# The Discovery of the Electron, Proton, and Neutron

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Introductory courses in chemistry invariably include an account of the historical development of our ideas on the structure of the atom. The three fundamental particles making up an atom are introduced, naturally, but the history of their discovery and the origins of their names, particularly for the proton, does not appear to be well documented.

The existence of a fundamental unit of electricity was first suggested by Michael Faraday in 1834 (1) to account for his results involving the electrolysis of solutions of aqueous acids and salts: " . . . if we adopt the atomic theory or phraseology, then the atoms of bodies which are equivalent to each other in their ordinary chemical action, have equal quantities of electricity associated with them." This idea was subsequently extended by other scientists including George J. Stoney, who first proposed in 1874 (2) the name "electrine" for the unit of charge on a hydrogen ion; he subsequently changed this in 1891 (3) to the name "electron".

The observation of a small number of large angle deflections of alpha particles ($He^{2+}$) incident upon a gold metal foil led Ernest Rutherford in 1911 (4) to suggest that the nucleus of an atom is very small and positively charged. Two years later he concluded from the results of experiments involving the scattering of alpha particles from simple gases (5) that "the hydrogen atom has the simplest possible structure of a nucleus with one unit charge." It appears that Rutherford was also the first tentatively to suggest the name "proton" for this fundamental particle. This occurred at an informal meeting around 1920 of the Physics Section of the British Association (6): "the name proton met with general approval, particularly as it suggests the . . . term 'protyle' given by Prout in his well-known hypothesis that all atoms are built up of hydrogen." The term itself is derived from the Greek *protos* (first), and Samuel Glasstone (7) has noted that it had been used as far back as 1908 or earlier as a general term for a unit from which all elements were built.

From observations of the nature of the particles formed from alpha particle scattering from N™, Rutherford was also the first to suggest in 1920 (8) that " . . . it may be possible for an electron to combine much more closely with the H nucleus, forming a kind of nuclear doublet. Such an atom would have very novel properties." In discussing the classification scheme for isotopes, William Draper Harkins first introduced in 1921 (9) the term "neutron": " . . . a term representing one negative electron and one hydrogen nucleus". It is interesting to note, however, that the same term had also been used by Walther Nernst (10) at least 10 years earlier in the

context of "... a compound of positive and negative electrons . . . an electrically neutral massless molecule".

The actual observation of such a fundamental particle had to wait until some time later when, in 1930, Bothe and Becker (11) reported that exposure of light elements, in particular beryllium, to alpha rays leads to a highly penetrating radiation. In 1931-1932 the Curie-Joliot and Joliot (12) reported that exposure of hydrogen-containing material, particularly paraffin, to this new radiation lead to the ejection of high-velocity protons. At the same time Chadwick (13) interpreted both these sets of results in terms of radiation consisting "of particles of mass nearly equal to that of the proton and with no net charge", which he identified with the neutron species first postulated by Rutherford.

These details should enable teachers to complete the historical account of the development of our present knowledge of atomic structure, which appears to be otherwise well presented in many introductory chemistry texts.

**Literature Cited**


1. Faraday, M. *Phil Trans. Roy. Soc.* (London) **1834**, 121, (Paragraph 869). Reprinted in *Experimental Researches in Electricity*, Dover: New York, 1965.
2. Stoney, G. J. *Phil. Mag.* **1881**, *11*, 381.
3. Stoney, G. J. *Sci. Trans. Roy. Dublin Soc.* **1891**, *4*, 663-607.
4. Rutherford, E. *Phil. Mag.***1911** *21*,669-688.
5. Rutherford, E. *Phil. Mag.* **1913** *26*, 702-712.
6. Footnote (p 282) to Masson, O. *Phil. Mag.* **1921**, *91*, 281-285
7. Glasstone, S. *Sourcebook on Atomic Energy;* Macmlllian: London, 1960; footnote p 42.
8. Rutherford, E *Proc. Roy. Soc.* **1920**, *97*, 374-400.
9. Harkins, W. D. J. *Am. Chem. Soc.* **1921,** *43*, 1038-1060
10. Nernst, W. *Theoretical Chemistry*, 3rd ed., Marmillan: London, 1911: p 396.
11. Bothe, W.; Becker, H. Z. *Phys.* **1930**, *67*, 289-306.
12. Curie-Joliot, I.; Joliot, F. *Compt. Rend.* **1931**, *143*, 1412-1414, 1416 1417: **1932**, *144*, 273-276, 708-711, 876-877.
13. Chadwick, J. *Nature* **l932**, *129*, 312; *Proc.Roy.Soc.* **1932**,*136*, 692-708: **1933**, *142*, 1-25