plenums.

Furthermore, the archives contain letters written by members of the Academy who wish to state their (often conflicting) opinions, in order to make them known to their fellow academicians and for posterity.

Herein, whenever I quote from the Committee reports and letters by members of the Academy, I am giving my own simple translation, but I try to convey correctly the sense of the original material, which is all in Swedish.

In addition, the Nobel Archives contain the original nominations and related correspondence, such as handwritten letters from Rutherford, Einstein and many other great scientists. It has been a distinct pleasure for me to hold these letters in my hand and to read them.

In the case of Rutherford, most of the nominations are in German. Here again, I have given my own (simple) translation.

I also present a number of extracts from letters written by or to Rutherford taken from a wonderful book [1] by Arthur Stewart Eve (1862-1941). The book was published in 1939, i.e., shortly after Rutherford's death. It bears the title "Rutherford" and the subtitle "Being the Life and Letters of the Rt Hon. Lord Rutherford, O.M.". Here Rt Hon. means Right Honourable, and O.M. stands for Order of Merit, an exclusive British award given by the King/Queen. Eve himself was a distinguished scientist, acknowledged with a string of honours. He had known Rutherford for 35 years. They had been colleagues at McGill University in Canada, and had become friends. Eve had the great privilege of having access to Rutherford's archive, put at his disposal by Lady Rutherford. I will assume that the letters have been correctly typed.

Eve's book seems to have been written in a hurry. I have found quite a few errors (incorrect dates, typos, and misspelled names) which could have easily been corrected in a later edition. Alas, there was no time for that! Eve died soon after the publication of his book. Nonetheless, in my opinion, it is a wonderful book.

Appendix B. Some of the Actors in Rutherford's Nobel Drama

◦ Svante August Arrhenius (1859 - 1927): 1903 Nobel Laureate in Chemistry. Member of the Nobel Committee for Physics, 1900-1927. A highly knowledgeable man. The Nobel Archives clearly show that his opinion and judgement mattered a great deal when Nobel Laureates were chosen.

◦ Johannes Stark (1874-1957): 1919 Nobel Laureate in Physics. Nominated Rutherford to the Physics Prize five times in the 1930s, with no success.

◦ Henrik Söderbaum (born 1862): Member of the Nobel Committee for Chemistry 1900-1933. Did most of the groundwork in connection with the 1908 Nobel Prize to Rutherford.

◦ The (Theodor) Svedberg (1884 - 1971): 1926 Nobel Laureate in Chemistry. Member of the Nobel Committee for Chemistry (1925-1964). Svedberg was a physical chemist and a member of the Physics Class of the Academy.

References

[1] A. S. Eve, "Rutherford", Cambridge at the University Press (1939)
[2] Svante Arrhenius, Report to the Royal Swedish Academy of Sciences (1924), Nobel Archives, Stockholm
[3] E. Rutherford, Nobel Lecture, see http://nobelprize.org/