JOHN DALTON, 1766–1844

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ON July 27, 1844, at the ripe age of seventy-eight, John Dalton passed peacefully away in Manchester. Local feeling was stirred to its depths ; it was unanimously agreed that nothing less than a public funeral could express the reverence felt for the memory of so great a man. This was the more remarkable since Dalton was a strict Quaker and as such was opposed to official ceremony. His remains lay in the darkened town hall, where some 40,000 people paid homage before interment took place in Ardwick Cemetery on August 12.

So many biographies and sketches of the life of Dalton have been published from time to time that it would be superfluous to labour the details in these columns. Suffice it to say that Dalton was born, probably on September 5, 1766, of humble parents in a thatched cottage in the secluded Cumberland hamlet of Eaglesfield, some half a dozen miles from Cockermouth. The cottage still stands, the thatch replaced by slate, and a suitably inscribed commemorative tablet has been inserted above the door. Fig. 1 shows the cottage with the tablet. Fig. 2 shows the Friends' Meeting House at Eaglesfield (where Dalton worshipped) as it appeared in 1895. In the foreground stands Mr. Norman, the oldest inhabitant of the village and the only one who then remembered seeing Dalton.

Fig. 1.

At an early age Dalton showed unusual industry and talent ; when a mere lad of twelve, he began to teach the village school in a barn, but discipline was difficult as his pupils included boys and girls several years older than himself and far more interested in each other than in their lessons. Three years later (1781) he joined his brother as usher in the Friends' School, Stramongate, Kendall, run by his cousin George Bewley. The school had been founded in 1698 and continued until some fifteen years ago, when it was closed down. It is still an educational institution, being used in part as an elementary school for senior boys and in part as school and dental clinics*.

Dalton appears to have been but an indifferent teacher, too much absorbed in his scientific pursuits to worry unduly about the progress of his pupils. About this time he gave a few lectures also to adult audiences, but Dr. Henry states that he was never an attractive lecturer. He seemed unable to devise really impressive experiments, and failed as often as he succeeded in carrying out even such elementary experiments as he did attempt. Nature seldom puts all her eggs in one basket.

While at Kendall, Dalton discovered that his idea of colour was abnormal—he was colour blind. To him pink appeared as blue, and a waggish friend suggested that this might be the cause of his remaining a bachelor, the pink cheeks of a maiden giving him "the blues".

* I am indebted to the Town Clerk of Kendall for this information.

In 1793 Dalton went to Manchester, where he entered upon a period of great scientific activity. It was here that, in 1803, he announced his Atomic Theory, which revolutionized our outlook on chemistry, rapidly raised him to the pinnacle of fame and earned for him the title of 'father of modern chemistry'. Honours of various kinds were showered upon him, but none affected his rugged character or his genuine native simplicity. In the words of Millington, one of his biographers, "even after all his triumphs and scientific achievements, he was at heart the simple countryman of frugal tastes, speaking the broad dialect of the Cumberland fells".

Dalton's interests, however, were by no means confined to physics and chemistry. In 1844, having been a member of the Manchester Literary and Philosophical Society for fifty years and occupied the presidential chair for the last twenty-seven of these, he presented his fiftieth annual meteorological report, having then made more than 200,000 separate recordings. He once (1801) wrote a book on English grammar. In this he pointed out that, while logically there can only be two tenses, past and future, it is convenient to regard the immediate past and future as the present. In his treatment of gender he was less fortunate ; few will accept his dictum that "phenomena" is the feminine version of "phenomenon".

In 1804 Davy invited him to lecture at the Royal Institution. Dalton evidently thought highly of Davy, referring to him as "a very agreeable and intelligent young man", but added that his habits were marred by one serious defect, to wit, he did not smoke ! Six years later, Davy suggested that Dalton should offer himself as a candidate for election to the Royal Society, but Dalton did not do so, possibly because the fees were too high for one holding so meagre a purse. He never laid himself out to make money ; for him money was merely a means to an end ; otherwise he had no use for it. Thus in 1818 he was invited to join the Arctic Expedition of Sir John Ross at a salary of £400–£500 a year. This would have been nothing less than a fortune to Dalton ; nevertheless he declined on the ground that he did not wish to interrupt his scientific investigations.

FIG. 2.

