Rutherford's Incredible Event

This is a passage from Ernest Rutherford's 1936 lecture, "The Development of the Theory of Atomic Structure."[1]

> I would like to use this example to show how you often stumble upon facts by accident. In the early days I had observed the scattering of α-particles, and Dr Geiger in my laboratory had examined it in detail. He found, in thin pieces of heavy metal, that the scattering was usually small, of the order of one degree. One day Geiger came to me and said, "Don't you think that young Marsden, whom I am training in radioactive methods, ought to begin a small research?" Now I had thought that too, so I said, "Why not let him see if any α-particles can be scattered through a large angle?" I may tell you in confidence that I did not believe that they would be, since we knew that the α-particle was a very fast massive particle, with a great deal of energy, and you could show that if the scattering was due to the accumulated effect of a number of small scatterings the chance of an α-particle's being scattered backwards was very small. Then I remember two or three days later Geiger coming to me in great excitement and saying, "We have been able to get some of the α-particles coming backwards…". It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you. On consideration I realized that this scattering backwards must be the result of a single collision, and when I made calculations I saw that it was impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus. It was then that I had the idea of an atom with a minute massive centre carrying a charge.

What did Rutherford show? Here is an accessible summary published on the American Nuclear Society's website.[2]

> J.J. Thomson in 1897 discovered that all atoms contain far smaller, fundamental building block particles eventually known as electrons. To account for the atom's overall neutral charge, in Thomson's model of the atom (published in March 1904 in Philosophical Magazine), the atom's electrons were embedded in a uniform "soup" of opposite charges throughout the volume of the atom-like negatively-charged plums in a positively-charged plum pudding.

---

1 published in *Background to Modern Science: Ten Lectures at Cambridge Arranged by the History of Science Committee, 1936,* Ed. Joseph Needham and Walter Pagel (Macmillan, 1938), 68-69.

2 `https://www.ans.org/news/article-724/lord-rutherford-and-the-atomic-pudding/`

Hans Geiger and Ernest Marsden, under the direction of Rutherford in 1909, directed a beam of alpha particles (helium nuclei) onto sheets of gold foil only a few atoms thick. The researchers expected that these alpha particles would pass through the dilute soup of the plum pudding gold atoms, with at most some minor deflections, perhaps of a few degrees. This was expected because the positive charge of the gold atom was supposedly diluted, spreading throughout the entire volume of the atom.

Instead, the researchers found alarming results. Some alpha particles were deflected at very large angles-including almost directly backward-while most alpha particles passed straight through. This kind of result was not expected from any theory of matter at the time. Rutherford was flabbergasted. ...

Rutherford interpreted the gold foil experiment results in his May 1911 Philosophical Magazine article-and the plum pudding model of the atom was destined for the dustbin. No soup of positive charge across a whole atom could carry the concentrated charge needed to deflect alpha particles so strongly. Instead, Rutherford reasoned that much of the atom's charge and most of its mass were concentrated into a very small central region-later to be called the nucleus-surrounded by a cloud of electrons.