Ernest Rutherford: Renowned as the Father of Nuclear Physics and Modern Chemistry

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Research Paper
Ernest Rutherford: Renowned as the Father of Nuclear Physics and Modern Chemistry

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Rutherford a name that is not in need of introduction to anyone who has ever taken physics or chemistry, in this research paper it shall be presented the reason Rutherford is dubbed as the Father of Nuclear Physics and Modern Chemistry, and his ever-growing impact on today's society even though his discoveries are over a century ago. Rutherford unlike other famous Scientists did not have just one or two discoveries but had a series of renowned and impactful discoveries that did not just rock the foundations of chemistry and physics but attributed to developing the world as a whole and causing advancements in all fields related to his discoveries. The importance of Rutherford is unparalleled to most scientist and the discoveries he found fast-forwarded both science fields advancement to decades ahead. As without him, many pivotal concepts would have not discovered: the half-life, the correct atom structure, α, β particles, and gamma rays as well as how to split an atom.

Rutherford was by all means a self-made man, even though he was born into a family of twelve whose parents were farmers and he spent most of his days would constantly of taking care of the livestock such as cows or other sorts of chores such as cleaning the house, that did not present an obstacle for him or his love for the sciences as he aspired to great lengths to become fluent in it, when he started school he went to a public school instead of private because of his financial status, however by showing his brilliance and resilience he was offered a full scholarship to one, and after finishing high school he was offered a scholarship to Canterbury College (one of the most advanced college in New Zealand), he continued on that path and it was fruitful to him as it enabled him to invent a new type of radio receiver that allowed him to be the first postgraduate student from another college to study within Cavendish labs, Cambridge University under the hands of none other than J.J. Thomson.

Under Thomson's direction he was able to develop and build a solid foundation for himself, most importantly he assisted in the discovery of the electron through researching the effect of x rays on gasses. He briefly was able to accomplish the largest length from which electromagnetic waves could be observed which was for half a mile. Due to Thomson's recommendation he was able to attain his first doctorate position at McGill University. In which Rutherford's entry to the world of radioactivity was due to Thomson, as well as shape his personality and improve his ability to work and synergize with other scientists.

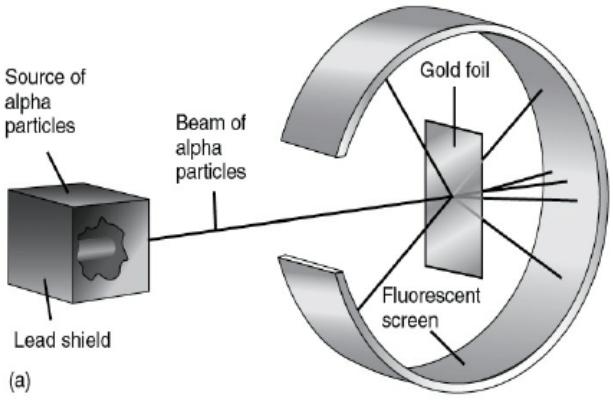


Diagram 1.1

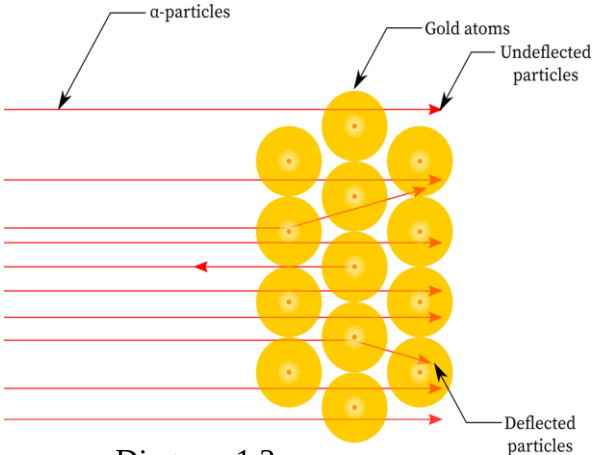


Diagram 1.2

Rutherford is most renowned for his Gold Foil Experiment (α scattering), as with the association of Hans Geiger and Ernest Marsden, the experiment was conducted through bringing a source of Uranium enclosed in a safety box to prevent radiation leaking and directed the only open end towards a gold foil sheet coated with Zinc sulfide, so that when the α particles bombard the sheet the observations would be as bright flashes of light as otherwise without the ZnS it would be barely noticeable. The process of