In 1822, however, Dalton was elected a fellow of the Royal Society; he also visited Paris, making the acquaintance of Laplace, Thenard, Ampère, Berthollet, Gay Lussac and numerous other savants. Alas, he could not meet Lavoisier. Ten years later he received the degree of D.C.L. at Oxford, along with his famous contemporary Faraday. In 1833 effect was given to a proposal of Charles Babbage, of calculating-machine fame, and he was awarded a Civil List pension of £150 a year, afterwards raised to £300. Meanwhile, Manchester decided to erect a statue in his honour, and that was duly completed. It still stands in the entrance to the Manchester Town Hall. In the same building is a mural painting by Ford Madox Brown depicting Dalton collecting marsh gas for his analyses. In 1834 Edinburgh conferred on him the degree of LL.D. and in the same year he was presented at Court to King William.

In a codicil to his will, Dalton bequeathed all his chemical and philosophical apparatus to his pupil and friend, Dr. William Charles Henry, who in 1854 published his well-known "Memoirs of the Life and Scientific Research of John Dalton".

Turning now to the theory which has made Dalton famous for all time, it may be well to remind ourselves that Dalton was not, and never claimed to be, the first to postulate an atomic theory of matter. Early Hindu literature shows that such a theory existed so long ago as 1200 B.C. Matter was regarded as an aggregation of minute, discrete particles which, though separated from each other by empty space, contrived to attract one another with sufficient force to account for the ordinary phenomena of cohesion. In later years the Greeks held similar views; we do not know if they borrowed them from the Hindus or arrived at them independently; they did, however, go a little further in that they regarded the particles as indestructible and always in motion. Democritus (460–360 B.C.) was an early exponent of these ideas, which at first were by no means popular but later came to be generally accepted.

Although useful to the physicist, the theory did not offer much help to the chemist, largely because it was purely qualitative in character. In the fourteenth century, Al Jildaki (died 1360) observed that "when substances react they do so by definite weights". Had this quantitative conception been suitably linked up with the atomic theory, our Law of Equivalent or Combining Weights would have been anticipated by several centuries. But the time was not ripe and the observation appears to have been forgotten. It required a Dalton to bridge the gulf.

Dalton's Atomic Theory is usually summarized as follows:

(1) The atoms of any one element are all alike and possess a definite and characteristic mass. They differ from the atoms of any other element both in their physical and chemical properties.

(2) Chemical compounds are formed when the atoms of two or more elements unite in simple chemical proportions.

Once these postulates are accepted, the Laws of Definite Proportions, Multiple Proportions and of Equivalent Weights become self-evident.

The exact manner in which Dalton arrived at his theory has been a matter of dispute, into which we need not enter. It may well be that the idea gradually crystallized in his mind as the result of prolonged thought in various directions. Neither need we worry because we now know that the theory, as given above, is not correct in detail. Thus, owing to the existence of isotopy, the atoms of any one element are not of necessity all alike; also, atoms do not always unite in simple numerical proportions when compounds are formed, as witness albumen and gelatin, to which reference is made below. The important point is that the essential feature of the theory is correct. It would not be difficult to re-state it, if such procedure were deemed necessary, to harmonize more closely with modern conceptions of matter. But a theory need not be correct in detail in order to be useful, and it is mainly by its use that we judge it.

One immediate advantage of the theory lay in the possibility it afforded of designing formulæ capable of indicating both qualitatively and quantitatively not merely the composition but also the constitution of chemical entities by means of symbols and formulæ. Hitherto, symbols had been used by the alchemists, more or less as cryptic labels, to denote various substances. Thus a circle denoted gold, a wavy line represented water, and so on. But such symbols gave no indication whatever either of the quantities involved or of the composition of the substances. Dalton denoted atoms by circles, suitably modified to distinguish between different elements. Thus represented a molecule* of carbon monoxide. As each circle denoted one atom of carbon and oxygen respectively, the formula clearly gave the amount of the gas present and its composition. When several atoms are united in a molecule, it may be possible to arrange them in different ways, yielding compounds with different properties. It is not generally known that Dalton himself realized this. He believed it to be the case with albumen and gelatin, which he formulated as

albumen gelatin

(that is, C_2H_2ON)

* We are ignoring the fact that at first Dalton wrote oxygen as ⊙ and afterwards altered it to ○; also that he used the word atom very frequently where we to-day would write molecule.

The example was unfortunate, for these molecules are far more complex than Dalton realized. This fact, coupled with the introduction of the simpler Berzelian notation, which led to the writing of empirical formulæ, such as CO_2 instead of the structural ○●○ (or OCO), caused Dalton's observation to be overlooked. Consequently when later chemists discovered true examples of isomerism, Dalton's contribution had been forgotten.