observing of the flashes would consist of Geiger and Rutherford sitting within a darkened room to ensure that they would detect the emitted α particles, after the initial trials they discovered that the trend was that most of the α particles passed undeterred while few particles were scattered with angles larger than zero-till 90 degrees and even fewer were spread with angles larger than 90 degrees with an estimate rate of deflection of one in 20,000 particles, as seen in diagrams 1.1 and 1,2 above, just as Rutherford had initially anticipated. To further clarify, Rutherford's belief on the way the α particles would behave when bombarding the metal sheet is the same as when a bullet would collide with a sandbag that most shots would go in a straight line however some may have different angles. This experiment allowed Rutherford to discover multiple theories and particles, initially that he had discovered the α and β Rays (currently named particles), as well he had identified their properties, in addition with assistance from Thomas Royds he was able to give evidence that the α radiation consists of Helium Nucleus (2 neutrons 2 protons) and from the conclusions he came up with through this experiment, he discovered one of the pillars of which most of future discoveries if not all will be based on, that he identified the structure of the atom, that most of an atom is vacant except for its minuscule nucleus, that is centred in the atom where its positive charge and mass are present, he identified this by observing the reaction of the α particles, where those who collided with the nucleus where deflected with large angles, through this he identified that the alpha particle had negative charge as it had experienced repulsion from the positive charged nucleus, and that was the main reason for the deflection of the a particles. Through the evidence presented by the experiment, he presented a new model of the atom based on the facts mentioned above, consequently proving J.J. Thompson's model of an atom (plum pudding) to be incorrect.

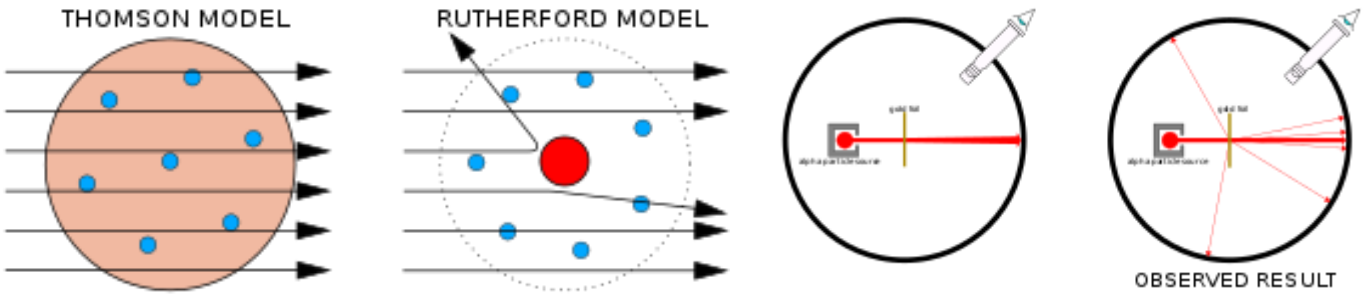


Diagram 1.3 Diagram 1.4

If Thomson's model of the atom was accurate, the alpha particles would have passed in a straight beam without any significant deflection as seen in diagram 1.4 however the exact opposite of that occurred. Through the conclusions he garnered through experimenting on radioactivity especially the alpha foil experiment, he was intrigued by the reason the nucleus had a positive charge, which led to him pointing out that the nucleus holds positive particles within it that causes the charge called protons.

Another pivotal discovery Rutherford was able to make is half-life, whereas Rutherford was mainly dealing with radioactive material, so while working he would notice that the material he was using would decrease by half in a fixed time frame continually which led him to discover that decay would occur to radioactive elements reducing half its weight constantly and that would occur on within a consistent same time period such as seen in the diagram 2.1, and that would cause the material to change into another which is similar to what happens in isotopes.

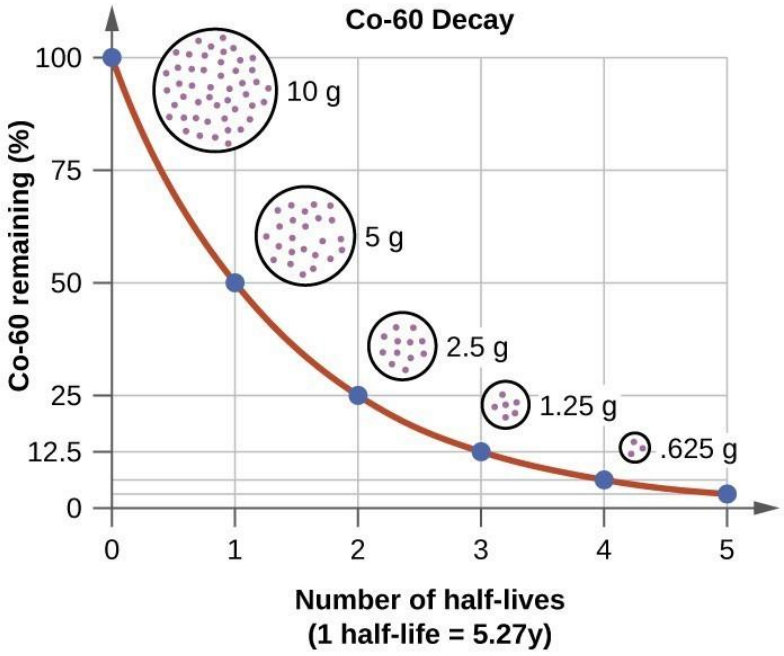
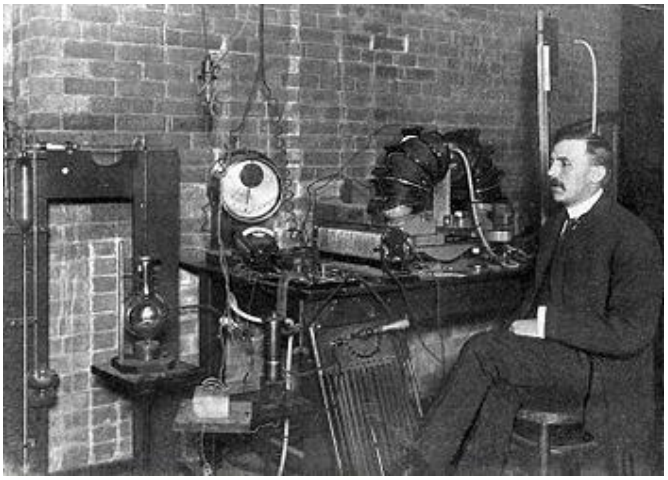


Diagram 2.1

As the end of world war one approached, Rutherford made an unprecedented discovery that many scientists had failed to make, it was so unparalleled to the extent he was granted the title "the world's first successful alchemist" , he was able to discover how to successfully split an atom, hence the reason was called the father of modern chemistry. The way Rutherford was able to accomplish that was by colliding alpha rays with nitrogen atoms using the machine in diagram 3.1, he perceived that alpha particles had less energy than the protons of the opposite direction compared to the initial amount before the experiment, Rutherford arrived to the conclusion that bombardment on α particles had caused the nitrogen atoms and its properties to transform to hydrogen ones. The reason this discovery is so impactful is that it proves and explains the change in atoms in chemical reactions, this is the reason that the conclusion is one of the most impactful on chemistry and had hurried its development to decades ahead.

Diagram 3.1



Due to Rutherford's research and experiments especially in the field of nuclear physics and radioactivity as well as his ability to prove and establish the structure of an atom and of radioactive decay. He impacted the future of the field in a way no one else did, as he did not only made a breakthrough in that field he opened it up to many people from those were his coworkers, apprentices or individuals studying his teachings, after his discovery a significant amount of people turned their head to this field, and were able to make scientific discoveries in it of both physics and chemistry nature. In other words that under his influence he opened a whole new dimension within the field to scientists who came after him. From the people he impacted due to his research, James Chadwick, who was an understudy of his, where he was able to discover the neutron, which was initially proposed by Rutherford who however was unable to prove it, as well due to his research on the α particles he inspired his Protégées as well as Patrick Blackett, a fellow researcher to demonstrated induced nuclear transmutation using these α particles which is the transition of a chemical element into another. In addition he influenced his apprentices, John Cockcroft and Ernest Walton to split lithium by colliding them with protons to make α particles using a particle accelerator. Rutherford was awarded the highest honors a Scientist could receive from being an awardee of the Nobel Prize in 1908 due to finding decay in chemical elements. He was awarded the chair and directory position at Cambridge University within Cavendish Laboratory as well as receiving the honor of being a president of multiple councils from the Academic Assistance council to the Royal Society of London and the Institute of Physics.

To conclude, the author believes that Rutherford was one of the most impactful individuals in both Chemistry and Physics and deserves appreciation as he was the cornerstone of these fields.

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