The question now arose as to how the union of atoms could take place. The first suggestion that atoms possess mechanical hooks was very natural at the time but was soon found inadequate. The connexion between chemical combination and electrical forces was then just beginning to be realized, for Nicholson and Carlisle had already in 1800 decomposed water electrically. In his Bakerian Lecture to the Royal Society in 1806, Davy formulated a qualitative electrochemical theory of chemical combination which was improved upon by Berzelius in 1812; but curiously enough, attention was focused more on the combining power of groups of atoms (radicals) than on individual atoms themselves. It was not until eight years after the passing of Dalton that Frankland introduced the conception of an atomic attractive power, that is, valency. The gate was thus opened to an enormous field of research on atomic forces and molecular structure, the confines of which even now appear to recede, like the end of a rainbow, the further we progress.

The foregoing may be regarded as some of the more immediate consequences of Dalton's theory. But the tale is not complete even yet. The atomic theory has migrated into realms undreamed of by its creator, and has opened up avenues of approach to problems the immensities of which appear to grow with each succeeding age.

In his brilliant researches, Faraday showed that electrically charged atoms or groups of atoms can exist in solution; he called them 'ions' and in 1835 enunciated his Laws of Electrolysis. It was inevitable, therefore, that the atomic conception of matter should eventually be extended also to electricity. This was first clearly done by Johnstone Stoney in 1874, who named the 'atom' of electricity an electron, and pointed out that Ne is Faraday's ionic charge for a univalent ion, N being Avogadro's number and e the 'atom of electricity', that is, the electronic charge.

But if electricity is atomic, what about other forms of energy? The breakdown of classical methods of calculating the intensity of radiation of a black body at various temperatures led Planck in 1900 to extend the atomic idea to energy in general. He suggested that bodies can only emit radiation in discrete portions or quanta—atoms of energy. This enabled him to draw up an expression that would account completely for the observed distribution of energy in the temperature-radiation spectrum. He was also able to explain the lack of agreement between the classical formulæ of Wien and Rayleigh, and to show that these formulæ represent extreme cases of his own universal expression.

Five years later, Einstein explained photo-electric effects as due to 'atoms of light' or photons; in other words, light waves possess atomic characteristics.

Limitations of space forbid further discussion of these themes. Sufficient has been said, however, to show that Dalton's Atomic Theory has proved one of the most fertile ever propounded. Just as a crystal dropped into a solution may yield a vast crop of crystals entirely unrelated in quantity to the size of the original crystal, so Dalton's theory has been a nucleus around which have collected, and are still collecting, new laws, hypotheses and theories.

MEN AND SCIENCE IN THE SEA FISHERIES*

By MICHAEL GRAHAM

IN 1863–65, Huxley, as a member of a Royal Commission, on fisheries, made a tour; and I cannot do better than quote a report in his own words on one of the places visited—the Isle of Skye. "He would mention an occurrence which made an indelible impression on his mind—the total earnings of one of those peasants, he might say his whole property and everything belonging to him, would not come to more than £5. Certain interested parties in Glasgow . . . had got a law smuggled through the House of Commons, where nobody cared anything about it, by which it was made penal to catch a herring during the three summer months of the year, a time at which herrings were swarming in innumerable millions . . . that meant that [a man] might be totally ruined or might be put in prison for doing this. . . . Now there was not the smallest imaginable reason why that enactment should have been passed. It was a stupid, mischievous and utterly useless thing. . . . That appeared to be one of the worst forms of modern oppression."

I cannot find words to express my admiration for this passage, of which I have given only excerpts. There the man of science, quite sure of his ground, raised his voice against arrangements that were not based on scientific facts; and in this cause he used all the power of the English language to convey meaning and feeling. Reading it to-day has a reviving effect, by contrast with the polysyllabic jargon of good intention, among which so many of our modern aims meander, and are lost.

This visit of Huxley's led to the Act of 1868, by which most of the restrictions on fishing were abolished; and it set the policy of no restriction without scientific justification which has ruled Britain ever since, and affected millions of lives and fortunes. Such is the power of the scientific attitude, in a bold and able man.

A second notable event in the history of British fisheries was an International Fisheries Exhibition and Congress in 1883, presided over by Huxley, who was now president of the Royal Society. The exhibits included a very good one from the United States Bureau of Fisheries, which was at that time pre-eminent in knowledge of life in the sea, owing to the inspiration of Agassiz. This exhibit aroused great interest among British scientific men, of whom Ray Lankester was one, and it led to their signing a memorial calling for organized marine research in Britain. Their feeling formed one of the major trends at the Exhibition.

A second noticeable trend, closely connected, was the demand from Mr. James Alward, and from other good skippers, for research into the biology of the fish themselves; and a third trend, voiced by the

* Substance of a discourse delivered at the Royal Institution on June 9.